Submission to the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

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Doctors for the Environment Australia

67 Payneham Road
College Park SA 5069
P 0422 974 857
E admin@dea.org.au
W www.dea.org.au

Healthy planet, healthy people.

Doctors for the Environment Australia (DEA) welcomes the opportunity to provide a submission to the NT Fracking inquiry.

DEA is an independent, self-funded, non-government organisation of medical doctors in all Australian States and Territories. Our members work across all specialties in community, hospital and private practices to prevent and address the diseases - local, national and global - caused by damage to our natural environment. We are a public health voice in the sphere of environmental health with a primary focus on the harms to health from pollution and climate change.

For over 10 years, DEA has been deeply involved in the public discourse on unconventional gas activity, providing input to governmental inquiries in several states and several Federal committees (Appendix A). In the Northern Territory, DEA has previously provided submissions to the Hawke Report in 2014[2], and to the terms of reference for the current inquiry[3].

Australia has seen rapid growth in interest and development of exploration and drilling for unconventional gas reserves from coal seams, shale deposits and tight sands. These reserves require special techniques such as fracking, in-seam and horizontal drilling. DEA is concerned that the rush to exploit this resource has outpaced regulation to protect public health and the environment, and to adequately assess the health impacts, including exposures to industrial chemicals.

There is increasing evidence in the published scientific literature outlining threats posed to human health through unconventional gas development (UGD). If revenue generation from royalties and profits for developers is seen to be the imperative, the external costs of adverse health outcomes, the costs of necessary extensive air and water monitoring and the negative economic effects of public health risks and psychosocial impacts need to be also considered.

The Australian Medical Association (AMA) has urged governments to ensure that all future proposals for UGD are subject to rigorous and independent health risk assessments, which take into account the potential for exposure to pollutants through air and groundwater and any likely associated health risks[4]. This sentiment has been echoed by the United Kingdom's Chief Scientific Adviser, whose annual report drew a direct comparison between hydraulic fracturing technology and past health issues including exposure to asbestos and tobacco[5].

In March 2017, the Victorian government passed legislation to ban any unconventional gas drilling in the state because of the unknown and unquantifiable risks to the safety and security of public health, water and agricultural industries.

Key recommendations

1. That the exploration and extraction of unconventional gas in the NT, including the use of hydraulic fracturing, be subject to an indefinite moratorium until health risk assessments of procedures and chemicals have been undertaken on an industry wide basis.

2. If the moratorium is rejected, mandatory Health Impact Assessments (HIA) for all UGD appropriate to the industry. This process should ensure:
   - Comprehensive epidemiological studies of population health both before and after gas extraction commences.
   - Support for research on potential health effects of UGD independent of industry funding, including long term prospective health studies.
   - Health surveillance of persons living and working near major UGD.
   - HIA to consider the health implications of greenhouse gas emissions on both Australian and international communities.

3. If the moratorium is rejected, adequate environmental monitoring be undertaken for the lifetime the project, including:
   - A mandatory full public disclosure of all chemicals used in the gas industry, and assessment of all chemicals for safety by the national industrial chemical regulator.
   - Independently audited air monitoring programs with publicly available results.
   - Comprehensive water monitoring programs that would provide early warning of potential contamination events.
   - Effective independent monitoring and reporting of waste water produced and methods of disposal.
   - Sufficient capacity and resources to effectively oversee compliance.

4. Review of all water legislation under drinking water Acts to ensure protection of surface and groundwater.

5. Full life cycle analysis of greenhouse gas from UGD, in accordance

with Australia's commitment to reducing emissions as a signatory to the Paris Agreement.

In response to the terms of reference:

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.

1. Risk Themes– Water

Water Quantity

Concerns about water usage relate to the large amount of water consumed by UGD and the potential depletion of sparse water sources in both the arid and the tropical regions of the NT[6]. The process of fracking a gas well requires between 4-22 million litres of water for each frack. Each well may need to be fracked between 5 and 13 times, and most gasfields will require the sinking of hundreds of wells[7].

While companies are bound by regulations while using local water, there are many unknowns that make it very difficult to perform risk assessments or reliable predictions of the impact on aquifers of drawing large amounts of water from multiple sites. Modelling of water dynamics is dependent on estimates of local hydrogeology, estimates in prescribing strata hydraulic properties, unknown variability in natural hydraulic connections to deeper formations and other parameters. Any modelling is subject to considerable uncertainty due to the paucity of data available[8]. This is especially true in NT where there are recognised gaps in knowledge of groundwater[9].

Competition for local resources of water has implications for food production and for the well-being of those who rely on water sources, and for water that would otherwise be available for stock. Depletion of aquifers will profoundly impact on water security for local residents and stock. In addition, native fauna and flora in surrounding areas that rely on scant sources of water may be impacted.

Water Quality

A central concern related to unconventional gas activity is the impact of chemicals escaping from mining processes. The potential for escape of chemicals underlies the majority of concerns to do with personal and public health, agriculture and the natural environment.

Hydraulic fracturing requires the drilling of directional wells (vertical and horizontal) and then the pressurised injection into the wells of fluids comprising large quantities of locally sourced water together with chemical additives, and sand, to open up or enlarge fractures, so-called 'propping agents'. A proportion of the drilling and fracturing fluids returns to the surface and needs to be treated or disposed of safely because some returned fluids contain chemicals. This water may also contain chemicals from the shales that produce the gas, including heavy metals such as mercury, lead and arsenic, and radioactive elements such as radium, thorium and uranium. When contaminated water returns to the surface, it has the potential to mix into the environment in numerous ways: in watercourses, open ponds, closed tanks, evaporation or from being trucked away to waste dumps. All of these provide opportunities for chemicals to 'escape' into the environment. The final disposition of these chemicals varies – some evaporate into the atmosphere, some are left in exposed mud ponds to concentrate for burial. Contaminated waste water needs to be stored in tanks or pits at the well site and then may be recycled for future use in fracking, injected into underground storage wells, or transported to wastewater treatment facilities for precipitation treatment, reverse osmosis or other measures. Salt can also be a major component of produced water; salinity can range from levels typical of drinking water to several times saltier than seawater[10], and salinity can be highly damaging to soils and waterways.

Hundreds of chemicals are available for use in drilling and fracking, although the number injected in any fracking event may not be large. Unquestionably, however, some of them can be toxic. For example, ethylene glycol is a clear liquid used in antifreeze and de-icing solutions. Exposure to large amounts of ethylene glycol can damage the kidneys, nervous system, lungs, and heart [11]. Exposure to 2-butoxyethanol occurs mainly from breathing air or having skin contact with products containing them. Breathing in large amounts of 2-butoxyethanol may result in irritation of the nose and eyes, headache, and vomiting [12]. Methanol is readily absorbed after oral, inhalation, or dermal exposure. It is metabolised to formaldehyde and formic acid in the body and is toxic in very small doses if ingested. Chronic exposure to methanol can cause headache, insomnia, gastrointestinal problems, and blindness in humans and hepatic and brain alterations in animals [13].

An additional long-term concern are the so-called "endocrine disrupting chemicals", which are of considerable significance because of their effects at miniscule concentrations, with potential impacts on fertility, growth and development. These agents have been identified in regions of unconventional gas activity at levels much lower than deemed to be safe by any Material Safety Data Sheet [14]. Note also that some chemicals are not identified by the user and, therefore, have no toxicity information. Most fracking chemicals have not been assessed for toxicity to humans or the environment [15,16].

Accumulation of contaminants in aquifers might have long-term and serious impacts. Studies on the transport and fate of volatile organic compounds have found they can persist in aquifers for more than 50 years and can travel long distances, exceeding 10 km[17].

Contamination of aquifers by chemicals in fracking fluids may occur non-accidentally, if fractures provide an underground path from the fracked well to the aquifers, evidence for which is becoming more certain. Published evidence from the US notes, *"The ability to delineate methane sources and thus the distinction between natural flux [local biological sources] and anthropogenic [from unconventional gas activity] contamination is based on the different isotopic and geochemical compositions of thermogenic relative to biogenic methane sources."* Some studies have thus indicated that high levels of methane found in sampled groundwater is related to stray gas contamination directly linked to shale gas operation [18,19].

Accidental Spills

While DEA acknowledges that regulatory frameworks are in place to try to encourage best practice, no amount of legislation or voluntary industry codes can prevent accidents, flooding and spillage of containment pools or casing failures. Accidents have occurred and will continue to occur, however strict the safeguards. In particular, the NT's monsoonal climate is associated with severe flooding events that could impact on containment pools or other storage. There are multiple documented cases of wastewater spills, failures of holding dams and release of contaminated wastewater in Australia and the United States[20,21,22]. Contamination of adjacent beneficial aquifers has also been documented in Australia and overseas[23]. Research in Colorado has found *"that surface spills are an important route of potential groundwater contamination from hydraulic fracturing activities and should be a focus of programs to protect groundwater."* [24]

Another route of groundwater contamination is well casing failure. Unconventional gas wells are lined by casings – steel pipes typically held in place with cement to contain fracking fluids, produced water, and produced natural gas. Casing failures can allow egress of fracking chemicals and fracking fluid from the drill to surrounding aquifers. The failure rate of casings is significant – estimated from recent international data at somewhere between 1 in every 50 to 1 in 16 wells drilled [25,26]. Ingraffea et al noted a 6-7% failure rate in modern wells, that horizontal wells are more likely to fail, and inspection rates of older and decommissioned wells may underestimate the long-term failure rates. The most favourable published figure for well failure is 1.88% with modern 21st century fracturing technology[27].

2. Risk Themes– Land

While the emphasis has been on human health, exposure to chemicals can have adverse impacts on fauna and flora within fragile ecosystems of the Northern Territory. There is a risk of loss of individual species and loss of biodiversity due to chemical contamination of the environment or depletion of water. There is simply not enough knowledge to estimate the risk. But if losses occur, they would be long-lived, difficult or impossible to remedy and would have a high impact, especially in the context of Aboriginal culture. As with water, land has important spiritual values, whose fragility is increasing with climate change[28]. Fracking therefore poses a risk to spiritual health through its impact on the land.

Valuing of land and water are integral to public health although this is not explicit in the Background Paper. Overlapping values reflect the inherent interconnection of health with the other values of land that are mentioned: terrestrial ecosystems and biodiversity, soil health, Aboriginal people and their culture, economic, amenity values and cumulative risks. Exposure to nature is increasingly recognized as an important health determinant [29,30].

3. Risk Themes– Air

It is increasingly being recognised that volatile chemicals used in the fracking process and the gases released from UGDs pose health risks to workers and people living nearby. Volatile organic compounds and hydrocarbons (including the carcinogen benzene) are released during unconventional gas operations, from venting, holding tanks, ponds, compressors and other infrastructure. Some of these mix with nitrous oxides from diesel-fuelled machinery, creating ground level ozone – a significant respiratory irritant.

Emissions measured near gas wells include the BTEX compounds - benzene, toluene, ethylbenzene, and xylene – of which benzene is a contributor to lifetime excess cancer risk[31]. Emissions of formaldehyde, hydrogen sulphide, acrylonitrile, methylene chloride, sulphuric oxide, and volatile organic compounds (VOCs) are recorded near gas drilling, and all have potential adverse health effects. Trimethyl-benzenes, aliphatic hydrocarbons, and xylenes may cause neurological effects, and can irritate the respiratory system and mucous membranes[32].

Air pollution is potentially a health issue for gas field workers. Accidental exposures to chemicals, and airborne silica from proppants have the potential to cause serious health impacts. While worker health has been excluded from the terms of reference for this inquiry, in small communities, workers and their families may represent a significant proportion of community members.

Greenhouse Gas Emissions

Compared with coal, gas combustion emits less carbon dioxide per unit of energy produced. This has led to the proposal by some that natural gas, which is predominantly methane, can and should be used whilst enabling societies to transition from coal to renewable energy sources.

However, it now appears that anticipated lower greenhouse gas emissions from gas obtained through hydraulic fracturing have been overstated. Hydrocarbons extracted through hydraulic fracturing have almost the equivalent greenhouse gas per unit energy produced as coal when the full life cycle is considered, including the energy used to build the gas field and apply the special techniques to extract it. Methane is the second largest greenhouse gas contributor to climate change after CO_2, with a global warming potential more than 86 times that of CO_2 over a 20-year period, and 34 times over a 100-year period[33]. Evidence is growing that only 2-4% of gas needs to be released or escape through fugitive emissions to wipe out the greenhouse emission advantage of gas over coal as an energy source[34]. Australian methane-emission reporting methodologies rely to a significant extent on assumed emissions factors rather than direct measurement. Comparison with similar UGD in the US, suggests that methane emissions in Australia could be significantly underreported [35].

Fugitive emissions are the gases that leak or are vented during the extraction, production, processing, storage, transmission and distribution of natural gas[36]. Importantly, they include unintentional leakage from wellheads, casing failures and corrosion in decommissioned wells that continue to leak over time[37]. Fugitive emissions contribute to air pollution and climate change. The level of concern can be seen in statements in industry publication such as GasTips, World Oil Oilfield Review: *"between 7% and 19% of more than 1000 wells drilled from 2005 to 2007 in western Canada had gas migration along the casing annulus, and 9% to 28% of them had gas leakage through surface casing vents"* [38]. Unintended natural gas migration along production wellbores, even for conventional gas, has been a *"chronic problem for the oil and gas industry ... as a result of poor primary cement jobs, particularly in gas wells"*.[39] Brufatto et al (2003)[40] cite U.S. Mineral Management Service data from the Gulf of Mexico indicating, *"By the time a well is 15 years old, there is a 50% probability that it will have measurable gas build up in one or more of its casing annuli"*. Schlumberger, one of the world's largest companies specialising in fracking, published in its magazine as long ago as 1994: *"Older fields will continue to benefit from the expertise of the corrosion engineer and the constant monitoring required to prevent disaster"* [41]. We emphasise: these words are from the industry itself. They point to the possibility of wear-out-failures that permit movement of contaminated water in the subterranean environment and into aquifers and of continuing fugitive gas emissions.

As climate change is widely considered the major global health threat of this century, fugitive emissions produced from the gas industry are an unacceptable health risk[42].

4. Risk Themes– Public Health

DEA asks the Committee to be aware that medical and health research literature on unconventional gas is rapidly expanding. Much published research – particularly in relation to shale gas - comes from the United States where an estimated 15 million people live within 1.6km of gas or oil wells. As a result, there has been a large increase in the number of published papers addressing unconventional gas activity and health. There are now over 400 peer-reviewed articles, on air pollution, water pollution/water security, soil pollution/food security and public health. More than ever, it is clear that a strong emphasis on health and well-being is required in any over-arching framework for the unconventional gas industry and that the principle of proof of safety from the regulated industry is required rather than absence of proof of harm.

Because the development and spread of unconventional gas activity is relatively recent, information on long-term impacts is limited. However, an increasing number of current observational studies associate adverse health outcomes with UGD. In 2016, the Physicians, Scientists and Engineers for Healthy Energy in the United States identified 555 peer-reviewed publications on unconventional gas activity[43,44]: 84% contain findings that indicate public health hazards, elevated risks, or adverse health outcomes. A summary of health risks of unconventional gas development has emphasised that more research is needed before we can reasonably quantify the likelihood of occurrence, or magnitude of adverse health effects of UGD[45].

Some examples of recently published studies on the health impacts of UGD include:

1. A Johns Hopkins University study used electronic health records to study over 35,000 patients with asthma treated through the Geisinger System in Pennsylvania, from 2005 to 2012. It found that unconventional gas well activity near patient residences was associated with increased risks of worsening of asthma[46].
2. Another recent study from Pennsylvania examined birth outcomes in relation to exposure to unconventional gas development in 9,384 mothers who delivered 10,496 newborns from 2009 to 2013. They found an association between UGD activity and preterm birth and with high risk pregnancy[47,48].
3. In a further study from Pennsylvania, published in 2015, researchers examined health care use with fracking activity. They looked at well numbers and density and examined over 95,000 inpatient hospital

records. They found that hydraulic fracturing as determined by well number or density had a significant association with cardiology hospital inpatient rates, and well density had a significant association with neurology hospital inpatient rates[49].

Importantly, in order to make any meaningful decisions about the risk to public health from UGD, baseline studies need to be undertaken as well as comprehensive epidemiological studies of population health, with support for research on potential health effects of UGD independent of industry funding, including long term prospective health studies. Also, health surveillance of persons living and working near major UGD needs to be carried out, with full and transparent disclosure.

Risk Themes– Aboriginal people and their culture

Non-material impacts of fracking are also important. The framing of Aboriginal culture and knowledge in a way that can be known and described, reflects a non-indigenous approach that may not reflect Aboriginal ways of knowing, in which culture is embedded in the land [50,51]. In the context of discussions about resource development, there remains a high degree of inequity between Aboriginal and non-Indigenous Australians.

Adverse effects on the health of Aboriginal people may be unanticipated. Strong reliance on bush food as a source of nutrition and cultural strength may put them at much higher risk of toxicity than other communities [52,53,54,55]. There is evidence that Aboriginal people's wellbeing does not improve when there is mining or other industrial activity near their communities, and in many cases wellbeing deteriorates[56].

We urge the panel to prioritise the value of water. For Aboriginal people and their culture, water holds spiritual values that transcend amenity and aesthetic worth[57,58]. Water is valued in desert environments through scarcity and vitality, and in tropical environments where water is embedded in day-to-day livelihoods. There is fear of water contamination with the prospect of fracking, for which assurances of safety ring hollow in the face of spiritual concerns. While the material values and risks described in the Background paper are important, without considering spiritual issues, the panel risks underestimating community impacts.

6. Risk Themes– Social

Apart from emphasising personal anxiety and distress related to chemical contamination of the environment, this section requires a brief summary of other, non-chemical-related, impacts on people and communities by unconventional gas activity. Challenges include chronic stress in the face

of excessive noises, intermittent smells and the industrialisation of their environment. This may be a particularly strong issue for people of outback Australia, including NT, many of whom identify with the relatively undeveloped physical environment [59], or those living close to well activities, as well as to the roads that cater to the well pads, there will be machinery noise or thousands of truck movements transporting chemicals or waste-water or gas. The level of involuntary adaptation to that will be required by residents of these areas, and the emotional and financial distress among families as to whether they will leave or continue to live in affected areas, are just some of the factors that will contribute to anxiety levels.

Community cohesion can be affected in many ways, before, during and after fracking operations. Divisiveness and conflict that can arise in small communities when fracking is proposed, and such conflict is already evident in NT during the course of this enquiry [60]. Different value systems among community members, decisions about the distribution of costs and benefits among current and future community members, loss of value of tourism and other industries that may be affected by fracking, changes in land values, perception of lack of transparency and misinformation and other sources of stress can all contribute to social disruption.

9. Risk Themes– Regulatory Framework

While regulatory guidelines may be set in place ensure that UGD safeguards health and the environment, no amount of regulation will be sufficient without the resources to both monitor compliance, and to administer and oversee enforcement and realistic fines for non-compliance.

People feel strongly that their health and wellbeing should be valued and protected by their government. If the industry does proceed, a firm commitment to public health research and surveillance would help to ensure a commitment to the protection of people's health and well-being.

We note how difficult it can be for communities to hold companies to account when there are breaches of practice, for example, the lack of penalty for ERA after a spill of 1,400 litres of radioactive slurry in 2013. Reasons given were that prosecution was not considered in the public interest, the company having suspended operations during the investigation of the spill, and uncertainty of a successful outcome of a prosecution. The non-profit Environmental Defenders Office considered the reason to be lack of political will, sending a message to the NT community that companies will not be held to account for poor standards of quality control [61].

High occupational health and safety standards would be expected to apply in all unconventional gas activities. Local medical services, however, are entitled to be aware of the chemicals likely to be involved in incidents and

to have an opportunity to prepare their emergency strategies.

The Precautionary Principle

Unconventional gas development has been described as an uncontrolled health experiment on an enormous scale[62]. DEA urges the use of the precautionary principle in considerations about any further expansion of the unconventional gas industry. The precautionary principle is a core tenet in environmental science and urges caution over unknown risk to ensure human health and the environment are protected [63]. This is particularly so with decisions involving technologies that are relatively new, where impacts on the health and well-being of future generations may be potentially serious, may be difficult or impossible to manage, and could be very long-lived. The burden of proof is on the unconventional gas industry to demonstrate the lack of risk of harm, rather than on those affected to demonstrate safety. The health of communities which disproportionately bear the burden of risk should be particularly considered, and their concerns heard, in the light of the inequity in the wider distribution of benefits.

Conclusion

As with many complex human activities, absolute certainty regarding impacts of unconventional gas development on public health may never be attained. However, there is already sufficient indication of the potential for harm to human health and the environmental determinants of health from an ever growing scientific evidence base.

Any economic benefits from this industry must be weighed against the long-term impacts on human health and the environment, and the impact of further global emissions on our ability to mitigate climate change. Decisions made today will affect the health, wellbeing and quality of life for future generations.

As doctors concerned about the health of Australians we urge the inquiry to reject further expansion of this industry until much more work can be done at a local level to more fully understand and prevent the serious risks that it poses.

Appendix A

DEA submissions and official statements on unconventional gas.

National:
Submission to the Select Committee on Unconventional Gas Mining, March 2016.
https://www.dea.org.au/wp-content/uploads/Select_Committee_on_UG_Mining_Submission_03-16.pdf

Submission to the review of the national industrial chemical notification and assessment scheme, August 2012.
https://www.dea.org.au/wp-content/uploads/2017/04/NICAS-08-12.pdf

Victoria:
Submission to the Inquiry into Unconventional Gas in Victoria, July 2015.
https://www.dea.org.au/wp-content/uploads/2017/04/Unconventional-Gas-VIC-submission-07-15.pdf

South Australia:
Submission to the Inquiry into Unconventional Gas (Fracking) – South Australia, January 2015.
https://www.dea.org.au/wp-content/uploads/2017/02/Inquiry-into-Unconventional-Gas-SA-01-15.pdf

Tasmania:
Submission to the Review of Hydraulic Fracturing (Fracking) in Tasmania. December 2014.
https://www.dea.org.au/wp-content/uploads/2017/04/Review-of-Hydraulic-Fracturing-Fracking-in-Tasmania-12-14.pdf

Western Australia:
Submission to the Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas. September 2013.
https://www.dea.org.au/wp-content/uploads/2017/04/WA-Inquiry-into-Hydraulic-Fracturing-UG-Submission-09-13.pdf

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