SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

Background and Issues Paper

20 February 2017

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Cover photo: Roper River near Elsey Homestead Gauging Station, G9030013, looking upstream of the river crossing.

1. Establishment of the Inquiry

On 14 September 2016 the Chief Minister of the Northern Territory, the Hon Michael Gunner MLA, announced a moratorium on hydraulic fracturing (or 'fracking') of onshore unconventional shale reservoirs in the Northern Territory. The Chief Minister also announced that he would appoint an independent scientific panel **(the Panel)** to inquire into the environmental impacts and risks associated with hydraulic fracturing **(the Inquiry)**. The moratorium will stay in place for the duration of the Inquiry.

On 3 December 2016 the Northern Territory Government announced the final Terms of Reference for the Inquiry and the composition of the Panel. The Terms of Reference are set out in **Attachment A**.

The Terms of Reference require 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.

The Panel must also determine the nature and extent of the risks of the unconventional shale gas industry on social, economic and cultural conditions in the Northern Territory.

Once the risks are identified, the Panel must determine whether or not those risks can be reduced to acceptable levels and, if so, what the government and industry can do to ensure those levels are achieved.

The Panel comprises ten scientific experts and is chaired by Justice Rachel Pepper of the Land and Environment Court of New South Wales. Biographies of the Panel members are available on the Inquiry's website.

The Panel will provide a report to the government at the completion of the Inquiry.

2. Purpose of this Paper

The purpose of this Paper is to facilitate a discussion between the Panel and Territorians about the Terms of Reference by identifying the potential risks of the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities in the Northern Territory.

In this Paper, when identifying risks, the Panel is referring to the issues concerning the hydraulic fracturing of unconventional onshore shale reservoirs in the Northern Territory.

Sections 3 and 4 of this Paper provide information about hydraulic fracturing, including the differences between conventional gas and unconventional gas, coal seam gas and shale gas, and the location of prospective shale gas reservoirs in the Northern Territory.

Section 5 gives an overview of prior reports that have been produced in relation to hydraulic fracturing in the Northern Territory.

Section 6 gives an overview of the framework that relevantly regulates hydraulic fracturing and the petroleum industry in the Northern Territory.

Section 7 lists the potential risks, or issues, associated with hydraulic fracturing for onshore shale gas in the Northern Territory.

Section 8 provides information on ways that Territorians can meet the panel and provide feedback on this Paper, including at hearings and community meetings that will be held across the Northern Territory in March 2017.

Sections 9 and 10 provide a timeline for the activities of the Inquiry and the Inquiry's contact details.

3. Some basic facts

3.1. What is the difference between conventional and unconventional gas?

The terms 'conventional' and 'unconventional' gas are often misunderstood and have taken on different meanings in different reports relating to the gas industry.

For the purpose of this Inquiry, 'unconventional' gas is found in source rocks such as coal and shale where the gas has been trapped in place (see the "oil-or gas-rich shale" in Figure 1). This is different from 'conventional' gas, which migrates into porous, permeable rocks and is trapped under a seal.

Conventional gas can typically be developed with a limited number of wells due to the accumulation of the hydrocarbons in a confined area with well-connected pore spaces within the source rock enabling effective drainage from strategically placed wells. The gas will flow to the surface under its own pressure driven by a water table (or aquifer) underneath an expanding pressurised gas cap overlying the gas (see the oil and gas accumulation below the "confining layer" under "vertical well" in Figure 1).

By contrast, with unconventional gas, the source rocks that hold the gas have much lower porosity (that is, the void spaces between the grains that make up the rock are very small) and much lower permeability (that is, the interconnectedness of the pore spaces to allow the gas to move through the rock is very low). Therefore, in order to make the gas flow, artificial stimulation, such as hydraulic fracturing, must be used.

Improvements have been made to the production of conventional gas and many of these techniques have been refined and applied to unconventional gas. Horizontal drilling and hydraulic fracturing have been used for decades on conventional reservoirs but better efficiency and accuracy has allowed this technology to be used in unconventional gas reservoirs making them economically viable

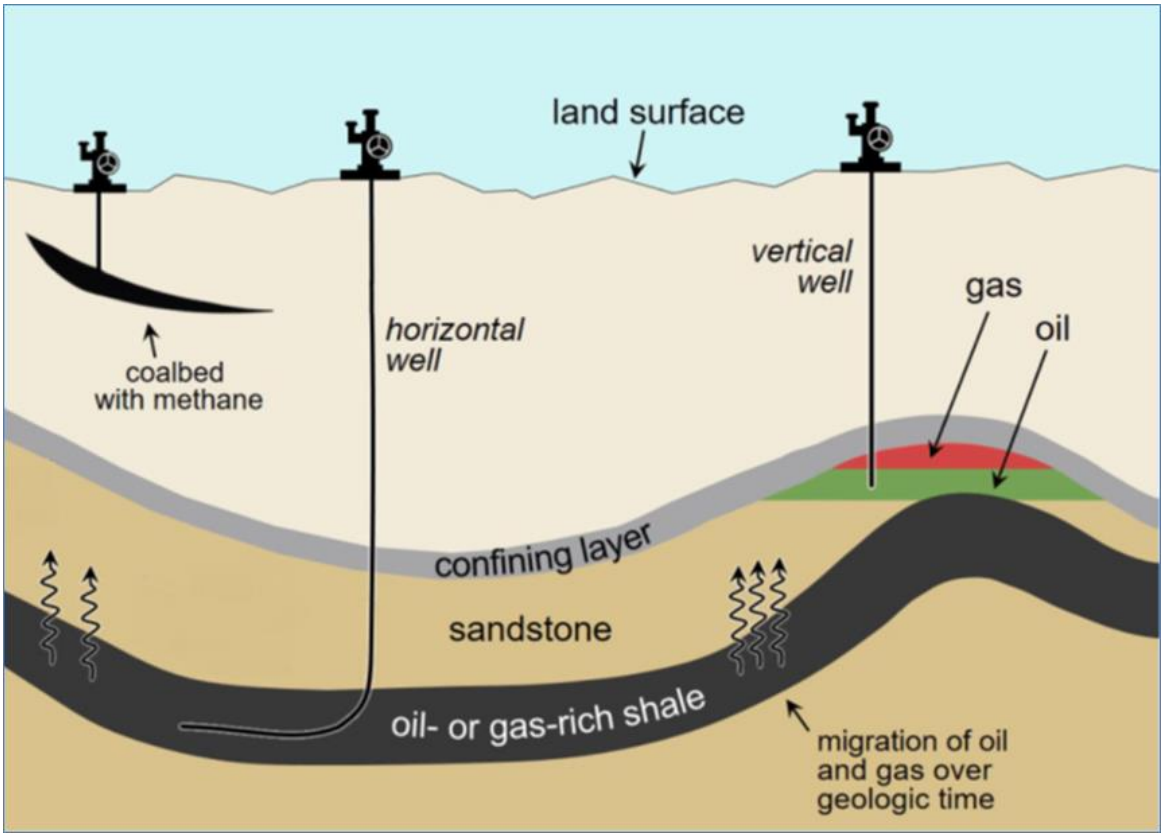


Figure 1: Schematic showing different types of petroleum accumulations and development Source: Modified from U.S. Environmental Protection Agency

3.2. What is the difference between coal seam gas and shale gas?

There are also misconceptions surrounding the differences between coal seam gas and shale gas. There are significant distinctions between the development of gas from coal seams and the gas from deep shales.

It is important to know what these differences are because this Inquiry is only concerned with onshore unconventional deposits of shale.

The main differences are indicated in Table 1 below. These include the fact that:

- coal seams (usually no more than 1,000 metres deep) are typically found closer to the surface than shales (which are found 1,500 to 4,000 metres deep);
- the extraction of coal seam gas does not always require hydraulic fracturing, whereas the extraction of shale gas always needs hydraulic fracturing;
- coal seam gas requires the removal of water from the coal to unlock the gas (dewatering). Large amounts of salty water (brine) is produced (produced water) and must be treated; and
- by contrast, the hydraulic fracturing of shale gas reservoirs often only returns a portion of the water that is used in the hydraulic fracturing process. This returned water (flowback water) can be recycled and re-used for the next hydraulic fracturing operation, or must be treated and disposed of.

	Coal seam gas	Shale gas
Source	Shallow coal seams	Deeper shales
Depth	300 m – 1,000 m	1,500 m – 4,000 m
Drilling direction	Mainly vertical	Horizontal and vertical
Proximity to aquifers	Shallow and therefore closer to potable water resources	Deeper and therefore further away from potable water sources
Surface footprint	Single exploration well per drill pad (a drill pad is the area disturbed by the installation of the drilling and extraction equipment) meaning a larger number of well heads in a given area.	Multiple wells can be drilled from each well pad meaning a lower number of completed well heads in a given area than for coal seam gas.
Hydraulic fracturing	Hydraulic fracturing in some coal seams with low permeability	Always requires hydraulic fracturing
Hydraulic fracturing extent (length x height)	200 – 300 m x 5 – 30 m	200 – 6,000 m x 30 – 300 m
Hydraulic fracturing pressure	35 MPa or 5,000 psi	35 – 70 MPa or 5,000 –10,000 psi
Water use	Requires dewatering of coal	No dewatering, but water is used for drilling and hydraulic fracturing
Hydraulic fracturing fluid volume per well	Approximately 1 ML (0.1 – 3 ML)	Approximately 20 ML (5 – 40 ML)
Number of wells required	Larger number of wells	Fewer wells required than for coal seam gas
Productivity (over lifetime of well)	Lower gas recovery (0.5 – 2PJ per well)	Higher gas recovery (2 - >10PJ per well)
Source	Shallow coal seams	Deeper shales
Depth	300 m – 1,000 m	1,500 m – 4,000 m
Drilling direction	Mainly vertical	Horizontal and vertical

Table 1: Typical differences between coal seam gas and shale gas. The data given in the above table will vary from case to case. Sources: CSIRO, Northern Territory Government.

3.3. The extraction of shale gas

Shale gas is mainly methane 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 as shown in Figure 2 below, 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, away from any aquifer.

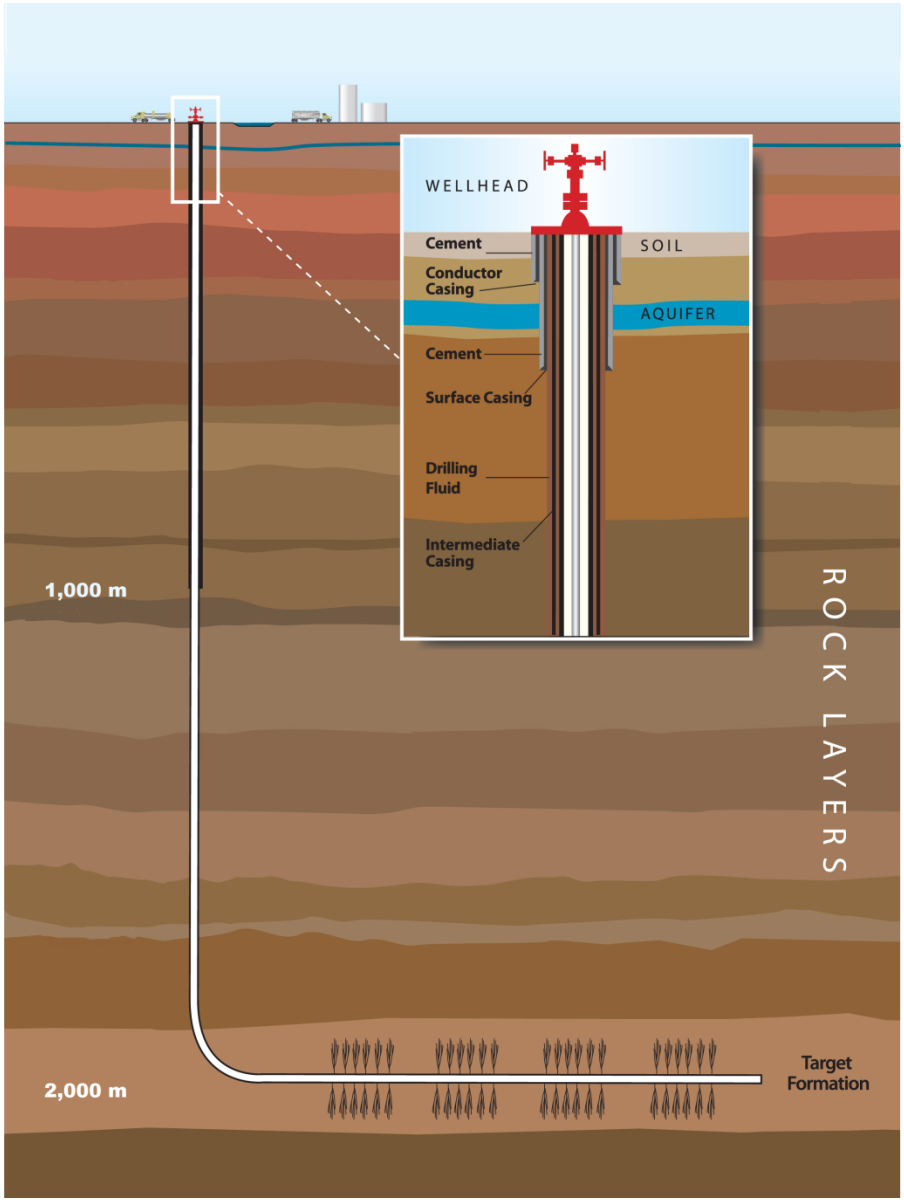


Figure 2: Schematic diagram showing typical well construction, casing, and horizontal drilling. Source: Modified from Society of Manufacturing Engineers.

3.4. What is 'hydraulic fracturing'?

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.

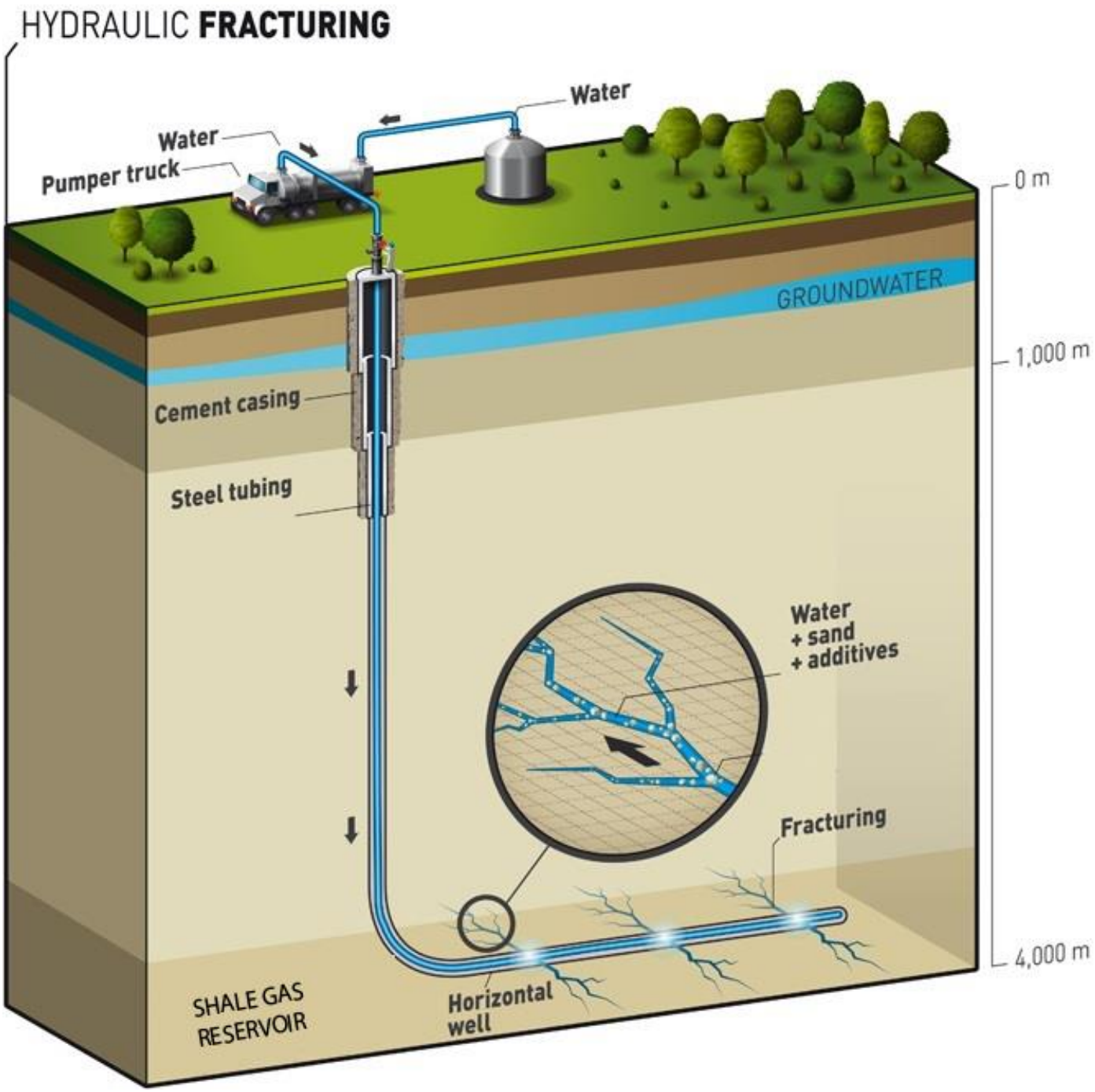


Figure 3: Schematic diagram of shale gas extraction process. Source: Modified from Total S.A.

An average of about 20 to 30 megalitres (ML) of water is used per fracked horizontal well, which would fill approximately between 6 – 10 Olympic sized swimming pools.

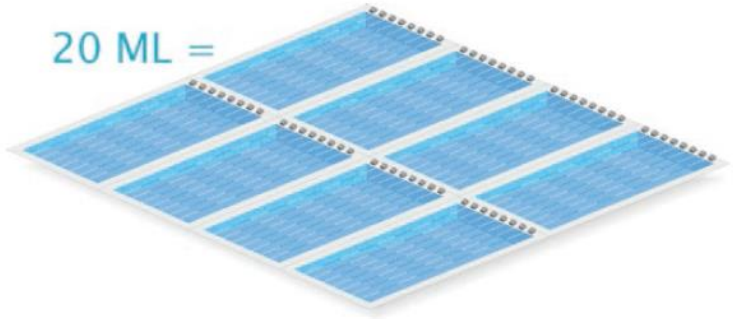


Figure 4: 20 megalitres would fill approximately 8 Olympic sized swimming pools. Source: CSIRO Gas Industry Social and Environmental Research Alliance.

To prevent the fractures in the rock from closing, proppant is added to the fracturing fluid and remains in the fractures holding them open as shown in Figures 3 and 5.

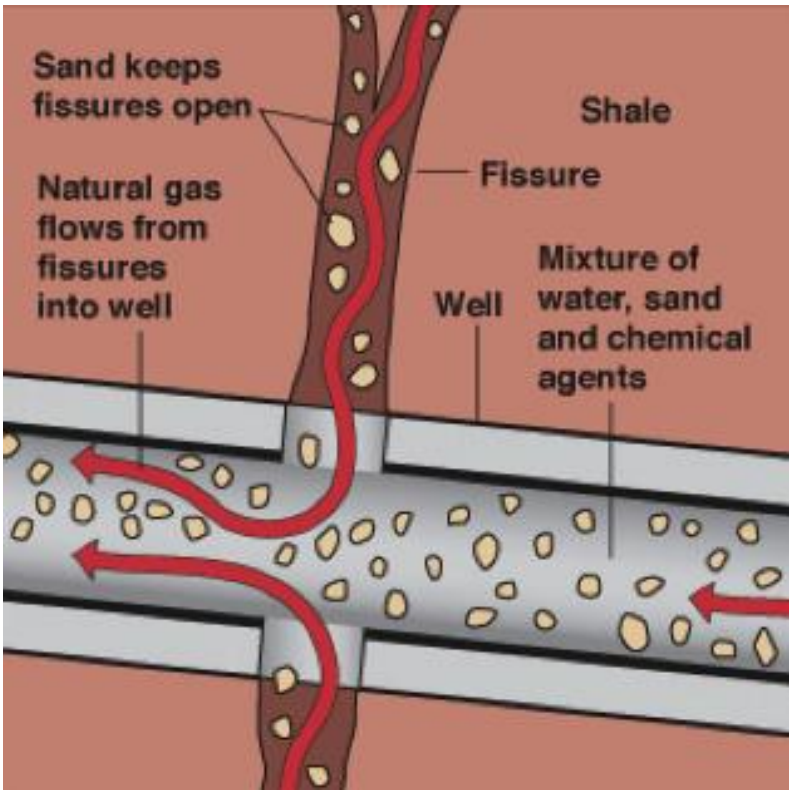


Figure 5: Diagram of proppant in action. Source: Modified from Al Granberg.

3.5. Chemicals used in hydraulic fracturing

Water and proppant make up around 99.5% of the hydraulic fracturing fluid. Added chemicals make up the other 0.5%. The following chemicals are commonly added to the water to perform the following functions (see Figure 6 below):

- a gelling agent, such as guar gum, is used to create a gel to suspend the proppant in the water and transport the proppant through the fracture;
- a gel breaker, such as ammonium persulfate (used in hair bleach), that reduces the viscosity or thickness of the hydraulic fracturing gels so that they can transmit water, and gas surfactants, such as ethanol, together with a cleaning agent, in order to allow high pump rates and reduce pressure;
- a bactericide or disinfectant, such as sodium hypochlorite (pool chlorine) and sodium hydroxide (used to make soap), to control bacteria growth in the well that contaminates the gas and restricts gas flow; and
- acids and alkalis, such as acetic acid (vinegar) and sodium carbonate (washing soda), to assist in the initiation of the fracture and improve fluid flow in the rocks.

Toxic BTEX chemical additives (benzene, toluene, ethylbenzene and xylenes) are banned in the Northern Territory for use in the extraction of unconventional gas.

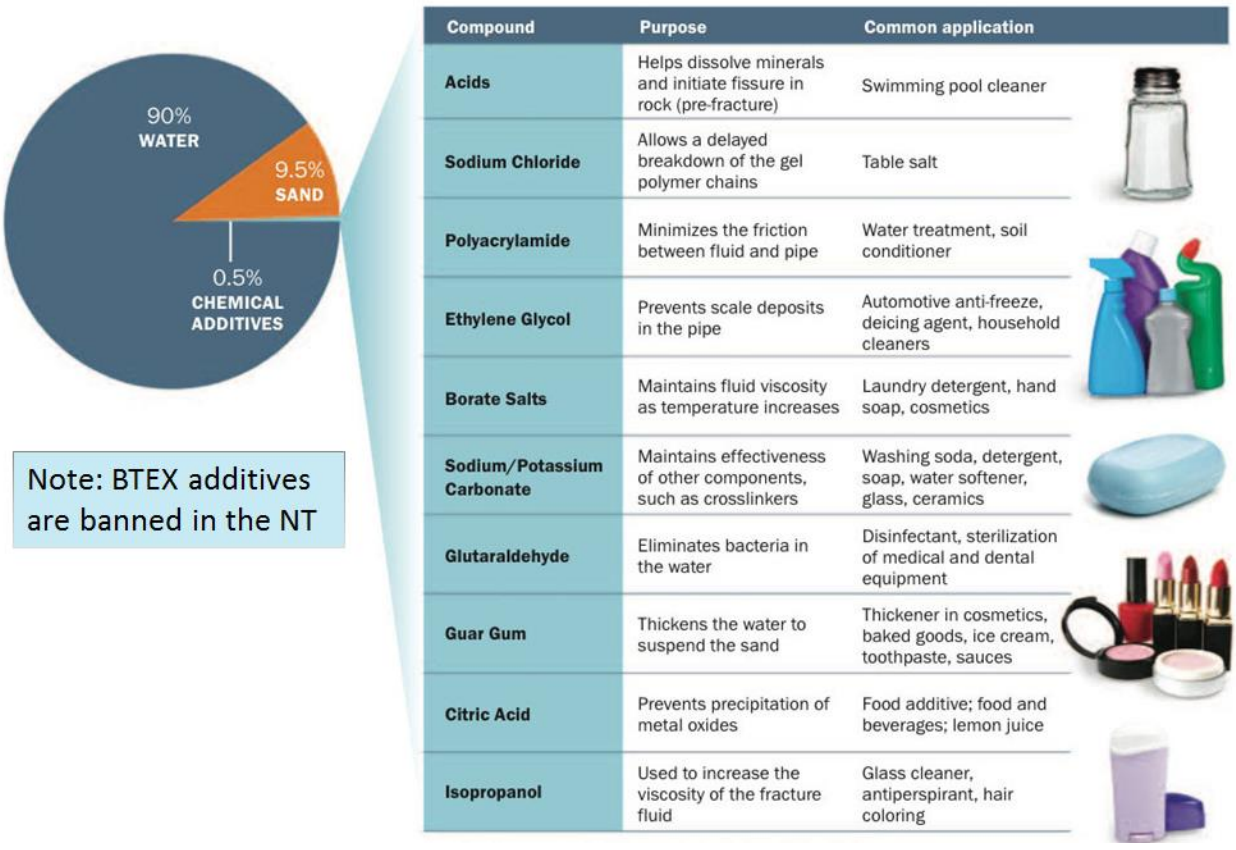


Figure 6: Typical hydraulic fracturing fluid additives that may be used. Source: Modified from US Department of Energy, 2009, Modern Shale Gas Development in the United States: A Primer.

4. Shale deposits in the Northern Territory

The location of the Northern Territory's known and potential shale gas resources is shown in Figure 7.

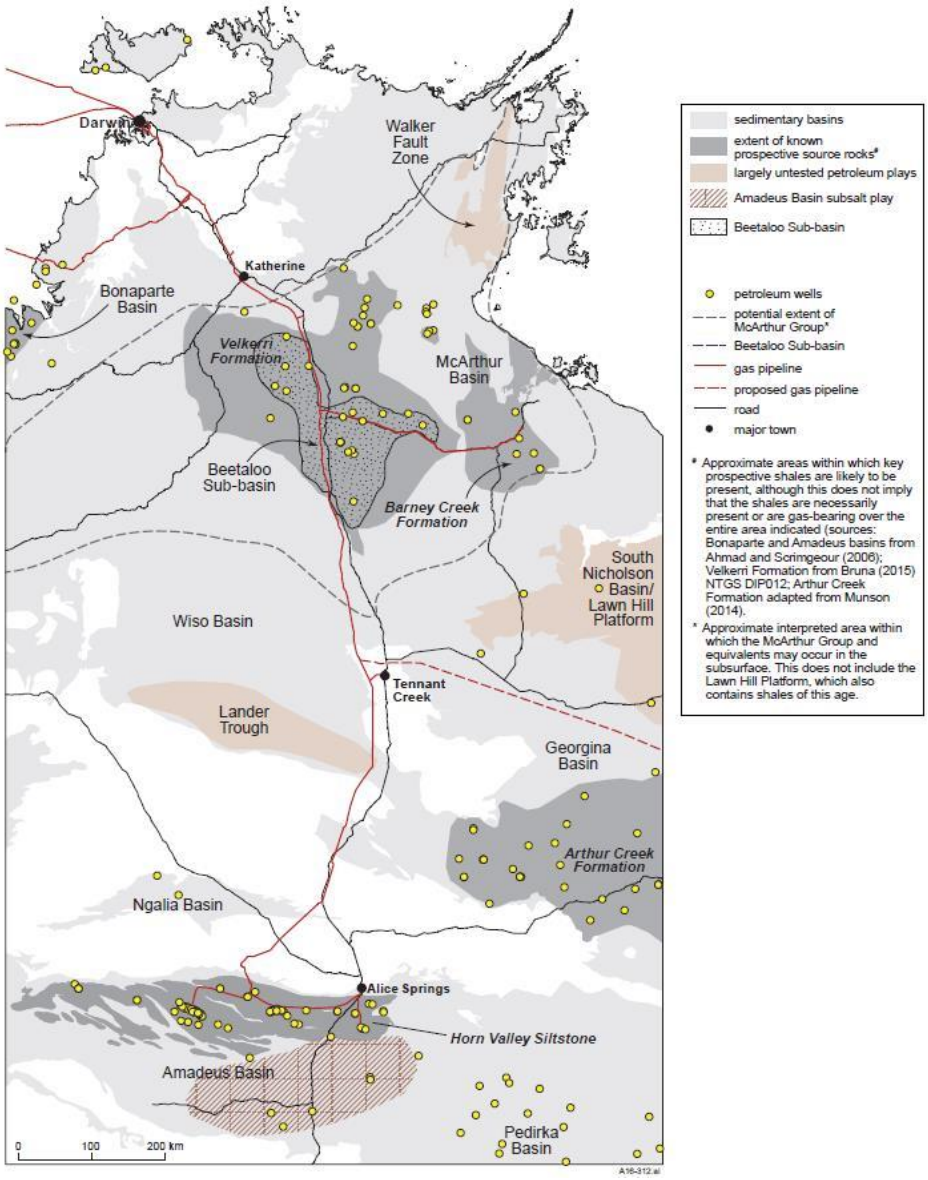


Figure 7: Shale gas resources and potential. Source: Modified from the Northern Territory Government.

The Northern Territory has had some experience with the hydraulic fracturing of conventional and unconventional gas.

Wells have been drilled in conventional gas reservoirs in the Mereenie and Dingo fields in the Amadeus Basin (see Figure 7 above) and have been hydraulically fractured.

Several exploration companies have drilled and hydraulically fractured unconventional shale wells in the Georgina Basin and the Beetaloo Sub-basin to test whether unconventional gas from the shale reservoirs can be economically developed. Two wells (Birdum Creek-1 and Amungee NW1H) in the Beetaloo Sub-basin have resulted in significant discoveries of shale gas resources.

Amungee NW1H was the first horizontal well in the Northern Territory that was stimulated using multi-stage hydraulic fracturing. Following the hydraulic fracturing, the well was tested for 57 days with gas rates in excess of 1.1 million standard cubic feet per day. This indicates that there is a high likelihood that the Beetaloo Sub-basin may be comparable to some of the most productive unconventional shale gas basins in the United States.

Shale gas is found in several basins throughout the Northern Territory. To date, notwithstanding ongoing exploration, only the Beetaloo Sub-basin of the Greater McArthur Basin has demonstrated any potential economic viability for shale gas extraction and production.

The Beetaloo Sub-basin lies beneath the Cambrian Limestone Aquifer (a freshwater aquifer).

5. Prior reports relating to hydraulic fracturing in the Northern Territory

The development and regulation of the onshore unconventional gas industry and, in particular, hydraulic fracturing, is a highly controversial matter in the Northern Territory, as it is elsewhere in Australia and the world. The last three Northern Territory governments have commissioned reviews and inquiries into the onshore petroleum industry to address the community's concerns in respect of the industry.

In 2011 the former Labor government commissioned Dr Tina Hunter from the Faculty of Law at Bond University to report on the capacity of the Northern Territory's legal framework to regulate the development of shale gas in the Northern Territory (**the 2011 Hunter Report**). A key recommendation from the 2011 Hunter Report was that government should prioritise the development and implementation of environmental regulations under the *Petroleum Act 1984* (NT).

In March 2014 the former Country Liberals government appointed Dr Allan Hawke as the Commissioner of an inquiry under the *Inquiries Act 1945* (NT) into hydraulic fracturing. Dr Hawke provided his report to government in November 2014 (**the 2014 Hawke Report**). The 2014 Hawke Report is an important document for the Panel. The Panel will build on the findings of the 2014 Hawke Report while responding to broader terms of reference, which include the Panel's consideration of the impacts and risks of the unconventional shale gas industry on the environmental, social, cultural and economic conditions in the Northern Territory.

One of the recommendations of the 2014 Hawke Report was that the government conduct a review of the environmental assessment and approval processes in the Northern Territory. The Country Liberals government therefore re-engaged Dr Hawke to conduct this work. Dr Hawke's second report (**the 2015 Hawke Report**) was released in late 2015. The 2015 Hawke Report did not relate directly to hydraulic fracturing, rather it provided the government with guidance on how activities with environmental impacts, such as hydraulic fracturing, might be effectively regulated.

Following the 2011 Hunter Report and the two Hawke reports, the Country Liberals government developed draft *Petroleum (Environment) Regulations* (**the draft Petroleum Regulations**). The draft Petroleum Regulations sought to implement many of the recommendations made in the earlier reports.

In early 2016, the Country Liberals government commissioned Dr Tina Hunter to conduct an independent assessment of the draft Petroleum Regulations to ensure they complied with the principles of best practice regulation (**the 2016 Hunter Report**). Although Dr Hunter described the draft Petroleum Regulations as "a quantum leap from the Northern Territory regulations of old", she also noted that further reforms to the regulatory framework were required in order to increase industry certainty, the accountability of the regulator, and the transparency of decision making.

6. The current regulatory framework

The principal piece of legislation that regulates the petroleum industry, including all unconventional gas, in the Northern Territory is the *Petroleum Act 1984* (NT). The *Petroleum Act* is administered by the Department of Primary Industry and Resources. Supporting the *Petroleum Act* are the *Petroleum (Environment) Regulations 2016* (NT) (**the Petroleum Regulations**) and the *Schedule of Onshore Petroleum Exploration and Production Requirements 2016* (**the Schedule**).

The aim of the Petroleum Regulations is to reduce the environmental impacts and risks associated with onshore petroleum activities, including the hydraulic fracturing of unconventional shale reservoirs, to levels that are both acceptable and as low as reasonably practicable.

The Petroleum Regulations require that any activity that may have an impact on the environment, such as hydraulic fracturing, is subject to an approved environment plan. A plan will only be approved if the Minister is satisfied that the gas company has demonstrated that all risks associated with the proposed activity will be reduced to the required levels. Key features of the Petroleum Regulations are that they:

- are objective-based, rather than prescriptive;
- give effect to the principles of ecological sustainable development by requiring the Minister to consider those principles when the Minister decides whether or not to approve an environment plan;
- ensure transparency and accountability by requiring the publication of environment plans and the Minister's reasons for approving a plan;
- require stakeholder engagement as a precursor to the submission of an environment plan; and
- require the Minister to consider any recommendations made by the Environment Protection Authority (the EPA) when making a decision about an environment plan.

The Schedule is also relevant to activities involving unconventional gas. The Schedule includes provisions dealing with operational matters relating to seismic surveys, drilling, and well integrity. The Schedule was amended in July 2016 to remove references to environmental management because these matters are now dealt with in the Petroleum Regulations.

Petroleum activities are currently exempt from the application of the *Water Act 1992* (NT). The Panel understands that the government is proposing to remove this exemption, which means that petroleum operators will require a licence under the *Water Act* where they use ground or surface water.

The 'water trigger' contained in the federal *Environment Protection and Biodiversity Conservation Act 1999* (Cth) applies to coal seam gas development, but does not apply to shale gas development.

7. The possible risks or issues associated with hydraulic fracturing

The first Term of Reference requires the Panel to "*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*".

An environmental impact, or risk, arises when there is an interaction between an activity, such as hydraulic fracturing, and the environment.

The first task of the Panel is to identify the risks, or issues, associated with hydraulic fracturing, its associated activities, and any unconventional shale gas industry. Once those risks are identified, the Panel will then determine the nature and extent, or 'level', of those risks.

The level of risk is determined by assessing the likelihood and consequence, or impact, of the risk. All risks associated with an activity will fit somewhere inside a risk matrix, an example of which is shown in Figure 8 below. Before any activity is approved it should be demonstrated that all the risks have been reduced to levels that are acceptable and as low as reasonably practicable.

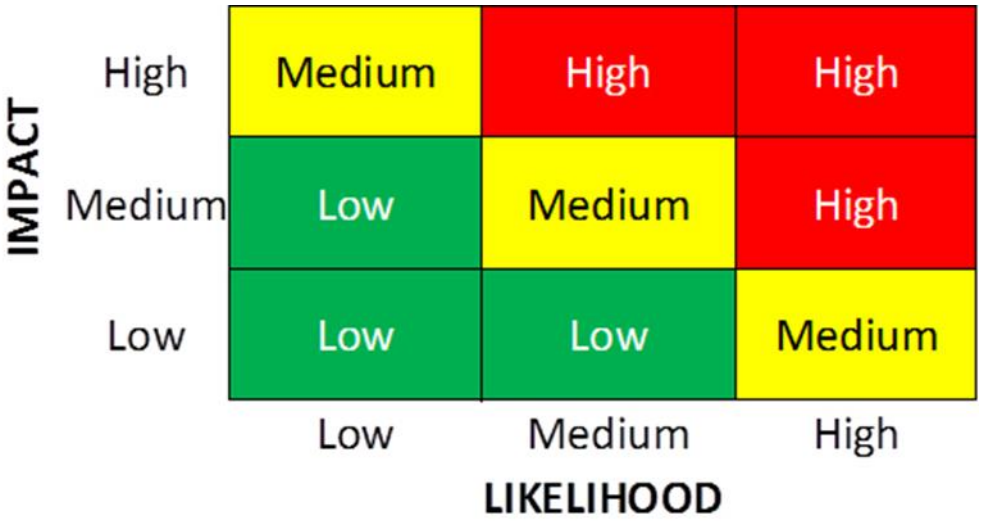


Figure 8: Example of a risk matrix

The Panel seeks feedback from all Territorians to ensure that the potential risks, or issues, identified in this Paper are appropriate for the Panel to consider during the course of the Inquiry. The Panel also seeks feedback on any other information relating to those possible risks, including whether, and if so how, such risks can be effectively managed.

The tables over the page list the potential risks, or issues, that the Panel considers relevant to this Inquiry. In populating the tables the Panel has had regard to the submissions that the Northern Territory Government received on the draft Terms of Reference for the Inquiry.

The risks have been organised into the following nine themes:

1. water;
2. land;
3. air;
4. public health;
5. impacts on Aboriginal people and their culture;
6. social impacts;
7. economic impacts;
8. land access; and
9. regulatory framework.

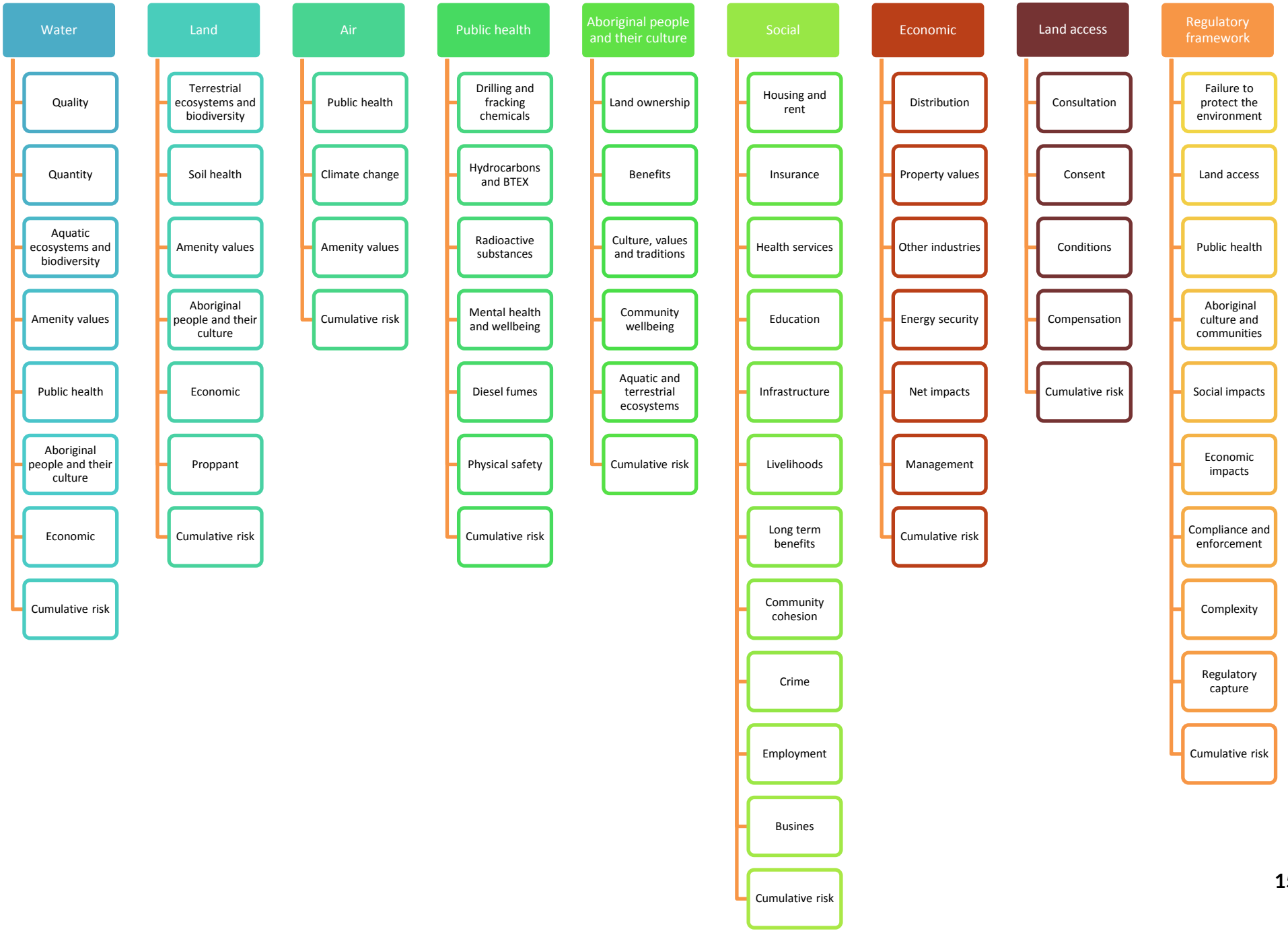
The Panel recognises that these themes, and the risks or issues identified within each theme, are intertwined and overlap, often to a substantial degree. They have been presented in separate tables to clearly indicate that they have been identified as issues by the Panel. They will, however, be considered both separately and together by the Panel to ensure that the extent of their interaction is addressed.

The Panel's next step is to examine the scientific evidence and to consult with Territorians regarding:

- the nature and extent (or level), if any, of the potential risks identified in the tables; and
- the ways, if possible, that such potential risks can be reduced to levels that are acceptable.

It is important to note that the Panel has not reached any conclusions at this stage about the nature and extent (or level) of any of the potential risks (or issues) identified in this Paper. Nor has the Panel reached any conclusion about what the acceptable levels of risk might be or how those levels might be achieved. This is the future work of the Panel. The Panel invites submissions on these matters.

Risk Themes


Water
Quality
Quantity
Aquatic ecosystems and biodiversity
Amenity values
Public health
Aboriginal people and their culture
Economic
Cumulative risk
Land
Terrestrial ecosystems and biodiversity
Soil health
Amenity values
Aboriginal people and their culture
Economic
Proppant
Cumulative risk
Air
Public health
Climate change
Amenity values
Cumulative risk
Public health
Drilling and fracking chemicals
Hydrocarbons and BTEX
Radioactive substances
Mental health and wellbeing
Diesel fumes
Physical safety
Cumulative risk
Aboriginal people and their culture
Land ownership
Benefits
Culture, values and traditions
Community wellbeing
Aquatic and terrestrial ecosystems
Cumulative risk
Social
Housing and rent
Insurance
Health services
Education
Infrastructure
Livelihoods
Long term benefits
Community cohesion
Crime
Employment
Busines
Cumulative risk
Economic
Distribution
Property values
Other industries
Energy security
Net impacts
Management
Cumulative risk
Land access
Consultation
Consent
Conditions
Compensation
Cumulative risk
Regulatory framework
Failure to protect the environment
Land access
Public health
Aboriginal culture and communities
Social impacts
Economic impacts
Compliance and enforcement
Complexity
Regulatory capture
Cumulative risk

7.1. Water

Table 7.1 lists the possible risks that the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities may have on water resources (surface and groundwater), including aquatic ecosystems and biodiversity, in the Northern Territory

Value	Risk
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; • re-injection of flowback water, produced water or treatment brines into a groundwater aquifer; and/or • induced connectivity between different groundwater systems as a result of seismic activity caused by hydraulic fracturing or reinjection of water. **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; and/or • spills of flowback water, produced water or brines produced by water treatment.
Water supply and distribution (quantity)	There may be a risk of adverse environmental impacts (including those listed in this table) 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.
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 ground water available to them.

Value	Risk
Amenity values	There may be adverse impacts on general amenity values such as 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 co-exist with the onshore unconventional gas industry, such as agriculture, pastoralism and tourism.
Cumulative risks	There may be cumulative risks associated with some or all of the risks identified above.

7.2. Land

Table 7.2 lists the possible risks that the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities may have on terrestrial (land) conditions, such as ecosystems, biodiversity, and soil health in the Northern Territory.

Value	Risk
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 vegetation loss on a local scale as a result of areas being cleared for roads, pipelines and drill pads or as a result of spills; • a risk of loss and/or fragmentation of habitat for fauna on a regional scale as a result of road and pipeline construction and operation; • a risk of adverse impacts on terrestrial ecosystems, including fauna and flora, as a result of changes to water quality and availability; • a risk of weed invasion as a result of increased traffic; • impacts on biodiversity and greenhouse gas emissions due to changed fire regimes; and • a risk of adverse impacts on fauna as a result of increased noise and light from petroleum operations.
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.

Value	Risk
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.
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, fisheries 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).
Cumulative risks	There may be cumulative risks associated with some or all of the risks identified above.

7.3. Air

Table 7.3 lists the possible risks that the hydraulic fracturing of unconventional shale reservoirs and its associated activities may have on the atmosphere and on climate change.

Value	Risk
Public health	The possible health risks associated with the release of gases from the hydraulic fracturing process are discussed below in “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 well heads, 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 national parks and rangelands due to gaseous emissions and flaring.
Cumulative risks	There may be cumulative risks associated with some or all of the risks identified above.

7.4. Public health

Table 7.4 lists the potential risk factors associated with the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities on public health. The main pathway through which chemicals and hydrocarbons will come into contact with humans or livestock is likely to be groundwater and atmospheric emissions.

The Panel recognises that there may be work, health and safety risks to workers on site due to the potential for exposures to be relatively higher than people located off-site. The Panel is of the view that such risks are different to public health risks and are outside the scope of this Inquiry.

Value	Risk
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 overall concentration of harmful chemicals in the water is low, the actual amount of chemicals can be significant and may pose a threat to the environment 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 benzene, toluene, ethylbenzene and xylenes (**BTEX**), which have featured prominently in some risk assessments relating to petroleum and unconventional gas extraction, although BTEX is less likely to be a prominent feature of gas extracted from shale deposits. The use of BTEX in drilling and fracking fluids is prohibited in the Northern Territory.
Radioactive substances	There may be a risk that 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.
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 and seismic activity.
Cumulative risks	There may be cumulative risks associated with some or all of the risks identified above.

7.5. Aboriginal people and their culture

Aboriginal people make up most of the resident population in the areas that are most prospective for unconventional shale gas development. Aboriginal people have proprietary interests under the *Aboriginal Land Rights (Northern Territory) Act 1978* (Cth), the *Native Title Act 1994* (Cth), and at common law. These interests are underpinned by traditional practices that connect Aboriginal landowning groups with their country. Notwithstanding these ownership interests, Aboriginal people are also one of the most disadvantaged groups in Australia.

The table below lists the possible risks that the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities may have on Aboriginal people and their culture.

Value	Risk
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.
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 or as the result of seismic activity caused by hydraulic fracturing or reinjection of water will have an adverse impact on Aboriginal culture, values and the traditions that connect landowning groups with their country and sustain community cohesion.
Community wellbeing	The development of the unconventional gas industry may have an adverse impact on the wellbeing of Aboriginal communities.
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.
Cumulative risks	There may be cumulative risks associated with some or all of the risks identified above.

7.6. Social impacts

The Panel is required to determine the social impact of the unconventional shale gas industry in the Northern Territory. The Panel has considered the most effective and efficient way to achieve this. An exhaustive assessment of the social impacts of the whole of the unconventional shale gas industry across the whole of the Northern Territory is not feasible in this Inquiry because:

- the footprint of a fully developed unconventional gas industry in the Northern Territory is currently unknown. Further exploration is required to understand the nature and extent of the resources and the infrastructure and workforce required to develop it; and
- no two communities in the Northern Territory are the same. Each community has its own unique community profile and will respond to the risks and benefits associated with development in a different way.

The Panel will utilise a leading practice framework for the identification, assessment, and management of social impacts associated with the development of the unconventional shale gas industry in the Northern Territory. 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.

The table below lists the possible social impacts associated with the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities in the Northern Territory.

Value	Risk
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 etc) 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 peoples' 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 impact on community cohesion and resilience, particularly in relation to fly-in, fly-out workers.
Crime	There may be an increase in crime.
Employment	They may be an impact on local employment and skill levels.

Value	Risk
Business	There may be an impact on local business opportunities.
Amenity	There may be a risk that the amenity of persons living on the land will be adversely impacted by hydraulic fracturing and its associated activities.
Cumulative risks	There may be cumulative risks associated with some or all of the risks identified above.

7.7. Economic impacts

It is likely that the development of an unconventional shale gas industry in the Northern Territory will bring with it economic benefits. However, the extent of these benefits is uncertain and with any benefits there are likely to be associated detriments and risks.

The Panel will engage an economist to undertake realistic economic modelling of these potential benefits and risks.

Table 7.7 lists the possible economic risks that may be associated with the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities in the Northern Territory.

Value	Risk
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 a risk that energy security in the Territory will be jeopardised if the gas is undeveloped.
Net impacts	There may be a risk that any economic benefits will not outweigh economic detriments.
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.

7.8. Land access

The unconventional gas industry has been highly controversial in Australia in large part due to issues around land use conflict and access to land. In Australia the Crown owns the mineral and petroleum resources beneath the ground and is able to grant titles to industry, regardless of the ownership of the land on the surface. This has resulted in tensions between those holding proprietary interests in land, on the one hand, and industry requiring access to the land in order to explore or extract the gas, on the other.

Table 7.8 outlines the risks to landowners, occupiers and traditional owners associated with the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities in the Northern Territory.

Value	Risk
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, where required, 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.

7.9. Regulatory framework

A regulatory framework is the principal way by which governments ensure that industries operate in ways that benefit the community as a whole and are in line with community expectations. However, there is a risk that the design and implementation of any regulatory framework does not meet its objectives and/or does not meet these expectations.

Table 7.9 lists potential risks associated with the statutory framework regulating the hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities in the Northern Territory.

Value	Risk
Failure to protect the environment	There may be a risk the regulatory framework does not adequately protect the environment (water, land, and air) from risks associated with hydraulic fracturing and associated activities.
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 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 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 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 or inadequate training of relevant officers. 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.
Complexity	There may be a risk that the regulatory framework is needlessly complex.
Regulatory capture	There may be a risk of 'regulatory capture' whereby the regulatory body becomes inappropriately aligned with industry and reluctant to regulate.
Cumulative risks	There may be cumulative risks associated with some or all of the risks identified above.

8. We want to hear from you

The Panel seeks feedback from the community and stakeholders on the potential risks, or issues, that the Panel has identified in this Paper.

The opportunity to make a written submission to the Panel on the Issues Paper closes on 30 April 2017.

Feedback can be provided by:

1. making a submission online by clicking on the "Have Your Say" tab at: www.frackinginquiry.nt.gov.au Written submissions will be published on the Inquiry's website;
2. attending a hearing to present to the Panel at any of the communities set out below; or
3. attending a community meeting at any of the communities set out below.

For information about the hearings and community meetings, including the registration process, please visit the Inquiry's website or contact the Inquiry by phone on (08) 8999 6573, by email at fracking.inquiry@nt.gov.au, or in writing to GPO Box 4396, Darwin, NT 0801, Australia.

Monday 6 March	Alice Springs
Tuesday 7 March	Tennant Creek
Wednesday 8 March	Katherine
Thursday 9 March	Darwin and rural area
Friday 10 March	Darwin
Monday 20 March	Maningrida
Monday 20 March	Gapuwiyak
Monday 20 March	Nhulunbuy
Tuesday 21 March	Ngukurr
Tuesday 21 March	Borroloola
Wednesday 22 March	Daly Waters
Thursday 23 March	Mataranka
Friday 24 March	Timber Creek
Monday 27 March	Wadeye
Tuesday 28 March	Yuendumu
Wednesday 29 March	Hermannsburg

9. Next steps

Following the community consultation program in March, the Panel will release an Interim Report summarising the feedback received by the Panel on the Issues Paper in mid-2017. The Panel will conduct further consultations following the publication of the Interim Report and a draft Final Report. A Final Report will be provided to the Northern Territory Government by the end of 2017.

At this stage, the anticipated timeline for the Inquiry is as follows:

3 December 2016	• Terms of Reference released
8 December 2016	• Inaugural meeting of the Panel
1-3 February 2017	• Site visit to Moomba
8-9 February 2017	• Second meeting of the Panel
20 February 2017	• Issues Paper released
6-10 March 2017	• Public hearings in Darwin, Katherine, Tennant Creek and Alice Springs
20-28 March 2017	• Public hearings in remote communities
30 April 2017	• Comments on the Issues Paper close
Mid 2017	• Release of the Interim Report
July - August 2017	• Public hearings in Darwin, Katherine, Tennant Creek and Alice Springs and remote communities
October 2017	• Release of draft Final Report
November 2017	• Briefings in Darwin, Katherine, Tennant Creek and Alice Springs and remote communities
December 2017	• Release of Final Report

10. Further information

Further information about the Inquiry, including upcoming community visits, is available on the Inquiry's website www.frackinginquiry.nt.gov.au.

The Inquiry's contact information is as follows:

GPO Box 4396
Darwin, NT 0801, Australia
Phone: (+61) 08 8999 6573
Email: fracking.inquiry@nt.gov.au

The website includes:

- latest news and updates about the Inquiry;
- information about hydraulic fracturing;
- links to other hydraulic fracturing inquiries in Australia;
- "Have your say";
- a registration option to receive email updates about the Inquiry directly;
- the Inquiry's contact information; and community updates, which are also set directly to those registered on the Inquiry's website.

TERMS OF REFERENCE FOR THE SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING OF ONSHORE UNCONVENTIONAL RESERVOIRS AND ASSOCIATED ACTIVITIES IN THE NORTHERN TERRITORY

BACKGROUND

On 14 September 2016 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 1945* (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.