

Dr Allan Hawke
Commissioner
Independent Inquiry into Hydraulic Fracturing NT

Dear Sir,

I am writing to express a number concerns that I have in relation to the impending unconventional hydrocarbon industry that is currently being embraced and encouraged by government in the Northern Territory. While I do understand that the actual act of hydraulic fracturing poses 'minimum' risk to the environment, there are other elements within the entire production process that do pose far more serious threats. I will try to include these various concerns to the industry practice in the relevant context to the terms of reference listed on your 'Independent Hydraulic Fracturing Inquiry' web page...

I would like to add that while I can see that the unconventional shale hydrocarbon boom maybe somewhat of a relatively, short term monetary gain to International Corporations, NT Government, and a few Territorian contractors, I highly doubt any form of sustainable industry such as agriculture, fishing or tourism will be able to survive alongside the petroleum mining giants. The unconventional hydrocarbon industry poses serious risk of potential long term negative impact on environment and human health, so even after the shale gas boom is over, the chance for agriculture, fishing and tourism to revitalise would be arduous and compromised.

I would also like to suggest here that a moratorium be put in place on the entire industry, until better community engagement and public awareness programs are in place informing of the potential risks to water, land, air and human health, and **ALL** people of the NT are able to make an educated opinion and stance...especially the indigenous people of the Northern Territory who still have strong cultural and spiritual ties to the land. If they are 'bought out' by the sugar coated promises made by the oil and gas companies, and their land and water destroyed, a 40,000 year old culture will be completely eradicated.

1. Historical and proposed use of hydraulic fracturing in the Northern Territory

Our local MLA and Minister of Mines and Energy, Mr Willem Westra Van Holthe, is 'easing' rising public concern by suggesting that "fracking has been happening in the NT for 40 years without incident". This is somewhat misleading information to create a false sense of security, as previous industry wells have been drilled for conventional hydrocarbons and the consequent fracturing required in order to increase flow has been fairly minimal in comparison to the invasive and water intensive practices seen with the unconventional oil and gas industry's deep shale, multistage high volume, slick water, hydraulic fracturing. The NT currently has between 27 and 30 producing conventional hydrocarbon wells. I'm not too sure where Mr Westra Van Holthe gained his information, and despite what he says, there have been spills and leaks associated with this industry, one in particular from Santos, at their Palm Valley well within the Mareenie oil and gas field, with well failure in the 1980's.. These incidents are embedded in the memory of many of the residents of Alice Springs during that particular time, there is some mention of them that can be found on internet and in newspaper archives, Department of Resources claim these incidents are no longer ongoing issues and are considered 'historical' ...but they are either ignored and denied or unknown by the Minister.

The unconventional hydrocarbon industry of today's world uses techniques vastly different to what we have seen in prior times...like comparing apples to oranges. The drilling for production of oil and gas from unconventional deposits requires a relatively new technique, which is in fact the combination of four technologies that have been 'refined' over a period of time. This technique is highly controversial, to the point that it has been placed under moratorium in Victoria, and various towns, states and countries around the world. Unconventional hydraulic fracturing has been outright banned in several European countries due to concern in relation to potential risks associated.

Independent researchers for Australian Council of Learned Academies, estimate the potential numbers of hydraulically fractured unconventional hydrocarbon wells in the McArthur Basin could be in the range of 15,506...Georgina Basin 28,331...Wiso Basin 10,827...Armadeus Basin 12,679. The Environmental Protection Authority has stated there would be too many wells to assess individually and that NT Government does not have the resources to comply. This is somewhat worrying, and I would ask the actual hydrocarbon industry players be made to pay a levy to cover the entire assessment process of independent regulators.

The Northern Territory currently has four deep shale horizontal drilled and hydraulically fractured wells. One owned by Falcon Oil and Gas, (Hayfield/Shenandoah, Sturt Plateau, northern Georgina Basin) the other three owned by Petrofrontier, (Lower Arthur Creek, southern Georgina Basin) all of which were drilled between 2011 and 2012. The first of these wells drilled by Petrofrontier and was in fact not only the NT's first, but also the first for Australia. These four wells are still so new, that to date Department of Mines and Energy research operation has still not received final reports on them. It is interesting to note, that Petrofrontier's Baldwin-2Hst1 well, suffered shallow casing failure during hydraulic stimulation. This would give a failure rate of 25% of NT's deep shale, horizontal drilling and hydraulic fracturing well within the first year.

Looking at the NT's oil and gas mining past, and especially the fact that the unconventional wells are still so new and without final report, and already at high failure percentage, it is ludicrous to place any assumptions that the introduction of widespread unconventional drilling, hydraulic fracturing, production across the NT is safe from any of the associated potential risks that have presented themselves across the world and the eastern states of Australia.

2. Environmental outcome of each hydraulic fracturing activity for hydrocarbon resources in the Northern Territory

As afore mentioned, looking at the NT's previous hydraulic fracturing activity for hydrocarbon resources is hardly a prerequisite for establishing any in depth knowledge of environmental outcome, due to the changed nature of hydraulic fracturing over the years, and the fact that so far our oil and gas industry has been produced from conventional wells and the numbers of these wells are relatively low. Additionally the mounting evidence of adverse environmental impacts in other regions of the world might suggest that the consequences relating to the unconventional hydrocarbon industry are both detrimental to the environment and unsustainable.

Independent researchers in Australia, along with department research and reports of actual events interstate and overseas, have raised a considerable list of environmental concerns in relation to an extensive hydraulically fractured unconventional hydrocarbon industry; these include, but are not limited to:

- Increased seismic activities due to the actual fracturing process in relation to naturally occurring faults and ground instability
- Seismic activity of more than 0.5 magnitude is likely (disturbing news in sinkhole country)
- Introduced seismic activity due to flow back waste water injection wells in areas that have never known earth tremor
- Substantial sized magnitude earth quakes able to cause environmental and infrastructure damage due to flow back waste water injection wells
- Extensive water use for initial fracturing process, with averages between 10 and 30 million litres per well and its potential effect on aquifer characteristics such as flow direction, salinity and water level
- Additional water usage for fracturing requirements throughout the well's lifespan
- 'Small percentages' of chemicals required, equates to thousands of tonnes/litres of chemicals per well, the bulk of these chemicals being acids; accident, human error, well failure, natural cause are areas in which contamination can be caused
- Portrayed as 'safe household chemicals', MSDS sheets paint a toxic picture of fracking chemical list, including endocrine disruptors and carcinogens. Several elements also pose serious risk to aquatic life.
- Between 30 and 80% of toxic 'produce' flowback water returns to surface, meaning millions of litres of contaminated waste water has to be dealt with in an environmentally friendly fashion
- Integrity of wastewater ponds and their redundancy against natural occurrences such as flooding, monsoonal rains, tropical/ex tropical cyclones etc
- Wastewater transport and the obvious risks associated
- Wastewater isolation against small ground dwelling animals and birdlife, in particular migratory waterbirds
- Wastewater brings to the surface large quantities of salt, volatile organics and radioactive materials
- Industrialization of natural environments
- Vegetation fragmentation and its effects on native taxa, surface water distribution, in particular areas relying on sheet flow irrigation, and weed introduction associated with a fully developed hydrocarbon industry
- Noise pollution and its negative effects on, or displacement of, native fauna
- Air pollution and its obvious effects on the environment and animal/human health
- Well integrity, both short term and long term and possible migration/contamination by chemicals, radioactive materials and gases into our aquifers and rivers
- Methane leaking and being released and the fact that it is pound for pound, almost 100 times worse greenhouse gas in its first 20 years of life in atmosphere than what carbon emissions are
- Social impact of Industrialization

3. Frequency types and causes of environmental impacts from hydraulic fracturing...

In the rush to expand and exploit a global unconventional hydrocarbon industry, vital baseline data studies have not completed. This has meant that many incidents have been brushed off by industry as coincidental or pre-existing. Not having crucial initial data in place as evidence has led to the hydrocarbon industry claiming there is no substantial proof for the many detrimental environmental and health impacts being seen, nor for the scientific papers and reports being written in association to

the practice and the effects being seen. This has been a harsh lesson for those in America, Canada, Europe and the eastern states of Australia.

At the 'pro fracking' information session held here in Katherine at Knotts Crossing in November 2013, a representative indicated to a graph depicting sharp increases in methane, arsenic and various other heavy metals in groundwater situated within areas of high activity with deep shale horizontal drilling and hydraulic fracturing. The graph clearly showed the less activity, the less the change in water with contaminants. This was simply put as, "possible coincidence" and that 'more studies would be needed to determine if there was a direct link'. I ask, should these studies not be completed BEFORE we see the spread of a controversial unconventional hydraulic fractured hydrocarbon industry across our landscape?

Even though reports have been written into the adverse health effects on humans due to toxins released into the water and air during unconventional gas production in Queensland, and a marked increase into infant seizures and spontaneous nosebleeds in children that can last for several days, headaches, nausea, lung irritations etc, hydrocarbon (shale) industry representatives have said, "All kids get nose bleeds, this is normal."

A recent article in Pittsburgh Post-Gazette reported that a 40 page brief had been filed with the court in Harrisburg, USA, stating it is the practice of Department of Environmental Protection regulators to not issue violation notice, fines, or formal determinations of contamination in cases where shale gas companies reach private settlements with water well owners. This practice makes it an almost impossible task to know where and when groundwater, wells and springs are contaminated due to the lack of publicly accessible records. (A blue buffalo count....?)

Having said that, there are recent cases against unconventional hydrocarbon industry companies, where it has been proved beyond doubt, fines given and compensation paid out, in relation to environmental damage, and the adverse effects experienced from it.

In a recent paper, Davies, RJ et al., Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation, Marine and Petroleum Geology, 2014, it is noted that:

- More than 4 million onshore hydrocarbon wells have been drilled globally
- Of 8,030 wells inspected in Pennsylvania, targeting Marcellus shale, between 2005 and 2013 6.3% had well barrier or integrity failure
- In a separate Pennsylvanian study, between 2008 and 2011, found 85 examples of cement or casing failures, 4 blowouts and 2 examples of gas venting
- The Department of Environmental Protection data on unconventional hydrocarbon wells, targeting Marcellus Shale, shows a figure of 3.4% well barrier leakage (219 violations for 6,466 wells)
- The same data base shows 6.2% (211 of 3391) shale gas wells drilled in 2011-2012 failed
- Inspection project in Netherlands, 2008, identified problems in 4% of production wells, and 60% of injection wells
- Water contamination caused by upward propagation of hydraulic fractures remains unproven, though the possibility cannot be totally ruled out
- Poor well integrity far more likely cause of elevated concentrations of thermogenic methane in shallow groundwater

A sharp increase in earth tremors have been seen in areas where unconventional hydraulic fracturing and the practice of waste water well injection occur. According to 'Science':

- Oklahoma – 3 magnitude 3.0 or larger between 1975 and 2008...from 2009 has been an average of 40 per year
- Between 1967 and 2000, midcontinent USA experienced on average 21 magnitude 3.0 or larger per year, 2001 began an increase in activity, by 2011 there was 188 M3.0 or more earth tremors in a year
- Microearthquakes (magnitude 2 or below) are routinely produced as part of hydraulic fracturing process, but the practice appears to pose low risk of inducing destructive earthquakes
- Wastewater injection disposal poses higher risk and can generate larger earthquakes..magnitude 5.6 event in Oklahoma destroyed 14 homes

What effect on natural unstable and sinkhole country will the activities of this industry have?

4. The potential for multiple well pads to reduce or enhance the risks of environmental impacts

To my knowledge, cluster drilling can include up 9 wells in a single pad. There are some quite obvious ways in which these will enhance risks to the environment:

- More chance of seismic activity
- More water usage
- More chemical required
- More flowback produce water
- More chance of well and equipment failure
- More change of accident
- More chance of aquifer contamination
- More chance air pollutants
- More noise
- More methane escaped/released in to atmosphere
- More drilling mud
- More salt

Possible pollutant spills at surface level are multiplied when cluster drilling is added to the equation, these spills have potential to contaminate creeks and rivers, and enter groundwater through wash off from rainwater. It is recommended in a German report, 'Environmental Impacts of Hydraulic Fracturing' released by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, that rainwater runoff from well pads be collected and disposed of in an environmentally friendly manner. This collection would most likely be near impossible in torrential wet season downpours, and it is noted in 'Groundwater Resources of the Tindall Limestone' by Department of Natural Resources, how quickly vast amounts of water can disappear down relatively small sinkholes in a short amount of time. I lived on the Sturt Plateau for ten years, and have witnessed this with my own eyes. This water is recharge for the aquifers, and poses a very real potential risk to groundwater and river health.

In my time on the Sturt Plateau, I came to understand how porous and cavernous the ground is below the surface, how much water can soak through black soil flats, have seen natural water wells and the development of new sink holes, and witnessed fairly small amounts of water cause the earth to fall through and cave in to sink holes below. All of these give me concerns for the various practices associated with the unconventional hydrocarbon industry, and the risks linked to them.

5. The relationship between environmental outcomes of hydraulic fracturing of shale petroleum deposits with geology, hydrogeology, hydrology.

As previously mentioned, increased seismic activity is likely with the act of hydraulically fracturing. This could prove to have adverse effect on 'sinkhole country' for which the Stuart Plateau and Katherine region is renowned.

Extracting large volumes of water from aquifers can change direction of the natural movement of groundwater, thus having effect on spring flow, this in turn could have adverse effect on the Top End's river levels which rely on springs for dry season flow.

Extracting large volumes of groundwater could drastically reduce water table levels, which is a very real risk in the desert country where water is already considered a mined resource, and can potentially increase salinity. Consideration also needs to be given to the fact that not every year's recorded rainfall levels are the same, and there have been previous times of drought, which has also had adverse effect on Top End rainfalls.

The current collective call of water of 20/80 seems to work well for the time being, but what in times of extreme dry wet when there is additional mining extracting large volumes?

It is noted that the industry prefers brackish water as it has less particle for blocking and clogging. Tindal Aquifer water has high lime content. Does this mean more acid is required to neutralise the water, or do petroleum companies plan on extracting from rivers, or damming for water? A requirement for additional acid has its obvious detriments, as does river extraction and dams.

There are several ways in which aquifers could potentially become contaminated.

- Pollutant discharges at ground surface, especially with the handling of fracking fluids, and management of flowback 'produce water'.. this is particularly relevant during hydraulic fracturing phase with handling of fracking fluid and flowback, and includes, transport, storage and disposal. These types of pollutant discharges can occur by accident, disruption, improper handling and equipment failure.
- There is potential for well integrity failure/blowout and for pollutant discharges to migrate via underground pathways and geological faults.
- There is potential for impact pathways to be created through the process of hydraulic fracturing which can allow gas to migrate upward and make its way in to aquifers. Since these types of flow processes take place very slowly, long term impacts have to be estimated.
- It is currently 'cost effective' and deemed 'environmentally friendly' practice to pump toxic flowback water into injection wells, this has been linked to seismic activity on a larger scale.

6. The potential for regional and area variations and the risk of environmental impacts from hydraulic fracturing in the Northern Territory.

Many regional variations will be slow in developing, but there is potential for aquifers to change course, or be contaminated. For example, hydraulic fracturing and associated industry risks on the Sturt Plateau could eventually disturb spring flow, or pollute and contaminate aquifers, creeks and rivers, throughout northern Georgina and the Daly Basins, having direct effect on the natural springs found on Vermelha Station, Eley Station, Mataranka Hot Springs, Strangways River, Roper River, Katherine River, Flora River....

Regional variations will also be seen on the surface on the landscape as more and more wells are drilled and erected. I have mentioned above the potential numbers of wells that can be drilled, working on the average of one well every 800 metres. Despite what some may think, the unconventional gas industry is very invasive and has huge impact on the visual aspect of the land.

Another consideration to factor in, is the most likely drop in rural land prices with the introduction of hydrocarbon wells, as has been the trend Queensland, NSW and various parts of the world. Katherine, and other smaller regional towns and communities, is not offered any protection from the oil and gas companies, who have right over landholders, and can enter pretty much where ever they want. This will have negative affect not only property value of the block with the well, but also the property values of neighbouring blocks. This potentially could affect insurances, as with the recent development in NSW with insurance companies giving notice to block and farm owners, if their land has a well built on it, their insurance will be void.

Mentioned at the pro fracking evening, the development of unconventional hydrocarbon industry for the purpose of export to Asia, will raise local gas prices to global market values. This means an increase in gas to local consumers, and also an increase in power prices. People in the NT are already struggling with increases to Power and Water implemented by CLP government. Housing prices are already high in the NT, with limited housing available...how will a possible 'boom' effect the rental prices? Limited available land for more housing, could possibly mean option of councils and local government would be to rezone and build on designated parkland. A boom would also mean an increase on other aspects of day to day life, an increase in rates, purchase prices etc, would mean that living in one of these centres would soon become almost impossible for lower income earners....as has been seen in areas of Shale gas in USA, and in CSG in Queensland.

This might be also the spot to mention the promise of jobs to local indigenous communities, that was made by industry representatives at the pro fracking meeting. I read NT Government's legislation saying indigenous community numeracy and literacy skills are too low. Mr Mantaring from Pangaea said the industry jobs were highly specialised and required very intense and rigorous training. I asked how many local aboriginals were currently employed by Pangaea on the Sturt Plateau development, and while he was quick to point out a few years ago they paid traditional owners and indigenous peoples a daily allowance to show Pangaea's exploration crew around on aboriginal lands, he was a little slower to admit there are currently no employed local indigenous people....but added that would be something for their drilling contractor to deal with.

7. Effective methods for mitigating potential environmental impacts before, during and after hydraulic fracturing with reference to:

- ***The selection of sites for wells:*** Considering 90% of the NT is either under active exploration or application for petroleum or gas, that the current petroleum and mining rights to land access and the existing four unconventional hydrocarbon wells and their locations, plus the locations of unconventional hydrocarbon wells in close proximity of residential,

agricultural, livestock feedlots, grazing land, culturally significant areas, right besides rivers and waterholes, overtop of aquifers, in areas of already dwindling water supply, on top of hills, in valleys, in bog lands, and those within national parks and state forests, and situated along and within natural occurring fault lines, in both eastern Australian states, the USA and Europe, one can safely say that that not a whole lot of consideration goes into the potential environmental, or human health impacts before, during or after drilling. My suggestion would be for moratorium on unconventional hydrocarbon industry with in NT while exclusion zones can be put in place, time given to allow the strengthening of environmental protection laws and making petroleum industry accountable for water usage and having to follow water allocation procedures instead of being exempt from, and giving the required time for independent baseline data studies covering all aspects associated or linked to the unconventional hydrocarbon industry to be completed prior to any drilling activity, and for establishment of independent regulators to preform regular visits and tests before, during and after drilling.

- **Well design, construction, standards, control and operational safety and well integrity ratings** Considering no guarantee can be given against well integrity, or accident, or human error (April 2014 Santos had to halt drilling of well at Mt Kitty gasfield, NT, when the drilling rig toppled over...as I type investigation of possible Benzene leak from a truck headed to exploration site) ; that global estimates on well failure in the first 12 months of construction can be as high as 8.2%, (not forgetting track record of unconventional hydraulic fracturing in the Northern Territory of four existing horizontal shale wells showing failure rate of 25% in the first year) it is well known fact within industry that these figures will rise as the wells age (60% by age of 30 years) due to cement crumbling and cracking and posing serious risk to our underground waterways . I ask moratorium be in place until we can be given a 100% guarantee that we will not see well failure in the first year, the fifth, tenth, twentieth, fiftieth,

- **Water use:** Deep shale horizontal drilling can potentially require tens of millions of litres of water per well, placing a moratorium on the unconventional hydrocarbon industry, until studies can be completed and the effects of extensive unregulated water use on aquifer levels, recharge flow and ground water directional movement are completed and determined, giving time for laws and policies to be changed bringing the petroleum industry into line with water allocation act, and ensuring the collective call is not bled dry.

- **Chemical use:** The use of chemicals is unavoidable within this industry, the list of chemicals that will be used must be made transparent, and the chemicals presented for what they are and not glossed over with terms such as ‘found in ice cream’... ‘Best practice’ needs to become solid, so that there is absolutely no way in which chemicals can spill or be leaked. Considering the recent topple of Santos drilling rig mid operation in the Kitty gas field, Central Australia, and the excessive leak of hydraulic chemicals from a truck along the Plenty Highway, both before the industry is well underway, it is easy to see that ‘best practice’ is not going to stop accidents or equipment failure. Baseline data studies need to be completed by an independent regulator before during and after drilling, on well pad, surrounding areas and roads, and human health.

- **Disposal and treatment of wastewater and drilling muds:** Wastewater is toxic, and brings to the surface large quantities of salt. This water cannot be released straight on the ground, trickle fed into creeks or used as a dust suppressant, evaporation fans should not be used. Any holding ponds need to be built to a strict standard and not in any areas where there could be sinkholes underneath, a method to dispel water birds and small animals needs to be in place. Waste water injection wells cannot be used around the Katherine area,

due to the sensitivity of sink holes. Drilling mud is toxic and more than likely holds radioactive material, this substance cannot be treated lightly, this substance cannot be spread throughout paddocks. A moratorium to all unconventional drilling needs to be placed while water and drilling mud disposal methods are set into place. Baseline data studies need to be completed covering all aspects of the waste water and drilling mud, before any drilling can go ahead. Independent regulators should be making regular visits and checks on each site and surrounding area to ensure standards are enforced.

- ***Fugitive emissions:*** Studies have shown toxins and emissions are released and do escape. Again, a moratorium needs to be in place while air quality assessments are made on effect on environmental and human health impact, and baseline data health studies on airborne toxins are completed on all people within a 100km radius of each well site. These fugitive emissions and airborne toxins need to be monitored by independent team before and after drilling, and throughout the well's life.
- ***Noise:*** The Territory is home to many rare and endangered native animals. Noise has been long known to dispel native wildlife populations, rendering them endangered or extinct to an area. A moratorium needs to be in place on all exploration and drilling activities, so that native animal numbers can be counted at various points around the territory, and at each proposed well site, and bioacoustics studies can be recorded and summarised. These studies should be undertaken at yearly levels.
- ***Monitoring requirements:*** ALL areas covered within these terms of reference need to be monitored before, during, after and on regular basis, by independent researchers and regulator. There can be no self-regulation in this industry .
- ***The use of single or multiple well pads:*** See above.
- ***Rehabilitation and closure of wells (exploratory and production) including issues associated with corrosion and long term post closure:*** How do we deal with this issue? There are grave concerns that mining companies will just cap the well and leave it at the end of its life span. In England it has been practice to cap off wells below ground and bury them...this should not be a recommendation to follow. These wells cannot be a legacy left behind by the unconventional hydrocarbon industry to our children and our grandchildren.
- ***Site rehabilitation for areas where hydraulic fracturing activities have occurred:*** See above

I thank you for allowing me the opportunity to have my say and voice the various concerns that I hold towards this highly controversial industry.

Charmaine Roth
Katherine NT