NORTHERN LAND COUNCIL
Our Land, Our Sea, Our Life

Address all correspondence to:
Chief Executive Officer
GPO Box 1222 Darwin NT 0801
45 Mitchell Street Darwin NT 0800
P: 08 8920 5100 • F: 08 8945 2633
Freecall: 1800 645 299
www.nlc.org.au
ABN 56 327 515 336

2 May 2017

Ref: F2016/0977:NO1

Department of the Chief Minister
Northern Territory Government
GPO Box 4396
Darwin NT 0801

By email: fracking.inquiry@nt.gov.au

Dear Minister

2017 SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING IN THE NORTHERN TERRITORY - BACKGROUND AND ISSUES PAPER

We thank you for the opportunity to submit comments to the Background and Issues Paper which was released for public comment on 20 February 2017. Officers of the Northern Land Council (NLC) have examined the document and have prepared a submission, which is attached.

The NLC submission draws attention to a number of concerns consistently raised by traditional Aboriginal owners, these and other concerns are further outlined in the NLC's submission:

- Water allocation;
- Water management;
- Well integrity; and
- Long term management of abandoned wells.

The NLC advocates that a wide array of cumulative, bioregional and strategic impact assessments be undertaken to ensure that all risks associated with the development of the onshore oil and gas industry are captured and to provide maximum protection to the natural, social and cultural environments. Such assessments should not be restricted to the onshore oil and gas industry.

Should you have any queries regarding our comments, please do not hesitate to contact Rhonda Yates on [redacted] or via email [redacted]

Yours sincerely

Joe Morrison
CHIEF EXECUTIVE OFFICER

A submission by the Northern Land Council to the 2017 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory.

April 30, 2017

This page has been left blank intentionally

Preface

The Northern Land Council (NLC) is pleased to provide a submission in response to the Northern Territory Government's 2017 Scientific Inquiry into Hydraulic Fracturing.

It is the NLC's firm opinion that such an approach must be based on world best practice, including as articulated in the 'United Nations Declaration on the Rights of Indigenous Peoples', the Mary River Statement (see Part 2, page 9) and the 'sustainable livelihoods' approach first proposed by Aboriginal Peak Organisations Northern Territory (APONT) in 2011. APONT described the key qualities of a Sustainable Livelihoods Approach as:

- Empowerment of the disadvantaged individual or community to determine their own livelihood pathways;
- Long term and flexible programming;
- Responsive and participatory planning and implementation;
- Activity-focused partnerships between disadvantaged people, their organisations, the public sector, the non-government sector and the private sector;
- Disaggregated strategies that address identifiable sub-groups (women, youth, the disabled); and
- Outcome-based monitoring and evaluation.

It is the primary responsibility of the NLC to support the informed decisions of traditional Aboriginal Owners to manage their land and seas, including when engaging with the onshore petroleum industry. The NLC's submission is made on behalf of its Aboriginal constituents who legally own 50% of the Northern Territory, including 85% of the coastline and have Native Title interests over the majority of the remainder whilst comprising 30% of the total population. The submission provides information on the relevance of the Hydraulic Fracturing Inquiry to the NLC and to the NLC's constituents and seeks to provide information related to each of the Terms of Reference issued by the Inquiry in its Background and Issues paper. Attachment 1 provides a complete list of the recommendations provided in and supported by the body of this submission.

It is not the role of the NLC to hold an opinion on the merits (or otherwise) of hydraulic fracturing. However the NLC is concerned that the Inquiry's Terms of Reference do not consider the impacts of the hydraulic fracturing of onshore conventional petroleum reservoirs given the risks associated with hydraulic fracturing are not constrained by the resource being defined as either conventional or unconventional. Nevertheless, the NLC lauds the wide-ranging nature of the Inquiry because its outcomes will help to ensure that decisions made by Aboriginal people in respect of onshore oil and gas developments continue to be undertaken in light of the best information available.

…….
Joe Morrison
Chief Executive Officer

30 April 2017

This page has been left blank intentionally

Table of Contents

Executive Summary

This document is the submission of the Northern Land Council (NLC) to the Northern Territory Government's 2017 Scientific Inquiry into Hydraulic Fracturing (the Inquiry). It addresses the Inquiry's 'Terms of Reference' and 'Background and Issues Paper' (20 February 2017) and draws upon much of the information already presented to previous Inquiries.

This submission is founded on the principle of self-determination and informed consent as espoused by the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). It is structured in two parts: the first part provides background to the hydraulic fracturing debate and describes the NLC and its role in the debate; the second part sets out the perceptions held by traditional Aboriginal owners and the NLC in respect of hydraulic fracturing and the proposed development of the onshore oil and gas industry.

These perceptions are addressed according to the nine themes identified by the Panel undertaking the Inquiry. These themes are risks related to: water, land, air, public health, Aboriginal people and their culture, social, economic, land access and the regulatory framework. In addressing these, the NLC's submission explains the statutory environment and processes that govern how the NLC advises traditional Aboriginal owners during decision-making. It also highlights some specific technical information which the NLC considers to be current leading practice, and makes 44 recommendations that aim to provide tightened control over all industries, including the oil and gas industry, that may have significant impacts on the environment, and on Aboriginal people are provided.

Chapter 13 groups the 44 recommendations into three main categories – Regulation, Environmental Assessment and Project Management. As well as being listed in their entirety in Chapter 13, recommendations are inserted throughout the text of this submission where relevant.

The NLC considers these recommendations essential should the Northern Territory Government decide to allow hydraulic fracturing and develop the onshore oil and gas industry. Most of them need to be applied across multiple industries to ensure that cumulative impacts are adequately addressed and this could be undertaken once Petroleum Legislation and Regulations has been changed and, if the moratorium is lifted, over the next few years of oil and gas exploration but prior to commencing production.

This page has been left blank intentionally

Part 1: Background Information

1.0 Introduction

Well stimulation techniques, often referred to as "hydraulic fracturing", have been commercially used in the USA since 1949 to produce oil and gas from compact sedimentary deposits located as much as 3500m below the earth's surface. In this process, water and chemicals, under high-pressure, are used to crack the rocks, releasing any oil or gas that is trapped within its ultra-fine matrix.

However, development of the shale oil and gas industries was slow, until the 1980s when US operators began to use high-volume hydraulic fracturing in conjunction with directional drilling to maximise the recovery of gas from deep shale layers. The method is now applied worldwide to extraction of oil and gas, but recent complaints about its potential environmental impacts have caused many jurisdictions to question the suitability of hydraulic fracturing for hydrocarbon production. As a result, hydraulic fracturing is now under intense scrutiny and subject to a number of environmental assessments or inquiries worldwide.

The Northern Territory entered the hydraulic fracturing debate in 2012 following identification of a potentially significant hydrocarbon source at the Beetaloo Basin. A 2014 Inquiry into the science behind hydraulic fracturing was followed by a review of the Northern Territory Petroleum Legislation and supporting regulations. Continued dissatisfaction with the outcomes of that Inquiry by some sectors of the community has now led to the establishment of a moratorium on hydraulic fracturing and a new Inquiry.

1.1 The Inquiry

On 14 September 2016 the Northern Territory Government announced a moratorium on the use of well stimulation techniques for exploration, extraction, production and Diagnostic Fracture Injection Testing (DFITs) used for production of hydrocarbons from shale. The Northern Territory Government has since established 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.

Chaired by the Honourable Justice Rachel Pepper and a panel of 10 scientists with expertise in disciplines such as water, geology, ecology, health, sociology and engineering expects to deliver its findings by the end of 2017. The Inquiry has been structured such that community engagement is maximised via written submissions, community consultations and public hearings across the Northern Territory.

This document represents the formal response of the Northern Land Council (NLC) to the Inquiry

1.2 Terms of Reference of the Inquiry

The Terms of Reference for the Inquiry are wide-ranging and go beyond the original intent of a Scientific Inquiry into hydraulic fracturing. Released in December 2016, they have been expanded to

include social and other aspects aimed towards informing how development of the onshore oil and gas industry might occur in the wider context of developing the Northern Territory.

Consequently, 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
    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
    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.
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.

2.0 The NLC and its functions

The NLC represents the interests of traditional Aboriginal owners in the northern half of Australia's Northern Territory. The NLC assists the Aboriginal people of its jurisdiction by providing services in key areas related to land management, land acquisition, mining, petroleum and other forms of economic development, land trust administration, native title services and advocacy, information and policy development. The vision of the NLC is a Territory in which the land rights of every traditional Aboriginal owner are legally recognised and in which Aboriginal people benefit economically and culturally from the secure possession of their lands and seas.

The NLC has statutory responsibilities under the *Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA) and the *Native Title Act 1993* (NTA) to consult with traditional Aboriginal owners with regard to proposals for exploration and production of minerals, oil and gas. Where instructed to do so, the NLC makes agreements with mining, oil and gas companies that are designed to protect the interests of its traditional Aboriginal owners. More detail about the ALRA and NTA processes and the way the NLC undertakes its consultations is provided in Section 10.1 of this submission.

2.1 The NLC's jurisdiction

The NLC has statutory responsibility under ALRA over more than 210,000 km^2 of the Northern Territory, and over 80% of the Northern Territory coastline.

In 1994, the NLC became a Native Title Representative Body under the NTA. In this capacity, the NLC also represents the Aboriginal people of the Tiwi Islands and Groote Eylandt. The NLC's role and functions as a Native Title Representative Body are set out under Part 11, Division 3 of the Native Title Act.

Figure 1 illustrates the extent of Aboriginal land interests in the NLC's region in the NT and the relationship between Aboriginal land interests and regions prospective for petroleum and potentially subject to hydraulic fracturing. The vast majority of this land remains under application for oil and gas exploration and the NLC anticipates that should the moratorium on hydraulic fracturing be lifted, these applications will be processed in accordance with the NTA or ALRA in the coming years.

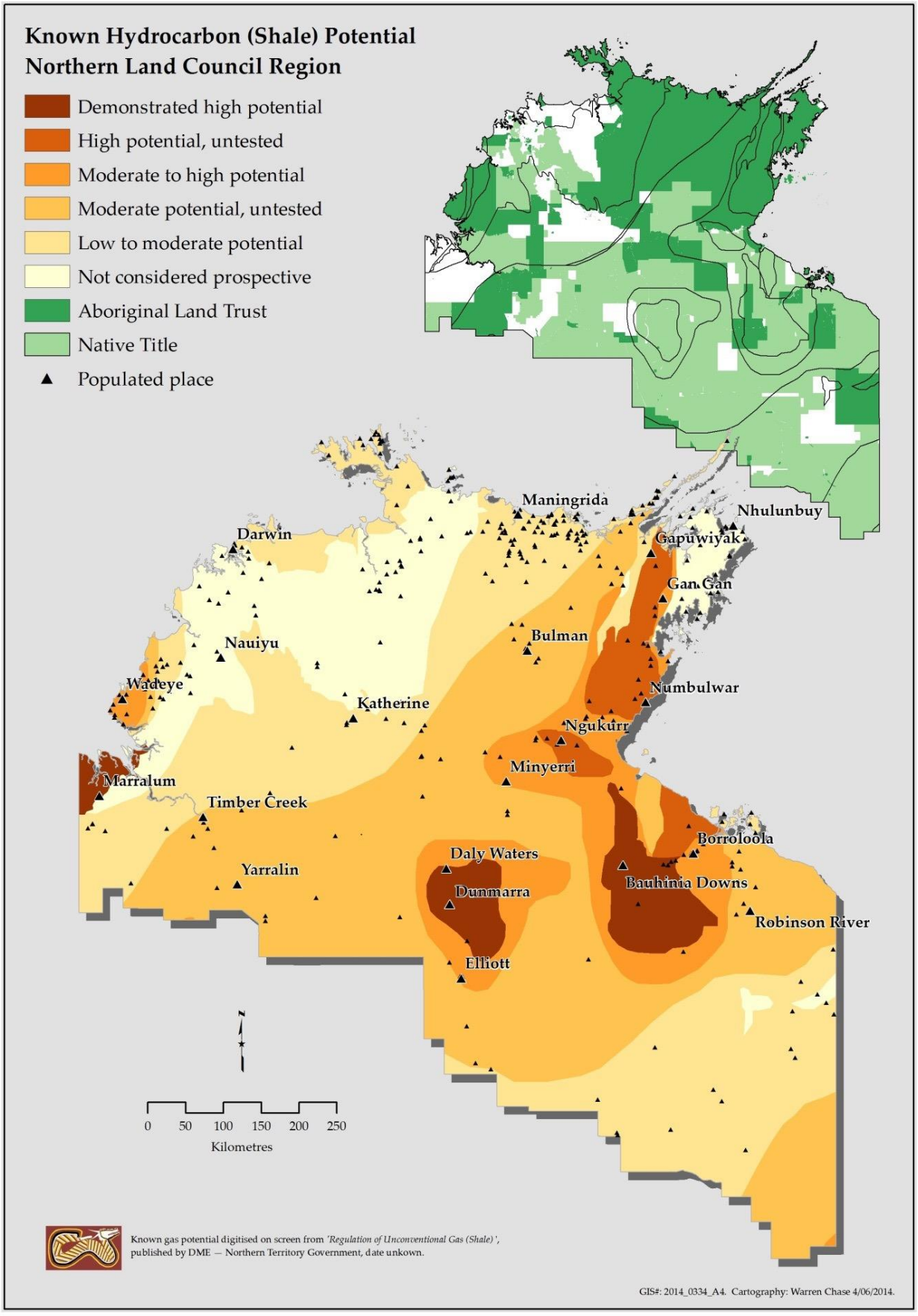


Figure 1: Map showing known hydrocarbon shale potential in the NLC jurisdiction.

2.2 The NLC's expertise related to hydraulic fracturing

The NLC's workforce includes a number of tertiary qualified personnel, including those with expertise in environmental science, land management, law, anthropology and chemical engineering. Consequently, the NLC is acquainted with the technology of hydraulic fracturing and with the social, cultural and environmental concerns related to development of the wider oil and gas industry, especially in terms of how it relates to Aboriginal people and their culture.

The NLC has had continued and close involvement with the debate about hydraulic fracturing since 2010, through a number of mechanisms including:

1) A visit to the United States and Canada in 2011 to assess the technology and impacts involved with hydraulic fracturing by:
    a. viewing and inspecting a number of producing fields in California, Texas, North Dakota and Colorado;
    b. discussing concerns about hydraulic fracturing with environmental interest groups in Pennsylvania, New York and Alberta;
    c. discussing concerns and benefits associated with hydraulic fracturing with First Nations people in Arizona and North Dakota; and
    d. attending public forums in Australia and in Calgary, Canada.

2) Review of significant worldwide documents related to hydraulic fracturing including:
    a. two separate USEPA assessments; and
    b. other National reviews and assessments including those in Australia, the United Kingdom, and Canada.

3) Making submissions related to previous inquiries and other documents within the Northern Territory and at Commonwealth levels, including:
    a. the 2016 "Senate Select Committee's Inquiry into Unconventional Gas Mining" chaired by Senator Glen Lazarus;
    b. the 2014 "Inquiry into Hydraulic Fracturing in the Northern Territory" chaired by Dr Allan Hawke;
    c. the 2015 Northern Territory Government's "Oil and Gas Development Strategy";
    d. the 2016 review of the Northern Territory Government's Draft Petroleum (Environment) Regulations;
    e. the 2016 review of the Northern Territory's Petroleum Legislation;
    f. the Terms of Reference for the 2017 "Scientific Inquiry into hydraulic fracturing in the Northern Territory"; and
    g. this present Inquiry.

4) Between 2012 and 2015, the NLC negotiated approximately 30 agreements on behalf of traditional Aboriginal owners and oil and gas companies seeking to access land subject to ALRA or NTA for the purposes of onshore petroleum exploration and/or production or infrastructure development. A majority of these agreements are Exploration Agreements. The NLC's consultation process and its understanding of the science of hydraulic fracturing and its potential for impacts to the physical, social and cultural environment have assisted in ensuring that Aboriginal people in the NLC region are properly informed when making decisions about onshore petroleum exploration and development proposals.

5) Close involvement with the vertical hydraulic fracturing program of Falcon Oil and Gas (Shenandoah-1A in 2011) and the horizontal hydraulic fracturing program of Origin Energy (Amungee-Mungee-1 in 2016); and

6) On behalf of our traditional owners, working closely with Origin Energy, Pangaea Resources and Santos in the development and management of their future plans for development of the potential gas reserves of the Beetaloo Basin.

Significant social concern exists about how the industry is being managed elsewhere, and this concern extends to sectors of the Aboriginal community. This submission aims to reflect the diversity of opinion among the Aboriginal people in the NLC region: some groups are in favor of hydraulic fracturing and the benefits it will bring; others are opposed to the development of the onshore petroleum industry on their lands due largely to concerns about potential negative environmental and other impacts; while others are undecided and seek further information before committing one way or the other.

2.3 Format of the NLC submission

The NLC does not hold a position on hydraulic fracturing because to do so would conflict with its statutory roles as defined by Commonwealth Legislation, namely ALRA and NTA. This neutral stance is exemplified by a resolution passed at a joint meeting with the CLC in August 2016, where both Councils went on record, stating that:

> *The joint meeting of NLC and CLC supports the rights of traditional Aboriginal owners to make their own decisions about the use of their land and waters free from outside influence. It is important to ensure that traditional owners have all the relevant information. The land councils will continue to make sure this happens.*
>
> *We recognise that some Aboriginal people have concerns about hydraulic fracturing and do not want it to occur on their lands and waters. But our job is to support and respect the decisions of traditional Aboriginal owners for the area in question.*

Put simply, if traditional Aboriginal owners say “no” to gas exploration and production, they will exercise their right to impose the veto where that right exists (such right only exists on Aboriginal land), and this decision will be supported by the NLC. If they say ”yes”, then the NLC will work with the traditional Aboriginal owners, the government and the oil and gas companies to ensure that outcomes are of the highest possible standard, environmentally, socially, culturally and economically.

The NLC’s submission has therefore been formulated to:

1) provide the Panel with background information describing how the NLC operates, where the NLC operates, the NLC’s capacity and its understanding about hydraulic fracturing; and

2) highlight to the Panel the issues and concerns which have been consistently raised by the NLC’s staff and traditional Aboriginal owner constituents with regards to hydraulic fracturing over the past 8 years. These have been placed in the context of the nine risk themes identified in the Background and Issues paper released by the Panel in late 2016.

The NLC's submission contains a number of recommendations that we believe should be considered by the Panel in its deliberations and implemented by the Northern Territory Government if it decides that a petroleum industry based around hydraulic fracturing of shale is to be developed.

Our response is limited to issues of major importance to traditional Aboriginal owners, but recognises that many of these concerns are common to the wider community. Our response has been tailored to provide the Inquiry with statements of fact that describe how the NLC manages interactions between gas companies and traditional Aboriginal owners. This will provide the Inquiry an understanding of how the regulatory process works and dispel many common misconceptions that are often espoused by the general public.

Our response also provides the Inquiry with details of the principal concerns that many traditional Aboriginal owners, irrespective of their views on hydraulic fracturing, hold with respect to how the regulatory processes are managed. We also provide a number of recommendations that we consider are essential to successful management of the oil and gas industry in the Northern Territory, should the government determine that the moratorium on hydraulic fracturing be lifted.

Part 2: The NLC's Submission

3.0 Risk Theme 1: Water

The NLC presents this part of its submission in the context of "The Mary River Statement", a declaration by about 80 Indigenous water experts from across Northern Australia who convened at Mary River Park in August 2009.

The following set of principles was developed for presentation to the Northern Australia Land and Water Taskforce:

1. Land, water and people are inextricably connected, which means unity of land, water and Indigenous people.
2. Water management and use includes all cultural uses, environmental flows, consumptive and commercial uses; all freshwater systems are included, whether on land or sea country.
3. Adherence to maintaining a balanced "Triple Bottom Line" (social and cultural, ecological and economic), and a fourth element of political sustainability.
4. Water dealings based on free, prior and informed decisions and engagement with Indigenous communities at all levels. This means representative bodies and Indigenous communities be fully informed and participate in process.
5. Principles of international law (e.g. UNDRIP, Ramsar) be guiding principles.
6. Water allocation needs to be linked with best practice, sustainable, efficient use and up-to-date information about environmental flows.
7. Traditional people across northern Australia are united in dealing with water issues and accordingly recognise that:
    - We have cultural and kindship responsibilities and obligations under customary law to look after water.
    - Traditional Owners have a right to be involved in the management and decision-making over water use.
    - Indigenous peoples have responsibilities and obligations in accordance with Indigenous law and customs. We have responsibility for maintaining the rivers, the environment and ecosystem in their natural state so as to ensure their sustainability of this whole environment.
    - Indigenous people need to be the primary interface in the planning and development of water usage, proposed and regulated.
    - Our water is part of our native title through our cultural and ceremonial practices that are part of the birds, animals, plants and us.

Risk Theme 1 of the Background and Issues Paper identifies eight major values related to water that the Panel considers might be at risk from hydraulic fracturing. These are:

- the quality of groundwater and surface water;
- water supply and distribution (water quantity);
- aquatic ecosystems and biodiversity;

- amenity values;
- public health;
- Aboriginal people and their culture;
- economic; and
- cumulative risks.

Of these, the most significant concerns expressed about hydraulic fracturing relate to sourcing of the volumes of water required for hydraulic fracturing, and the potential for contamination of potable drinking water by brine, chemicals and/or fugitive oil and gas.

Traditional Aboriginal owners within the NLC's jurisdiction, regardless of their views on hydraulic fracturing, have consistently asked that a greater emphasis is placed on:

1) protection of the quality of potable water sources;
2) a guarantee of the integrity of natural springs;
3) ensuring long-term access to potable water; and
4) protecting the cultural aspects of water.

This requires an in-depth analysis of how the quality and availability of potable water sources will be managed and protected.

3.1 Water quality

Protection of near surface and surface water bodies is of paramount importance because many remote communities rely on these water sources for their survival. High-quality water is required for domestic and drinking purposes and to maintain natural ecosystems that provide food and/or are of aesthetic or cultural importance. The risks that a developing oil and gas industry poses to potable surface and groundwater quality are threefold and may occur via:

1. the release of fugitive gas and/or oils;
2. cross-contamination by brines (highly saline waters) contained within deeper aquifers; and/or
3. the release of chemicals used during hydraulic fracturing of shale.

These risks can be managed if gas wells are constructed to a high standard, if well integrity is maintained throughout production and abandonment, if surface management systems are well designed, and if water quality is monitored throughout and beyond each well's operational life.

3.1.1 Well construction

Use of appropriate materials and multiple cemented cases (or barriers) are the key environmental safeguards used by the oil and gas industry to reduce the risk of well failure. This is now a standard industry practice, and is used irrespective of whether or not oil or gas is recovered by conventional means or through the more unconventional hydraulic fracturing. Construction standards and testing/proving methodologies used in the USA are published by the American Petroleum Institute (API), which recommends the use of multiple casings constructed from materials that meet ASTM quality standards (API, 2002; API 2005).

The use of multiple cemented casings represents a risk mitigation strategy built around multiple redundancies – meaning that should one of these barriers fail, the others will still protect the

environment. There are usually four barriers, of which the surface casing is the most critical to environmental protection because it provides the main seal that isolates freshwater zones. The surface casing often extends tens of metres below the freshwater zone. Additional protection is provided by the other two casings; and by the production tubing, which runs through the innermost (production) casing.

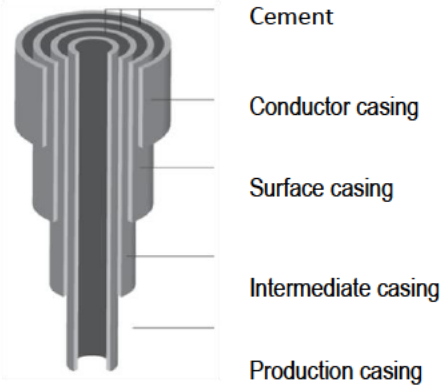


Figure 3: Internal structure of a typical oil and gas production well.

Modern casing and cement materials are resistant to corrosion and to the high pressures encountered at depth and that result from hydraulic fracturing, however these materials can be damaged by improper handling, transport and storage techniques and this can have a negative impact on well integrity. Although cement compounds have been developed specifically for application in the onshore petroleum industry, it should be noted that these cements are subject to hydration chemical reactions and that over time these cements, like all cements, will deteriorate.

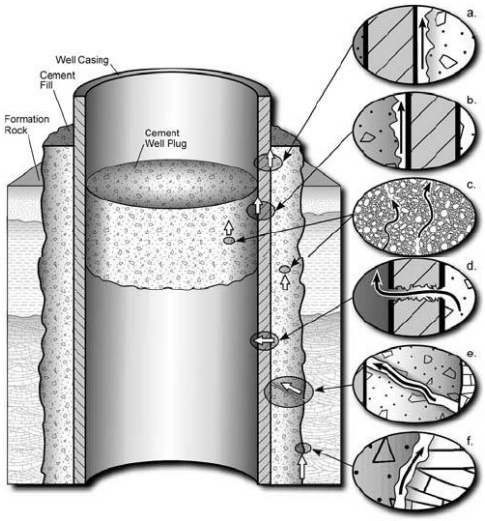
Unplugged or poorly plugged wells and wells that lose their integrity have the potential to act as conduits, allowing fluids and gases to migrate upwards. Should this occur, there is an increased risk that gas, oil or brines may contaminate potable groundwater systems.

Recommendation: *The highest possible standards should be applied to well construction and to materials used in well construction.*

3.1.2 Well integrity

The NLC considers well integrity failure resulting from poor construction or age as one of the biggest risks associated with the oil and gas industry. This issue is of significant interest to NLC's constituents, because where petroleum projects progress, protection of the environmental assets of Indigenous people becomes contingent on well integrity. The NLC's agreements with oil and gas companies currently stipulate that wells must be constructed with multiple barriers and be third-party certified prior to use.

Integrity of a well depends upon the standard of materials used in in well construction and the manner in which the well is constructed, especially the number of barriers in place. Integrity is normally assessed prior to hydraulic fracturing by using bond-logging (which reveals imperfections in the casing and cementing process) and after hydraulic fracturing by pressure-testing. However, unanticipated problems can occur and wells may fail. A number of possible failure mechanisms have been identified (Dusseualt et al, 2000; Mavroudis, 2001) and are described in figure 4.



Mechanisms of failure

(a) between cement and the exterior of casing.
(b) between cement and the interior of casing.
(c) through the cement.
(d) through the casing.
(e) through fractures (channels) in the cement.
(f) between cement and the formation rock.

Figure 4: Possible pathways for oil/gas migration in an abandoned well. Similar pathways will be observed in a producing well, with the exception of (b) and (c) where the plug is not in place. Pathway (d) is more likely to be predominant in an abandoned well, if the casing has corroded.

Comparable, publicly available statistics related to well failures in the Northern Territory are difficult to find and the Panel should avail itself of this information from industry and/or government during its deliberations The NLC is aware of only one example of "well failure" within its jurisdiction – and the NLC understands that this well did not involve hydraulic fracturing. The cause of this failure should be scrutinised so that traditional Aboriginal owners can be assured that there were no long-term or widespread environmental impacts and so that similar incidents do not occur in the future. Improvement of environmental performance in any industry is often a response to effective governmental regulation, so if the mistakes made in respect of well construction are to be avoided in the Northern Territory, effective industry regulation is imperative.

Recommendation: *Information about well failures in the Northern Territory should be made publicly available.*

3.1.3 Abandoned wells

The long-term integrity of abandoned wells is one aspect of the oil and gas industry that has not received thorough analysis in hydraulic fracturing reviews. The NLC is concerned about ongoing management of abandoned wells because these might present a risk of long-term chronic environmental impact through continuous leakage of oil or gas into the atmosphere, aquifers or both. Details about longevity of casings and cements in corrosive environments are difficult to find, which makes it hard to determine the level of this risk.

To address concerns about the integrity of abandoned wells, an analysis of the physics of oil and gas migration is required to determine the level of risk of upward migration of large quantities of oil and/or gas within a depleted well, and to provide more reliable data related to the longevity of well construction materials. Even where negligible risk is established, it would be prudent to maintain an enduring record of well locations and institute well-funded systems to maintain and monitor any problem wells identified. The highest standard of plugging and abandonment should also be applied in fields where a risk of upward migration of oil and gas from depleted shale exists.

Recommendation: *There should be a system implemented by the government which records the location of wells and maintains and monitors any problem wells identified.*

3.1.4 Faults, fractures and conduits

Concerns are often expressed that natural faults and fractures in rocks may create conduits allowing oil, gas or production water to migrate to the surface or into near surface groundwater systems. Gas migration should take place under conditions similar to those of faulty abandoned wells, so a similar analysis of the physics involved may better inform the degree of risk this presents. In the absence of definitive information, avoidance of placing wells in highly faulted areas will minimise the risk of faults creating new pathways for groundwater contamination.

Recommendation: *Subsurface mapping should be used when planning well placements to identify abandoned wells and possible fault lines or weaknesses within the geological formation that may allow migration of gas to near surface aquifers. Wells should not be placed where there are fault lines or weaknesses.*

3.1.5 Surface and waste water management systems

Hydraulic fracturing requires management of large volumes of water on the surface. The NLC is concerned that the large volumes of water used might lead to contamination of surface water and near surface groundwater aquifers if it is not managed effectively. The water is mixed with

chemicals before being injected down the well, and then recaptured as produced water that returns to the surface once gas is released from the shale. This creates three pathways by which contaminated water can enter potable water supplies:

(i) injection directly into the aquifer if well integrity has failed;

(ii) overland flow into rivers, lakes and streams; or

(iii) leaching into near-surface aquifers if spilt on the surface.

Those aquifers that are at greatest risk are shallow (usually less than 30m below the surface) and have a porous substrate (such sandstone and karst).

Produced water is often stored above surface in large, open tanks, which allow the water to evaporate in hot, dry climates. The NLC considers this approach may be unsuitable in tropical climates, particularly when the wet season approaches and areas are prone to flooding. Improved environmental protection could be achieved by utilizing purpose-built above surface storage tanks which can then be removed to facilitate disposal of produced water.

An alternative method of water disposal, which involves direct injection of produced water into deep aquifers, is often used in the USA. However, reinjection of water requires additional wells to be drilled, which are subject to the same concerns related to their construction and integrity. This method of disposal should not be permitted until its potential impacts are better known and a thorough understanding of regional geology (including fault lines), groundwater quality and flow regimes are acquired.

Recommendation: *All above surface procedures involving management of large volumes of water (including mixing of chemicals and storage of produced water) should be performed using enclosed tanks.*

Recommendation: *An investigation into the specific risks and impacts posed by the injection of wastewater under pressure into abandoned wells, deep aquifers or other geological structures must be completed prior to such action being permitted.*

3.1.6 Water quality monitoring

The NLC is concerned that there is a limited amount of water quality data available from many of the areas that show high potential for gas production, and that this limited amount of data does not allow possible contamination of potable water to be accurately determined. The data that exist are difficult to find and to collate.

Where water quality data exist, background (or natural) levels for many of the key contaminants that might result from hydraulic fracturing (e.g. BTEX, methane and organic derivatives of hydraulic fracturing chemicals) are not available, making it difficult to determine now and in the future:

a) if contamination has occurred;
b) the extent of any contamination; and
c) the level of risk to health and the environment that any contamination might pose.

The NLC is concerned that direction, flow rates and connectivity between the numerous aquifer systems are not well established. This make it difficult to fully determine the degree of risk related to slow vertical and/or horizontal migration of contaminants that might occur. This absence of information highlights the need for more detailed local and regional hydrogeological studies so that potential movement of contaminated groundwater can be more accurately assessed on a site-by-site basis.

The NLC is also concerned that materials used for construction of wells might not be suitable for use under conditions where groundwater is acidic, contains high concentrations of dissolved CO_2 or O_2, or is highly corrosive. When designing wells and selecting cements and casing, local water quality parameters should be taken into account so that the risk of barrier failure is minimised and the long-term integrity of wells is maintained. This may require selection of ASTM verified materials for use, supported by an appropriate degree of regulatory oversight.

The key to successful control rests with development of a water quality management plan, based upon a set of water quality criteria. Once identified, a suitable suite of water criteria should be continuously monitored throughout production and well into the post-abandonment phase of the project. To ensure prompt action by the gas producer, the water management plan should be formulated according to a tiered approach, where specific activities are designed to manage problems at each level, before they begin to escalate.

Recommendation: *Greater detail related to water quality, quantity and the location and directions of flow and flow rates of potable aquifers should be made more readily available to traditional Aboriginal owners.*

Recommendation: *Groundwater chemistry should be taken into account and wells engineered in response to any specific and local groundwater chemical risks identified.*

Recommendation: *Each well pad constructed should be accompanied by at least one water bore that is used to (i) measure the quality of potable water in the vicinity of that well pad prior to hydraulic fracturing and (ii) continuously monitor quality of that water during hydraulic fracturing episodes and throughout production.*

Recommendation: *A tiered risk management approach based on the monitoring of specific chemical species in potable aquifers should be applied throughout production as part of a gas company's production management plan. This approach should be designed so that specific interventions are taken by the gas company in response to key trigger values being reached.*

3.2 Water Resources

Most of the smaller Northern Territory communities, pastoral stations, and Aboriginal homelands are reliant on consistent supplies of potable bore water. The NLC and traditional Aboriginal owners express their concern that access to water may be disrupted if volumes of water required by the gas industry are continuous, high, remain unregulated or are not managed efficiently. The NLC understands that oil and gas activities are currently exempt from the application of the Water Act 1992 (NT) (Water Act). The NLC understands that the government is in the process of removing this exemption which means that oil and gas operators will require a licence under the Water Act where they use ground or surface water.

The amount of water used for hydraulic fracturing varies between wells, depending largely on the number of individual fracturing events undertaken. Volumes required are often quoted around 10 – 12 million litres per well.

Should the Northern Territory Government proceed with development of the onshore petroleum industry, then a review of how water allocations are managed should be undertaken to reduce the cumulative risk posed to groundwater quality, volumes and flow, while catering for industrial diversity and social demands. If adequate controls are not placed on all users, overuse of potable water sources by industry may lead to significant drawdown of aquifer levels, with disastrous impacts on the natural environment and on remote communities that rely on bores for their domestic use.

Failure to allocate water in a fair and reasonable manner will have ramifications that may also include impacts on other enterprises, such as tourism and on cultural qualities and activities that require healthy, well-watered environments. These impacts would be felt greater in the more arid areas, where the effects of small drawdown volumes may be greatly magnified. Groundwater-fed rivers, springs, waterholes and streams are not only of ecological importance, but, in many cases, hold cultural significance. Consequently, the NLC believes that changes in water allocations and to the Water Act should be made to guarantee that the domestic and cultural needs of remote communities and homelands are always considered before those of competing industries.

To ease pressure on groundwater and surface water supplies, all industries should be encouraged to consider how they manage water. Water conservation should be a priority and there are a number of different methods by which the quantity of water required for extraction of gas from shale can be minimised. These include:

1) adoption of a re-use, re-claim and recycle philosophy;
2) capture of large volumes of rain and flood water during the wet season;
3) use of water of lesser quality (preferably from deeper aquifers); and

4) application of alternative technologies that require smaller volumes of water, such as gas lifts.

Recommendation: *Water allocations and the Water Act should be amended so that the domestic and cultural needs of remote communities and homelands are the highest priority and placed before the needs of competing industries. A balance between the requirements of competing industries must be achieved.*

Recommendation: *Petroleum companies must minimise the use of potable water in the practice of extracting onshore gas reserves.*

3.3 Cumulative Impacts

Many traditional Aboriginal owners have expressed concern about the cumulative impacts that a wide range of industrial activities are having on water quality, its availability and their combined impacts on the natural environment and traditional food sources. There is concern that decisions have been and are still being made in the absence of a detailed understanding of groundwater flow patterns and information related to baseline water quality and quantity.

Traditional Aboriginal owners are observing expanding areas of impacted environment and are concerned that proper management of water supplies is a contributing factor. It appears that wide-ranging baseline studies of groundwater and recharge rates are not being assessed across aquifers, or at landscape or bioregional scales to create the level of information necessary to determine the volumes of water that can be sustainably utilised by multiple industries, without detrimental effects on communities and ecosystems.

Recommendation: *Whether or not hydraulic fracturing is permitted, the Northern Territory Government should commit to undertaking groundwater, surface water and other assessments that consider the cumulative impacts of multiple industries across regional scales. This should commence with studies in the most prospective gas bearing regions, and be expanded as part of a larger Strategic Environmental Assessment related to economic development across the Northern Territory.*

4.0 Risk Theme 2: Land

Risk Theme 2 identifies six major values related to land access that the Panel considers might create a risk to the land. These include potential impacts to:

- terrestrial ecosystems and biodiversity;
- soil health;
- Aboriginal people and their culture;
- economic;
- amenity values; and
- cumulative risks.

The NLC has concerns that significant environmental fragmentation may occur if the onshore petroleum industry is not developed in a controlled fashion. Should widespread environmental fragmentation occur, it may be detrimental not only to environmental amenity but may have significant impacts on how traditional Aboriginal owners utilise traditional and natural resources due to changes in species' abundance and biodiversity.

Development of a mature onshore petroleum industry would most likely create a grid, or 'patchwork' of small cleared areas connected by roads and possibly other infrastructure, which could fragment local environments if not carefully planned and managed. Fragmentation poses a risk to the abundance and diversity of species, as well as a flow-on effect to Indigenous populations whose wellbeing stems from spirituality and a culture that is based on natural resources. Pastoral, mining, tourism and agricultural activities have already caused significant damage to the Aboriginal estate, so the cumulative environmental and cultural impacts that might be caused by a developing the onshore petroleum industry need to be understood in terms of those existing impacts and managed accordingly. Environmental implications are outlined below, while those of a spiritual and cultural nature are discussed further in Section 10.2.

4.1 Fragmentation

Fragmentation starts to become a major concern where forests are clumped into discrete areas occupying less than about 0.6 km^2 and separated by long corridors (Riiters et al, 2000). Edge effects begin to dominate, and impacts (including those on individual species) begin to be seen. This suggests that a reduction in ground cover of less than 5% due to placement of well infrastructure will pose a very low risk of environmental fragmentation. However, other physical qualities of the landscape (for example, susceptibility to erosion and soil nutrient capacity) must also be considered because these may impact on the landscape's ability to recover and maintain its contiguity.

Modelling of cumulative impacts in the Western Canadian Sedimentary Basin (Schneider et al, 2003), in Alberta's forests (Braun and Hanus, 2005) and in Pennsylvania (Slonecker et al, 2012) showed that fragmentation follows a consistent pattern once it occurs. There would be first a shift from old growth to new growth species; second, a decrease in species dependent on continuous habitats in favour of different species confined to smaller, fragmented areas; and third, the number of exotic species will increase at the expense of natives.

Recommendation: *The potential for environmental fragmentation should be analysed on a case-by-case basis and considered with existing ecological impacts as part of the cumulative assessment within the wider Environmental Impact Assessment, when a production field is being planned.*

4.1.1 Multiple wells on a single pad

The risk of environmental fragmentation may be reduced by separating well pads by a pre-determined distance and by increasing the number of wells on each pad. Distance between wells may differ between locations and should be determined during the planning phase from specific scientific analyses and economic optimisations for each proposed production area.

A number of other infrastructure management techniques can be applied to further minimise the risk of environmental fragmentation. Modern technology allows multiple horizontal wells to be drilled from a single surface location, thereby reducing the cumulative surface impact of the operation. Co-locating wells and facilities such as storage tanks, liquid separators, and vapour recovery units require less land disturbance, fewer roads and pipelines, and smaller footprints reduce traffic for ongoing operations and maintenance activities.

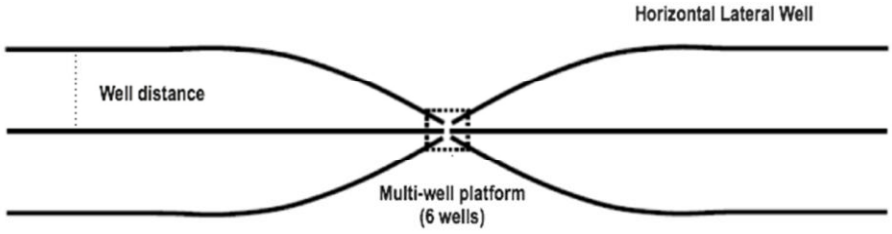
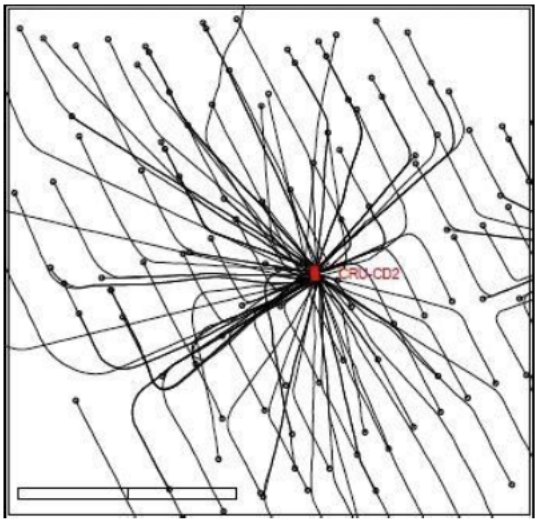


Figure 5: Typical schematic layout of a six well platform

The maximum number of wells that can be placed on a single well pad has still to be determined, but there has been a steady increase since 2007 (Ladlee and Jacquet, 2011). To date, the maximum appears to be 51 wells located on a single 18,000m^2 site that was designed to extract gas from multiple layers below a canyon in Parachute, Colorado (Hicks, 2012). Its construction allows the company to extract gas from an area of 2.6km2, while disturbing <1% of the land's surface. The well pad's schematic is shown in Figure 6. However, the case for construction of multi-well platforms appears quite well established in terms of minimising surface disturbance, the approach used is largely economics driven, rather than deliberately aimed at addressing cumulative impacts on the natural environment.



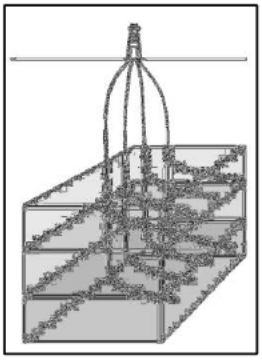


Figure 6: schematic layout of multi-well platform in Parachute, Colorado – plan view (left) and underground view (above). (Hicks. B 2012)

4.1.2 Distance between well pads

The extent of impacts that might be encountered across a shale deposit depends upon a number of key factors including: the number of wells constructed (well density); the distance between wells or multi-well platforms (W); fracture spacing (F_s) and fracture half-length (X_f). W is generally defined by the maximum area of the resource reservoir that can be efficiently and economically drained by one well, which is equivalent to the distance between the centres of adjacent laterals; X_f is the radial distance from the wellbore to the outer tip of a fracture penetrated by the well or propagated from the well by hydraulic fracturing; and Fs is the distance between fractures (also equivalent to the distance between the perforations in the production tubing). The relationship between these variables is shown in Figures 7 and 8.

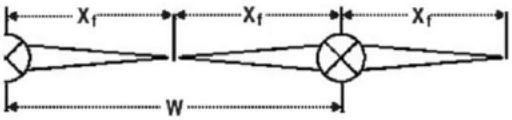


Figure 7: Fracture half-length (X_f) and well distance (W).

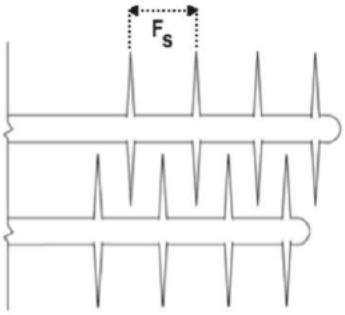


Figure 8: Fracture spacing (F_s)

Although multi-well platforms will result in less surface disturbance compared to multiple single wells, the physical characteristics of the shale deposit will ultimately define the full extent of

disturbance. Porosity and permeability impact on how easily shale can be fractured and this, in turn, dictates the fracture half-length and distance that wells must be separated to ensure that interaction between fractures does not occur.

For example, the Barnett shale has an optimal fracture half-length of 120m (Yu and Sepehrnoori, 2013); optimal well spacing of 305m and optimal fracture spacing of 18m, so using an average horizontal well length of 1.5km, it is calculated that one well would be required for production every 0.5km^2. Using a surface area of 20,000m^2 for a single well pad means that, on average 4.4% of each square kilometre has to be cleared. However, if 6 wells were installed on a single platform, the optimal distance between platforms becomes around 1.65km (Cook et al. 2013) and the percentage of disturbed area falls to <1% of each square kilometre.

Recommendation: *Production planning should include construction of multiple wells on single well pads and optimisation of the distance between well pads to minimise the risk of environmental fragmentation.*

4.1.3 Multiple conventional wells

In the example above, average well density is low, at around 2.2 wells per km^2. If horizontal wells were replaced with vertical wells that were then hydraulically fractured, average well density would increase to at least 3 times that value. This would significantly increase the risk of environmental fragmentation and loss of biodiversity along with attendant increases in other physical impacts (such as road traffic) and risks associated with water use and contamination. Even if conventional wells were suitable for extraction of gas from large shale deposits, better environmental management would be achieved using horizontal hydraulic fracturing methods.

4.2 Cumulative impacts

Traditional Aboriginal owners and the NLC are concerned that imposition of another industrial development may lead to significant land degradation if the cumulative impacts are not properly managed. There is and should be no preference for one industry over another. Instead, competing and co-existing industries should be encouraged to work together so that any synergies related to necessary land clearing can be optimised and the risk of environmental fragmentation reduced.

Many of the cumulative impacts can be determined using the Environmental and Social Impact Assessment (ESIA) process, and assessments made on the basis of proposed activities and an understanding of the surrounding ecosystem. In the Northern Territory, these assessments are usually performed on a project-by-project basis, which tends to restrict the degree to which cumulative impacts are assessed, particularly at landscape or bioregional scale. It may therefore be preferable to consider cumulative impacts of land clearing in the context of a wider Strategic Environmental Assessment that considers the impacts of all industries in line with the future development of the Northern Territory.

5.0 Risk Theme 3: Air

Risk Theme 3 identifies four major values that the Panel considers might represent a risk to air quality. These include:

- public health;
- climate change;
- amenity values; and
- cumulative risks.

The primary component of natural gas is methane, a clean-burning fuel. However, methane is a greenhouse gas that, if released directly into the air, traps heat in the atmosphere. Because of this, there are concerns about methane and other volatile organic compounds (VOC) that might be released during oil and gas operations.

5.1 Fugitive gases and climate change

Concerns related to human health impacts from fugitive gases and other greenhouse gases are discussed in section 6.0 of this submission.

Methane is a powerful greenhouse gas thought to be 25 times more potent than carbon dioxide (CO_2) in affecting the climate over a 100-year time horizon and 72 times more potent over a 20-year horizon. However, uncertainty about the amount of fugitive methane that is emitted over the lifetime of a natural gas well and its associated infrastructure remains. Estimates range from as high as 12% (Howarth 2015) to about 1% (Peischl et al, 2015) of total production.

The NLC is concerned that this wide variation in results is created by a combination of factors and that current regulations do not appear to focus on measures to monitor and continually reduce fugitive gas emissions. This creates a risk that release of fugitive greenhouse gases may become uncontrolled, especially if they are released over the long-term by abandoned wells that no longer retain their integrity.

In addition to regulatory controls, management plans for fugitive gases that are linked to air quality standards should be in place prior to drilling, exploration and production. These may vary across production fields, so site-specific approaches, built around tiered risk management could be utilised. Under these systems, specific interventions would be undertaken once fugitive gases reach certain levels, with inspection and maintenance regimes becoming more rigorous as amounts of fugitive gases increase.

The NLC believes that this approach should be supported by a detailed life-cycle analysis of greenhouse gas emissions and development of air quality standards and reporting mechanisms for each producing well and through tighter controls on operational processes such as venting and flaring.

Recommendation: *Provisions must be made in regulations and/or operational plans to set standards, to analyse ambient air quality prior to production of gas, and to monitor fugitive gas emissions continually throughout drilling, production and following well abandonment.*

Recommendation: *A tiered risk management approach based on monitoring of fugitive gases should also be applied throughout all phases of drilling, exploration and production as part of each oil and gas company's management plans. This approach should be designed so that specific interventions are taken by the gas company in response to key trigger values being reached.*

5.2 Venting

Venting is a safety measure used to reduce the risk of fire or explosion. It is the controlled, direct release of gases into the atmosphere during the course of oil and gas production operations. These gases might be natural gas or other hydrocarbon vapours, water vapour, and other gases, such as carbon dioxide, that are separated in the processing of oil or natural gas.

Venting may occur during well completion, and maintenance of wells, pipelines and other pressurised equipment. Although the amount of greenhouse gases vented from an individual well or piece of equipment may be small, the cumulative impact from several wells or larger pieces of infrastructure is of greater concern. The amount of greenhouse gases released during venting should be controlled through regulation, monitoring and capture (where possible) to reduce the potential for impact on the natural environment.

Recommendation: *Provisions must be made in regulations and/or operational plans to monitor and control venting to reduce the amount of greenhouse gases released, without compromising the overall safety of operations.*

5.3 Flaring

Flaring is a safety mechanism that uses the controlled burning of vented natural gas in the course of routine oil and gas production operations. Flares can also be used to burn gas that is deemed uneconomical to collect and sell. Flares generate heat and, like venting, are noisy because they emit gases into the atmosphere at high velocity. There are several reasons why it may be necessary to flare gas during drilling, production or processing:

- a temporary flare is used during well production testing. During this part of the process, flaring may last until the flow of liquids and gas from the well and pressures are stabilised. This could take several days or weeks;
- In an emergency situation where equipment or piping becomes over-pressured, special valves on the equipment automatically release gas through piping to flare stacks.; or

- flares are also used as an outlet for gas during maintenance and equipment repairs (such as during pigging or after cleaning wells). Under these conditions, the flare is operated temporarily until the emergency situation is resolved, or until maintenance is complete.

In April 2012, the U.S. Environmental Protection Agency issued its first-ever, federal rules for unconventional wells, requiring that companies fully phase in control measures to capture targeted emissions by January 2015. These control measures primarily involve using portable equipment to capture and separate the mixed gases, liquids, and other substances that flow from new wells during the "flow back" period. The captured natural gas can then be re-injected, used on-site, or sold.

Flare gas regulations should be enacted to require oil and gas companies to put in place measures to capture targeted emissions.

Recommendation: *Regulations should be put in place requiring companies to fully phase in control measures to capture targeted emissions and to minimise the use of flaring.*

6.0 Risk Theme 4: Public Health

Risk Theme 4 identifies seven major values that the Panel considers might represent a risk to human health. These risks include:

- drilling and fracking chemicals;
- hydrocarbons and BTEX;
- radioactive substances;
- mental health and wellbeing;
- diesel fumes;
- physical safety; and
- cumulative risks.

As discussed in section 3, maintaining the integrity of water quality is the principal means through which human health can remain protected. The NLC is aware of and supports the NT Government's ban on the use of BTEX during drilling, the requirement for disclosure of chemicals to the Department of Mines and Energy (DME), and the DME's publication of such information in the "chemicals disclosure list" on the internet.

6.1 Chemicals

There is a range of chemicals that are used in the hydraulic fracturing process that may have adverse impacts on the environment and human health. Traditional Aboriginal owners have specifically raised questions pertaining to the risks associated with the use of chemicals during hydraulic fracturing. The NLC and gas companies provide as much information about those risks as is available during the consultation process.

Although chemicals used for hydraulic fracturing are disclosed in the Northern Territory, the NLC notes that information relating to health risks of specific chemicals can be difficult to find and to interpret. In some cases proprietary chemicals, consisting of unrevealed chemical constituents may be used, making full disclosure difficult. In these circumstances consultation may become further complicated where translation into an Aboriginal language is required. An independent assessment of the risk posed by specific chemicals on a project-by-project basis would be helpful, especially if translated into local Aboriginal languages.

Other problems may be encountered with transport and handling of bulk quantities of chemicals. As discussed in section 3.1.4, systems and equipment for the management and mixing of chemicals on the surface should be designed so that the potential for spillage is minimised. Where possible, less hazardous materials should be used and mixing of chemicals undertaken with a minimum of water inside enclosed tanks.

Recommendation: *Oil and gas companies should work with Land Councils to translate information about chemicals and their health risks to ensure that traditional Aboriginal owners have a clear understanding of the potential risk to their health, their community and its water supplies.*

6.2 NORM/TENORM

The NLC recognises that there is a potential risk that small amounts of naturally occurring radioactive materials (NORM) might be brought to the surface following hydraulic fracturing. NORM, such as uranium (U), radium (Ra), and thorium (Th), are present in the natural environment, including subsurface soils, rock, and water. The primary radionuclide of concern is ^{226}Ra, which may become concentrated in residual wastes and sludge as produced and flowback waters begin to evaporate. Wastes created this way are classified as technologically enhanced naturally occurring radioactive material (TENORM). If spillages occur, surface soils and near surface aquifers may also be contaminated.

When properly managed, NORM and TENORM do not pose any significant health risk, but management plans that ensure wastes are properly contained and recovered in the event of a spill should be prepared by the oil and gas industry. The Northern Territory Government should also consider constructing a purpose built facility for managing sludge, waste and water that is shown to contain NORM and TENORM at levels that might represent an unacceptable risk to the public.

Potential radionuclides should be identified through initial environmental impact assessment of waters and subterranean geology and if observed in flowback or deep aquifer waters, managed in accordance with national guidelines. National guidance for the management of NORM (and TENORM) can be found in the Australian Government's "Safety guide for management of naturally occurring radioactive material (NORM)" (ARPANSA, 2008). The industry and its regulators should consider the advice contained within this guide when developing appropriate radiation protection measures and/or a regulatory approach for the onshore oil and gas industry.

Recommendation: *Industry specialists, ARPANSA and government regulators should work together to develop systems and/or regulations for the management of naturally occurring radioactive materials.*

6.3 Fugitive and greenhouse gases

With the possible exception of the potential for release of hydrogen sulphide and methane, the NLC has few concerns about potential health risks related to fugitive and greenhouse gases. Any concerns about the potential for greenhouse gas emissions from an oil and gas industry on climate change have been discussed in section 5.1 of this submission.

Hydrogen sulphide is a pungent, highly toxic gas that is occasionally found in low concentrations in conjunction with methane in natural gas. When flared, it produces another odorous gas, sulphur dioxide. However, there may be a significant cumulative impact on air quality, and therefore human health, if multiple wells are constructed on a single well pad and fugitive methane is detected.

The impact of methane on ambient air quality is likely to be highly localised, around the well pad, and dissipate quickly with distance. In locations where hydrogen sulphide is present, its pungent odour may make the impact more noticeable over a larger area. To minimise the risk and its

nuisance value to traditional Aboriginal owners living in proximity to shale gas wells, oil and gas companies should determine the likelihood of fugitive gases being released from wells as part of their environmental impact assessment, the types of fugitive gases and their potential health impacts.

If a risk of significant fugitive gas release exists, management plans should be developed in consultation with affected communities and a minimum offset distance between wells and nearby communities, homelands and other residential areas should be determined so that the nuisance value and potential risk from fugitive methane and hydrogen sulphide is reduced to a minimum. Both gases should be included in monitoring regimes and monitored across the life of the project.

Recommendation: *All communities, homelands and other residential areas located on Aboriginal land should be excluded from onshore petroleum exploration and production permits. These exclusion zones should be based on a standard minimum distance between residences and permit boundaries.*

Recommendation: *Minimum offset distances between wellheads and communities, homelands and other residential areas must be negotiated with residents likely to be affected by noxious gas emissions and plans for monitoring and management of those gases must be put into place.*

7.0 Risk Theme 5: Aboriginal people and their culture

Risk Theme 5 identifies five major values that the Panel considers might create a risk to the culture of traditional Aboriginal owners; namely:

- land ownership;
- benefits;
- culture, values and tradition;
- community wellbeing;
- aquatic and terrestrial ecosystems; and
- cumulative risks.

Impacts on Aboriginal culture are managed or protected through a number of legislated and other mechanisms, including specific clauses in agreements negotiated with oil and gas companies under ALRA and NTA (NLC Agreements). Key legislation includes the Northern Territory Sacred Sites Act, the Northern Territory Heritage Act and Commonwealth Legislation such as ALRA, the NTA and the Aboriginal and Torres Strait Islander Cultural Heritage Act. Adherence to these Acts means that sacred, culturally sensitive, historic and archaeological sites will remain protected or well managed.

Under terms of NLC Agreements, companies must procure an AAPA Certificate or have an NLC sacred site survey completed before they can enter and work upon any part of their tenement. Additional layers of protection are added by the necessity for discussion of works programs with traditional Aboriginal owners prior to commencement and engagement of senior traditional Aboriginal owners (custodians) by the company to monitor operations to ensure culturally sensitive areas are not adversely impacted.

7.1 Traditional practices

Past grants of freehold title and pastoral leases have been used to create a legal system in which the Aboriginal estate has become fragmented, resulting in disenfranchisement of many Aboriginal people from their cultural and land ownership rights. Many traditional practices rely upon access to land, sacred sites and the use of natural resources, and loss of access has placed survival of these practices at high risk.

The NLC recognises that Aboriginal culture is fluid, adaptable and constantly changing in response to external stimuli, however some traditional Aboriginal owners are concerned that the degree of change is too extensive and too rapid. Oil and gas companies should therefore be prepared to work with Land Councils and traditional Aboriginal owners to ensure that any degree of change is managed in a sensitive and practical manner that does not significantly impact upon existing traditional practices, while at the same time allowing any change to occur in a manner controlled by Aboriginal people. A typical example might be a slow but steady shift from traditional work patterns to those more akin to the requirements of industry.

In similar fashion, oil and gas companies should also work closely with traditional Aboriginal owners to maintain traditional practices by utilising them in work management programs where applicable. A typical example might be the application of traditional knowledge and land management practices (e.g. fire management) to rehabilitation and abandonment.

7.2 Cultural knowledge and values

Cultural knowledge and values are at the core of the Aboriginal way of life that preceded European contact by many millennia. Some degree of cultural evolution across time is inevitable, but industrialisation of the Northern Territory has the potential to lead to rapid and significant loss of traditional Aboriginal ecological and cultural information. Overall spiritual values of the landscape will be lost if individual sites become isolated, cultural values of water will be damaged if it becomes contaminated and the wider traditional ecological and cultural knowledge that constitutes the unique Aboriginal body of science will eventually become diminished once traditional practices are no longer followed.

When used in combination with western scientific views, traditional practices, ecological knowledge and cultural knowledge offer a more complete understanding of the natural environment and processes that can be used to manage it. Unfortunately, the Northern Territory's environmental assessment process does not offer prominent consideration of the value inherent in traditional ecological and cultural knowledge, and tends to treat it as a heritage management problem rather than as a unique set of contributing data. Traditional Aboriginal owners desire that their unique ecological and cultural knowledge and practices remain protected and are utilised where possible to create environmental assessments and analyses that are meaningful to them and to the wider Northern Territory society.

For this to be achieved, the NLC recommends that the Northern Territory's environmental impact assessments and/or legislation be restructured to make it mandatory for all projects to consider not only impacts on traditional practices, cultural knowledge and ecological knowledge, but also to collate, record and utilise it throughout all phases of their operations. Industry, including the onshore oil and gas industry, should commit to its own programs designed to protect traditional Aboriginal ecological and cultural knowledge so that it may be preserved and transmitted to future generations. Special consideration should be given to the aesthetic and cultural values of water, which traditional Aboriginal owners consider to be placed at greatest risk by hydraulic fracturing.

Recommendation: *Systems and processes for all projects should be designed to capture and protect cultural knowledge and traditional knowledge and practices and to apply this knowledge with a particular focus on environmental maintenance, management and rehabilitation.*

Recommendation: *The environmental impact assessment process should be amended to ensure that all major developments (including oil and gas) consider fully their impacts on the spiritual and cultural values of flora and fauna species and of water contained within their area of influence.*

Recommendation: *Provisions within the environmental impact assessment process should be put in place to ensure that impacts on the aesthetic and cultural integrity of natural water sources are unaffected by hydraulic fracturing and by rapid development of an oil and gas industry.*

7.3 Production from beneath sacred sites and clan boundaries

In the course of its consultations with the NLC, traditional Aboriginal owners have asked if it is possible for oil and gas companies to access a deposit and extract oil and/or gas from beneath neighbouring lands where negotiations have not concluded or where consent has not been granted, or from beneath sacred sites. In some instances, sacred sites and their features can extend below the surface and may be associated with subterranean water, rocks and rock formations.

The AAPA has recorded and registered numerous sites that have culturally sensitive subterranean features. These subterranean features may be actual and/or conceptual extensions of surface sacred site features such as billabongs, river or hills and may constitute parts of dreaming tracks. They are often viewed in Aboriginal culture as inhabited by Creation Ancestors (and especially the "Rainbow Serpent") that communicate across large areas and connect with or emerge to form sacred sites and other surface features.

Although AAPA, NLC site surveys and consultation processes delineate areas where operations are excluded and oil and gas operators are bound by the terms of NLC Agreements including certificated "restricted work areas", some traditional Aboriginal owners remain concerned that companies may interpret these conditions as relating to surface areas only. It is possible that hydraulic fracturing may be permitted beneath sacred sites, beneath areas where consent has not been obtained and/or beneath restricted work areas, thus creating a risk that unexpected surface damage may occur.

If hydraulic fracturing occurs beneath a culturally sensitive area (such as a sacred site), there may be adverse impacts on:

- spiritual and physical wellbeing of site custodians;
- cultural values of the landscape and particular species or environmental places; and
- cultural or customary practices of Aboriginal clans.

If hydraulic fracturing occurs under non-consent areas or beyond the boundaries of an area of consent, then this may:

- undermine the rights of neighbouring Aboriginal clans to negotiate future benefits from oil and gas extraction;
- reduce the potential economic benefit that would be obtained from future extraction;
- generate conflict between Aboriginal clan groups if one group benefits from extraction from beneath the neighbours estate;
- undermine confidence in the oil and gas operator, the industry and its regulators; and
- result in demands for compensation for loss of an economic resource.

The NLC believes that these issues can be handled through its negotiations and consultation process, however the effectiveness of negotiations would be improved if oil and gas companies committed to

placing wells a safe distance from areas of concern, and demonstrating that hydraulic fractures and horizontal wells would not extend beneath them. Alternatively such requirements could be imposed through legislative and/or regulatory mechanisms.

Recommendation: *Horizontal wells must be positioned so that they do not extend beneath sacred sites (unless permitted by Agreement with traditional Aboriginal owners) or beneath areas where consent to explore and produce has not been obtained.*

Recommendation: *Management systems should be put in place to monitor and clearly demonstrate the subterranean extents of horizontal drilling and induced hydraulic fractures.*

8.0 Risk Theme 6: Social

Risk Theme 6 identifies thirteen major values related to land access that the Panel considers might create a risk to wider society; these are:

- housing and rents;
- insurance;
- health services;
- education;
- infrastructure;
- livelihoods;
- long term benefits;
- community cohesion;
- crime;
- employment;
- business;
- amenity; and
- cumulative risks.

Many of the NLC's concerns related to social impacts (including community cohesion and resilience, employment and business opportunities) are tied closely to economics or Aboriginal culture and traditional activities and are therefore discussed under other, more relevant risk themes. Others, such as health care, education and dealing with crime rates are more pertinent to issues of governance by the Northern Territory Government.

8.1 Changing population demographics

Many of the remote locations that contain prospective oil and gas reserves are small and predominantly populated by Aboriginal people. Availability of services can be problematic and in many places, infrastructure is poor and requires upgrade. A rapidly developing onshore oil and gas industry creates a risk that existing infrastructure will be swamped and unable to cope with increased populations and movement of traffic.

While it is of importance to increase the viability of the Northern Territory's remote towns and services, the NLC is concerned that significant increases in population may create undue pressure on services present in remote towns such as Elliott. Although there is a prospect of services being improved, the degree of improvement may be tempered if oil and gas companies choose not to base the bulk of their workforce permanently in the area (i.e. if they opt for Fly-In Fly-Out types of arrangements). This may result in localised 'boom and bust' economies or transfer of wealth out of the regions.

Large, rapid increases in populations may also lead to increased pressure on use of land and natural resources, which may be to the detriment of local Aboriginal culture. Other social problems, such as localised inflation, or increased crime may ensue if increases in population are not moderated. These are risks that may be beyond the capacity of industry, the NLC and traditional Aboriginal owners to resolve, but need to be discussed in light of a wider Strategic Environmental Assessment, and have plans put into place to manage the impacts.

8.2 Improving Infrastructure

Currently, there appears to be an imbalance in how funding is distributed around the Northern Territory, with most monies allocated to maintenance of services and infrastructure in the areas around Darwin. Consequently, the infrastructure, utilities and services in remote towns are of a lower standard and most likely not sufficient for production of oil and gas. Significant works will be required if the industry is to progress to a point where it is capable of providing a suitable level of support to nearby towns and communities.

The NLC believes that, in the interests of its constituents, the Northern Territory Government and the onshore oil and gas industry should commit to investing strategically in remote towns and infrastructure. If the Northern Territory is to progress economically and socially, the Government's focus on Darwin should be reduced and a greater share of the profits and royalties from the industry should be allocated to remote infrastructure development in accordance with a pre-determined "royalties for regions" process.

Additional investment could be provided by the oil and gas industry to support key services and industries aimed at maximising employment, training and business opportunities to improve long-term resilience and sustainability of remote communities.

Recommendation: *Commitments should be made by the onshore oil and gas industry and by the Northern Territory Government to upgrade key utilities and services in remote towns so that entire communities will benefit from the royalties generated from the oil and gas industry.*

9.0 Risk Theme 7: Economic

Risk theme 7 identifies seven major economic values that might be related to development of a gas industry based on hydraulic fracturing; these include:

- distribution;
- property values;
- other industries;
- energy security;
- net impacts;
- management; and
- cumulative risks.

Committed to the development of a sustainable economic future for our constituents, the NLC looks to industry, including the onshore oil and gas industry, and various layers of government to manage their business to the benefit of Aboriginal people.

9.1 Potential economic benefits to traditional Aboriginal owners

Many Aboriginal communities are remote and largely reliant on welfare. A mature and well-designed onshore oil and gas industry offers the potential to address a number of the economic pressures placed on people living under these conditions. The NLC has identified five potential streams of income-related avenues that could be applied directly to Aboriginal communities to foster community development and help ease these pressures. These include:

1. a share in the wider community benefits generated by the 10% Northern Territory government royalty placed on gas production;
2. receipt of compensation through NLC Agreements;
3. business development opportunities created through NLC Agreements;
4. direct employment and training opportunities related to exploration for, and production of, gas; and
5. additional community infrastructure and development benefits that may be negotiated as part of a production Agreement.

It is difficult to place an accurate figure on the full economic value that a mature oil and gas industry may provide to remote communities because this would depend on the volume of gas produced, the rate at which it is produced, its market value and the terms and conditions in any negotiated Agreements.

A number of traditional Aboriginal owners have expressed interest in the community and individual benefits that would become available. A number of work-based opportunities have already emerged from NTA Agreements negotiated between the NLC and onshore petroleum companies. These include work for traditional Aboriginal owners in environmental management, monitoring and remediation, civil works and construction and cultural monitoring and protection. The NLC continues to work to expand these opportunities so that the economic returns and benefits to remote Aboriginal communities are maximised in areas where there is gas exploration and production.

9.2 Potential economic detriment to traditional Aboriginal owners

Royalties received from Agreements are generally split amongst traditional Aboriginal owners according to their relationship to the land. The NLC is careful to ensure that its understanding of the anthropology of areas proposed for development of the onshore petroleum industry is as accurate as far as possible and that efficient management systems are in place.

Although its constituents stand to benefit from a developing onshore oil and gas industry, the NLC is cognisant that the influx of large amounts of money into remote Aboriginal communities may create several economic related risks, including:

- localised inflation, that will impact upon individuals that do not receive direct financial benefit from NLC Agreements;
- social risks related to perceived inequity in wealth distribution between those traditional Aboriginal owners who have agreed to gas exploration and those who have not;
- social risks related to perceived inequity in wealth distribution between traditional Aboriginal owners (who receive the direct financial benefits under the NLC Agreements) and members of the affected Aboriginal community (who do not receive financial benefits); and
- mismanagement, theft or loss of large amounts of compensation received under the NLC Agreements.

Consequently, benefits may be short-lived or create unnecessary conflict between community residents if management of benefits is not carefully administered. The NLC is concerned that these problems may be exacerbated by external influences if third parties target vulnerable people (including traditional Aboriginal owners).

Recommendation: *The oil and gas industry and the Northern Territory Government should work with the Land Councils to ensure that benefits to traditional Aboriginal owners are managed in a manner that benefits all Aboriginal people living in a gas-producing area.*

10.0 Risk Theme 8: Land access

Risk Theme 8 identifies five major values related to land access that the Panel considers might create a risk to the rights of traditional Aboriginal owners; these are:

- consultation;
- consent;
- conditions;
- compensation; and
- cumulative risks.

These values relate only to how access is agreed between Aboriginal people and gas companies; however there is a second and equally important issue that must be considered – how the infrastructure necessary for the industry to operate might impact on how Aboriginal people access and use land. These are two separate, but related issues, and both have implications for a number of other risk themes discussed in this submission.

10.1 Access to land by companies and the protection of Aboriginal peoples' rights.

As part of its statutory role under ALRA and the NTA, the NLC acts as an intermediary between gas companies and traditional Aboriginal owners. Under the processes utilised, the rights of Aboriginal people are well protected because companies' access to land subject to ALRA and the NTA is prescribed by law. This creates negligible risk that a project would be able to proceed without the knowledge of, or without prior consultation with, Aboriginal people.

10.1.1 Consultation

The NLC's consultation processes with traditional Aboriginal owners have developed over a period of 40 years in compliance with ALRA and NTA. They represent current leading practices, as defined by the principles of Free, Prior and Informed Consent. On lands subject to ALRA, traditional Aboriginal owners make decisions, with outcomes supported by the right to veto exploration and production of oil and gas. Where the NTA applies, the right to veto exploration and production of oil and gas does not exist, but the traditional Aboriginal owners who hold native title have the right to negotiate terms of an agreement.

A significant part of the consultation process revolves around developing working relationships with gas companies. Through these relationships, the NLC remains informed of developments and negotiate mutually beneficial plans and proposals designed to ensure our traditional Aboriginal owners' rights remain protected and they receive reasonable financial compensation. Progress is made in stages and each stage is presented to traditional Aboriginal owners via Work Program meetings designed to discuss impending activities and opportunities that might become available.

Quality of information provided during consultations

The key to successful consultation is to provide high quality, relevant and accurate information to the relevant decision-makers. The NLC does this through:

- anthropological advice to ensure that the correct people make the decisions;

- technical and scientific advice related to the natural environment, mining, oil and gas and other industrial developments;
- legal advice during negotiations; and
- an in-depth understanding of hydraulic fracturing as has been outlined in Part 1 (Background Information) of this submission.

10.1.2 Consent

As indicated in section 10.1.1, the risk of a company entering Aboriginal land without consent is negligible, but consent provisions differ according to legislation. The NLC manages the question of consent in accordance with either ALRA or NTA legislation through the consultation processes detailed below.

ALRA

Where Aboriginal freehold title exists under ALRA, gas companies **must** have the consent of the NLC prior to accessing land for exploration. The NLC must consent to the grant of an exploration permit only if it is satisfied that the traditional Aboriginal owners understand the nature and purpose of the terms and conditions, and as a group, consent. As part of this process, the NLC must also consult with any Aboriginal community or group that may be affected by the grant of the exploration licence and must ensure that they have an opportunity to express their views to NLC.

To determine if consent exists, the NLC uses a three-part consultation process.

During the first meeting, the company describes its proposals to traditional Aboriginal owners who then decide whether to refuse consent, or enter into negotiations with the company. If the traditional Aboriginal owners refuse consent, no exploration activities can be conducted on the land for a period of 5 years.

If traditional Aboriginal owners do not refuse consent to exploration at the first meeting, the NLC then completes a site survey to identify areas of interest that are to be excluded from exploration, and negotiate an agreement with the company. The NLC must be satisfied that the terms and conditions of such agreements are reasonable. The agreement and results of the survey are then presented to the traditional Aboriginal owners at a second meeting, where a final decision whether to refuse consent, or enter into the agreement with the company is made. If the traditional Aboriginal owners refuse consent, the land is placed into moratorium, and no exploration activities can be conducted, for a period of 5 years. If the traditional Aboriginal owners choose to enter into the agreement, then consent for both exploration **and** production is deemed to be given.

NTA

Under the NTA petroleum companies **must** negotiate an agreement with the Native Title parties prior to being permitted to access land for exploration.

The NLC uses a two-part process during its NTA negotiations. At the first meeting the company describes its proposals to the Native Title Parties, who then instruct the NLC whether or not to negotiate an agreement with the company. If the Native Title Parties instruct the NLC that they are not willing to negotiate an agreement, the company then has the right to seek an arbitrated outcome.

If the Native Title Parties instruct the NLC to negotiate an agreement, the finalised agreement is taken to a second meeting to ratify its terms and conditions.

10.1.3 Conditions and compensation

Specific conditions (e.g. environmental and cultural protection) and rates of compensation are contained within agreements made between the petroleum company and the NLC (on behalf of its traditional Aboriginal owners). Where agreements are negotiated under ALRA or the NTA, land access arrangements are also supported by specific terms and conditions. These terms and conditions are designed to ensure that companies cannot access land or undertake exploration activities without first having those activities presented to and discussed by affected traditional Aboriginal owners or Native Title Parties (i.e. 'cleared').

Clearances have two aspects, which take the form of discussions at work program meetings, and the acquisition of AAPA certificates or an NLC sacred site clearance. Unless both of these steps have been completed the company will be in breach of its agreement and exploration is unlikely to occur.

There is a smaller risk that conditions and compensation negotiated on land subject to ALRA will not be beneficial to traditional Aboriginal owners, because the project can be vetoed if conditions and compensation are believed to be inadequate and/or unreasonable. A more significant risk occurs where land is subject to the NTA and traditional Aboriginal owners refuse to negotiate an Agreement and an arbitrated outcome is sought.

10.2 Potential restrictions preventing Aboriginal people from accessing land.

Any restriction placed on access to land by infrastructure has a spiritual dimension. In Aboriginal culture, many sites of significance are connected by 'dreaming tracks', which connect to sites maintained by other traditional Aboriginal owner groups, and whose country may be hundreds of kilometres distant. Restrictions placed on the ability to visit sites of significance, or a physical barrier (e.g. a fence) across the chain of connecting sites of a single tradition may result in distress to Aboriginal people.

In many locations where pastoral properties exist and areas of land have been fenced off, Aboriginal people still retain the right to access sacred sites to perform ceremony and to enjoy cultural recreational activities such as hunting and fishing. This right is enshrined in the *Pastoral Land Act (NT)* and pastoralists are encouraged to provide access to traditional Aboriginal owners and site custodians. This right must continue to be maintained in locations where the oil and gas industry is being developed and consequently the NLC seeks to protect it through its agreements with oil and gas companies under the NTA. Under ALRA, Aboriginal people are entitled to enter upon Aboriginal land in accordance with Aboriginal tradition.

There is a risk that if production fields are not well planned, infrastructure may diminish the ability of Aboriginal people to access land for cultural purposes. A similar impact may be created by some legislation and industrial practices that are aimed at protecting human health and safety. A careful balance between health and safety and cultural rights is required and the NLC believes that this could be achieved by minimising the amount of land disturbed for infrastructure development. The principle of using pads containing multiple wells, set at optimum distance (discussed in sections 4.1.1 and 4.1.2) in conjunction with burial of other infrastructure such as pipelines and power lines would minimise surface-based restrictions.

This approach would also minimise the number of operational areas where access might be restricted due to health and safety and/or other management requirements.

Recommendation: *Onshore gas producers should maximise traditional Aboriginal owners' access to land by minimising the number of operational areas and burying ancillary infrastructure where possible.*

11 Risk Theme 9: Regulatory Framework

Risk theme 9 identifies 10 major values related to how the Northern Territory Government might regulate hydraulic fracturing and the oil and gas industry; these include:

- failure to protect the environment;
- land access;
- public health;
- Aboriginal culture and communities;
- social impacts;
- economic impacts;
- compliance and enforcement;
- complexity;
- regulatory capture; and
- cumulative risks.

The NLC sees a consistent message running through many of the reviews of unconventional methods of gas production methods that the NLC has examined (Royal Society, 2012; NSW Parliament, 2012; Cook et al, 2013; Council of Canadian Academics, 2014; Hawke, 2014; O'Brien, 2015). That message is:

> *"The technical challenges and risks posed by techniques for production of unconventional gas can, in general, be managed within a clear, revised, legislative framework which is supported by an effective and transparent reporting and compliance regimes and by drawing on appropriate expert advice"*

Following its study of the onshore petroleum industry in Canada and the USA in 2011, the NLC considered that the Northern Territory's legislative and regulatory framework for dealing with onshore oil and gas projects was unsatisfactory. The NLC began working with the Northern Territory Government and other stakeholders to address key issues that were not adequately covered by the *Petroleum Act*, *Petroleum Regulations* and the *Schedule of Onshore Petroleum Exploration and Production Requirements*. Although some work was done to review and reform onshore petroleum industry-related regulations in the Northern Territory, including an Inquiry into the hydraulic fracturing technique (Hawke, 2014) and a review of the Northern Territory's Environmental Regulations (Hawke, 2015), there is still considerable room for improvement to be made to the Northern Territory's regulatory regime.

The NLC has doubts that existing Government, Regulatory and Land Management bodies in the Northern Territory currently hold sufficient capacity to adequately manage rapid development of the onshore oil and gas industry. In accordance with its submission to the 2016 Senate Select Committee's Inquiry into Unconventional Gas Mining (NLC, 2016), the NLC maintains a preference for a Regulatory model that uses a harmonised 'dual systems approach' where control is devolved to individual States (or Territories), but the Commonwealth retains a degree of coordination and oversight, to create a minimum level of standards and consistency across Australia.

The NLC supports efforts to improve transparency and accountability with regard to the onshore petroleum industry. In this regard the NLC advocates for information pertaining to all payments made to the NT Government for environmental or security bond to be made publically available.

Recommendation: *All transactions relating to environmental or security bonds paid by oil and gas companies to the Northern Territory Government should be made publically available. Oil and gas production royalty payments made to the Northern Territory Government should also be publically released. .*

Recommendation: *The capacity of the Northern Territory Regulators, in terms of skills and number of personnel required to regulate the onshore petroleum industry must be increased.*

11.1 Environmental protection

The level of concern that has been expressed about the prospect of an oil and gas industry that uses hydraulic fracturing, suggests that a strong regulatory framework aiming towards the highest level of environmental protection is required. To achieve this will require a review not only of petroleum legislation and its environmental regulations, but eventually other interdependent legislation and regulations a company must consider when undertaking its environmental assessments. This review could include the raft of legislation reviewed in 2015 (Hawke, 2015) as well as expansion of the Coal Seam Gas 'water trigger' in the Environmental Protection and Biodiversity Conservation Act 2000 (EPBC Act) to cover all types of onshore petroleum exploration and production.

Recommendation: *Environmental legislation should be reviewed in line with the outcomes of this Inquiry and a 'water trigger' legislated for all onshore petroleum exploration and production activities, preferably in the EPBC Act, as has already been done for coal seam gas.*

Many of the environmental concerns target the protection of valuable water supplies also required for domestic use, mining, pastoral, tourist and agricultural industries, and a healthy environment. Although all of these will use and contaminate water to varying degrees, the concern is that development of the onshore oil and gas industry in addition to these may result in levels of contamination from which the natural environment would not fully recover. Robust regulation of water use and wastewater disposal, across all industries is needed to balance the economic, cultural and environmental needs of the Northern Territory and especially of remote Aboriginal communities.

The NLC believes that this level of regulation is best informed through bioregional assessments of prospective gas production areas that consider cumulative impacts, not only across multiple well placements, those of other, nearby industrial, pastoral and agricultural developments. Such an

assessment should be spatial and temporal in nature, incorporate bioregions and should be included as part of a wider Strategic Environmental Assessment for the Northern Territory.

The NLC believes that the current method of preparing individual environmental management plans on a well-by-well basis is inadequate in comparison to the level of impact that might be expected from the onshore petroleum industry. Consequently, the requirements of Environmental Impact Assessment should be modified to meet the need for improved assessment of cumulative impacts, especially where a large number of wells exist in a relatively small area, such as a single production pad and/or across a gas production licence area.

Recommendation: *The use of potable water and disposal of wastewater by all industries must be regulated.*

Recommendation: *Reform of existing Northern Territory legislation and regulations should be designed, in partnership with Land Councils and the Aboriginal Areas Protection Authority, to bring water use for hydraulic fracturing and other extractive industry purposes into the water allocation planning framework, in line with the National Water Initiative framework.*

Recommendation: *A greater focus must be placed on the potential for cumulative impacts on water resources, including water quality, for all projects referred for environmental impact assessments.*

When wells are in continuous operation, there is an expectation that they are well serviced and maintained. Once the gas is exhausted, each well is plugged with cement and abandoned. Despite the mechanisms by which wells might fail being quite well established (see discussion in Section 3.2), there are little data to describe how long it might be before an abandoned well begins to leak (if ever). The regulatory framework must therefore also consider the potential for future environmental impacts caused by abandoned wells and associated infrastructure, where responsibility for them ultimately rests, and how the costs associated with their maintenance will be managed. The NLC is concerned that the Northern Territory Government may be insufficiently resourced to monitor the full extent of future environmental impacts posed by the development of the onshore oil and gas industry.

The first step would entail specifying construction according to industry standards and best practice and enforcing the emplacement of multiple barriers, to reduce the risk of well failure. This should be

supported by ongoing research into improving well safety and reliability, along with the consideration of options through which management of older wells can be done. These options may include the implementation of a levy and/or bond system similar to that implemented for managing mining legacies in the Northern Territory.

Recommendation: *Regulations should specify that all oil and gas wells are constructed according to the highest standards available and should be constructed with multiple (i.e. a minimum of 5) layers of casing cemented in place.*

Recommendation: *All well locations must be registered and regulations for the management of legacy issues must be put in place.*

Recommendation: *A levy and/or bond system that aims at funding future monitoring and maintenance of abandoned wells should be implemented.*

11.2 Protection of Aboriginal communities and culture

Strong legislation is required to protect the rights and the culture of traditional Aboriginal owners in the face of advancing technology and increasing development of intensive resource extraction industries such as onshore oil and gas.

The NLC considers that existing arrangements under the ALRA and the NTA provide a robust mechanism whereby access to land and Aboriginal interests in that land can be managed. Any changes that might be made to Northern Territory legislation and regulations to allow an onshore oil and gas industry to develop must not be to the detriment of existing legislation and the rights of Aboriginal people.

However it may be possible to trigger positive changes that improve protection of rights to land and to practice culture. The NLC believes protection of Aboriginal rights and economic development of Aboriginal people could be further enhanced by moving the regulatory regime away from one of 'deemed consent to production', to one where consent to explore is separated from consent to produce on Aboriginal land subject to ALRA.

Change in this aspect of the regulatory regime may create an environment of improved relationships, because traditional Aboriginal owners no longer feel pressured into making decisions about production based on incomplete knowledge. It may also allow for a more focussed approach to future production and greater protection of environmentally and culturally sensitive areas, while

encouraging Aboriginal people to work with companies and regulators to maximise economic potential and benefits, secure in the knowledge that culture is being protected.

Recommendation: *Consideration should be given to changing the Petroleum Act to allow separate mechanisms for consent to exploration and consent to production and to making recommendations for similar changes in ALRA.*

Recommendation: *Any changes made to the Petroleum Act and Petroleum Regulations must not conflict with and must not diminish the protections afforded to Aboriginal people under the ALRA and the NTA.*

Recommendation: *Any changes made to the Petroleum Act and Petroleum Regulations must not conflict with and must not diminish the cultural protections afforded to Aboriginal people under Federal and Territory cultural heritage and sacred sites legislation.*

Recommendation: *Any changes made to the Petroleum Act and Petroleum Regulations must encourage economic security within Aboriginal communities.*

12 Concluding remarks

Over the past 8 to 10 years, there has been considerable worldwide debate about the use of hydraulic fracturing to recover oil and gas from coal seams, tight sands and shale numerous governments worldwide have undertaken inquiries into the matter and, on the basis of those, have generally chosen to allow hydraulic fracturing; others have rejected hydraulic fracturing outright mainly due to the perceived environmental risks. The Northern Territory's Aboriginal population has a profound interest in this discussion because there are a large number of oil and gas projects proposed for Aboriginal land and land on which the NTA applies.

The NLC is aware of diverse views amongst Aboriginal groups about whether hydraulic fracturing poses an acceptable risk or not. This submission seeks to express the full range of these views, and to invite ongoing dialogue to enable free, prior and informed consideration of projects proposed for land within the NLC's jurisdiction. The NLC can achieve this by taking the Inquiry's findings to its constituents and by incorporating them into its own consultation process.

Arguments against hydraulic fracturing revolve around stakeholder concerns related to the risks to the natural environment and to the health of people. The counterbalance to the argument is largely economic – that the processing of the Northern Territory's shale oil and gas deposits has the potential to provide significant and positive economic benefits.

Technical reports and financial assessments suggest that the economic impact of the shale oil industry on the Northern Territory is likely to be immense. Traditional Aboriginal owners are aware that many areas over which they hold Aboriginal freehold title or native title rights are resource rich. However, Aboriginal people are also among the most socio-economically disadvantaged of people in the Northern Territory, so it is only natural that they might wish to materially benefit from the economic potential offered by the oil and gas industry, and understandable that they remain cautious where developments might pose a risk to their land, its resources, their culture and associated spiritual attachments.

The NLC's submission therefore does not argue for or against hydraulic fracturing, but supports improved and more detailed understanding of the process and its impacts so that traditional Aboriginal owners can make better-informed decisions about how they manage resource development on their land. By taking this approach, the NLC seeks a balanced outcome that allows for co-existence of multiple industries operating without the risk of overexploitation or an accumulation of adverse impacts. This would provide traditional Aboriginal owners the freedom to choose how they wish economic development to proceed on their lands and how they wish to develop socially. In accordance with its statutory role, the NLC will continue to advocate for the interests of traditional Aboriginal owners should the moratorium on hydraulic fracturing be lifted to ensure that while economic and social development may occur, the rights to land and maintenance of culture are not adversely affected.

Throughout the debate, it is clear that the potential for contamination of potable water [and air], combined with an inefficient and inappropriate regulatory regime is the over-riding concern. It is important that any modifications to regulations for water do not focus solely on the oil and gas industry, but are placed in the correct context of wider development of the Northern Territory by

considering the potential for cumulative impacts from a wider range of industries, while always prioritising the needs of remote communities.

Likewise, it is important that if the onshore oil and gas industry is permitted to proceed, the Northern Territory must learn from the problems that have been encountered in other countries like the USA and develop leading practice standards for well construction, management and abandonment. Only then will the economic benefits of oil and gas production be generated, while protecting the natural and cultural values of the environment. The NLC's recommendations, aimed at achieving this goal, follow.

13 Recommendations

The NLC has incorporated a number of recommendations in its submission that it believes should be implemented if the Northern Territory Government decides to proceed with development of the onshore petroleum industry and utilise the process of hydraulic fracturing. The NLC believes that these recommendations are critical to offering maximum protection to the environment and to Aboriginal land rights and culture, while at the same time encouraging optimal beneficial outcomes, especially of an economic nature. There are 44 recommendations in total, collated below under three theme headings.

Many of the recommendations cover several themes and most can be addressed through improved regulations, improvements to the environmental impact assessment process or better environmental management systems. The NLC believes that many of these recommendations are not unique to hydraulic fracturing and the oil and gas industry, but should also be applied to other industries operating in the prospective gas producing regions.

13.1 Recommendations for regulatory change

1. *The highest possible standards should be applied to well construction and to materials used in well construction.*
2. *Information about well failures in the Northern Territory should be made publicly available.*
3. *There should be a system implemented by the government which records the location of wells and maintains and monitors any problem wells identified.*
4. *Water allocations and the Water Act should be amended so that the domestic and cultural needs of remote communities and homelands are the highest priority and are placed before the needs of competing industries. A balance between the requirements of competing industries must be achieved.*
5. *Provisions must be made in regulations and/or operational plans to set standards, to analyse ambient air quality prior to production of gas, and to monitor fugitive gas emissions continually throughout drilling, production and following well abandonment.*
6. *Provisions must be made in regulations and/or operational plans to monitor and control venting to reduce the amount of greenhouse gases released, without compromising the overall safety of operations.*
7. *Regulations should be put in place requiring companies to fully phase in control measures to capture targeted emissions and to minimise the use of flaring.*
8. *Industry specialists, ARPANSA and Government Regulators should work together to develop systems and/or regulations for the management of naturally occurring radioactive materials.*
9. *All transactions relating to environmental or security bonds paid by oil and gas companies to the Northern Territory Government should be made publically available. Oil and gas production royalty payments made to the Northern Territory Government should also be publically released.*
10. *All. The capacity of the Northern Territory Regulators, in terms of skills and number of personnel required to regulate the onshore petroleum industry must be increased.*

11. *Environmental legislation should be reviewed in line with the outcomes of this Inquiry and a 'water trigger' legislated for all onshore petroleum exploration and production activities, preferably in the EPBC Act, as has already been done for coal seam gas.*
12. *The use of potable water and disposal of wastewater by all industries must be regulated.*
13. *Reform of existing Northern Territory legislation and regulations should be designed, in partnership with Land Councils and the Aboriginal Areas Protection Authority, to bring water use for hydraulic fracturing and other extractive industry purposes into the water allocation planning framework, in line with the National Water Initiative framework.*
14. *Regulations should specify that all oil and gas wells are constructed according to the highest standards available and should be constructed with multiple (i.e. a minimum of 5) layers of casing cemented in place.*
15. *All well locations must be registered and regulations for the management of legacy issues must be put in place.*
16. *A levy and/or bond system that aims at funding future monitoring and maintenance of abandoned wells should be implemented.*
17. *Consideration should be given to changing the Petroleum Act to allow separate mechanisms for consent to exploration and consent to production and to making recommendations for similar changes in ALRA.*
18. *Any changes made to the Petroleum Act and Petroleum Regulations must not conflict with and must not diminish the protections afforded to Aboriginal people under the ALRA and the NTA.*
19. *Any changes made to the Petroleum Act and Petroleum Regulations must not conflict with and must not diminish the cultural protections afforded to Aboriginal people under Federal and Territory cultural heritage and sacred sites legislation.*
20. *Any changes made to the Petroleum Act and Petroleum Regulations must encourage economic security within Aboriginal communities.*
21. *All communities, homelands and other residential areas located on Aboriginal land should be excluded from onshore petroleum exploration and production permits. These exclusion zones should be based on a standard minimum distance between residences and permit boundaries.*

13.2 Recommendations for improvements to environmental impact assessments

22. *An investigation into the specific risks and impacts posed by the injection of wastewater under pressure into abandoned wells, deep aquifers or other geological structures must be completed prior to such action being permitted.*
23. *Irrespective of whether hydraulic fracturing is or is not permitted, the Northern Territory Government should commit to undertaking groundwater, surface water and other assessments that consider the cumulative impacts of multiple industries across regional scales. This should commence with studies in the most prospective gas bearing regions, and*

be expanded as part of a larger Strategic Environmental Assessment related to economic development across the Northern Territory.

24. *The potential for environmental fragmentation should be analysed on a case-by-case basis and considered with existing ecological impacts as part of the cumulative assessment within the wider Environmental Impact Assessment, when a production field is being planned.*
25. *The environmental impact assessment process should be amended to ensure that all major developments (including oil and gas) consider fully their impacts on the spiritual and cultural values of flora and fauna species and of water contained within their area of influence.*
26. *Provisions within the environmental impact assessment process should be put in place to ensure that impacts on the aesthetic and cultural integrity of natural water sources are unaffected by hydraulic fracturing and by rapid development of an oil and gas industry.*
27. *A greater focus must be placed on the potential for cumulative impacts on water resources, including water quality, for all projects referred for environmental impact assessments.*

13.3 Recommendations for improved project management

28. *Subsurface mapping should be used when planning well placements to identify abandoned wells and possible fault lines or weaknesses within the geological formation that may allow migration of gas to near surface aquifers. Wells should not be placed where there are fault lines or weaknesses.*
29. *All above surface procedures involving management of large volumes of water (including mixing of chemicals and storage of produced water) should be performed using enclosed tanks.*
30. *Greater detail related to water quality, quantity, and the location and directions of flow and flow rates of potable aquifers should be made more readily available to traditional Aboriginal owners.*
31. *Groundwater chemistry should be taken into account and wells engineered in response to any specific and local groundwater chemical risks identified.*
32. *Each well pad constructed should be accompanied by at least one water bore that is used to (i) measure the quality of potable water in the vicinity of that well pad prior to hydraulic fracturing and (ii) continuously monitor quality of that water during hydraulic fracturing episodes and throughout production.*
33. *A tiered risk management approach based on the monitoring of specific chemical species in potable aquifers should be applied throughout production as part of a gas company's production management plan. This approach should be designed so that specific interventions are taken by the gas company in response to key trigger values being reached.*
34. *Petroleum companies must minimise the use of potable water in the practice of extracting onshore gas reserves.*
35. *Production planning should include construction of multiple wells on single well pads and optimisation of the distance between well pads to minimise the risk of environmental fragmentation.*

36. *A tiered risk management approach based on monitoring of fugitive gases should also be applied throughout all phases of drilling, exploration and production as part of each oil and gas company's management plans. This approach should be designed so that specific interventions are taken by the gas company in response to key trigger values being reached.*

37. *Oil and gas companies should work with Land Councils to translate information about chemicals and their health risks to ensure that traditional Aboriginal owners have a clear understanding of the potential risk to their health, their community and its water supplies.*

38. *Minimum offset distances between wellheads and communities, homelands and other residential areas must be negotiated with residents likely to be affected by noxious gas emissions and plans for monitoring and management of those gases must be put into place.*

39. *Systems and processes for all projects should be designed to capture and protect cultural knowledge and traditional knowledge and practices and to apply this knowledge with a particular focus on o environmental maintenance, management and rehabilitation.*

40. *Horizontal wells must be positioned so that they do not extend beneath sacred sites (unless permitted by Agreement with traditional Aboriginal owners) or beneath areas where consent to explore and produce has not been obtained.*

41. *Management systems should be put in place to monitor and clearly demonstrate the subterranean extents of horizontal drilling and induced hydraulic fractures.*

42. *Commitments should be made by the onshore oil and gas industry and by the Northern Territory Government to upgrade key utilities and services in remote towns so that entire communities will benefit from the royalties generated from the oil and gas industry.*

43. *The oil and gas industry and the Northern Territory Government should work with the Land Councils to ensure that benefits to traditional Aboriginal owners are managed in a manner that benefits all Aboriginal people living in a gas-producing area.*

44. *Onshore gas producers should maximise traditional Aboriginal owners' access to land by minimising the number of operational areas and burying ancillary infrastructure where possible.*

14 References

API (2002): API Specification 10A: Specification for Cements and Materials for Well Cementing (ISO 10426-1: 2002) - Petroleum and natural gas industries— Cements and materials for well cementing— Part 1: Specification, 23rd Edition, American Petroleum Institute, 2002.

API (2005): API Specification 5CT: Specification for casing and tubing (ISO 11960:2004), Petroleum and natural gas industries—Steel pipes for use as casing or tubing for wells, 8th Edition, American Petroleum Institute, 2005.

ARPANSA (2008): Safety Guide – Management of Naturally Occurring Radioactive Materials (NORM), Australian Government Radiation Protection Series Number 15, Canberra, 2008

Braun, T and Hanus, B (2005): Forest Fragmentation – Effects of Oil and Gas Activities on Alberta Forests, Bureau of Economic Geology, University of Texas, viewed 5th June 2014, http://www.beg.utexas.edu/energyecon/ thinkcorner/Forest_Fragmentation_Alberta.pdf

Cook, P, Beck, V, Brereton, D, Clark, R, Fisher, B, Kentish, S, Toomey, J and Williams, J (2013). Engineering energy: unconventional gas production. *Report for the Australian Council of Learned Academies, www.acola.org.au.*

Council of Canadian Academies (2014): Environmental Impacts of Shale Gas Extraction in Canada; *The Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction, Council of Canadian Academies, Ottawa, Ontario.*

Davies et al, Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation, Marine and Petroleum Geology (2014), http://dx.doi.org/10.1016/j.marpetgeo.2014.03.001

Dusseault MB, Gray MN and Nawrocki OA (2000); Why Oilwells Leak: Cement behavior and long-term consequences, *Society of Petroleum Engineers International Oil and Gas Conference, Beijing, China, November 7-10, 2000, pp. 1 – 5*

Hawke A (2014): Report of the Independent Inquiry into Hydraulic Fracturing in the Northern Territory; *Darwin, Australia, 28 November 2014*

Hawke A (2015); Review of the Northern Territory Environmental Assessment and Approval Processes; *Darwin, Australia, 1 May 2015*

Hicks, B (2012): Multi well pad will sink OPEC – the strangest octopus you'll ever see, Energy and Capital, December 13, 2012, viewed 5th June 2014, http://www.energyandcapital.com/articles/multi-well-pad/2892

Howarth RW (2015): Methane emissions and climatic warming risk from hydraulic fracturing and shale gas development: implications for policy, *Energy and Emission Control Technologies, 3, 45 – 54*.

King GE and King DE, Environmental Risk Arising From Well-Construction Failure—Differences Between Barrier and Well Failure, and Estimates of Failure Frequency Across Common Well Types, Locations, and Well Age, SPE Production and Operations, November 2013, 323 - 34543

Kondash A, and Vengosh A (2015): Water footprint of hydraulic fracturing, *Environmental Science and Technology letters, 2, 276 – 280.*

Ladlee, J and Jacquet, J (2011): The implications of multi-well pads in the Marcellus Shale, Research and Policy Series, Pennsylvania State University, Vol. 43, September 2011

Mavroudis D (2001). Downhole environmental risks associated with drilling and well completion practices in the Cooper/Eromanga Basins, *Report Book 2001/00009, Department of primary Industries and Resources, South Australia, 71p.*

NLC (2016): Northern Land Council submission pertaining to the Senate Select Committee's Inquiry into unconventional gas mining, Unconventional Gas Mining Submission 273, April 2016,

NSW Parliament (2012): Legislative Council. General Purpose Standing Committee No. 5 Inquiry into coal seam gas, *General Purpose Standing Committee No. 5., Report 35, Sydney, New South Wales*.

O'Brien S (2015): Implications for Western Australia of hydraulic fracturing for unconventional gas; *Standing Committee on Environment and Public Affairs, Report 42, Legislative Council of Western Australia, Perth, Australia.*

Peischl et al (2015): Quantifying atmospheric methane emissions from the Haynesville, Fayetteville and northeastern Marcellus shale gas production regions, *Journal of Geophysical Research: Atmospheres, 2119 - 2139*

Riiters, KH, Wickham, JD, O'Neill, RV, Jones KB and Smith, ER (2000): Global-scale patterns of forest fragmentation, *Conservation Ecology, Vol. 4, No. 2, pp. 3, viewed 5th June 2014*, http://www.consecol.org/vol4/iss2/art3/

Royal Society (2012): Shale gas extraction in the UK: a review of hydraulic fracturing, Report of the Royal Society and the Royal Academy of Engineering, June 2012.

Schneider, RR, Stelfox, JB, Boutin, S and Wasel, S (2003): Managing the Cumulative Impacts of Land-uses in the Western Canadian Sedimentary Basin: A Modelling Approach, *Conservation Ecology 7, (1), 8*. Available at http://www.ecologyandsociety.org/vol7/iss1/art8/

Slonecker, ET, Milheim, LE, Roig-Silva, CM, Malizia, AR, Marr, DA and Fisher, GB (2012): Landscape consequences of natural gas extraction in Bradford and Washington Counties, Pennsylvania, 2004–2010, U.S. Geological Survey Open-File Report 2012, Vol. 1154, pp.36

Yu W, and Sepehrnoori K, (2013): Optimization of Multiple Hydraulically Fractured Horizontal Wells in Unconventional Gas Reservoirs, Journal of Petroleum Engineering, 2013, 1-16, http://dx.doi.org/10.1155/2013/151898