SUBMISSION TO THE SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING IN THE NORTHERN TERRITORY

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INTRODUCTION

Thank you for the opportunity to make a submission to the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory.

My name is Geralyn McCarron. I am a general practitioner living and working in Brisbane, Queensland. I hope my personal insights into the reality of the unconventional gas industry in Queensland may be of value in your decision-making. I am also a member of the National Toxics Network and for your consideration I attach as part of my submission the NTN paper[1] *"Unconventional Gas Exploration and Production: Human Health Impacts and Environmental Legacy"* written by Dr Mariann Lloyd-Smith, dated April 2016.

The issue of unconventional gas development was first brought to my notice in 2011 in the context of Tamboran's plans to use hydraulic fracturing for shale gas in the Lough Allen Basin, the area of North West Ireland where I was born and raised. As I researched the implications of their proposal I became aware that in their "information sessions" in Ireland the picture Tamboran was presenting to the community bore little relationship to reality[2]. I also became aware that the unconventional gas industry was already developing in Queensland particularly in the Tara/ Chinchilla /Kogan area of the Darling Downs. In June 2012 I had to opportunity to visit the Western Darling Downs on a bus trip organized by Bridging the Divide, a Brisbane based, nonprofit, community organization. The lived experiences related by the people I met were confronting. On that and on several return visits I met many people who were extremely concerned about the noticeable deterioration in the health of their families since the advent of the gas industry.

THE QUEENSLAND EXPERIENCE OF UNCONVENTIONAL GAS

In June 2012 the Queensland Government had committed to investigate the growing health complaints of residents. The months passed and by February 2013 no health report had been published, yet both the industry and politicians repeatedly stated that Queensland Health had investigated and no health problem had been found. In a letter[3] printed in The Sydney Morning Herald (19th January 2013), Rick Wilkinson, Chief Operating Officer Eastern Region, Australian Petroleum Production & Exploration Association Ltd (APPEA) claimed that Queensland Health had *"reported no pattern of illness consistent with effects from natural gas extraction."*
It was in those circumstances that in February 2013 I surveyed and documented[4] the reported health impacts of 113 individuals from 38 families living an the area of the Darling Downs heavily impacted by the gas industry. Overall 58 % of people surveyed reported adverse health impacts which they attributed to the industry.

Of the 96 individuals aged between 6 and 82 years, 72% complained of skin irritation, whereas only 17% had previously had problems with their skin. People reported symptoms of discomfort, sensitivity, itch and inflammation of their skin which, particularly in adults, was often in the absence of a visible rash. 32 % of respondents reported spontaneous nose-bleeds,

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[1] http://www.ntn.org.au/wp/wp-content/uploads/2016/05/NTN-Unconventional-Gas-Report-April-2016.pdf

[2] Please see Appendix 2 regarding Tamboran in Ireland.

[3] Letter, Rick Wilkinson, Sydney Morning Herald http://www.smh.com.au/national/letters/churches-fail- to-put-reasoned-argument-20130118-2cz9s.html

[4] http://www.ntn.org.au/wp/wp-content/uploads/2013/05/Symptomatology-of-a-gas-field-An-independent-health-survey-in-the-Tara-rural-residential-estates-and-environs-April-2013.pdf

while only 7% had a history of nose bleeds prior to CSG. Eye irritation was a major issue, occurring in 60% of respondents. Headaches, tingling, paraesthesia, numbness, difficulty concentrating and extreme fatigue were frequently reported.

People reported their symptoms improved or disappeared when they were away from the area.

The reported health impacts in the children were of particular concern to me.

There were 31 children in the age group 6-18 years.
19 (61%) reported spontaneous nose bleeds. Skin irritation affected 24 of the 31 children. Almost all the children (28 out of 31) reported mild headaches and in over half (17 out of 31) the headaches were severe. Over 30% of the children (10/31) experienced paraesthesia. Cough, chest tightness, chest pain, difficulty sleeping, nausea, rashes, difficulty concentrating and muscles pains and spasms were frequent concerns.

There were 17 children in the 0-5year age group.
Parental concerns included rashes (11), eye irritation (11), and cough (5).
Very significant symptoms reported in this age group were:

- twitching and unusual movements (6);
- poor colour/blueness of mouth or limbs (6);
- blood from the nose (9);
- headaches (8);
- tingling/numbness/ pins and needles (5).

Of the 13 children who were walking, 5 were reported to have demonstrated unusual clumsiness or unsteadiness.

Parents particularly noted their children who had been playing outside coming in with nose-bleeds. Often they had linked increased frequency of these occurrences with wind direction and some had stopped their children playing outside at these times. Some adolescents had had daily nose-bleeds for three months at a time. These rural children now deliberately avoided going outdoors when possible. Adults who had lived in the bush all their life now found their lives restricted to indoors. Children were noted to be constantly rubbing their fingers. Children complained of *"ants in their hands*" and one infant reportedly screamed and dipped his fingers in water in the middle of the night. Children were reported to be waking at night in distress wanting their mums to rub their limbs. Children were reported to be waking out of their sleep with headaches.

In several cases children were the younger children in large families. Parents who were very experienced noted that older siblings who had already left home, who were born and raised in the same environment prior to the advent of the gas industry had been healthy.

Extreme fatigue, difficulty focusing and difficulty concentrating were new and debilitating symptoms for many residents. Some people could identify distinct individual odours at different times, variously described as:" rotten eggs, sickly sweet, like pine tarsal, acetone, creosote, after burn from cigarette lighter." Many people noted the association between their symptoms, wind direction and the location of the CSG waste water/evaporation ponds. Symptoms were worse when odours came through. Some people commented on the link between road spraying and their symptoms.

For adults and children alike, eye irritation and skin irritation, particularly when outside, were said to be constant background complaints, with severe exacerbations linked to odour events. For some the discomfort was severe and their skin peeled in the shower.

Infants, children and adults alike suffered from headaches. Some had been so intense that they had been investigated with CT scans and lumbar puncture.

Children and adults alike complained recurrently of a metallic taste which made them nauseous and anorexic. Undiagnosed cough, repeated diagnosis of 'flu', pneumonia, pleurisy and exacerbation of asthma were recurrent themes. Children were missing a lot of school. Sleep disturbance was endemic within the families surveyed. Many people related this directly to the noise associated with CSG activities: trucks moving, reversing, beeping, the noise and vibration from drilling, fracking and seismic testing. Some people were very clear that their sleep was disturbed by noise and vibration from the compressor station, at distances up to 15km away. Many other people's sleep was disturbed by the constant strain of living with, and dealing with, the impact of CSG on their daily lives. Many expressed helplessness and hopelessness in the face of their children's ill health and their inability to help and protect them. Some had the capacity to move away and did. Most found themselves trapped.

Eventually in March 2013 the long anticipated Queensland Government report[5] into the health impacts in the Tara region was released. It states:

"In summary the most that can be drawn from the DDPHU[6] report is that it provides some limited clinical evidence that might associate an unknown proportion of some of the residents' symptoms to transient exposures to airborne contaminants arising from CSG activities."

This finding was important as the Government report involved minimal non-systematic environmental sampling, and relied mainly on inadequate industry commissioned data. The investigation of patient symptoms was grossly underfunded and understaffed, with no medical staff actually visiting the site. Only 15 people were examined clinically. Positive findings of volatile chemicals were dismissed, despite the fact they are potentially capable of causing health impacts, especially over long periods of time. Rather than evidence of safety, the absence of evidence reflected absence of investigation.

The salient and critical recommendation from this government report was that an air-monitoring program *"be established by DEHP[7] to monitor overall CSG emissions and the exposure of local communities to those emissions."*

Despite assurances from the then deputy health minister and the head of Queensland health that there was a *'whole of government'* plan to enact the recommendations of the report, four years later there is still no information on overall gasfield emissions and the exposures of local communities to those emissions. In fact FOI information and direct communication with Dr Bristow from Darling Downs Health and Hospital Services indicates that this critical recommendation for the health of the community was actively blocked by DEHP. In a remarkable catch-22 DEHP determined that (based on the same minimal environmental industry commissioned data from 2012) the gas companies were in compliance and therefore did not support expanding the programme. It is irrelevant whether the companies were in compliance[8] with their environmental authority. The issue was never whether they were compliant. The issue underlying the genesis of the government report and its recommendations was the health of the community and the community's exposure to gasfield emissions.

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[5] Coal seam gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data

[6] Darling Downs Public Health Unit

[7] Department of the Environment and Heritage Protection

[8] What does compliance mean? Emission limits are not prescribed for each gas well or the broader reticulation system but rather, emission from this infrastructure must not cause nuisance or environmental harm. Queensland has no limit on flaring or venting of gas. Each gas well can vent/flare 3 million cubic metres of gas before they have to pay royalties.

'Natural' gas must reach export standards, but it is the contaminated waste that is vented, flared, sprayed, evaporated and buried at source in the Darling Downs that is the source of the problems for the region and its residents. The industry has been involved in a series of overtly dangerous and damaging activities in order to dispose of the massive volumes of contaminated waste generated. These activities, with the blessing of the authorities, include flaring, venting of raw gas, use of massive waste evaporation ponds and lined and unlined waste pits, road spraying of CSG waste water, and spraying of drilling muds and untreated human waste onto agricultural land which is in the middle of a flood plain.

One of the very serious issues impacting the health of people in Queensland's gas field is water contamination. For years residents have been reporting what they termed *"toxic rain*[9]", debris which was sometimes white, sometimes black falling onto themselves and their property. It takes the paint off cars. It has been falling onto residents' roofs and into their rainwater tanks, the collecting system for their domestic and drinking water supply.

Limited testing by DEHP, local council, the TV programme "today tonight" and tests organized by the residents themselves has repeatedly shown similar results. Rainwater tanks in the gasfields have been contaminated with heavy metals particularly lead, at levels 10 times above safe drinking water levels. This is in tanks with no lead in the collecting system. Other heavy metals repeatedly implicated are barium, chromium, arsenic, and nickel. Water in the rainwater tanks has been found to be extremely acidic with pH's of the order of 4.36, 4.37. Hydrocarbons have been found. Contamination with radioactive materials including lead 210 and Caesium 137 has been found in the sediment at the bottom of the rainwater tanks. The rainwater collecting systems have been seriously polluted with airborne contaminants. Residents who cannot afford to buy bottled water even for drinking let alone have access to the large amounts of water necessary daily for safe bathing, washing dishes, clothes and cleaning household surfaces have been left in a severely compromised situation. The appropriate authorities are fully aware of the situation. No assistance to secure safe water has been given by them.

Other water sources in this rural community have been seriously contaminated and compromised. Previously reliable water bores bubbled gas and became flammable. Bores which were productive of water of sufficient quality and quantity for domestic use and to sustain 145 head of cattle through Queensland's longest drought began blowing gas, and eventually failed. The children who were bathed in the bore water screamed from the rashes which developed where their skin had been submerged. These impacts have been repeatedly reported to the appropriate authorities. Nothing has been done.

In this flood plain another traditional method of harvesting water has been overland flow into domestic and stock dams. In an attempt to get rid of its contaminated waste the industry sprayed raw CSG produce water onto rural roads. This ran off the road into domestic and stock dams with subsequent skin eruptions in people who came in contact with the dam water and with death of stock, and native wildlife including yabbies in the dams. These impacts have been repeatedly reported to the appropriate authorities, yet they did nothing to assist the residents.

Multiple constraints limited the resident's efforts to organize their own biological testing. There was no facility to test for potential gas field contaminants at local pathology providers, so specimens of urine were sent to an occupational health and safety laboratory for analysis of gasfield/industrial contaminants. Cost was a major issue, as expensive tests (tax deductible for the gas companies) were full price for gasfield residents with limited resources. There were limitations on what could be tested for. Some chemicals could not be tested for directly, only their metabolites or breakdown products in the urine. Reference ranges apply only to adult workers exposed for the equivalent of an 8 hour day to a single agent. No reference levels exist

[9] See appendix 1, extracts of submissions to the Federal Senate Inquiry into unconventional gas.

for children or adults exposed to multiple contaminants 24 hours a day/ 7 days a week.[10]

Out of 16 urine samples, 13 people had evidence of mixtures of 2 or more toxic chemicals in their urine including phenol, cresol, PAH, metabolites of toluene, metabolites of xylene, acetone and methylethylketone.

Directly as a result of a peak in severe symptoms the urine of a three year old child was tested. Testing revealed extremely high levels of hippuric acid, the major metabolite of toluene, in his urine. As soon as she was aware of the result, the mother of this child immediately contacted her local Queensland Health doctor with the contents of the report.

Toluene metabolites found at high levels in a child in a non-occupational context is worrying, taking into account the short half-life i.e. toluene is quickly metabolised. This should have prompted investigation by the health department as a matter of urgency. Toluene is a known neurotoxin, an irritant and a suspected reproductive toxin that can be absorbed via inhalation. It is known to be associated with coal seam gas and has been found repeatedly in air samples in the residential estates.

The families received no assistance from the health department.

Since I first visited the Darling Downs in 2012 I have returned on many occasions. I have witnessed the extreme distress of many families and I have personal knowledge of many families who have had no choice but to leave their homes and everything they knew and loved because of the impact on their health. I also have personal knowledge of many families who, despite the impact on their health, are effectively trapped in the gasfields as no one is willing to buy their home. In desperation[11], families have in fact just walked off the land with nothing to show for a lifetime of work, resulting in the local council auctioning their properties for unpaid rates.

Two years after I first surveyed the health of 113 residents, to my knowledge 45 people had left the area. One had died and there were several more I could not account for. To my knowledge six families had been bought out by the gas industry with gag orders attached to the contract.

Reports of headaches, sore eyes and nose-bleeds continue as before. In addition there have been increasing community anxieties about apparently increased incidences of unusual cancers, cancers in young people and what appears to be clusters of cancers in small

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[10] Occupational health standards cannot be applied to children. Children are not just little adults, and in children the risks of exposure to low level toxins is not well understood. The level of risk which is considered acceptable for exposure of an adult 80kg worker to a single toxin over an 8 hour working day cannot be extrapolated to an unborn baby or infant exposed 24hours a day to a mixture of toxins, many of which are unidentified. Some chemicals can affect the endocrine system at extremely low levels. Children and unborn babies are most vulnerable. In pregnancy and early infancy chemicals can cause permanent brain damage at levels of exposure that would have little or no adverse effect in an adult. The cause of human health impacts may not be simple, that is a single chemical culprit, but be the cumulative impact over time of several related or unrelated chemicals. It is the interactions of a mixture of chemicals both outside and inside the body which warrant investigation. If one compound prevents the breakdown or excretion of other compounds from the body then unforeseen toxicity can result. If solvents are part of the mix, then the blood brain barrier may be compromised, with serious and unpredictable consequences

[11] One example involves a couple who were expecting their first grandchild at the property. 5 years previously they had sank a new bore. At some time since then QGC drilled a well 500-600 metres from their bore. The water commenced bubbling, with an awful smell of H2S. Over 2 months their pigs wasted, the chickens were dying. The landowner was afraid to have his family eat the eggs or vegetables. He shot all his pigs, pulled out all his vegetables, and the family walked off their land.

communities including pancreatic cancers, sarcomas, lymphomas and leukaemias amongst others.

Concerns include, for example, three cases of pancreatic cancer within a 10km radius in a community of approximately 50 people when the incidence of pancreatic cancer is usually of the order of 11/100,000 people.

There are just 3 families living immediately beside a gas hub, and for years there has been an unlined CSG waste-water pond on one property. Cancer in the forms of leukaemia and a rare type of sarcoma have been diagnosed in two young adult siblings in one family and the child next door has also been diagnosed with leukaemia.

On the other side of the gas hub, in a lane where 6 families live, cancer has been diagnosed in 5 of the houses.

At the local school (of approximately 500 students) 2 were being treated for sarcoma.

These serious community concerns regarding unusual patterns of cancer have not been investigated.

The often asked and unanswered question for many people living in the gas fields of the Darling Downs is, *"Is it safe to live here?"*

In Queensland there were no baseline studies and no adequate investigation of the health complaints has yet occurred. Indisputable facts are hard to come by, but information I have acquired from the Darling Downs Hospital and Health System is extremely concerning.

According to Queensland Government statistics[12], between June 2007 and June 2012, the population of the Darling Downs increased by 7% (from 235.193 to 251,893).

According to statistics compiled by the Darling Downs Hospital and Health Services[13],[14] (Figs 3, 2 , 12 and 20) while the population increased by 7% between 2007 and 2012:

Acute hospital admissions for respiratory conditions increased by **124%**;
Acute hospital admissions for circulatory conditions increased by **114%**;
Invasive cancer incidence increased by **14%**; and
Attempted suicides increased by **50%.**

[12] http://www.queenslandplan.qld.gov.au/resources/assets/regional-fact-sheets-darlingdowns.pdf

[13] Statistics requested by Dr Geralyn McCarron regarding potential health impacts associated with the coal steam gas industry.

[14] Note- data was accessed in September 2015, so statistics for 2015 are incomplete

Figure 3: Acute hospital admissions - respiratory conditions by residence and year

Residence	Year										Grand Total
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Chinchilla	15	24	27	41	38	112	206	195	194	134	986
Dalby	32	46	61	64	55	211	308	316	291	211	1595
Elsewhere		1	1	1	2	1	5	3	3	0	17
Goondiwindi	6	12	8	14	12	101	142	131	134	95	655
Inglewood	1	1	1	6	4	29	53	50	28	24	197
Kingaroy	22	46	49	61	55	156	213	237	243	190	1272
Miles	8	9	13	12	12	47	75	78	70	50	374
Millmerran	3	5	11	7	13	23	50	42	32	19	205
Southwest	8	56	52	27	44	53	88	214	187	49	778
Stanthorpe	12	17	25	33	36	122	147	145	174	106	817
Texas	2	3	7	10	5	12	31	22	26	10	128
Toowoomba	491	922	1035	1032	1152	1224	1317	1278	1513	984	10948
Warwick	26	172	312	284	315	373	321	287	346	259	2695
Grand Total	626	1314	1602	1592	1743	2464	2956	2998	3241	2131	20667

Figure 2: Acute hospital admissions - circulatory conditions by residence and year

Residence	Year										Grand Total
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Chinchilla	32	65	53	63	57	167	289	372	331	189	1618
Dalby	38	89	97	82	88	262	516	531	503	316	2522
Elsewhere		1		3	1	2	3	12	2	3	27
Goondiwindi	5	33	23	32	27	102	216	164	164	110	876
Inglewood	1	7	16	6	11	21	33	56	49	37	237
Kingaroy	36	86	109	93	102	194	374	342	419	221	1976
Miles	9	18	35	28	22	76	123	112	94	55	572
Millmerran	5	20	20	17	25	41	64	75	58	26	351
Southwest	37	88	67	71	80	74	137	243	286	82	1165
Stanthorpe	28	50	63	61	69	203	318	336	315	221	1664
Texas	9	11	12	16	11	28	40	43	36	25	231
Toowoomba	702	1485	1736	1691	1834	2023	2159	2391	2606	1637	18264
Warwick	51	334	536	533	571	629	641	614	566	374	4849
Grand Total	953	2287	2767	2696	2898	3822	4913	5291	5429	3296	34352

Figure 12: Queensland Invasive Cancer Incidence and Mortality for Year and Residence

Year	Incidence			Mortality		
	Darling Downs	South West	Total	Darling Downs	South West	Total
2005	1366	137	1503	476	52	528
2006	1500	124	1624	497	42	539
2007	1479	128	1607	483	61	544
2008	1599	173	1772	502	52	554
2009	1681	133	1814	528	58	586
2010	1571	135	1706	521	51	572
2011	1622	138	1760	509	45	554
2012	1693	150	1843	550	60	610

Figure 20: All attempted suicides by year – Darling Downs and South West

Year	Total
2006	112
2007	230
2008	244
2009	247
2010	282
2011	275
2012	346
2013	403
2014	471
2015	208
Grand Total	2818

These statistics give significant credence to the resident's ongoing health concerns.

For years the people forced to live with unconventional gas have been reporting to the relevant authorities in Queensland the impacts on their health and the evidence of environmental harm- death of native wildlife, birds and domestic animals, the foul odours, cracks in the earth, bubbling from the soil, gas in the water bores- even the Condamine River is flammable[15].

https://www.facebook.com/jeremybuckingham/videos/1367696236582894/

RIVER ON FIRE! Gas explodes from Australian river near frackin...

Still from a video posted by Senator Jeremy Buckingham demonstrating the extreme flammability of the bubbling river.

[15] In mid 2012 a local resident alerted the public to the fact that several kilometres of the Condamine River was bubbling. In true *'Yes Minister'* style, within hours of the evidence being posted on social media, the authorities and the gas companies denied it could be related to gasfield activities... then they announced an *'investigation'*. The bubbles proved to test strongly positive for methane. The people living along the river for more than 60 years had never seen anything like it before; in their environmental impact statements the gas companies had never once documented such a dramatic scenario as a bubbling, burning river; despite all evidence to the contrary, the industry still tries to push the theory that it is naturally occurring and that the river was always bubbling.

The level of environmental harm is now so undeniable that the Queensland Environment Department is prosecuting Linc, an underground coal gasification company, for reckless environmental harm at the plants between 2007 and 2013 and allege groundwater and hundreds of square kilometres of prime agricultural land have been put at risk. The soil is contaminated with high levels of hydrogen sulphide, carbon monoxide and hydrogen and over an area of 320 square kilometers around Hopeland farmers have been forbidden to dig a hole deeper than 2 metres due to leakage of these gases from the soil. Government testing has also confirmed soil contaminated with high levels of benzene. Recently the "area of caution" where soil contamination has been confirmed has been doubled. Inexplicably, despite the government having enough evidence of serious environmental harm over an extensive area to actually prosecute the offending company, they have left the families living in the middle of known areas of contamination without appropriate information despite repeated and ongoing requests. This is despite the fact that stock and domestic water bores in the area are "kicking' with explosive levels of gas. Water bores have dropped more than 60 metres and are unusable. Volatile organic compounds at 5% per volume have been measured on resident's verandahs and stock animals have been dropping dead[16]. Chemicals of serious concern such as benzene, toluene, naphthalene, cresol xylene and phenol were identified in an investigation into the "Linc Stink" as far back as 2012. Inexplicably also, although the government has postulated that the mechanism of harm was Linc energy caused fracturing of the overburden, allowing escape of gases from the under ground fire and leakage along underground river beds, they have given Origin energy permission to drill more than 100 coal seam gas wells in the same area of Hopeland, fracturing the overburden with each well and providing multiple conduits for seepage of gas to the surface. This is in the same area where a farmer is not permitted to dig a hole deeper than 2 meters.

The level of environmental harm from air pollution is plainly visible. In scenes reminiscent of 'Apocalypse Now' the night sky glows orange from the flares [17] and the resident population continues to breathe the toxic fumes.

The night sky. ORANA FLARE from 20km away. Courtesy of Rev G. Slaughter. March 2017

[16] See appendix 1, extracts from residents submissions to the Federal Inquiry into Unconventional Gas
[17] https://www.chinchillanews.com.au/news/orange-light-in-the-sky-over-chinchilla-explained/3154351/

AUSTRALIAN RESEARCH INTO THE IMPACTS OF UNCONVENTIONAL GAS

Remarkably, or perhaps not since the main coal seam gas research body at the University of Queensland is funded by gas companies Santos, Arrow, QGC and Origin, minimal academic research into the health impacts of the unconventional gas industry has come out of Queensland.

Werner[18], Vinks et al wrote:
"More importantly, while evidence of the environmental cause of adverse health impact was lacking, several scholars and experts voiced concerns about the potential for adverse health outcomes. These concerns were based on credible evidence of detrimental environmental impact and strongly suggest that the lack of evidence of health impact does not dismiss claims of health impact. The available evidence, or lack thereof, is not sufficient cause to rule in or rule out significant or specific, future, or cumulative health impacts of UNGD activities.

It is probable that the lack of evidence on direct causal links between environmental hazards and health outcomes is a result of the rapid expansion of this industry in a short period of time — leaving evidence-based research activities with very little time to respond. Additionally, there is the potential for environmental health outcomes with longer latencies for which effects may not yet be seen."

In an exploratory study of all-age hospitalization[19] for three study areas in Queensland Werner et al also found that certain hospital admission rates increased more quickly in the CSG study area than in the other study areas.
The CSG area showed increases in hospitalization rates compared to the rural areas for neoplasms (RR: 1.09, 95 % CI: 1.02–1.16) and blood/immune diseases (RR: 1.14, 95 % CI: 1.02–1.27).

In 2014 Santos and Maher from Southern Cross University reported[20] wide-spread enrichment of both Methane (up to 6.89ppm) and Carbon dioxide (up to 541ppm) within the production gas field in the Tara region, compared to outside.

In 2015 a survey by Australia's Commonwealth Scientific and Industrial Research Organisation[21] of 390 residents in the Chinchilla region of Queensland found that 48.5% felt their community was *'only just coping', 'not coping'* or *'resisting'* the industry. While 51.5% felt their community was adapting, just 11.4% of this group saw the change as *'into something different but better'*

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[18] Werner AK, Vink S, Watt K, Jagals P. Environmental health impacts of unconventional natural gas development: a review of the current strength of evidence. *Science of the Total Environment* 2015; **505:** 1127-1141. **https://doi.org/10.1016/j.scitotenv.2014.10.084**

[19] Werner AK, Watt K, Cameron CM, Vink S, Page A, Paul Jagals P, All-age hospitalization rates in coal seam gas areas in Queensland, Australia, 1995–2011
BMC Public Health (2016) 16:125 DOI 10.1186/s12889-016-2787-5
http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-2787-5

[20] Maher DT, Santos IR, Tait DR, Mapping Methane and Carbon Dioxide Concentrations and δ13C Values in the Atmosphere of Two Australian Coal Seam Gas Fields Water Air Soil Pollut (2014) 225:2216 DOI 10.1007/s11270-014-2216-2

[21] https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/coal-seam-gas/Socioeconomic-impacts-of-coal-seam-gas-in-Queensland.pdf

Dr Meuthen Morgan from the University of New England investigated the mental health impacts of unconventional gas[22].
Dr Morgan wrote:
"Farmers are exposed to a unique range of vocational stressors, and while mental health morbidity is similar to their non-rural counterparts, suicide rates in the farming community are higher."
"Farmers in the CSG- Stressed and Globally-Stressed profiles exhibited clinically significant levels of psychological morbidity."
"stress associated with CSG impacts both on-farm (operations, profitability, and personal privacy) and off-farm (health, community and environmental) were assessed as severe"

Professor Melissa Haswell who has recently been appointed Professor of Health, Safety and Environment at the School of Public Health and Social Work at QUT in her recent paper[23] "Health concerns associated with unconventional gas mining in Western Australia: A critical review." Technical Report · March 2017 Professor Haswell wrote:

"Since 2013, there has been an increasing focus on the likely vulnerability of developing fetuses and children to environmental hazards as compared to adults. The complex developmental processes that occur during gestation are exquisitely sensitive to chemicals and signals in the uterine environment. There is a growing understanding of the negative impacts of various exposures to the mother during pregnancy on birth outcomes, for example air pollution (PM2.5) and tobacco smoking on birth weight and preterm births, as well as alcohol and other drugs on brain development. Many of the chemicals involved in unconventional gas mining have reproductive and developmental toxicity.

Infants and children continue to face higher risks from toxic exposures due to their higher metabolic and respiration rates, their smaller body size and smaller and immature organs, including the liver, lungs and kidneys that deal with or store many toxins that enter the body. Children also experience greater exposure to toxins in the environment through outdoor play activities, compared to adults.

It is also very important to recognise that infant and child well-being is highly sensitive to psychosocial and community stressors, including noise, negative emotions expressed by others and witnessing aggression and conflict."

In the Australian context it is disturbing to me what has not been done. I approached the NHMRC asking them to actively promote and fund high quality scientific research into the health impacts of unconventional gas. In reply I got a letter ignoring my request and assuring me that that considerable work is being undertaken by the Australian Government in relation to coal seam gas (CSG) including the National Chemicals Notification and Assessment Scheme (NICNAS), Commonwealth Scientific and Industrial Research Organisation (CSIRO), Department of Environment, Australian Research Council (ARC), and other government agencies.

I am aware of the published work of some of these agencies with regard to unconventional gas and it simply reinforces my view that funding must be found for unbiased scientific research that is rigorously planned, implemented and actually addresses the questions that need to be answered. The unbiased scientific contribution by these agencies with regard to unconventional gas is, in my opinion, pitifully lacking.

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[22] Morgan M, "Fracked: Coal seam gas extraction and farmers' mental health" Journal of Environmental Psychology April 2016. http://www.sciencedirect.com/science/article/pii/S0272494416300317
[23] Haswell M, https://www.researchgate.net/publication/314230557_Health_concerns_associated_with_unconventional_gas_mining_in_Western_Australia_A_critical_review

As an example of my concern, I would point you to the previously mentioned report from the office of the Chief Economist entitled *"Review of the socioeconomic impacts of coal seam gas in Queensland 2015"*[24].
The remarkable and shocking admission in this Government Report, considering that this was in theory a report that was meant to review the socioeconomic impacts of CSG in Queensland was: **"We made a conscious decision not to meet with local landholders and community groups."** This fundamental omission demonstrates a lack of understanding of both the issues at stake and the context of socioeconomic impact assessment.

With regard to the work of CSIRO, I think it would be fair to say that in the years before CSIRO was subjected to massive personnel and funding cuts and political interference, it was an organisation whose research was recognised and highly respected both nationally and internationally. Nevertheless, their published research so far as it relates to the CSG industry does not, I believe, meet the exacting standards the public would expect from the CSIRO. In 2014 CSIRO published a report[25] into CSG fugitive emissions. It is true they labelled it a 'pilot' study, but since CSIRO is our national scientific agency, and since CSG had, at that time already been a serious issue in Queensland for 8 years one might have expected more diligence in the design of the project. Minimal wells were tested (43 out of more than 5,000 wells) and even the selection of those wells was biased, influenced by the participation of the companies. Of the 43 non-randomised wells examined, only three showed no emissions. These were two plugged and abandoned wells and one suspended well that had been disconnected from the gas gathering system. But of real significance CSIRO noted a larger source of methane that they were not monitoring for, a source which was interfering with their study, that was found on a gas relief vent on a water gathering installation close to one of the wells examined. They noted that an indicative estimate of the emission rate from this vent suggested that the source was at least three times higher than the largest well pad emission rate. Similar installations are widespread through the Queensland gas regions.

I am aware of NICNAS and its study of CSG chemicals. Naively I would have assumed that prior to 2006, that is, prior to the commencement of intense CSG exploration, the chemicals to be used for this purpose, in the massive quantities necessary would have been vetted for safety by the national industrial chemicals regulatory body. That obviously did not happen. My understanding is that of the 23 chemicals commonly used for fracking in Australia, only 2 of them have been assessed by NICNAS in any context, (unrelated to CSG) and nothing to date has been published by NICNAS regarding assessment of chemicals associated with CSG extraction. This is despite NICNAS commencing a project in 2012 to address this issue.[26] The exclusions for this project are rather important.

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[24] Stakeholders involved in formulation of this report included:
• social science and other researchers, including from the Gas Industry Social and Environmental Research Alliance (GISERA), and the University of Queensland's Centre for Coal Seam Gas (UQ-CCSG) • Queensland Government representatives, including the Office of Groundwater Impact Assessment (OGIA) and the Department of Natural Resources and Mines (DNRM)
• representatives from the GasFields Commission Queensland (GFCQ) • industry associations, including the Queensland Resources Council (QRC) and the Australian Petroleum Production and Exploration Association (APPEA) • representatives from coal seam gas companies and joint ventures operating in Queensland.
Remember that GISERA is a partnership between CSIRO, Australia Pacific LNG (APLNG) and QGC; and the Centre for Coal Seam Gas at the University of Queensland (UQ-CCSG), which has funding from Santos, Arrow Energy, QGC and APLNG all gas companies with a vested interest in the outcome of any study.

[25] http://www.environment.gov.au/system/files/resources/57e4a9fd-56ea-428b-b995-f27c25822643/files/csg-fugitive-emissions-2014.pdf

[26] http://www.nicnas.gov.au/communications/issues/fracking-hydraulic-fracturing-coal- seam-gas-extraction/information-sheet

"In particular, the National CSG Chemicals Assessment project does not examine impacts of drilling and hydraulic fracturing chemicals on deeper groundwater systems such as confined aquifers. Also, the assessment does not examine fugitive emissions of geogenic gases such as methane. The assessment of human health and environmental impacts associated with geogenic chemicals and other chemicals used at CSG sites, such as diesel fuels and machinery lubricants, is also outside the current project scope; as is an examination of the risks associated with the chemicals used in the extraction of shale and conventional oil and gas extraction in Australia."
We are informed by NICNAS that the 'mixtures' of drilling or fracking chemicals will not be assessed in this study, only individual active ingredients, despite the call by the WHO and other researchers to assess the cumulative load of chemicals used. NICNAS has acknowledged there is a lack of human or environmental toxicological data for many of the products in use but will not be in the position to address these data gaps. The project by NICNAS will not initiate new health studies and there is no 'health and medical research' mandate. Five years after commencement of the project, thousands of wells have been already been drilled, thousands of wells have been fracked and refracked in the shallows and there is not even the most basic information yet available from our national industrial chemicals regulatory regarding the safety of the chemicals being used. Dr Mariann Lloyd-Smith[27], senior advisor to IPEN and a member of the UN Expert Group on Climate Change and Chemicals has labelled the government's assessment of Coal Seam Gas chemicals "a total farce".

On 22nd July 2014 in private communication with ARPANSA[28] I was informed that:
"ARPANSA is not aware of any comprehensive radiological risk assessments conducted in Australia dealing specifically with the impact of TENORM emitted by coal seam gas exploration, extraction and processing."

At this late stage in the unconventional gas industry's development, the dearth of independent, high quality scientific research into the human health impacts of the unconventional gas industry in this country is a very significant problem.

INTERNATIONAL RESEARCH INTO UNCONVENTIONAL GAS

Conversely, internationally there is an extensive and rapidly increasing peer-reviewed body of literature regarding the documented impacts of the unconventional gas industry, yet many data gaps remain.

Despite industry's repeated outright denial of harm caused to water resources, the December 2016 update of the American EPA report[29] finally confirms contamination of drinking water resources and the multiple industry activities resulting in more frequent or more severe impacts. I quote:

"People rely on clean and plentiful water resources to meet their basic needs, including drinking, bathing, and cooking. In the early 2000s, members of the public began to raise concerns about potential impacts on their drinking water from hydraulic fracturing at nearby oil and gas production wells."
"The hydraulic fracturing water cycle describes the use of water in hydraulic fracturing, from water withdrawals to make hydraulic fracturing fluids, through the mixing and injection of

[27] http://www.sunshinecoastdaily.com.au/news/csg-assessment-total-farce-says-advisor/2911067/

[28] Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
[29] https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990

hydraulic fracturing fluids in oil and gas production wells, to the collection and disposal or reuse of produced water. These activities can impact drinking water resources under some circumstances. Impacts can range in frequency and severity, depending on the combination of hydraulic fracturing water cycle activities and local- or regional-scale factors. The following combinations of activities and factors are more likely than others to result in more frequent or more severe impacts:

- *Water withdrawals for hydraulic fracturing in times or areas of low water availability, particularly in areas with limited or declining groundwater resources;*
- *Spills during the management of hydraulic fracturing fluids and chemicals or produced water that result in large volumes or high concentrations of chemicals reaching groundwater resources;*
- *Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources;*
- *Injection of hydraulic fracturing fluids directly into groundwater resources;*
- *Discharge of inadequately treated hydraulic fracturing wastewater to surface water resources; and*
- *Disposal or storage of hydraulic fracturing wastewater in unlined pits, resulting in contamination of groundwater resources.*

"Cases of impacts were identified for all stages of the hydraulic fracturing water cycle. Identified impacts generally occurred near hydraulically fractured oil and gas production wells and ranged in severity, from temporary changes in water quality to contamination that made private drinking water wells unusable.

" "significant data gaps and uncertainties in the available data prevented us from calculating or estimating the national frequency of impacts on drinking water resources from activities in the hydraulic fracturing water cycle."

The Physicians for Social Responsibility and Concerned Health Professionals of New York have compiled and regularly updated the "*Compendium*[30] *of scientific, medical and media findings demonstrating risks and harms of fracking*" (Unconventional oil and gas extraction) in the United States. The fourth edition was published in November 2016.
They note:
"...more than 80 percent of all of the peer-reviewed literature that is relevant to assessing the environmental, socioeconomic, and public health impacts of shale and tight gas development has been published since January 2013. Indeed, nearly one-quarter of the now more than 900 available studies were published in the first nine months of 2016 alone. The vast majority of the literature reveals both potential and actual problems. Specifically, as demonstrated by PSE's statistical analysis of the body of scientific literature available from 2009-2015—which, at the date of publication included 685 peer- reviewed papers—

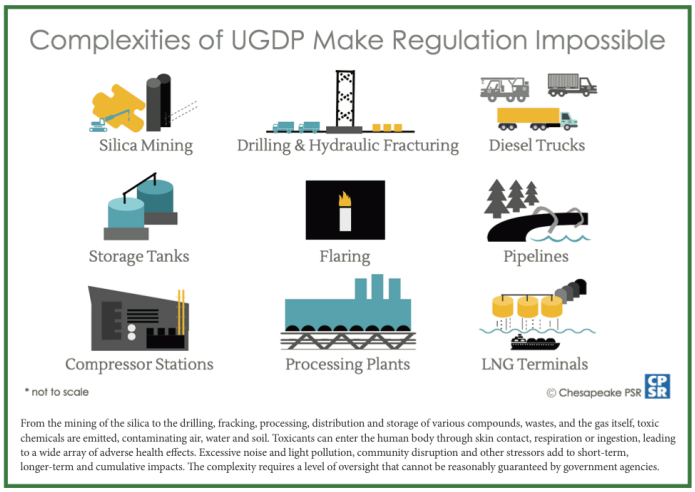
69 percent of original research studies on water quality found potential for, or actual evidence of, water contamination;
87 percent of original research studies on air quality found elevated air pollutant emissions; and
84 percent of original research studies on human health risks found signs of harm or indication of potential harm."

Significantly the growing evidence indicates that regulations are simply not capable of preventing harm. On analysis of the 900 available studies the Physicians for Social Responsibility and Concerned Health Professionals of New York conclude that: *"regulations have not prevented significant harms; and that some harms are not preventable through regulatory opportunities".*

[30] http://www.psr.org/resources/fracking-compendium.html?referrer=https://www.google.com.au/

The Chesapeake Physicians for Social Responsibility argue that the complexities of Unconventional gas exploration and production make regulation impossible[31].

"From the mining of the silica to the drilling, fracking, processing, distribution and storage of various compounds, waste and the gas itself, toxic chemicals are emitted, contaminating air, water and soil. Toxicants can enter the human body through skin contact, respiration or ingestion, leading to a wide array of adverse health effects. Excessive noise and light pollution, community disruption and other stressors add to short-term, longer-term and cumulative impacts. The complexity requires a level of oversight that cannot be reasonably guaranteed by government agencies."



Professor Haswell, in her paper "Health concerns associated with unconventional gas mining in Western Australia: A critical review" notes:
"In December 2016, a comprehensive systematic review of 156 peer-reviewed publications was published, examining the evidence of human exposures to harmful air and water pollutants, health impacts, seismic activity and climate impacts of unconventional gas mining. This review found multiple potential hazards to human health associated with mining and substantial gaps in understanding that prevented confirmation of the safety of the industry, and recommended no new developments in the United Kingdom until research demonstrated its safety."

EXAMPLES OF STUDIES OF IMMENSE SIGNIFICANCE TO PUBLIC HEALTH ARE:

- Pregnant women who live near active unconventional natural gas development operations (UNGD) in Pennsylvania were at a 40 percent increased risk of giving birth prematurely and at a 30 percent risk of having a high risk pregnancy (eg hypertension and asthma).[32] (study of 9,384 pregnant women and their 10,496 newborns January 2009 to January 2013);

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31 https://static1.squarespace.com/static/54949381e4b05fcc6a96c5c6/t/58754debe6f2e1e518ac8a15/1484082670803/FrackingRegulationsCannotProtectMarylandChesapeakePSRJan2017DontFrackMDFrackingBan.pdf

32 Casey JA[1], Savitz DA, Rasmussen SG, et al Unconventional natural gas development and birth outcomes in Pennsylvania, USA Epidemiology. 2016 Mar;27(2):163-72. doi: 10.1097/EDE.0000000000000387. https://www.ncbi.nlm.nih.gov/pubmed/26426945

- The more exposure a pregnant woman had to gas wells, the higher her risk for a smaller than normal baby. Mothers whose homes were nearest to a high density of wells were 34% more likely to have babies who were 'small for gestational age'[33];
- Children born in areas with the highest number of gas wells had a 30% increased rate of congenital heart defects (CHD) compared to children born in areas with no gas wells within 10km. (25,000 births from 1996 to 2009)[34];
- A Yale University research team reports[35] that carcinogens involved in UNG operations have the potential to contaminate both air and water in nearby communities in ways that may increase the risk of childhood leukemia. The team identified 55 known or possible carcinogens that may be released into air and water from UNG operations. Of these, 20 are linked to leukemia or lymphoma.
- Pennsylvania residents with the highest exposure to active unconventional gas wells were nearly twice as likely to experience a combination of migraine headaches, chronic nasal and sinus symptoms, and severe fatigue[36];
- Health symptoms reported by residents increased as distance between household and gas wells decreased. Among persons living less than one km from drilling and fracking operations, rashes and respiratory problems were more prevalent[37];
- Those who live near a higher number of, or larger active gas wells were 1.5 to 4 times more likely to suffer from asthma attacks than those who live further away, with the closest group having the highest risk. Increased risk at all stages of well development, pad preparation, drilling, stimulation/fracking and production.[38] (Study of 35,000 medical records between 2005 and 2012);
- Cardiology hospitalisation was 27 percent higher than in control communities with no wells. Neurology inpatient prevalence rates were significantly associated with density of wells. Hospitalisations also rose significantly for cancer, skin conditions, and urological problems. No such increase in health problems was observed in a control Pennsylvania county without any drilling and fracking activity.[39] (Hospitalisation 2007-2011, study of 93,000 inpatient records.);

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[33] Shaina L, Stacey LA et al, Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania. 2015 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0126425

[34] McKenzie L, Guo R et al, Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado. Environmental Health Perspectives, April 2014 https://ehp.niehs.nih.gov/1306722/

[35] Elliott EG, Trinh P, et al. Unconventional oil and gas development and risk of childhood leukemia: Assessing the evidence. Science of The Total Environment Volume 576, 15 January 2017, Pages 138–147 http://www.sciencedirect.com/science/article/pii/S0048969716322392

[36] Tustin AW, Hirsch AG, Rasmussen SG, et al Associations between unconventional natural gas development and nasal and sinus, migraine headache, and fatigue symptoms in Pennsylvania. Environ Health Perspect. 2017 Feb;125(2):189-197. doi: 10.1289/EHP281. Epub 2016 Aug 25. https://www.ncbi.nlm.nih.gov/pubmed/27561132

[37] Rabinowitz PM, Slizovskiy IB, et al Proximity to natural gas wells and reported health status: results of a household survey in Washington County, Pennsylvania. *Environ Health Perspect*; DOI:10.1289/ehp.1307732 https://ehp.niehs.nih.gov/1307732/

[38] Rasmussen SG Ogburn EL, et al Association between unconventional natural gas development in the Marcellus Shale and asthma exacerbations.
JAMA Intern Med. 2016 Sep 1;176(9):1334-43. doi: 10.1001/jamainternmed.2016.2436. https://www.ncbi.nlm.nih.gov/pubmed/27428612

[39] Jemielita T, Gerton G, et al. Unconventional gas and oil drilling is associated with increased hospital utilization rates. 2015 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0131093

It should be noted that the health impacts of air pollution potentially impacts a wide area, and those who rely on locally produced food whether from their own production or bought at market, risk contamination. The flares contain widely-recognized toxins, such as benzene, which pollute the air. Local people complain of respiratory problems such as asthma and bronchitis. There have been over 250 identified toxins released from flaring[40] including carcinogens such as benzopyrene, benzene, carbon disulphide (CS2), carbonyl sulphide (COS) and toluene; metals such as mercury, arsenic and chromium; sour gas with H2S and SO2; Nitrogen oxides (NOx); Carbon dioxide (CO2); and methane (CH4) which contributes to the greenhouse gases

It is important also to note that In 2013 the World Health Organisation[41] defined outdoor air pollution as a class I carcinogen. Diesel fumes, benzene, particulate matter all cause cancer. The health danger of particulate matter[42] is well understood. Particles, if small enough, can be absorbed from the lungs directly into the bloodstream causing damage to multiple organs. This includes lung damage, strokes, heart attacks, kidney damage, diabetes, and hypertension. With particulate matter, as with benzene, there is no safe level of exposure or a threshold below which no adverse health effects occur. Air pollutants react to form other harmful compounds. Ozone is formed when the oxides of nitrogen and volatile organic compounds combine in the presence of sunlight. Ozone can permanently damage children's lungs. A study by the University of Southern California[43] of fourth grade school children found that each increase of 20 parts per billion in ozone was associated with a 63% school absence rate increase for illness.

HEALTH IMPACTS OF CLIMATE CHANGE

In its early days of unconventional gas development, it was mistakenly promoted as being a viable transition fuel towards renewables. There is increasing evidence that the fugitive and deliberate emissions from gas operations in the form of methane have not been adequately measured, calculated or accounted for[44]. Since methane is a powerful greenhouse gas, up to 80 times more powerful than carbon dioxide the level of methane released into the atmosphere is critical. To have any benefit over dirty coal in terms of climate change, fugitive emissions of methane must be less than 3% but emissions from unconventional gas developments have been measured at between 4 and 30%. Recent research[45] also indicates that natural gas power plants emit up to 120 times more methane than facility-reported estimates.

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[40] Ismail OS, Umukoro GE, Global Impact of Gas Flaring, Energy and Power Engineering, Vol. 4 No. 4 (2012) , Article ID: 20231 , 13 pagesDOI:10.4236/epe.2012.44039

[41] International Agency for Research on Cancer, press release no 221 17 Oct 2013 http://www.iarc.fr/en/media-centre/iarcnews/pdf/pr221_E.pdf -

[42] Review of evidence on health impacts of air pollution REVIHAAP project, WHO 2013, http://www.iarc.fr/en/media-centre/iarcnews/pdf/pr221_E.pdf

[43] The Ozone We Breathe, http://earthobservatory.nasa.gov/Features/OzoneWeBreathe/ozone_we_breathe2.php

[44] http://www.abc.net.au/news/2017-02-28/the-clean-green-image-of-coal-seam-gas-is-under/8312466?pfmredir=sm

[45] Lavoie TN, Shepson PB et al. Assessing the Methane Emissions from Natural Gas-Fired Power Plants and Oil Refineries. Environmental Science and Technology. http://pubs.acs.org/doi/abs/10.1021/acs.est.6b05531

An accurate assessment of methane emissions' contribution to climate change is critical as climate change poses major risks to health. As documented[46] by the Doctors for the Environment Australia: *"Climate change is widely regarded as the biggest threat to health in the 21st century (Costello et al. 2009; WHO 2015). Climate change affects health in many ways: directly through extreme events* such *as heatwaves, floods, bushfires, and indirectly via worsening air quality, changes in the patterns of infectious diseases, threats to food and water supplies, and effects on mental health."*

COMPOUNDED DIFFICULTIES FACED BY COMMUNITIES FORCED TO LIVE WITH THE GAS INDUSTRY

Significant compounded difficulties are likely to be experienced by rural and low socio-economic communities dealing with pre-existing stressors who already have limited access to health care and who are forced to live with unconventional gas.

Unconventional gas projects are often promoted as "development" but their introduction has not brought better quality of life or additional services to the local people in Queensland. In the rural residential estates the residents live on rural blocks ranging in size typically from 30 to 250 acres. They are surrounded by the infrastructure of the gas industry. But there are no shops, petrol stations, schools or other basic facilities. Despite massive gas infrastructure now surrounding them basic facilities have not improved. The nearest doctor is in Tara which is an approximately 70km round trip. Residents habitually travel to medical facilities in Chinchilla, Dalby and Toowoomba where the regional base hospital is located. An added burden of ill health in such a rural situation adds significant challenges that would be unthought-of in an urban area. This includes the extended time involved in travel to and from a health care facility, the sometimes impossible ability to access reliable transport and needing to have available the significant amount of money required for petrol or diesel, money which may not exist or be earmarked for other vital purposes. In a person who is already incapacitated these challenges may be insurmountable.
In rural families who were previously semi–self sufficient, having had access to their own safe drinking water, vegetables, chickens etc. the financial burden created by contamination of these basic requirements has been a major stressor. The complete devaluation of their home and property making them unsaleable has left many people trapped in an untenable situation and at the mercy of the gas company as the only possible buyer.

In the rural towns such as Chinchilla and Miles, the impact of the initial (short lived) boom associated with the construction phase of the gas industry and the inevitable bust on the resident population was different but also devastating.
I quote the words of Karen Auty, resident of Chinchilla, from her submission[47] to the Federal Senate Select Committee on Unconventional Gas Mining[48], which was initiated and chaired by Senator Glenn Lazarus.

" KAREN AUTY RESIDENT OF CHINCHILLA, SUBMISSION 285
"Sky rocketing rents (during the construction phase) forced out many permanent, long term residents. Pensioners, retirees, sole parents, single income families and non-industry workers left

[46] https://www.dea.org.au/wp-content/uploads/DEA_Climate_Change__Health_Fact_Sheet_final.pdf
[47] http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Gasmining/Gasmining/Submissions

[48] Please see Appendix 1 for extracts from further submissions to the Senate Inquiry of gasfield residents, all of whom are personally known to me.

the town in droves. They will not return. Young children, (were) living in tents at the showground in the midst of a very chilly winter was something previously unseen in this town. Lack of Public Housing contributed to this situation.
Those of us fortunate enough to own our own homes have been subject to crippling increases in our Western Downs Regional Council rates. In just five years my rates have risen from $1083 to $2011. Unimproved land valuation increased from $58,000 to $182,500[49]. This is despite no expenditure by Council in the form of kerbing and channelling or improvements of any kind. The demand for new and investment housing resulted in 'pop-up' housing estates, constructed before adequate infrastructure, such as storm water drains, were in place. This directly resulted in flooding of long established properties where flooding had never been an issue. Many of the new houses developed slab cracks and structural damage within two years of construction, putting into question the quality control and signing off on building regulations. "
TRAFFIC A huge increase in the regions' traffic, especially by heavy vehicles, impacted our local roads, not just in wear and tear, but also in the road toll and road trauma rate. I believe the statistical rise is unmatched anywhere in Australia. With the traffic increase came a phenomenal rise in roadside litter. Council and/or Main Roads seem unable to restore this eyesore to a pre-industry standard.
CRIME RATE The population of the town, including surrounding 'worker camps' more than tripled, yet policing numbers did not reflect this. The rise in assaults, alcohol and drug related incidents, thefts, vandalism, break and enters and traffic incidents have had a negative impact. Our police station throughout the significant 'boom' period remained opened only part-time hours. Their very recent upgrade, along with staffing resources, came years too late.
Other government services have proved to be under-resourced and inadequate to service the population. This includes the court house, hospital and mental health facilities." "I can only add to this, that since the construction bubble has burst, the town has been left reeling with high unemployment, inadequate infrastructure and services, still rising Council rate costs, plummeting land valuations, a glut of vacant rental properties, spiking crime rates and struggling local businesses.
The abrupt change of demographic is mostly due to the real estate crash and the large number of rental vacancies, with recommendations from Centrelink and other such agencies in coastal and interstate cities that Chinchilla is now attractive for welfare recipients and parolees. This influx has seen our Police and Court services stretched as the issues of domestic violence, drug use/ offences and property thefts have reached levels previously unheard of in our once quiet and safe town.
Families that are heavily impacted by their misfortune to live in proximity to gas infrastructure find their physical and mental health worsening with each passing week. The response from Government has been nothing short of token and indeed appalling."

In areas of socio-economic disadvantage typically targeted by the unconventional gas industry a percentage of the population inevitably suffer the added disadvantage of inadequate literacy levels. Regardless, they are expected to wade through industry and government documents including EISs which may be of the order of 7000 pages and write formal submissions in reply without any assistance to do so. They may or may not have the time, resources, skills or knowledge to navigate their way around government websites and complaint systems. Even if they have the knowledge and skills they may not have the physical ability to access information in a timely manner, or at all, due to inadequate internet and mobile connection.
In meetings with industry representatives to negotiate access or other legal agreements, the industry inevitably has a team of trained negotiators, possible including those who are legally trained, whereas residents in rural areas are often unaware of their rights. In rural areas of Queensland where traditionally a man's word was his bond, landholders found to their cost that their concepts of honour and honesty did not apply to the gas companies[50].

[49] Update 2017 rates, unimproved value has fallen to $35,000 but rates remain over $2,000 per year and council has its biggest ever deficit.
[50] Gas companies are regularly referred to by rural landholders as "liars, cheats, and thieves."

According to Australian Petroleum Production and Exploration Association chief executive David Byers:
"Experience in Queensland[51] shows that gas companies have been able to successfully negotiate thousands of land access agreements and compensation arrangements with farmers so this is an issue that can be successfully managed."

In Queensland, one of the factors which put already vulnerable people at risk has been the perception that they are required to cooperate, negotiate and enter into legally binding agreements with the gas companies. This is particularly so when such an agreement is subject to a gag clause which has the effect of isolating the individual from their community. Invariably confidentiality clauses are insisted on by the gas companies and it is unusual for 3rd parties to have any insight into the constraints enforced on landholders by the gas companies. However I have access to a document[52] which a landholder refused to sign.
The circumstances were that the family were surrounded by gas infrastructure and one of the major problems they endured was the unbearable noise day and night. Complaints to the government agencies resulted in no action, and they were told to negotiate an alternative access agreement with the gas company. The landowner entered negotiations with the aim of finding a solution to the noise so that the family could enjoy peaceful sleep, study and leisure and reverse the serious adverse impacts of noise on their health and wellbeing.
For the purposes of noise regulation the deemed background noise in rural areas is 25dB, (the actual background noise may be as low as 15-20dB). It is recognized that noise levels "greater than 5 dB above the background noise levels are likely to cause annoyance."
The AAA drawn up by the gas company for signature did nothing to address the aim of noise reduction at the household. They did not suggest sound-proofing, or a night time noise curfew. Instead, for the next 50 years (or longer if defined by the company) for the princely sum of $70,000 in full and final payment the gas company expected the landowner to sign a document accepting noise levels of 55dB during the day and night-time noise levels of 62dB.
The landowner was expected to sign a document permanently indemnifying the gas company and its agents against all harm caused by them by way of not only noise but also dust, odour, light and vibration, and not only to his family, but also to visitors and subsequent owners of the land. He was prohibited from raising objections with government agencies and disclosing the contents of the agreement.
In the meantime throughout the months and years he was being given the runaround by the gas company's legal team, the government agencies charged with protecting his interests refused to engage with him as he was *"in negotiations for an alternative access arrangement."*

The adverse impact on mental health in communities forced to live with the intrusion of the gas industry has been in some cases extreme. The pre-existing traditional stressors of life on the land are already significant – the need to cope with the cycles of drought and flood, inadequate prices, physical isolation, a tendency towards stoicism, reluctance to seek help and inadequate services available to name a few. When individuals are then submersed for years in a struggle to keep gas companies off their land, or dealing with the harm caused by gas company's presence the pressure mounts. When they are spending significant amounts of time which would be better dedicated to their work, rest, family or even sleep reading documents, writing submissions, attending unpaid meetings with gas employees and lawyers and endlessly worrying the mental health toll is high. When the land is their life, the loss of intergenerational equity can be devastating. When in addition the community is divided and secrecy is imposed, the social relationships and support structures usually protective of mental health may be absent.

[51] http://www.theaustralian.com.au/business/mining-energy/farmers-fight-for-rights-to-royalties/news-story/105c4e00b71630588c088b7e037cf752
[52] See Appendix 4

The adverse impacts on the mental health, as well as the social and economic well being of the community can be compounded by the direct actions of the gas companies. Allegations[53] over allegedly unpaid work have been made against Santos at the down turn of the industry in Queensland, with liquidators for Lean Field Development claiming that *"Santos owes Lean Field an estimated $6.3million."*

RECOMMENDATIONS

In 2013 in my report on the health impacts in Queensland I made the following recommendations.

1) A fully funded comprehensive medical assessment of residents currently living in proximity to unconventional gas development should be carried out as a matter of urgency.
2) The planning and urgent implementation of fully funded, long term epidemiological studies is essential to track the health of people exposed to CSG over the next several decades. This must include workers in the industry as well as people who may already have left the area because of health concerns.
3) Health impact assessments must be an integral part of any and every unconventional gas development. No new permit should be issued without one, and health impact assessments should be carried out for every development already in place.
4) Comprehensive air and water monitoring (an open, ongoing and unlimited information loop) is essential. If we are looking at possible non beneficial human health impacts we need to look at all the gases and volatiles both natural and derived emitted via well drilling, gas and pipeline valves, leaking wellheads, flaring, and other processes involved in gas collection/purification/refining to export specifications. This monitoring is urgently required. It must be independent, unbiased, fully funded and available for public scrutiny preferably in real time and in electronic form.
5) Gas companies must be required to fully and openly disclose in a timely manner, all chemicals, and all quantities of chemicals, used or planned to be used for drilling, fracking, cleaning, dehydration, and other processes at every gas facility. All historical results they have of analyses of air, soil and water should be available for public scrutiny.
6) The federal government must develop legislation, a unified standard, to protect public health across Australia from the impacts of unconventional gas development and other extractive industries.
7) There must be open, fully informed, public debate on the future of the unconventional gas industry in Australia.

These recommendations were made with reference to the industry in Queensland where baseline monitoring of health and the environment had never been done. It is apparent that comprehensive baseline monitoring should be an absolute requirement prior to any proposed development. No company should be allowed to go on site and drill an exploratory well in any region of Australia until adequate data had been collected on the baseline status of air, soil, surface and ground water in that area and the baseline data was freely, easily, permanently, and publically available. Baseline environmental data collection should occur over a prolonged time period, preferably of the order of 2 years to cover seasonal changes, extremes of

[53] See appendix 3 Courier Mail article. http://www.couriermail.com.au/business/pipeline-company-collapses-claiming-late-payments-by-gas-giant-santos/news-story/22ae992bfc7140193f41be1590ce34c8

temperature including temperature inversions, humidity, wind direction, rainfall or lack of it, water levels etc.

A reliable method of understanding and recording the baseline health of the community with systematic long term follow up including mechanisms for identifying adverse health impacts at an early stage should be in place before any exploratory work is permitted.

Should the industry be permitted, it is essential to ensure that all data that should be collected is collected. Enforcement of collection of comprehensive, real time air and water monitoring giving accurate, reliable and timely information on the actual exposure of individuals to the full range of environmental toxins including mixtures is critical. **Built into any permit should be criteria under which permission would be withdrawn.**

HOWEVER FOUR YEARS AFTER I DOCUMENTED THE HEALTH OF RESIDENTS IN QUEENSLAND'S GASFIELDS, MY CONCLUSION AND RECOMMENDATIONS ARE THAT THE UNCONVENTIONAL GAS INDUSTRY SHOULD NOT BE PERMITTED ANYWHERE IN AUSTRALIA.

It is my opinion that the risks to human health, the environment and intergenerational equity are too high.

Published outcomes from some of the peer reviewed medical research into the health impacts of unconventional gas are so significant and have such serious potential implications for public health that in my opinion it is necessary to invoke the precautionary principle in consideration of the future of the unconventional gas industry.

The Wingspread Declaration on the Precautionary Principle counsels that 'When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not established scientifically. In this context the proponent of the activity, rather than the public, should bear the burden of proof' (Science and Environmental Health Network 2016).

Decisions made as a result of the current Scientific Inquiry into Hydraulic Fracturing in The Northern Territory will have profound consequences far into the future. The burden of responsibility placed on those making decisions regarding the future of the unconventional gas industry is significant and unenviable. However in light of the evidence already freely available including knowledge of the impacts of the unconventional gas industry both in Queensland and in the USA, ultimately decisions regarding sanctioning, promoting or permitting the activities of the unconventional industry come down to decisions regarding duty of care.

I would suggest that:

- If you value the health of our citizens including children who are not yet born, please do not permit unconventional gas developments.
- If you value the air we all breathe, the water we drink, the safe nutritious food we grow in Australia, do not permit unconventional gas developments
- If you value Country, if you understand that we are all merely the temporary custodians of this ancient land do not allow it to be destroyed and contaminated on your watch.
- If you value this remarkable landform with its surface and underground water, its wildlife and extraordinary cultural heritage, please do everything you can to protect it.

Dr Geralyn McCarron

APPENDIX 1- Extracts from Submissions[54] of residents of the Darling Downs to Federal Senate Select Committee on Unconventional Gas Mining

1. REVEREND GRAHAM SLAUGHTER UNITING CHURCH MINISTER, SUBMISSION 20

"The irresponsible determination by successive Queensland State Governments, in conjunction with Federal and Local levels of government, to rely on the extraction of Unconventional Gas Mining, which includes the Coal Seam Gas Industry and the Linc Energy Underground Gasification Project at Hopeland near Chinchilla as a major component of the State's resources-driven economy has been a monumental failure, economically, sociologically, environmentally, and an affront to the human rights of people living in close proximity to mining operations and infrastructure. Unfortunately, this industry has been perpetuated through a climate of corruption, lies, cover ups and bullying, and by the greedy lure for wealth which cannot justify the sacrificing of people and the environment as nothing more than collateral damage, for the misguided and mistaken view that this was somehow ensuring the State's economic future and prosperity."

"Another major failure of the State Government, I believe, has been in its apparent reluctance to adequately investigate health issues as they began to be reported. The Health Department report, "Coal seam gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data" which is dated March 2013 concluded that "a clear link can not be drawn between health complaints by some residents in the Tara region and impacts of the local CSG industry on air, water, or soil within the community." ("6. Conclusions" p-18 of the report) The report went on to suggest "Solastalgia" as the reason for residents' complaints about health issues however, whilst their situation is stressful and has its own consequences, physical symptoms such as rashes and blisters which I have witnessed, and from what they have told me, something is making them sick."

2. NOOD AND NARELLE NOTHDURFT Residents British Gas (QGC) gasfield near Chinchilla, SUBMISSION 28

"It is hard to write and convey 10 yrs of fighting, standing up for ourselves against a CSG giant as well as the lack of government support into a few pages. The emotional, the mental health, the health of our family and the money expenditure of fighting this gas industry is criminal on both the gas company and the governments behalves. We bought a beautiful property we didn't buy a gas field, this industry was thrust upon us."

"The noise we put up with is horrendous. Initially, there was noise from the drilling rigs, 3 weeks on each well, of which there are 30 wells within 2.5 km from our home (a sensitive receptor). Then there is the work over rigs that we were never told about, they service each well at least once a year, again there are the 30 wells around our home. That means there is a drilling rig operating close by at any time. We were never consulted about the noise on our place or neighbours or the other infrastructure that effects us every day, and then there was the obscene amount of noise from the installation of the main pipeline going to Gladstone that is 80m from our front door. Most wells have a HPU (hydraulic power unit) which consists of an engine either v6 or v8 running on untreated production gas, (have been measured at 216 parts of VOC's.) this engine runs the well head . the well head is a pump, it pumps water up from the ground, in that water is the gas. The water and gas are then separated by pipes and a separator before it goes into the gathering pipe system, to the processing plants. There are 30 wells around our home with in 2.5 km, All of

54 http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Gasmining/Gasmining/Submissions

which we can hear. The noise sounds like 30 v8 trucks with their engines revving outside our home all the time. We don't sleep from the noise. The noise actually sends vibrations through the house and through our bodies. Low frequency noise vibrations were also reported in the Qld health 2013 Tara gas report. This is also documented from our independent noise expert. We have had our noise expert do 2 lots of 2 week noise monitoring at our house at our own expense, to prove the noise that comes from their operations. An industry that has been thrust upon us. The separators at the well site have a high pitch whistle when gas goes through them. This whistle can be heard for kms. I cannot stand the noise, it is ear piercing. So instead of hanging clothes on the line they go into the dryer. More expense for us again for an industry that was forced upon us."

"Over the years I have noticed the children getting sick, sick, sicker. Especially the babies that were born here on this property. My own health is also failing. We all had metal tastes in our mouths, food was now tasting funning. Fatigue, that I couldn't control. Headaches, migraines, nose bleeds, nausea. Just never felt well any more. My husband and I suffer a headache that never goes away. We were taking Panadol like pez lollies. There has to be something wrong with that. I had been to the doctors numerous times for the fatigue, they would say well you do have 11 children. But I knew it was different. I live with chronic pain, some days so bad it takes me hours to get out of bed. I have bad depression, I don't go to town anymore I don't visit people I don't feel well enough. I have had 3 miscarriages since 2008, which have been devastating to me. Was it the Gas?
My seven yr old boy……. has been suffering fast on setting headaches for a few years now. They are so serve he bangs his head into the wall the floor anything to make them stop. He vomits then can't keep fluids down and gets dehydrated. A couple of times he has been in hospital for them and dehydration. Metal taste in mouth. Sore limbs. He has missed so much school, his learning is now affected.
8yr old girl…… suffers metal taste ,fatigue, sore limbs, blood pooling in her nose all the time, severe fast onsetting headaches, bangs her head to make them stop. Has missed a lot of days of school
10yr old girl……., metal taste , nasal problems, migraines that go on for hours and hours, sore limbs, never feels well
12 yr old girl ……metal taste, fatigue, headaches never feels well, nose bleeds
15 yr old boy……headaches, migraines that he loses the use of the right side of his body. He has a couple of days off school after the headaches. Metal taste in mouth. Has nasal problems
16 yr old girl……headaches, migraines that last a couple of days. Days off school because of them. Has had sores in hair that wouldn't go away, until I shaved her head.
The children will be playing happily and fall to the ground with a headache, followed by hours of screaming to make the headache stop. Children wake up in the middle of the night saying they are scared, something in their belly they can't see it they feel it. My husband and I feel this feeling of being anxious all the time in our belly especially while sleeping. This is the vibration from the noise. The ringing in our ears is unbearable and very annoying. I don't hang clothes on the line from the noise outside. I'd rather use the dryer it is a better noise, one I can handle. The noise has driven me crazy.
There was never any base line studies done. NO AIR, NO WATER NO SOIL. NO HEALTH. I don't know if the gas is making our children and us sick. But I do know we were not sick before the gas moved in here. We are the ones that have to prove it. We are the ones spending lots of money finding out what is wrong with our children and ourselves. We have MRIs done, eye doctors, we went to a DR in august 2015 to help with the children. His conclusion was the environment that we live in could not be ruled out for their health problems. Because when we leave the environment they don't seem to suffer."

3. JOHN JENKYN'S RESIDENT BRITISH GAS/ QGC GASFIELD NEAR CHINCHILLA, SUMISSION 275

"Over the past eight or so years, our home has been surrounded by and inundated by 'new neighbours' – noisy, polluting, disrespectful and insidious neighbours.

Thousands of gas wells and associated infrastructure now impacts our lives and our region. Our region and locale is now home to (but not limited to):
Numerous enormous toxic brine and produced/waste water evaporation ponds; reverse osmosis plants and associated infrastructure; field compressor stations, processing facilities; turbines, generators, wells, separators, pipelines and vast tracts of clearing, drill rigs, high and low point vents & drains; FIFO man camps, fracking set-ups, flares, open air human effluent dumps and lay-down storage yards, pollution/smog, increased vehicular movements and a fractured community – the list goes on.
How quickly things changed and our lives were upturned. I have experienced the disappearance of our hopes for the 'Great Australian Dream'. We no longer have dreams for our future, our dream are in tatters, our health is impacted and our prospects are grim."

"The standout impact for me personally is my wife Jo's health.
Jo has suffered from depression over the past five or so years. Nowadays Jo spends most days on the couch. There is no longer any point for her to go outside to tend her beloved garden as it has long since died.
Things have worsened since Jo's third breakdown and subsequent asthma induced heart attack which 'coincidentally' occurred on the back of the ongoing stresses associated with QGC negotiations and the constant barrage of dust and bugs that invaded our home night and day 24/7 whilst Murphy Pipe and Civil carried out major pipeline construction next door to our property. Immediately prior to Jo's asthma induced heart attack, the dust was so dense that at the time that we were unable to see further than 1.5m from our kitchen window. The heart attack followed hot on the heels of two years of constant sleep deprivation thanks to gas field construction – not to mention the accompanying odours and tastes brought about by the intensive and invasive petroleum development that had engulfed our home.
Not long after coming home from hospital, Jo had an angina attack. She has since lost any real joy of life and is a virtual prisoner in our 'gas factory' home.
I have lost a lot of weight having to 'pick up the slack' and maintain the home. Cooking, cleaning, caring and work has seen me run ragged with a number of health complaints. In a twelve month period we visited the doctor at least 35 times.
My son Aaron loses weight when he is kept awake all night. I am very worried for him as he is suffering greatly.
A common complaint that my family now has is sore eyes. Our eyes sometimes water to the point whereby it is difficult to see. On other times they are dry and itchy. We regularly buy and apply eyedrops to 'lubricate' our eyes.
When the breeze is blowing from the north and the west (which is an almost daily occurrence) my family and I experience:
A constant acidic/metallic/sour taste in our mouths. I can only liken it to the taste incurred when one touches a copper pipe or handles some old 2 cent pieces and then your finger makes contact with your mouth.
Other symptoms include itchy, burning eyes (sometimes watery, sometimes dry), a waxy (ever eaten a cold sausage roll?) type film and tingly sensation in our mouths.
A tingly /burning sensation in the back of our throats Mild and chronic headaches Dizziness and nosebleeds Unexplainable skin rashes
I was completely knocked out cold once and then transported by ambulance to Tara Hospital (where no investigation was carried out). I have also passed
out on three other occasions at my back doorstep with no real explanation other than 'something in the air'.
Generally these days, we are unable to breathe freely through our noses – our ability to smell subtle odours has diminished but we are able to detect stronger odours."

"Existence here has been nothing short of hellish noise-wise since the gas industry kicked off, particularly for our son Aaron. We worry greatly about the impacts upon him. The incessant noise and low frequency vibrations that emanate from gas industry infrastructure 24/7 impact our

daily lives. Both Aaron and Yasmin grind their teeth in their sleep in reaction to this. It is not uncommon for Aaron to be unable to sleep at all throughout the night, he lies awake moaning and laughing – which in turn causes sleeplessness for the entire household, not to mention weight loss for Aaron. We fear about the ramifications (health-wise) of taking Aaron outside in his wheelchair for some 'fresh, gas factory air'. As such, he spends a lot of time indoors. It would be fair to say that we now live a tortured existence."

"Environmental impacts
About 5mm of rain fell one afternoon and the following day most of the plants in our garden that were not protected by the house were either dead or dying. Jo was devastated, she had created and nurtured that garden).
There were dead toads here and there too. Later on that day, I turned the sprinklers on from the dam – and I found that after a week of watering, it had killed almost everything that the rain had missed.
We used to have yabbies in our dam. For a period of some two years, prior to and during the construction phase of the Kenya Reverse Osmosis plant, we had tankers dumping (what we suspect to be raw, untreated coal seam gas water) on the bitumen road outside our house – this was done under the guise of 'dust suppressant' – dust suppressant on a bitumen sealed road? I have photographs and video of this being carried out. This continued night and day. When it rains, the run off from Chinchilla Tara Rd feeds into our dam. After a decent rain event a few years back, I noticed the yabbies leaving our dam, I put them back in. They all died. (See photo below for reference)
QGC said that they would test our dam some years back – but they never have.
Image of yabbies dead on the bank of a dam not far from our home. The oily film on the dam was the same as the film on our home dam at the time that our yabbies died. This prompted me to pull over and have a look at it. I then saw the dead yabbies and took this photo. I wonder whether the formaldehyde fallout that we are exposed to has caused or contributed to this type of event?"

"We are impacted 24/7 with emissions from gas field related infrastructure and activities but there is still no permanent air monitoring.

When it rains, a substance comes down onto our roof and vehicles, coating everything in a light coloured powder. I once had the unusual substance that coats one of my rainwater tanks tested, it

came back as being cadmium. This particular tank is a reasonably new plastic rainwater tank and sits out in the open not far from my house.
Here is a photograph showing the substance tested as cadmium that coats one of my rainwater tanks. Note that this tank is out in the open, exposed to the atmospheric conditions."

"Enormous gas flares became evident in our area around September 2014. The length and breadth of this industry requires intensive venting (of which the emissions are not visible to the naked eye). We have not been told of the air pollutants coming from the various sources of emissions. Our night sky is now regularly aglow – orange from the flares. Often the air here itself appears a smoggy colour. On cloudy nights, the impacts of the intensive flaring and venting are evident. The inversion layer seems to hold down all the emissions upon us like a blanket.
Here is a photograph that I took of our night sky during a heavy flaring period. The sky would ordinarily be black, perhaps with stars visible. When they are flaring, it looks like someone has turned the sky orange and our sinuses /noses begin to run."

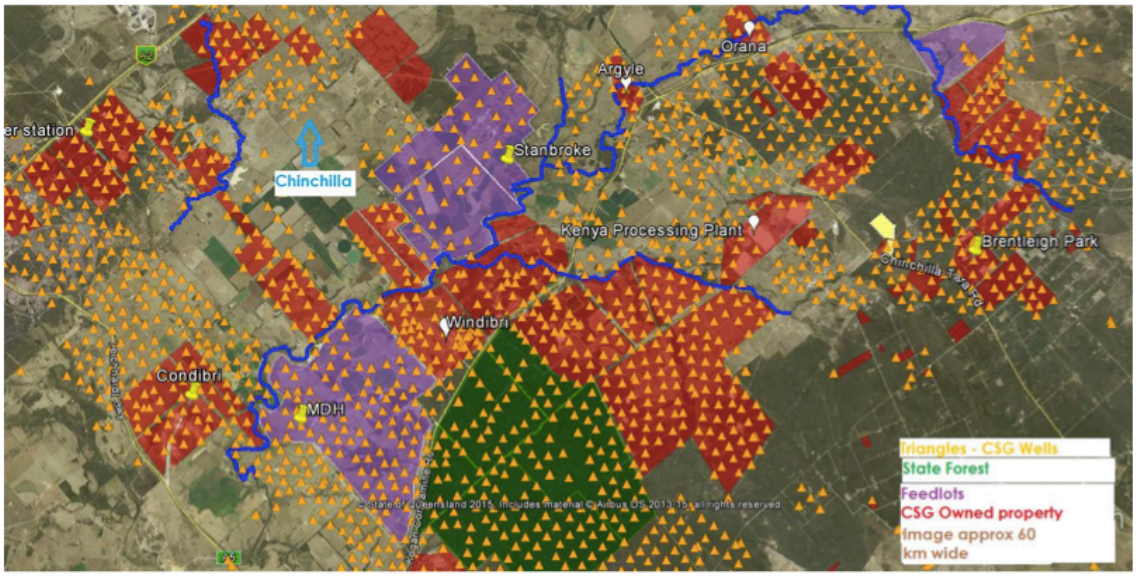
"Nine Mile Creek (which flanks the QGC Kenya facility) is often a very odd, gunky shade of green, as is nearby Wieambilla Creek. Many of the dams and waterways have thick algal, oily type films over them.
Here is a photograph of Nine Mile Creek flooding (and flowing) after a recent rain event."

"Here is a photograph of the Nine Mile Creek taken just 3 days later.
Note the green film and colour of the water. Remember that this creek is situated in the heart of the gas factory and subject to discharge and run off from industry."

"Over the past five or so years, I regularly see dead crows on the side of the road between Moonie and home. Where else does one see dead crows as commonplace? Why are they dying? The once abundant variety of birds that existed here are long gone. Habit fragmentation coupled with such huge areas of clearing has put paid to them I'd say."

4. SHAY DOUGALL. RESIDENT HOPELAND NEAR CHINCHILLA, SUBMISSION 203

"Social
The social impact of the industry has been devastating. It has divided extended families, it has resulted in many marriage break ups, it has changed the very fabric of the community with many locals leaving and socioeconomic disadvantaged groups being sent to the community due to the devastating economic downturn.
My initial problem with CSG is the fact that a Multinational company can walk onto a persons free hold land and install damaging infrastructure that produced toxic emissions and leaks toxic fluids and the individuals have no ability to deny access and little to no support in making the companies accountable for the damage.
Secondly the amount of land that the Multinational CSG companies purchase from our community is stunning. Much of this land purchase is on direct access to creeks and rivers and include the farmer's water allocation.
This land grab significantly impacts on the social fabric of the community. Those people used to volunteer, buy their lunch in town, buy their groceries, buy their rural supplies in town. They went to our schools and our churches.
Now those properties no longer contribute to our national agricultural production. They are no longer being managed and stewarded intimately by individuals connected to the land and the community for pest and disease and fire fuel load.
Extraordinarily, the multinational CSG companies then lease this land grabbed country to a singular corporate entity to exponentially increase their Feedlotting capabilities again devastating the local producers.
This purchased land is peppered with unfettered CSG operations, without the rigour an individual farmer would hold them to, and the cattle are being backgrounded among it. And yet there is no baseline testing of the impact of the industry on the air, water, land, or plants/animals produced among it.
The impact of the industry is to insidiously industrialise a rural landscape and transform individuals pursuing peaceful contributing lives into a living nightmare of unimaginable noise, massive increase in vehicle movements, light pollution day and night, atmospheric pollution from very small inspirable particulates such as silica to atmospheric pollution so obvious it changes the colour of the sky and the surfaces it lands on.
The insidious creep of this industry is in some ways the biggest heartache for the locals. Instead of being honest and starting out that the district is being reallocated by the government from being Australian and rural to being multinational and industrial and giving people dignified and fair opportunities to move out and move on with their lives or adjust their expectations and plans accordingly, an evil underhanded creeping approach is taken whereby the spin from the government and the industry try to deny the transformation is happening and force individuals to put up and shut up or vilify them into just walking away."



"Business
Many businesses were priced out of operations due to outsourcing by the industry in the early days, then those that managed to survive were not able to as the massive economic hit occurred when the industry walked out of town leaving unprecedented real estate vacant and the dollars going with them.

Agricultural & Environmental
The agricultural sector has suffered through the loss of employees to the supposed lucrative mining jobs. However a greater impact that this industry will have on the agricultural sector will be the removal of water from the underground resources, the removal of stock and domestic water bores, the buying up of water allocations by the industry, and the buying up of what was dozens of small operators and the inevitable monopoly of one large corporate feedlot.
Combine that with the casual use of produced water, land spraying, lack of biosecurity, buried infrastructure acting as hidden landmines and the damage will be untold and unfixable.
The quiet removal of Stock and domestic water bores as a fait au complit is one of the most extraordinary thieving actions perpetrated on this and future generations. I only hope someone else is able to provide a detailed submission on the way in which the Government has authorised the wholesale removal of a water resource from the farming families of this and future generations.
The image below shows the domestic water bores that have exhibited massive water and gas emissions (also described as 'kicking') as a direct result of the water table being removed through CSG Activities. The area is one of Prime agricultural land. According to the Government's own report many of these bores were on the 'long term effected list' but have started demonstrating significant impact already with the only solution being to close them in and remove them from the farmers assets."

5. ELAINA GARCIA, SUBMISSION 271

"I and my partner run a 1280 acre beef cattle grazing property downstream of the Barakula State Forest, which is in the process of becoming a National Park.
A number of CSG leases have been taken within the Barakula.
The water we use for our beef cattle comes from Stockyard and Charlie's creeks, which are fed from run-off from within the Barakula, as are our farm dams, which are also used for stock watering.
We are legally liable for toxins in the beef from the cattle we produce, but we have no control over the pollutants released into our catchments and creeks by the CSG industry. Any bores we might put down will also be contaminated by CSG industry pollution. This industry is not regulated to keep their evaporation ponds from overflowing in intensive rain events, of which we have had three since December 2011. There is no legal redress for us if our water is contaminated as we do not have any contracts with the CSG industry. If our water is contaminated it cannot be made good."

6. MR JOE HILL (FARMER ANGUS BEEF STUD NEAR MILES GIVING ORAL TESTIMONY TO BENDER SENATE INQUIRY IN DALBY) (following an influx of CSG reverse osmosis water onto his land from a burst dam on a neighbouring property.)

Mr Hill: *"Yes. In that report they released, they talked about the fact that you should get an indemnity from the company. That is a lot of rubbish. I do not have any infrastructure or anything to do with them on my property, but if this water is contaminated and contaminated my stock, it*

does not matter. I do not have any compensation agreement with any company, so where am I going to be? And it does not cover the Australia beef industry. If I have contaminated stock and it gets picked up in Korea or Japan or America, they would have a field day with it. It would not be Joe Hill's beef or Queensland beef, it would be the Australian beef industry is contaminated. The whole industry would be put at risk. Even this MLA report did not cover the Australian beef industry. They are only telling you to have an agreement with the companies."
Senator LUDWIG: "*So you do not have any well heads on your property?"*
Mr Hill: "*No, nothing at all."*
Senator LUDWIG: *"Are you near well heads or properties-"*
Mr Hill: *"I have two well heads on the north-western side, about 60 metres from my boundary. I have well heads on the western side that are probably a couple of hundred metres away. I am pretty well surrounded."*

7. BENDER FAMILY RESIDENTS HOPELAND NEAR CHINCHILLA, SUBMISSION 274

- The property of 'Valencia' has maintained a piggery since 1940, hence George Bender has decades of experience in developing and managing a piggery. At its peak operations, George Bender won numerous local and State awards at various pig fairs and competitions. Georges' knowledge of breeding and caring for pigs is not to be discredited.
- Unseen stock losses commenced during 2010, and as the gasfields expanded and the frequency of the Linc Stink 'odour' increased, there was a direct correlation to the negative impacts to the health of the pigs.
- The negative health of the pigs had never been witnessed before in the 75 years of operation, and certainly never in the life of George Bender, who lived his entire life on 'Valencia'.
- It is estimated that over the years that the Business has lost up to 900-1000 pigs due to changes in the environment (air quality). This equates approximately to lost income (gross) of $165,000+ (excludes the perpetual impact from losing adult sows with respects to loss of future litters).
- Stock losses are still continuing into 2016 due to ill health.

- The first indications of health impacts due to unconventional gas mining where noticed on the property 'Valencia' during 2010 with a strange and unfamiliar 'odour' and pigs becoming unwell, and dying within days.
- George and Pam Bender were only informed in early (first half) 2011 that the 'odour' was coming from the Linc Energy UCG plant located approximately 6km from 'Valencia', by another member of the Hopeland community who lives closer to the UCG plant.
- During unfavourable weather conditions, that is, when the wind direction was coming from the south-easterly direction (from the Linc Energy direction), an 'odour' that could be best described as "burning oil", and was being most noticeable in the air during the night and early mornings.[5]
- The 'odour' would initially be noticed by the family pet dog who would then alert George and Pam either during the night or early morning. Upon going outside, the 'odour' would be present.
- Human impacts that were experienced included:
    - Difficulty in breathing
    - Headaches
    - Sore eyes including a burning sensation
- The first formal complaint to Linc Energy about the 'odour' was made via telephone on the 29th May 2011 by George to Linc Energy.
- In correspondence on 8th June 2011, Linc Energy offered an Alternative Arrangement, George and Pam Bender did not agree to these terms of the Alternative Arrangement which included the following:
    - Linc Energy to sponsor the installation of up to $7,500 incl GST for the installation of reverse cycle split system air conditioning at 'Valencia'
    - In accepting the above offer, to keep the terms of this Alternative Arrangement confidential (gagging clause)
- Extreme health impacts (death) were being witnessed to the livestock on the property, whereby a piggery operation is being managed.
- In 2011 major concerns were being witnessed in the condition and the health of the pigs; the animal health impacts had never been witnessed beforehand. See Appendix C for photo evidence. Health concerns include the following:
    - Pigs gasping for air and dying without any physical cause
    - Pigs aborting near full term, or sows unable to deliver a live litter
    - Adult sows dying, unable to give birth; most likely due to the litter dying inside the sow near full term
    - Young pigs becoming sick with swollen eyes, rashes and lung (breathing) issues
    - Animals wasting away (losing significant weight over a short time period, within a few days)
- The above health concerns coincided with an odour nuisance events or major gas flaring/venting events.
- A sick weaner pig was euthanised and autopsied at Bell on the 17th December 2013, the pig had lost weight, had a distended abdomen and was hairy. Major abnormalities where found with the lung and heart. Note: Autopsy Report dated 20th January 2014, from Bell Veterinary Services is being withheld due to sensitivity of the report.

APPENDIX C – Photos of Health Impacts on Pigs

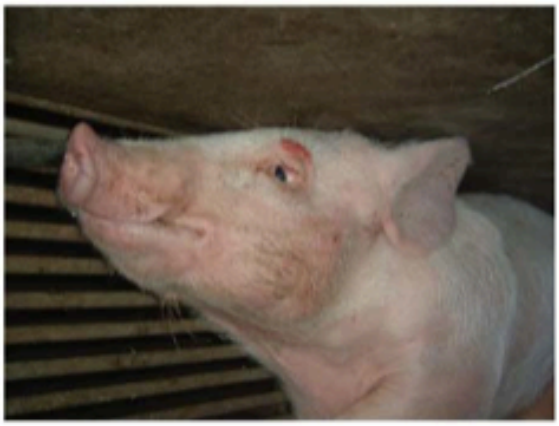


Photo 1: 24 January 2016, young weaner euthanised

Photo 2: 16 February 2016, grower with serious eye issues (the number of pigs with eye issues since the invasion of unconventional gas in now a regular occurrence, never witnessed before in George Bender's 68yrs of breeding pigs on 'Valencia'. Are you going to believe a farmer with 68yrs of experience, or an industry with limited experience and are in denial of the risks associated with their practices?)

9 September 2012: young weaner glasping for air

23 November 2013: young pig, sore eyes, rashes and wasting away

2 April 2013: Stillborn litter

15 April 2015: Stillborn litter

22 February 2014: young pigs gasping for breath, hairy, sore eyes and weight wasting

22 March 2014: young weaner weight wasting, hairy, unable to breathe

22 March 2014: young weaner weight wasting

2 March 2015: young weaner weight wasting

The Bender Family Submission:
Select Senate Committee Inquiry into The adequacy of Australia's legislative, regulatory and policy framework for unconventional gas mining including coal seam gas (CSG) and shale gas mining

5 October 2014: young weaner, sore eyes and weight wasting

15 March 2015: grower died, unable to breathe

12 May 2015: young weaner with sore eyes and rashes, trouble breathing

15 April 2015: young weaner with sore eyes

15 April 2015: young weaner dying, gasping for breath

30 May 2015: pen off of young weaners wasting away and dying

APPENDIX 2 - TAMBORAN IN IRELAND

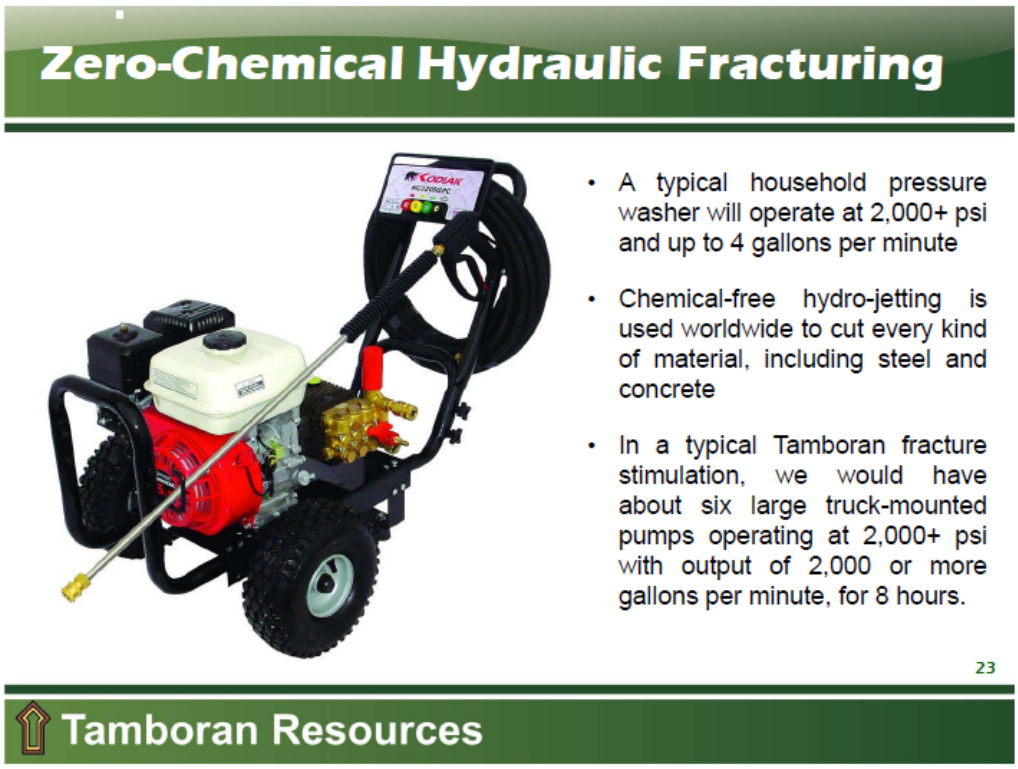
The founder of Eastern Star gas was Patrick Elliot. David King was co founder. Eastern Star Gas was part owned by Santos during exploration work in the Pilliga forest NSW. In 2011 Santos acquired 100% of Eastern Star Gas (up from 20.9%).

In 2009 the directors of Eastern Star Gas Patrick Elliott and David King established the company named "Tamboran". Richard Lane (late of Southwestern Energy) joined them as deputy chairman in 2012.

Tamboran was funded by Santos both in their incursions into Ireland and into the Northern Territory.

Tamboran's so called "public information events" in Ireland were misinformation sessions, seriously misrepresenting the reality of the unconventional gas industry. To the people of rural Ireland, they claimed that they were going to hydraulically fracture deep shale formations using multi well pads **without using any chemicals-** just sand and water.

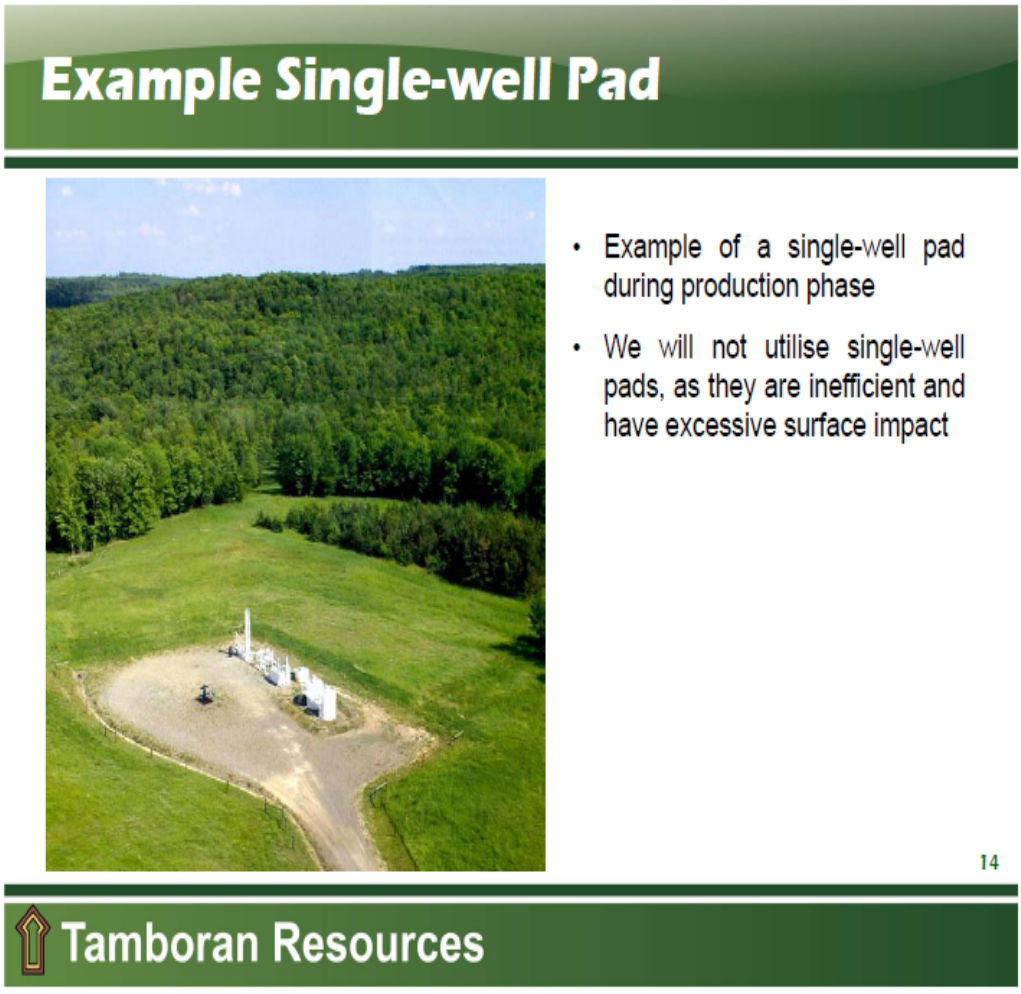
This is a slide they showed at one of their community events.



Incredibly this was Tamboran's representation of the reality of hydraulic fracturing to the rural Irish people.

In Ireland Tamboran planned to drill and frack 1500 wells on cluster pads each containing 16 to 24 wells.

This is an actual image of a 16 well pad in Canada.



This is the image Tamboran used in Ireland for their "information" sessions.

Tamboran actively mislead the people of Ireland regarding water contamination saying it was a *"common misconception that produced water associated with hydraulic fracturing activities will poison lakes and rivers with radioactive waste"* when they as Eastern Star Gas had already polluted an aquifer in the Pilliga with uranium at levels 20 times higher than drinking water standards.

In light of Tamboran's overt misinformation campaign in Ireland and the concepts of informed consent versus deceptive behaviour, I would urge the Inquiry to investigate the legality of access agreements that were signed with Tamboran in the Northern Territory

APPENDIX 3 Pipeline company collapses claiming late payments by gas giant Santos

QLD Business

Pipeline company collapses claiming late payments by gas giant Santos

GLEN NORRIS, The Courier-Mail
April 6, 2016 9:21pm
Subscriber only

RESOURCES giant Santos has been embroiled in a $6 million dispute over allegedly unpaid work on its central Queensland LNG pipeline.

Murarrie-based Lean Field Developments went into voluntary administration earlier this year owing creditors about $30 million.

Liquidators from Deloitte Touche Tohmatsu claim Santos owes Lean Field an estimated $6.3 million.

Santos has denied the liquidator's claim, which relates to work on GLNG's 420km gas pipeline from the Surat and Bowen basins to Curtis Island, near Gladstone.

Scores of smaller sub-contractors have been caught up in Lean Field's collapse and are expected to receive as little as 3¢ for every $1 owed.

Lean Field joins a growing number of pipeline contractors going under as work dries up on gas projects in Queensland and energy prices remain depressed.

Engineering and construction company WDS, which also counted Santos as a customer, went into liquidation late last year.

Santos earlier this year flagged writedowns and cuts to its oil and gas reserves as it joined the expanding list of energy players hit by the slump in commodity prices.

Lean Field directors complained there was an inability to collect money owed by Santos, with the gas giant advising earlier this year that a $4.1 million payment due in February would be more than a month late.

A Santos spokesman said there was now a process in place to determine the amount of any money owed. That process was not completed.

“Santos wants to see any amount that may be owed is made available through the legislative process to subcontractors who completed work and were not paid by Lean Field Developments,” the spokesman said.

Lean Field had offices and facilities in Australia and Canada and employed more than 200 staff on projects across Australia.

Lean Field also did work on the QCLNG project, now operated by Shell.

Lean Field also did work on the QCLNG project.
Toowoomba-based Ryvil Industries is owed about $900,000 by Lean Field after working on building the Santos pipeline in the Roma area.

“We are in a bad way,” a company spokesman said. “We have had to knock back work because we do not have the cash.”

Sunshine Coast-based Sunstate Pipelines is owed more than $100,000 by Lean Field.

“We had a lot of trouble getting paid after October last year,” a spokesman said.

“When I rang Lean Field on February 9, I was told the money would be in the bank the next day. The next day the administrators walked in.”

Deloitte liquidator Richard Hughes told Lean Field creditors last month that secured creditors and employees would have to be paid first before unsecured creditors received anything. Secured creditors include Canadian bank Alberta Treasury Branch, which is owed $3 million, and the Federal Government-owned Export Finance and Insurance Corporation, which is owed $2 million.

Mr Hughes said that, despite a marketing campaign to sell the company, no offers had been made and therefore its assets would be sold off.

http://www.couriermail.com.au/business/pipeline-company-collapses-claiming-late-payments-by-gas-giant-santos/news-story/22ae992bfc7140193f41be1590ce34c8

Appendix 4 confidentiality agreement

See extracts from scanned document on the following pages.

2 Additional features of Alternative Arrangement

2.1 Subject to **clause 2.3**, the Tenement Holder shall pay or cause to be paid to the [redacted] the Compensation Amount detailed in Item 4 of **Schedule 1**, nett of any tax, within the time specified in Item 4 of **Schedule 1**.

2.2 The [redacted] agree that this Agreement includes the Alternative Arrangements for purposes of the Environmental Authority and that Schedule F – Table 1 – Noise Limits at Sensitive Receptors, of the Environmental Authority shall not apply to the Operations during the Term.

2.3 The [redacted] agree that the Compensation Amount shall be paid in full and final satisfaction of all present and future claims which may have arisen or may in the future arise as a result of noise emissions from the Operations, and the [redacted] further agree to release and discharge the Tenement Holder, its nominees, contractors, agents and employees from all present and future claims, demands, complaints, costs, losses, damages, liabilities, expenses, actions or proceedings which have arisen or may arise as a result of noise emissions from the carrying out of the Operations.

2.4 The Parties agree that this Agreement may be pleaded as a bar to any legal proceedings commenced by the [redacted] in any Queensland Court against the Tenement Holder or its contractors in respect of noise impacts from the Operations.

2.5 The [redacted] warrant they are the only persons resident at the Sensitive Receptor likely to be affected by noise from the Operations. In the event that other persons occupy the Sensitive Receptor during the Term and make a claim against the Tenement Holder or its contractors for noise related nuisance or impacts, the [redacted] hereby indemnify the Tenement Holder and its contractors in respect of any such claim.

3 Other possible impacts

3.1 The [redacted] agree that the Compensation Amount is also being paid in full and final settlement of all present and future claims which may have arisen or which may in the future arise as a result of any dust, odour, light or vibration emissions arising from the Operations, and the [redacted] further agree to release and discharge the Tenement Holder, its nominees, contractors, agents and employees from all present and future claims, demands, complaints, costs, losses, damages, liabilities, expenses, actions or proceedings which have arisen or which may arise from any dust, odour, light or vibration emissions arising from the carrying out of the Operations.

3.2 The [redacted] agree not to commence any such proceedings against the Tenement Holder or its Contractors and further agree that this Agreement may be pleaded as bar to any such proceedings commenced by the [redacted] in any Queensland Court in respect of dust, odour, light or vibration impacts from the Operations.

3.3 The [redacted] warrant they are the only persons resident at the Sensitive Receptor likely to be affected by dust, odour, light or vibration impacts from the Operations. In the event that other persons occupy the Sensitive Receptor during the Term and make a claim against the Tenement Holder or its contractors for dust, odour, light or vibration related nuisance or impacts, the [redacted] hereby indemnify the Tenement Holder and its contractors in respect of any such claims.

4 Term

4.1 This Agreement continues for the Term specified in Item 5 of **Schedule 1**.

5 Confidentiality

5.1 The terms of this Agreement shall be kept confidential by the Parties and shall not be disclosed to any other person except:

(a) where disclosure is required as a matter of law or by the rules of any stock exchange;

(b) in the case of the Tenement Holder, where the disclosure is made to a person which is intending to acquire an interest or has acquired an interest in the Petroleum Authorities;

(c) to the legal and financial advisors of each party;

(d) in the case of the Tenement Holder, to any person which has entered or intends to enter into a joint venture with the Tenement Holder with regard to the conduct of the Operations or a bona fide proposed purchaser of the Petroleum Authorities; or

(e) to the extent that may otherwise be agreed between the Parties.

6.3 Force majeure and term

In the event that force majeure circumstances reasonably require an extension to the Term, beyond 50 years, the [redacted] will not unreasonably refuse an extension of the Term. For purposes of this clause, force majeure means, to the extent that the party affected could not have reasonably foreseen it, any act, event or cause which is beyond the reasonable control of the party concerned including war, insurrection, civil disturbance, blockade, strikes and other labour conflicts, riot, embargo, epidemic, earthquake, storm, flood, explosion, fire or lightning.

6.4 No objection to occupation and use

The [redacted] will not raise any objection, with any party or Government Department or agency, to the Tenement Holders' occupation and use of the Operations area and to the immediate undertaking of the Operations, including by the Tenement Holders' contractors and their employees.

6.5 Obligations in event of sale

Before executing any document purporting to sell, assign or lease any interest they may have in the Land, the [redacted] will secure the agreement of any intended purchaser, assignee or lessee of such interest, to this Agreement (not including payment of compensation by the Tenement Holder) through an enforceable deed which is expressed to be for the benefit of the Tenement Holder and its contractors. The executed deed is to be given to the Tenement Holder, within two days of its execution.

Schedule 1

Items

Item		
1.	**Sensitive Receptor**	The dwelling/residence located on the Land being Lot
2.	**Environmental Authority**	Environmental Authority No: PEN100020207
3.	**Operations**	i. All authorised activities under the Petroleum Authorities including but not limited to construction and related activities (e.g. Construction of well pads, access tracks, pipelines, laydown areas, ponds, fixed facilities, borrow pits and camps) ii. All well development and related activities (e.g. drilling, workovers/completions, hydraulic stimulation iii. Fixed operating plant and associated and incidental facilities
4.	**Compensation Amount**	$70,000.00
5.	**Term**	[50] years from the date of execution of the agreement

NTN NATIONAL TOXICS NETWORK

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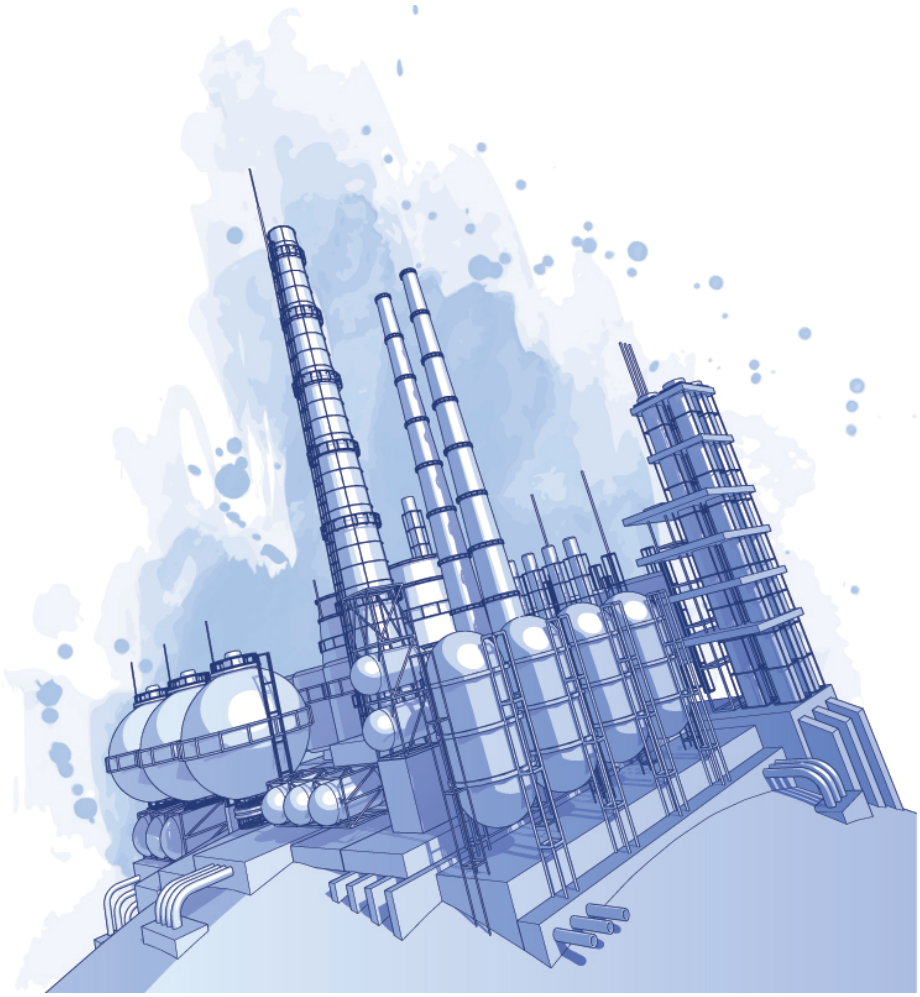
Working globally for a toxic free future

Unconventional Gas Exploration and Production: Human Health Impacts and Environmental Legacy



April 2016

Dr Mariann Lloyd-Smith

Contents

Unconventional Gas Exploration and Production:
Human Health Impacts and Environmental Legacy

This report is intended to be a living document and will be updated as new important information is released.

Summary

The industrialisation of the rural landscape brought about by unconventional gas (UG) activities with its associated air and water pollution can significantly damage the environment and put at risk the health of communities and associated agricultural industries.

Despite many years of operation, the UG industry, including shale and coal bed methane / coal seam gas, still does not have effective ways to deal with its contaminated wastewater, solid wastes and its impact on groundwater aquifers. As the Australian government's National Pollutant Inventory demonstrates, the industry cannot control its toxic air emissions, which continue to escalate.

While improved regulation may, to some extent, reduce the impacts of hydraulic fracturing (fracking/HF) and other activities of the UG industry, the global alert released in 2012 by United Nations Environment Programme acknowledged that it is impossible to regulate this industry into safety and unintended impacts are inevitable.

'UG exploitation and production may have unavoidable environmental impacts. Some risks result if the technology is not used adequately, but others will occur despite proper use of technology. UG production has the potential to generate considerable GHG emissions, can strain water resources, result in water contamination, may have negative impacts on public health (through air and soil contaminants; noise pollution), on biodiversity (through land clearance), food supply (through competition for land and water resources), as well as on soil (pollution, crusting).'

- UNEP Global Environmental Alert System 2012

In 2015, the New York Department of Health published the findings of their inquiry[1] into unconventional gas and high-volume hydraulic fracturing (HVHF). It concluded that: '*Overall weight of the evidence from the cumulative body of information demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with HVHF, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health.*'

The Inquiry noted that an evaluation of the studies revealed critical information gaps and confirmed these needed to be filled to more fully understand the connections between risk factors such as air and water pollution and public health outcomes among populations living in proximity to HVHF shale gas operations. The Department of Health determined that until the science provides sufficient information to determine the level of risk to public health, HVHF should not proceed in their state.

The Inquiry's major findings are summarised as:

- Air impacts that could affect respiratory health due to increased levels of particulate matter, diesel exhaust, or volatile organic chemicals.
- Climate change impacts due to methane and other volatile organic chemical releases to the atmosphere.
- Drinking water impacts from underground migration of methane and/or fracking chemicals associated with faulty well construction.
- Surface spills potentially resulting in soil and water contamination.
- Surface-water contamination resulting from inadequate wastewater treatment.
- Earthquakes induced during fracturing.
- Community impacts associated with boom-town economic effects such as increased vehicle traffic, road damage, noise, odour complaints, increased demand for housing and medical care, and stress.

1.0 Chemicals used and released in unconventional gas exploration and production

Toxic

In Australia, a wide range of chemicals are used and released in unconventional gas exploration and production. These include drilling fluids, fracking fluids, wastewater treatment chemicals and industrial cleaners. They are also many volatile and semi-volatile compounds released to air and water as fugitive emissions. Some are the product of industrial UG uses and UG wastes and others are the naturally occurring toxic substances released from the coal seams or shale rock.

Hydraulic fracturing (HF) used in coal seam gas, shale and tight gas production, involves injecting wells at high pressure with water, proppants, radioactive tracers and chemical additives to fracture the formation and produce new cracks and pathways to help extract the gas. While chemical additives make up less than 2% of the fracking fluid, this still translates to large volumes of chemical additive. For instance, an estimated 18,500 kilograms of HF products were used in a single coal seam gas (CSG) HF in Australia with up to 40% not recovered.[2]

The European Parliament report[3] estimates 16 tonnes of acute toxic substances were used to frack tight gas in Lower Saxony, Germany. The US industry fracfocus database reports up to 100 tons (approx. 90 tonnes) of chemical can be added to fracking fluid used in shale gas production depending on depth and pressure requirements. A well can be 'fracked' a number of times throughout its life-time.

At a minimum, HF usually requires:

- biocide to prevent bacterial action underground (e.g., glutaraldehyde, tetrakis hydroxymethyl phosphonium sulfate);
- clay stabiliser to prevent clay expanding on contact with water and plugging the reservoir (e.g., tetramethyl ammonium chloride);
- gelling agent to hold the proppant in suspension (e.g., mixtures of guar gum, diesel);
- gel stabiliser (e.g., sodium thiosulphate) and gel breaker (e.g., sodium persulfate);
- friction reducer to ease pumping and evacuation of fluid (e.g., polyacrylamide, mixtures of methanol, ethylene glycol, surfactants); and
- buffer fluids and crosslinking agents.

HF can also utilise corrosion inhibitors (eg formamide, methanol, naphthalene, naptha, nonyl phenol); scale inhibitors (eg ethylene glycols); iron control (eg citric acid, thioglycolic acid); pH adjusting agents (sodium or potassium carbonate) and various surfactants to affect fluid viscosity (eg isopropanol, 2-BE.) Large quantities of proppants are used for each fracturing, consisting of sand or manufactured sol-gel ceramic spheres based on alumino-silicates, for example in one shale gas trial HF in Australia, approximately 45,400kg of proppant (Terraprop Plus) was used.[4]

The US House of Representatives Committee on Energy and Commerce identified more than 750 chemical products used in HF containing 650 hazardous substances plus 279 products with trade secrets.[5] These included carcinogens (eg naphthalene), neurotoxins (eg isopropanol), irritants/sensitisers (eg sodium persulfate), reproductive toxins (eg ethylene glycol) and endocrine disruptors [6] (eg nonylphenol). Some of the chemicals were found to be dangerous at concentrations near or below chemical detection limits, (eg glutaraldehyde, brominated biocides), propargyl alcohol, 2-butoxyethanol (2-BE) and heavy naphtha.[7]

US industry self-reporting on 9,310 individual fracking operations between January 2011 and September 2012, noted cancer causing chemicals were used in one out of every three HF operations. While not all companies report and not all chemicals used in the process are disclosed because of 'trade secret' exemptions, industry did report that known carcinogens like naphthalene, benzyl chloride and formaldehyde were used in 34 percent of all HF operations.[8]

The independent scientific assessment (2015) undertaken at the request of the California State Government acknowledged that operators have unrestricted use of many hazardous and uncharacterized chemicals in HF and acid treatments and that the use of these chemicals underlies all significant potential direct impacts of well stimulation in California.' The assessment acknowledged that no agency has systematically investigated the possible impacts and noted the environmental characteristics of many chemicals remain unknown: '[We] *lack information to determine if these chemicals would present a threat to human health or the environment if released to groundwater or other environmental media.'* [9]

1.1 Endocrine Impacts of UG Chemicals

Chemicals used in HF have been identified as endocrine disrupting compounds (EDCs). These include ethylene glycol monobutyl ether, 2-ethylhexanol, ethylene glycol, diethanolamine, diethylene glycol methyl ether, sodium tetraborate decahydrate, 1,2-bromo-2-nitropropane-1,3-diol, n,n-dimethyl formamide, cumene, and styrene.[10] Many chemicals associated with unconventional oil and gas (UOG) can block or antagonise hormone receptors, particularly androgen and estrogen receptors (antiestrogens, antiandrogens). [11] Prenatal exposure to anti-androgenic EDCs like ethylene glycol, can lead to delayed sexual development, birth defects such as hypospadias and other problems. Prenatal exposure to ethylene glycol-methyl cellosolve (ethylene glycol monobutyl ether, 2-Methoxyethanol) can lead to reproductive damage, congenital birth defects, intrauterine growth restriction and death, while perinatal exposure to toluene can reduce serum testosterone in rats. Perinatal exposure to EDCs has been shown to cause permanent changes in the brain and effect behaviour, obesity, fertility, cancer and result in other adverse health outcomes in laboratory animals depending on the timing of exposure.

Some impacts may be inherited and passed through epigenetic[12] changes that may not become apparent for many years.[13]

1.2 Health Impacts of Chemicals Used in Hydraulic Fracturing in Australia

A review of the health impacts associated with HF chemicals used in Australia demonstrate they are toxic to human health or the environment. The following information was compiled from publically available sources.[14]

Glutaraldehyde - a biocide; is highly irritating to the eyes, skin and the respiratory tract of humans and laboratory animals. It has caused skin sensitization in humans and laboratory animals, and asthma in occupationally exposed people. In animal tests, glutaraldehyde by inhalation caused lung damage in rats and mice and in tests using in mammalian cells in culture glutaraldehyde caused DNA damage, mutations and some evidence of chromosome damage. Data indicates that both algae and fish embryos may be particularly sensitive to long-term glutaraldehyde exposure.

Ethylene Glycol - a scale inhibitor and solvent; is known human respiratory toxicant and can also irritate the eyes, nose and throat. Exposure is associated with increased risks of spontaneous abortion and sub-fertility in female workers and birth defects in animals. Ethylene Glycol is an endocrine disrupting substance (EDC).

2-Butoxyethanol (2BE, ethylene glycol monobutyl ether, EGBE) - a surfactant and solvent; high doses of 2BE can cause reproductive problems and birth defects in animals. Animal studies have also shown it can destroy red blood cells. There are no carcinogenicity studies available for 2BE and it was declared a Priority Existing Chemical by Australian regulators due to its high mobility, low degradation and potential to contaminate aquifers.

Nonylphenol Ethoxylate - a surfactant; NPE is a persistent, bioaccumulative, endocrine disruptor, which has been detected widely in wastewater and surface waters. NPE can mimic the natural hormone, estradiol and binds to the estrogen receptor in living organisms. Nonylphenols (NP) are formed from the environmental degradation of NPEs. NP can cause the feminisation of aquatic species, decrease male fertility, and decreases survival in young fish. Sexual deformities were found in oyster larvae exposed to NP and it is linked to increases in breast cancer in mice. Canada classified NPE metabolites as toxic. The European Union classifies NP as very toxic to aquatic organisms, which may cause long-term adverse effects in the aquatic environment.

Methanol - a corrosion inhibitor; methanol is volatile organic compound (VOC), which is highly toxic to humans. It causes central nervous system depression in humans and animals as well as degenerative changes in the brain and visual system. Chronic exposure to methanol, either orally or by inhalation, causes headache, insomnia, gastrointestinal problems and blindness in humans and hepatic and brain alterations in animals. Methanol is highly mobile in soil and can volatilizes from water. Once in air, its half-life is over 2 weeks. The chemical reacts with photochemically produced smog to produce formaldehyde. Methanol was listed as the most commonly used HF chemical by the United States House of Representatives Committee on Energy and Commerce. [15]

Sodium Persulfate - used as a gell breaker; exposure via inhalation or skin contact can cause sensitization, i.e., after initial exposures individuals may subsequently react to exposure at very low levels of that substance. Exposure can also cause skin rashes and eczema. Sodium persulfate is irritating to eyes and respiratory system and long-term exposure can cause changes in lung function resulting in disease of the airways and/or asthma.

Tetrakis hydroxymethyl)phosphonium sulfate (THPS) - a biocide; is toxic to microorganisms with acute toxicity values for algae less than 1 milligram per litre. Repeated

skin exposure to THPS can result in severe skin reaction and cause skin sensitization.[16] It has shown mutagenic potential (in vitro) and cancer potential in rats. No exposure information is available for either humans or organisms in the environment and little is known about the effects of the break down products of THPS

Naphthalene – *a* friction reducer; is classified by the International Agency for Research on Cancer (IARC) as a *'possible human carcinogen'* and by the US EPA as *'reasonably anticipated to be human carcinogen*' based on nasal and lung tumours in lab animals. Chronic exposure of workers and rodents to naphthalene causes cataracts and/or damage to the retina. Naphthalene metabolites have been found in the urine of workers.

1.3 Chemicals Not Assessed

Many HF chemicals have not been assessed for their long-term impacts on the environment and human health. In Australia, of the 23 identified as commonly used 'fracking' chemicals, only 2 have been assessed at all by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) and neither for their use in CSG.[17] While the Australian government states it is in the process of addressing this, their assessment which was due in 2015 will not consider impacts on deep groundwater or air and is hampered by the lack of toxicological data. Nor will the mixtures used in drilling and fracking fluids be assessed for toxicity or persistence. Chemical mixtures may form new compounds when exposed to sunlight, water, air, radioactive elements or other natural chemical catalysts.

1.4 Secrecy and Confidential Business Information

Proprietary data and trade secret regimes mean that the disclosure of full formulations is usually not possible even by those who use the products. An example of this is the material safety data sheet (MSDS) for a commonly used friction-reducing chemical, INFLO 150. The Australia MSDS lists its active ingredients as:

- Methanol (CAS 67-56-1) at 5-10%
- Ethylene Glycol (CAS 107-21-1) at 10-30%
- Oxyalkylated Alcohols (trade secret) 10-30%

The following are also listed but with no details on Chemical Abstracts Service Registry Number (CASRN), they cannot be identified.

- Fatty Alcohol, Oxylalkylated Alkanolamine(s), Silicone(s), Surfactant(s)

The US MSDS for INFLO 150 provides a little more information describing the surfactant as a fluorocarbon surfactant but still does not provide a distinct CAS number. Fluorocarbon surfactants belong to a group of chemicals, perfluorocarboxylic acids (PFCAs) that can be extremely persistent, capable of long-range transport and are widespread throughout the environment and in wildlife. Many are found in human blood indicating bioaccumulation and concentrations in wildlife high on the foodchain, strongly suggest biomagnification. While little toxicology data is available for the majority of the PFCAs, some are known to have serious adverse health impacts.

The 2015 Californian assessment recommended that all operators should report the unique Chemical Abstracts Service Registry Number (CASRN) identification for all chemicals used in HF and acid stimulation, and the use of chemicals with unknown environmental profiles

should be disallowed.[18] Despite this, discussions with the legal representative of Haliburton, maker of HF fluids stated that the company is not willing to provide full details of the formulation to either the users or government regulatory bodies.[19]

1.5 Drilling Impacts

Whether or not a UG well is fracked, the industry still results in significant chemical usage and releases. According to the International Energy Agency, the lifespan of an UG well is 5 to 15 years with output typically declining by between 50% and 75% in the first year of production. As a result many new wells are required to be drilled to keep a gas field commercially viable. Hence, the impact of the large amounts of drilling fluid components needs to be addressed in an assessment of the impacts of the UG industry.

Drilling fluid components include:

- Viscosifiers to increase viscosity of mud to suspend cuttings (eg bentonite, polyacrylamide)
- Weighting agent (eg barium sulphate);
- Bactericides/biocides to prevent biodegradation of organic additives (eg glutaraldehyde);
- Corrosion inhibitors to prevent corrosion of drill string by acids and acid gases (eg zinc carbonate, sodium polyacrylate, ammonium bisulphate);
- Defoamers to reduce mud foaming (eg glycol blends, light aromatic and aliphatic oil, naptha);
- Emulsifiers and deemulsifiers to help the formation of stable dispersion of insoluble liquids in water phase of mud;
- Lubricants to reduce torque and drag on the drill string (eg chlorinated paraffins)
- Polymer stabilisers to prevent degradation of polymers to maintain fluid properties (eg sodium sulfite);
- Breakers to reduce the viscosity of the drilling mud by breaking down long chain emulsifier molecules into shorter molecules (eg diammonium peroxydisulphate, hemicellulase enzyme);
- Salts (eg potassium chloride, sodium chloride, calcium chloride); and in the case of drilling for shale gas;
- Shale control inhibitors to control hydration of shales that causes swelling and dispersion of shale, collapsing the wellbore wall (eg anionic polyacrylamide, acrylamide copolymer, petroleum distillates).

Some drilling chemicals, such as silica or crystalline quartz, bentonite clay and cristobalite are known to be carcinogenic with the primary malignancy associated with exposure through inhalation. [20]

1.6 Drilling Muds, Cuttings and Wastes

Drilling muds consisting of drilling fluid, weighting agents, and stabilizing materials need to be disposed of safely. The mud has come into contact with the coal and its contaminants, which are transported to the surface with the drilling muds.

Trials undertaken in Queensland on a proposal for land spraying of drilling byproducts identified environmental hazards including release of potentially toxic additives, salt compounds, heavy metals, hydrocarbons, pH-control additives, and total suspended solids

(TSS).[21] The report notes that concentrations of aluminium, boron, iron, manganese, molybdenum, vanadium and mercury exceeded the Australian and New Zealand Environment and Conservation Council (ANZECC 2000) Guidelines[22] and detectable concentrations of petroleum hydrocarbons were observed in drilling muds. They concluded that the C6–C9 fraction, which include benzene, toluene, ethyl benzene and xylenes (BTEX) may pose a risk from to the environment and to human health.

In June 2013, New Zealand milk giant, Fonterra, announced it would no longer accept milk from farms that accept CSG muds and drilling cuttings on their properties, citing both contamination concerns and the extra cost of testing the milk at about $80,000 per year.[23]

2.0 Chemical Pollution Risks to Water

Potential risks to ground and surface water have been identified as:

- leakage of drilling fluids from the well bore into near surface aquifers;
- fracking pressure resulting in cracks in the well casing allowing leakage of fluids;
- contamination from flow back fluid;
- accidental spills of fluids or solids at the surface;
- surface and subsurface blow outs;
- chemicals remaining in the underground from repeated fracking or naturally occurring contaminants finding their way from the producing zone to shallow or drinking water aquifers through fractures in the rock; and/or
- discharge of insufficiently treated waste water into surface water or underground.[24]

2.1 Contamination of Groundwater

Australian industry has acknowledged that drill holes can intersect with one or multiple aquifers potentially mixing groundwater from different strata or altering the groundwater chemistry through exposure to air, gas, drilling fluids or release of natural compounds.[25] BTEX chemicals were found in 5 out of 14 monitoring wells in Arrow's Queensland gas fields with benzene at levels 6 and 15 times Australian drinking water standard.[26] Toluene was found in a private drinking water bore adjacent to Queensland gas fields.[27]

In 2014, Santos coal seam gas project in the Pilliga Forest, New South Wales was found to have contaminated aquifers with uranium at 335 micrograms per litre; 20 times the Australian Drinking Water guideline of 17 ug/l. [28]

US EPA investigation of ground water contamination

In 2011, US EPA investigation of water contamination in 23 drinking water wells near natural gas extraction sites detected high concentrations of benzene, xylenes, gasoline range organics, diesel range organics, and other hydrocarbons in groundwater samples from shallow monitoring wells near pits indicated that they were a source of shallow ground water contamination. They concluded that compounds associated with hydraulic fracturing had contaminated the aquifer at or below the depths used for domestic water supply.[29]

US EPA Report Assessment of Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resource

The US EPA 2015 report[30] on groundwater contamination confirmed specific instances when

fracking *"led to impacts on drinking water resources, including contamination of drinking water wells."* The report notes that spills occurred between January 2006 and April 2012 in 11 states and included 151 cases in which fracturing fluids or chemicals spilled on or near a well pad but due to the methods used for the EPA's characterization of spills, these cases were likely a subset of all fracturing fluid and chemical spills during the study's time period. The study notes that the relatively small number of contamination incidents included in the report might be due the lack of pre- and post-fracking data about drinking water resources; the dearth of long-term studies; and *"the inaccessibility of some information on hydraulic fracturing activities and potential impacts,"* most likely held by UG companies.

Methane in Groundwater

Methane was detected in private drinking water bores adjacent to Queensland gasfields.[31] US studies have shown that methane levels in drinking water are higher in areas with a high density of wells and methane levels increased over time coinciding with the increasing number of wells. Methane contamination of water was evident in 60 water wells near active gas wells in the US.[32] Contamination at 19 to 64 parts per million was above US federal government safety guidelines. The majority were situated one kilometre or less from a gas well. Wells more than a kilometre from active gas wells had only a few parts per million. In a follow up study, the distance to gas wells was found to be the most significant factor. Water wells close to gas-drilling sites had methane levels more than six times higher than more distant wells.[33]

2.2 Produced Water

Produced water is the term used by the industry to describe the wastewater produced along with the gas. Produced water from both CSG and shale gas is contaminated with heavy metals, naturally occurring radioactive materials (NORMs), fracking or drilling chemicals, volatile and semi volatile organic compounds and high concentrations of salts.

For a typical shale gas well, daily produced water volumes range from 300 - 4,500 litres (80 to 1,200 gallons).[34] The amount of produced water from a CSG well varies between 0.1 - 0.8 megalitres (ML) per day.[35] Large quantities of salts are a by-product of CSG production, as produced water tends to be highly saline.[36] Produced water is often used for dust suppression on roads, reused for brick making, sent to holding ponds or partially 'treated' and released into waterways.

The treatments to remove contaminants from produced water are limited by the chemicals they can remove, the energy needed and their economic costs. Reverse osmosis has significant limitations and cannot remove many of the organic chemicals used in UG activities. Low molecular weight, non polar, water-soluble solutes such as the methanol and ethylene glycol are poorly rejected by reverse osmosis filtration.[37] As the costs and difficulties of dealing with large quantities of wastewater grow, Australian UG companies are trialing reinjection into aquifer formations, despite the risks of seismic events, as experienced in the US.

In Queensland, the UG company Santos claimed in their original environmental impact statement that they would treat the produced water to Australian standards before disposing of it in local waterways. However, the company found that they were unable to treat the water to Australian standards and in late 2012, requested permission to dump its contaminated water. They were given authorisation by the Queensland government to pump 12-18 million litres per day into the Dawson Creek.

In Australia, high levels of lead, mercury, chromium, hydrocarbons and phenols have been detected, seven months after a spill of produced water in the Pilliga Forest CSG gas field.[38] In 2011, bromine was detected in treated produced water released by Eastern Star Gas at six times background levels. Methane was also detected at 68 micrograms per litre (ug/l), whereas it was not detected in the upstream control sample.[39]

In 2014, BTEX was detected in the water from two of four CSG wells and an aboveground water storage tank at the AGL CSG project in Gloucester in New South Wales. Five samples included BTEX, one at concentration of 555 ppb.[40] The New South Wales EPA suspended AGL's CSG Waukivory Project.

2.3 Flowback

Flowback refers to the 15 - 80% of the hydraulic fluid mixture that returns to the surface after fracking. It contains some of the chemicals injected, plus contaminants from the coal seam like BTEX, polycyclic aromatic hydrocarbons (PAHs), NORMs, heavy metals and other volatile organic compounds (VOCs). Samples taken from the top of the wellhead, a day after the well had been 'fracked', detected bromodichloromethane, bromoform, chloroform and dibromochloromethane, as well as benzene and chromium, copper, nickel, zinc.[41]

An assessment of the impacts of hydraulic fracturing for shale and tight gas in West Australia's drinking water supply areas by the West Australian Department of Health notes that there were 96 substances found in the flowback fluids that were not used in hydraulic fracturing fluid; of these 96 substances, 28 were found to be listed by regulatory agencies as known or suspected carcinogens.[42]

Published studies from USA show that even after treatment, flowback water had dangerous levels of bromine and radium-226.[43]

Australian company, AGL was criticised after its contractor, Transpacific transported 600,000 litres of flowback from its NSW Gloucester projects to be discharged into Hunter Water's network. [44] Hunter Water had previously advised both companies it would not accept the discharge after it was informed that the flowback water would contain 450 litres of the biocide, Tolcide (active ingredient THPS). AGL then made arrangements to send its flow backwater to WORTH Water Treatment Plant in Windsor, however the company rejected more CSG wastewater.

AGL ended its trial of using CSG wastewater for irrigation after regulators found it left behind unacceptably high levels of salt and heavy metals. The EPA reviewed the monitoring data from the irrigation trial and, based on this review, would not support a continuation of the trial. AGL is currently transporting its contaminated waste over 1000 km to the plasma arc facility in Brisbane.

2.4 Wastewater Contamination in the US

Researchers from Duke University found elevated levels of chloride and bromide downstream from Treatment Facility in south-western Pennsylvania, which was treating UG effluent. Bromide can combine with naturally occurring organic matter and chlorine disinfectant to form drinking water contaminants called trihalomethanes, which are associated with liver, kidney, and nervous system problems. The researchers reported highly elevated concentrations of bromide over a mile downstream from the plant, which indicated a potential future burden for drinking water treatment facilities downstream.

Radium-226 levels was detected in stream sediments at the point of discharge, that were approximately 200 times greater than upstream and background sediments and well above regulatory standards.[45]

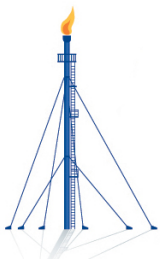
Endocrine Disrupting Chemicals in Wastewater

In a 2013 US study,[46] surface and groundwater near areas experiencing high levels of unconventional gas activity in Colorado were shown to contain endocrine-disrupting chemicals (EDC) with moderate to high levels of EDC activity. The concentrations of chemicals detected in surface and ground water were in high enough concentrations to interfere with the response of human cells to male sex hormones and estrogen. Samples taken from sites with little drilling showed little EDC activity. Exposure to EDCs can increase the risk of reproductive, metabolic, neurological, and other diseases, especially in children and young organisms.

2.5 Unsustainable Water Use

UG activities use very large quantities of water that compete with human and agricultural needs for water, raising important water equity issues. This is clearly acknowledged by the UG industry. Australian UG company Santos notes, '*The drawdown of ground water heads within coal seam gas aquifers is a necessary process and an unavoidable impact associated with the depressurisation of the coal seam.'* [47] There can be significant losses in pressure both within the aquifer, and/or in the overlying and underlying aquifers. Santos predicted for their Queensland CSG fields within the Bowen Basin, groundwater drawdown of 7 to 25 metres by 2028. Significant drawdown of farm bores has already been experienced in the region.

3.0 Air Contaminants Released from Unconventional Gas Exploration and Production



Data from the Australian government's National Pollutant Inventory (NPI) shows the UG industry is a significant source of air pollutants with releases of particulates (PM_{10}, $PM_{2.5}$), nitrogen oxides and VOCs. According to the NPI data, the quantities emitted are increasing. Air toxics associated with UG activities can cause serious, irreversible health effects, including cancer, neurological problems and birth defects. [48] In 2013, the World Health Organisation[49] declared that outdoor air pollution is carcinogenic.

There are many sources of toxic air pollutants in gas fields and related infrastructure, including high point vents, equipment/engines, drilling rigs, boilers/heaters, generators, flares, storage tanks, injection pumps, dehydrators, vehicles and gas skimmers. Major sources of air pollutants are the compressor stations that move natural gas through pipelines and gas processing plants.[50]

The following priority pollutants have been identified with some forming precursors of secondary pollutants such as ozone. [51]

Nitrogen Oxides - NO_x are emitted from machinery, compressors and flaring. NO_x can react with VOCs to form ground-level ozone, which is linked to asthma attacks and other serious health effects. Nitrogen dioxide can cause respiratory problems, heart conditions and lung damage.

Carbon monoxide - CO is emitted during flaring and from machinery and is poisonous if inhaled. It inhibits the blood's ability to carry oxygen and can cause dizziness, unconsciousness and even death.

Sulfur dioxide - SO_2 reacts with other chemicals to form acid rain and particulate pollution, which can damage lungs and cause respiratory illness, heart conditions and premature death.

Hydrogen sulfide - H_2S occurs naturally in some gas formations and can be released when gas is vented or flared, or via fugitive emissions. It is a toxic gas, which is lethal if inhaled at high concentrations

Volatile Organic Compounds **-** VOCs are present during all stages of UG activities including drilling, flaring, from equipment/machinery, hydraulic fracturing, flowback and holding ponds. Semi volatile chemicals are injected underground during fracking, a percentage of which eventually surfaces. Some VOCs cause cancer in animals (e.g. methylene chloride), in humans (e.g. formaldehyde) or are suspected human carcinogens (e.g. chloroform, bromodichloromethane). VOC exposure may result in eye, nose, and throat irritation, headaches, visual disorders, memory impairment, loss of coordination, nausea, damage to liver, kidney, and central nervous system.[52] Some VOCs like formaldehyde and styrene are endocrine disrupting chemicals (EDCs).[53]

Sampling of air around homes near gasfields has detected a wide range of VOCs many of which are toxic. [54] Community sampling around Queensland gas activities also detected dichlorodifluoromethane, a potent chlorofluorocarbon (CFCs) which damages the ozone layer.[55]

A more detailed discussion of testing, results and impacts from UG on the Queensland Tara Estates is available later in this brief.

BTEX (benzene, toluene, ethylbenzene, xylene) **-** BTEX chemicals are naturally occurring VOCs released from coal deposits and are also found in associated groundwater.[56] Drilling, fracking and removal of produced water release BTEX from the coal seam. Their short-term health effects include skin, eye and nose irritation, dizziness, headache, loss of coordination and impacts to respiratory system while chronic exposure can result in damage to kidneys, liver and blood system.

Benzene - causes leukemia, non-Hodgkin's lymphoma and also affects the immune system. It may also cause chromosomal aberrations and mutations in human and animal cells. [57] It has been linked to birth defects[58] and sperm abnormalities. [59] The WHO identified exposure to benzene as a major public health concern. They note that benzene is a well-established cause of cancer in humans with IARC classifying benzene as carcinogenic to humans (Group 1).

Polycyclic Aromatic Hydrocarbons - PAHs are a group of very toxic volatile compounds. They are a significant air pollutant associated with unconventional gas production. Research[60] indicates that people living or working near active natural gas wells may be exposed to pollutants at higher levels than the US EPA considers safe for lifetime exposure. High levels of PAHs were found across the study area with levels increasing closest to the wells.

3.1 Particulates and Airborne Silica

Particulate matter (PM) is released during construction of the infrastructure, venting, flaring, engines and diesel exhaust and via silica based proppants. Exposure to respirable crystalline silica can cause silicosis, lung cancer, autoimmune diseases, pulmonary disease and chronic kidney disease.[61]

The US National Institute for Occupational Safety and Health (NIOSH) released a Hazard Alert, identifying exposure to airborne silica as a health hazard to workers conducting hydraulic fracturing operations.[62] They identified a range of sources of silica dust exposure during HF operations. While workers experience the most direct exposure, silica dust may also be an air contaminant of concern to nearby residents.[63] NIOSH acknowledges a lack of information on occupational dust exposure in the gas industry, including exposure to diesel particulates. Diesel exhaust is classified as a Group 1 carcinogen by IARC.[64]

Chronic inhalation of PM_{10} and $PM_{2.5}$ can cause respiratory problems, cancer, heart attacks, strokes, diabetes, asthma, hypertension, renal disease or premature death. PM also provides an effective pathway for other contaminants such as heavy metals and radioactive substances into the broader environment. The Australian government acknowledge that there is no threshold for PM at which health effects do not occur [65] yet, UG companies are not required to report emissions of either $PM_{2.5}$ or PM_{10} unless they exceed a threshold of 400 tonnes per year, or 1 tonne per hour.

3.2 Synergy Between Particulates and Air Pollutants

Particulate matter (PM) travels deep into the lung and crosses directly into the bloodstream carrying with it other toxic chemicals. The surface area of the particle drives a synergistic response, producing greater than an additive response.[66] Together, the mixture is even more dangerous to health than the added individual risks and importantly, there is no evidence of a safe level of exposure to the combined air pollutants or a threshold below which no adverse health effects occur.

3.3 Gas Processing - a Key Source of Air Pollution

Gas processing is needed to remove impurities before natural gas can be used. It produces many by-products, which are often vented to the air e.g. ethane, propane, butanes, pentanes, higher molecular weight hydrocarbons, hydrogen sulphide, carbon dioxide. A 2015 study using hourly measurements from Photochemical Assessment Monitoring Stations in the Baltimore, MD and Washington, DC areas, observed that daytime ethane concentrations have increased significantly since 2010, growing from 7% of total measured nonmethane organic carbon to 15% in 2013. They noted this trend appears to be linked with the rapidly increasing natural gas production in upwind neighbouring states.[67]

Flaring

The USEPA has banned gas flaring (the burning off of natural gas from a new well) in most cases since January 2015 due to growing concerns over air pollution[68]. There are no restrictions on UG flaring in Australia. Flaring releases hydrogen sulphide, methane, BTEX [69] and is recognised as a significant source of soot or black carbon pollution.[70]

3.4 Australian UG Industry Reports to the National Pollutant Inventory

Australia is one of the few countries where the UG companies are required to self-report their emissions to land, air and water to the government's National Pollutant Inventory (NPI).[71] The data submitted each year represents their calculated estimated emissions for a limited list of around 100 chemicals and heavy metals. The data show many thousands of tonnes of toxic chemicals are annually being released to air by the UG industry and the figure is increasing.

The NPI data confirms that the processing of coal seam gas is also major and increasing source of air pollution in Australia.

Emissions of particulate matter (PM) from the QGC's Kenya Processing Plant (ATP620) and Compressor Stations near Tara, have consistently risen over the last 5 years.

Table 1: QSG's Kenya Processing Plant (ATP620) and compressor stations, Queensland

EMISSIONS	2011-2012	2013 - 2014	2014-2015
Particulate matter (PM)	54 tonnes	342 tonnes	1,113 tonnes

Other emissions from the Kenya facility have also increased significantly.

Table 2: QGC's Kenya Processing Plant

EMISSIONS	2013-2014	2014-2015
NOx	710 tonnes	1,300 tonnes
CO	410 tonnes	1,000 tonnes
Total VOCs	89 tonnes	180 tonnes

While QGC's Windibri Processing Plant and Compressor Stations in 2014-15, reported a drop in total PM emissions from 1,316 tonnes to 495 tonnes, it reported a significant increase in total VOCs rising from 91 tonnes in 2013-14 to 160 tonnes in 2014-2015. As well it released 62 tonnes of the carcinogen formaldehyde.

Large increases in pollutants released from the gasfields are also evident.
QGC's Ruby Jo gas field in Tara, Queensland, reported emissions :

Table 3: QGC's Ruby Jo Gas Field, Queensland

EMISSIONS	2012-2013	2014-2015
CO	80 tonnes	1,600 tonnes
NOx	230 tonnes	810 tonnes
PM	30 tonnes	1902 tonnes
VOC	69 tonnes	110 tonnes

In South Australia, Santos Merrimelia Gas in Leigh Creek, have significantly increased their emissions of CO and NOx over the last three reporting periods .

Table 4: Santos Merrimelia Gas, Leigh Creek, South Australia

EMISSIONS	2012-2013	2013-2014	2014-2015
CO	32 tonnes	850 tonnes	1,900 tonnes
NOx	220 tonnes	580 tonnes	1,200 tonnes

Curtis Island QLNG plant, a significant point source

The Curtis Island QLNG plant an export facility in northern Queensland, reported to the NPI for the first time for 2014-2015 reporting year. The facility released 4,800 tonnes of deadly carbon monoxide, 4,300 tonnes of nitrous oxides, 620 tonnes of volatile organic compounds, 190 tonnes of formaldehyde, 29 tonnes of acetaldehyde, and 17 tonnes each of Benzene and Toluene (methylbenzene). It also released 546 tonnes of particulate matter. It was third largest emitter in Gladstone.

Table 5: Curtis Island QLNG Plant, Queensland

EMISSIONS	2014-2015
Carbon monoxide	4,800 tonnes
Nitrous oxides	4,300 tonnes
Volatile organic compounds	620 tonnes
Formaldehyde	190 tonnes
Acetaldehyde	29 tonnes
Benzene	17 tonnes
Toluene (methylbenzene)	17 tonnes

Cumulative Air Pollution Load

The numerous gasfields and infrastructures in a single region may add up to significant cumulative releases. For example, in the Leigh Creek, South Australia region where Santos has 23 oil and gas facilities and activities reporting to the NPI in 2014-15 including significant amounts of volatile toxic compounds:

Table 6: Combined Santos Oil & Gas facilities, Leigh Creek, South Australia

SANTOS GAS FACILITIES 2014-2015	VOLATILE ORGANC COMPOUNDS (tonnes)	BENZENE (tonnes)
Big Lake shale gas	890	
Toolachee Gas	370	17
Merrimelia Gas	150	
Tirrawarra Gas	460	23
Strzelecki Gas	100	
Kidman Gas	160	
Gidgealpa Gas	360	15
Della Gas	250	11
Daralingie Gas	220	
Bookabourdie	210	
TOTAL	**3,170**	**66**

The emissions resulted in over 3,170 tonnes of total VOCs and at least 66 tonnes of the very toxic benzene released into the Leigh Creek region from Santos gas projects alone. These projects also reported many 1,000s of tonnes of CO and NOx and smaller amounts of many other contaminants. NPI figures reflect the steady growth in cumulative air emissions from UG activities across regions.

3.5 Australian Research on Fugitive Emissions

Fugitive non-methane and methane emissions are an issue usually associated with abandoned wells but are evident over the complete gas exploration and production cycle. Research conducted at Australia's Southern Cross University[72] measured atmospheric radon (^{222}Rn and ^{220}Rn) and carbon dioxide (CO_2) concentrations as a measure of fugitive emissions in the Queensland gas fields. The researchers found a 3-fold increase in maximum radon ^{222}Rn concentration inside the gas field compared to outside with a significant relationship with the number of wells. They suggest the presence of radon and CO_2 indicates the possible release of other gases, such as VOCs. They argue that CSG activities such as the depressurisation by groundwater extraction from the coal bed strata change the geological structure and pressures, helping gases to seep through the soil and be released to the atmosphere.

In a submission to the Australian government, the same researchers reported hotspots with concentrations of methane (CH_4) as high as 6.89 ppm and CO_2 as high as 541 ppm near Tara. Background atmospheric CH_4 outside the gas fields were lower than 2ppm.[73] In a follow up study, they confirmed the widespread enrichment of both CH_4 and CO_2 within the production gas field, compared to outside. The CH_4 and CO_2 values showed distinct differences within and outside the production field, indicating a CH_4 source within the production field had a signature comparable to the region's CSG.[74]

Methane Leaks

Further evidence of fugitive emissions can be seen in the bubbling methane gas reported along a five kilometre stretch of the Condamine River in Queensland, Australia. The Queensland government's initial investigation [75] notes that four CSG wells were within five kilometre radius of the gas seep but there was no evidence of fracking within 40 kilometres. Methane was measured at 80% of the lower explosive limit (LEL) (at river surface) equating to 4% gas in air. Another Queensland government study found 26 of 58 gas wells tested leaked methane; one above the LEL, 4 at or above 10% of the LEL and 21 with levels between 10-3000ppm. Similar figures were found in surrounding gas fields.[76]

Methane is a powerful greenhouse gas with a global warming potential much greater than that of CO_2. The IPCC calculated that methane is 34 times stronger as a heat-trapping gas than CO_2 over a 100-year time scale. The IPCC report also stated that over a 20-year period, methane has a global warming potential of 86-105 compared to CO_2.

3.6 Naturally Occurring Radioactive Materials

Naturally Occurring Radioactive Materials or NORMs, like uranium, thorium and their progeny radium-228 and radium-226 are found in both coal seams and shale.[77] The level of reported radioactivity varies significantly, depending on the radioactivity of the reservoir rock and the salinity of the water co-produced from the well. The higher the salinity, the more NORMs are likely to be mobilised. Since salinity often increase with the age of a well, old wells tend to exhibit higher NORM levels than younger ones.[78]

Radon and Radium

UG activities such as drilling, fracking, removal of produced water, earthworks and transport result in radioactive substances being remobilized and relocated either via waste water,

'bonding' with dust particulates or via resuspension in air. Direct particle fallout, as well as washout from rain provides an effective pathway for these contaminants to find their way into the wider environment including surface water and onto rooftops and into domestic water tanks.

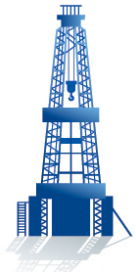
Both radon and radium emit alpha particles, which are most dangerous when inhaled or ingested. Radium is a known carcinogen[79] and exposure can result in increased incidence of bone, liver and breast cancer. Consuming radium in drinking water can cause lymphoma, bone cancer, and leukemia.[80] Radium also emits gamma rays, which raise cancer risk throughout the body from external exposures. Radium-226 and radium-228 have half-lives of 1,600 years and 5.75 years, respectively. Radium is known to bioaccumulate in invertebrates, mollusks, and freshwater fish,[81] where it can substitute for calcium in bones.

Radon is an inert gas, so it doesn't react with other elements and usually separates from produced water along with methane at the wellhead. When inhaled, radon can cause lung cancer, and there is some evidence it may cause other cancers such as leukemia.[82]

A US analysis of waste obtained from reserve pits used in unconventional natural gas mining confirmed elevated beta radiation readings. Specific radionuclides present included ^{232}Thorium decay series (^{228}Ra, ^{228}Th, ^{208}Tl), and ^{226}Radium decay series (^{214}Pb, ^{214}Bi, ^{210}Pb). The research indicated the potential for exposure to technologically enhanced naturally occurring radioactive materials and potential health effects from individual radionuclides.[83]

In 2014, a Santos coal seam gas project in the NSW Pilliga Forest was found to have contaminated aquifers with Uranium at 335 micrograms per litre, which is 20 times the Australian Drinking Water guideline of 17 ug/l. [84] As much uranium is in the form of Uranium-238, its detection above drinking water levels should have prompted immediate testing for radionuclides in the groundwater, which are far more harmful to living organisms. Unfortunately, testing for radioactivity did not occur.

4.0 Implications for Human Health



There has been no comprehensive assessment of the health implications of UG air pollutants to residents or workers in Australia. A US based human health risk assessment of air emissions concluded residents closest to well pads i.e., living less that half a mile from wells, have higher risks for respiratory and neurological effects based on their exposure to air pollutants; and a higher excess lifetime risk for cancer. [85]

Children living in close proximity to UG activities are at particular risk from air pollutants, due to their unique vulnerability to hazardous chemicals[86] Children's exposure to chemicals at critical stages in their development may have severe long-term consequences for health. WHO has expressed a priority concern around children's exposure to air pollutants [87]

4.1 Maternal Exposure

Maternal exposure to air pollutants carries significant risks as the placenta is not an effective barrier to chemical transfer from mother to the foetus. Toxins can also be transferred from mother to baby through breast milk. The developing fetus and baby is particularly sensitive to environmental factors with '*critical windows of vulnerability*' during prenatal and early postnatal development, during which chemical exposures can cause potentially permanent

damage to the growing embryo and fetus.[88] Early exposure to carcinogens can also increase the risk of developing cancer later in life.[89] In utero and in early infancy, pollutants can cause permanent brain damage at levels of exposure that would have little or no adverse effect in an adult.[90]

A 2015 study [91] demonstrates that the higher a baby's prenatal exposure to PAHs, the more serious the impact on the brain and the greater the behavioural and developmental problems. The findings suggest that prenatal exposure to PAH air pollutants contributes to slower processing speed and attention-deficit/hyperactivity disorder symptoms. Importantly, the damage is not isolated to prenatal stages.

A large study from Colorado found that children born in areas with the highest number of gas wells had a 30% increased rate of congenital heart defects compared to children born in areas with no gas wells within 10km. [92] A 2015 retrospective cohort study using electronic health record data on 9,384 mothers linked to 10,946 neonates between January 2009 to January 2013 showed that prenatal residential exposure to unconventional natural gas development activity was associated with two adverse pregnancy outcomes; preterm births and high risk pregnancies, adding to evidence that unconventional natural gas development may impact health.[93] An earlier study from Cornell University concluded that babies born within 2.5km of a gas well had lower birth weight and more health problems than babies who were born within 2.5km of a well that was planned but had not been drilled.[94]

4.2 Unconventional Gas and Chemical Mixtures

A 2015 review [95] of more than 100 scientific, peer-reviewed publications on unconventional oil and gas (UOG) chemicals and their impacts found that research points to potential adverse health outcomes from mixtures of these chemicals. The review suggests there is strong evidence of endocrine disrupting chemical mixtures having additive effects. In light of the potential for environmental release of UG chemicals that can disrupt hormone receptor systems, it is desirable to assess the complex hormonally active environmental mixtures when assessing the health impacts of UG chemicals and releases.

The WHO framework for assessing mixtures[96] provides example situations where a risk assessment for combined exposure to multiple chemicals might be necessary such as the emissions of multiple substances from a common source as in the case of fracking or drilling; the presence of multiple substances in surface waters; exposure to multiple pollutants in the atmosphere; and exposure to a formulated multicomponent chemical product (e.g., HF fluid products). The potential impact of co-occurrence of, and concomitant exposure to, multiple chemicals should always be taken into account in problem formulation for any risk assessment. The WHO concluded that lack of data on exposure or even the key components and their combined hazards does not obviate the need to introduce risk management measures to reduce exposure.

4.3 Case study - Darling Downs / Tara, Queensland

The people of the Western Downs gas fields had been reporting adverse impacts since 2008 when untreated CSG waste was sprayed on local roads for 'dust suppression.' In 2009, residents reported health impacts such as rashes, nosebleeds, nausea and vomiting which forced people to leave their homes. In 2013, the Queensland Government released its Health Report into residents' complaints, which acknowledged that there was *'some evidence that might associate some of the residents' symptoms to exposures to airborne contaminants arising from CSG activities.'* [97]

Air Pollutant Testing

Despite the knowledge of the significant releases in the Tara region, there has been no comprehensive monitoring of air pollutants. However, single point sampling of ambient air around Tara homes by industry and government has detected a wide range of VOCs many of which are toxic. These include acetone, acrolein, alpha-pinene, benzene, benzothiazole, chloromemethane, cyclohexane, dichlorofluromethane, ethanol, ethyl acetate, ethylbenzene, 2-ethyl-1-hexanol, heptane, hexane, heptadecane, hexadecane, 2-methylbutane, methylcyclohexane, methylene chloride, methyl ethyl ketone, 3- methylhexane, 3 methylpentane, naphthalene, pentane, phenol, propene, tetradecane, tetrachlorethylene, 1,2,4,-trimethylbenzene, toluene, vinyl acetate, xylene, ethanol, phenylmaleic anhydride, methyl ethyl ketone.[98]

In sampling undertaken by Australian gas company, QGC [99] (the ERM Report) in response to residents' complaints, only 13 air samples were collected in all. A single sample was taken at five Tara properties with two samples at each of the remaining four properties.

Benzene

While many VOCs were detected in the air, the ERM Report concluded that apart from the benzene exceedance, there were no other exceedances of the air quality screening criteria. Yet, in the case of 26 chemicals, the health criterion was below the detection level used by the laboratories. For example, US EPA Regional Screening Levels for 1,1,1,2-tetrachloromethane is 0.33 µg/m3, whilst the limit of detection used by the different labs varied between 8.3 µg/m3 and 12 µg/m3, well above the health criteria. The report acknowledges that it cannot be categorically stated that concentrations in the samples were also below the relevant criteria value.

In the case where benzene was detected above health risk criteria, it was dismissed stating that 'benzene was not a compound that is found in CSG and therefore could not be attributed to CSG activities.' This was in contrast to statements found on the website of the Queensland Government's Department of Environment and Heritage Protection where it states that: *"BTEX compounds (benzene, toluene, ethylbenzene, xylene) are found naturally in crude oil, coal and gas deposits and therefore they can be naturally present at low concentrations in groundwater near these deposits".*[100] Benzene had already been detected in monitoring bores at an Arrow Energy fracking operation[101] in Queensland. The dismissal of benzene exceedances was unacceptable when other BTEX chemicals such as toluene, a neurotoxin, had been found in the air around a number of Tara homes and in the air above a resident's water bore. [102] The level of toluene in air above the bore was measured at 0.33ppm but was dismissed as below levels of concern. Yet, it was above the 'Chronic Reference Exposure Limits' used for long term exposure by California, Massachusetts, Michigan states in the USA.[103]

Inadequate Monitoring

The total ERM monitoring period was only nine days and clearly inadequate. The methodology resulted in testing limits of reporting for some chemicals that were substantially higher than the reference air quality criteria. The monitoring was not designed to identify short-term peaks or troughs in air concentrations. In order to assess air contaminants, sampling is needed over an extended period of time. This was demonstrated in a 2012 study on air pollution associated with unconventional gas activities. The twelve month study[104] detected 44 hazardous air pollutants at gas drilling sites including a wide range of air toxics, e.g., CH_4, methylene chloride, ethane, methanol, ethanol, acetone, and propane, formaldehyde, acetaldehyde, PAHs / naphthalene. Most importantly, the authors noted a great deal of variability across sampling dates in the numbers and concentrations of

chemicals detected. Notably, the highest percentage of detections occurred during the initial drilling phase, prior to hydraulic fracturing on the well pad.

Community Testing

The Queensland Government facilitated some *adhoc* sampling for VOCs in air at the Wieambilla Estate in Tara in response to ongoing community concerns. They provided Summa canisters[105] with a 1-minute sampling period and passive diffusion samples to residents for use when appropriate. Again many VOCs were detected and while most were below relevant guidelines and the criteria used, the number and type of compounds was diverse.

Summa canister sampling found the following VOCs: hexane, propene, chloromethane, dichlorodifluromethane, methylene chloride, ethanol, acetone, methyl ethyl ketone, acrolein, vinyl acetate. Vinyl acetate exceeded the annual criteria in one case.

Passive samplers also found the following VOCs: pentane, hexane, heptane, tetradecane, hexadecane, heptadecane, cyclohexane, 2-methylbutane, 3-methylpentane, 3-methylhexane, methylcyclohexane, tetrachloroethylene, 2-ethyl-1-hexanol, ethyl acetate, benzene, toluene, xylene, ethylbenzene, 1,2,4-trimethylbenzene, phenol, benzothiazole, naphthalene, alpha-pinene.

Benzene was detected at 0.6 ppb; above the US EPA recommendations of 0.4ppb, which over a lifetime could cause a risk of one additional cancer case for every 100,000 exposed persons.[106] The benzene result was simply dismissed as an *'outlier'.*

In community sampling around UG activities over an eight-hour period, ethanol and chlorofluorocarbons (CFCs) were detected.[107] Dichlorodifluoromethane, a potent ozone depleting chlorofluorocarbon (CFC) was detected in all 3 air samples.

In July 2014, small suite of tests were undertaken by the Queensland State government around e a Tara family residence which identified Acrolein at 9.6ppb, more than 100 times higher than acceptable chronic exposure standard.[108] The US Texas annual criterion is 0.066ppb. Acrolein is an acute irritant of the eyes, nose, throat, lungs and skin and is reported to be used by the oil and gas industry as a biocide in drilling waters, as well as a scavenger for hydrogen sulphide and mercaptans. Flares are also a possible source of acrolein. Formaldehyde[109] was also detected.

Despite the increased rate of radon detected inside the Queensland gas fields, there has been little radionuclide analyses or testing in the Tara communities surrounding gas fields. However, limited independent testing has detected worrying levels of beta and alpha radioactivity in Tara residents' water tanks. This represents a significant concern for the children, as they are far more vulnerable to radioactivity than adults with sensitivity to radiation being highest early in life.[110] Particulate pollution provides an effective pathway for radioactive substances into the broader environment, and it is hypothesized that through resuspension of radioactive substances and washout from rain as well as direct particle fallout onto roofs and tanks, this has resulted in the detection of radioactivity in the water and sediment of Tara residents' water tanks.

An assessment of the scope and severity of the Tara region's air pollution is not possible from a review of the data sets that are available or from industry's reports of the estimated air releases. However, both the real world experience of serious particulate pollution and the consolidation of available information, does paint a worrying picture of the region's air quality and its possible impacts. This requires both an urgent investigation and precautionary management responses to protect human and environmental health.

Tara Residents' Observed Symptoms

The physical and social impacts on the affected residents have been substantial but the Queensland Government's Health Report[111] into residents' complaints was cursory and included little clinical investigation. The report concluded that it was unable to determine whether any of the health effects reported by the community were clearly linked to exposure to CSG pollutants. This was not a surprising finding and but one that is common in cases of chronic chemical exposures and suspected health effects, especially when no baseline health or environmental data was available. The report did however acknowledge that there was 'some evidence that might associate some of the residents' symptoms to exposures to airborne contaminants arising from CSG activities.'

In response to the Queensland government report which did nothing to allay community concern, in February-March, 2013 a Brisbane based GP, Dr Geralyn McCarron conducted a health survey of residents within the Western Downs gasfields. Her findings were published in the Australian and New Zealand Journal of Public Health.[112] Full details are also available in her report, "Symptomatology of a gas field."[113] Thirty-five households in the Tara residential estates and the Kogan/Montrose region were surveyed in person and telephone interviews were conducted with three families who had left the area. Information was collected on 113 people from the 38 households. Over half (58%) the residents surveyed reported that their health was definitely adversely affected by CSG, whilst a further 19% were uncertain.

In all age groups, there were reported increases in cough, chest tightness, rashes, difficulty sleeping, joint pains, muscle pains and spasms, nausea and vomiting. Approximately one third of the people over 6 years of age were reported to have spontaneous nose bleeds, and almost three quarters were reported to have skin irritation. Over half of children were reported to have eye irritation. Of particular concern were the symptoms that could be related to neurotoxicity (or nervous system damage), and the frequency with which these symptoms were reported in children.

Approximately a third of the all the children to age 18 were reported to experience paraesthesia (abnormal sensations such as pins and needles, burning or tingling). Almost all the children aged 6-18 were reported to suffer from headaches and for over half of these the headaches were severe. Of people aged 6 years and over, severe fatigue and difficulty concentrating was reported for over half. Parents of a number of young children reported twitching or unusual movements, and clumsiness or unsteadiness.

Urine specimens from 16 people living in Queensland's gasfields were tested privately. Testing revealed a mixture of chemical contaminants including phenol, cresol, acetone, polycyclic aromatic hydrocarbons, methyl ethyl ketone, toluric acid, a metabolite of xylene and hippuric acid, a metabolite of toluene. Thirteen people had mixtures of two or more chemicals in their urine. The chemicals that returned positives in urine samples were not chemicals routinely tested for in normal pathology laboratories. The associated reference ranges relate only to occupational exposure to a single chemical toxin and to adult workers whose exposure is limited to a typical 8hour working day. There are no "normal" values or reference values for children exposed 24 hours per day, 7 days per week to a chemical cocktail.

The results of the survey carried out by Dr McCarron may have influenced the gas company, QGC decision to buyout six affected families from Tara.

5.0 New South Wales Chief Supervising Scientist Report

The Chief Scientist and Engineer's Independent Review of CSG Activities in New South Wales, [114] (CSS report) recommends CSG only go ahead if there is *'appropriate engineering and scientific solutions in place to manage the storage, transport, reuse or disposal of produced water and salts.'* Professor Fell notes in the CSS report *"the problem of disposal of treatment concentrates remains the elephant in the room."*[115] He stressed that for the large plants the quantity of salts to be disposed of is substantial and while they are currently being stored in brine ponds awaiting resolution of the disposal issue, this storage is potentially environmentally hazardous.

The CSS report also notes that '*fracking fluids remain a potentially high threat to human health'* and Professor O'Kane, lead author of the report is quoted as saying fracking should be banned if the risk to human health can't be known for sure.[116] The CSS report acknowledges that we are no closer to knowing those risks. It found there were health risks at all stages of CSG extraction with exposures via water, soil and air pollution. The report listed possible adverse health outcomes as respiratory, cardiovascular, genitourinary and digestive diseases, skin problems, some types of cancer, injuries, hormonal disruption, fertility and reproductive effects.

The CSS report acknowledges there is a need to better understand the nature of the risks of pollution or other environmental damage from CSG, as well as the capacity and cost of mitigation and/or remediation e.g., for abandoned wells. It stressed the need for a better understanding of the industry impacts to better manage cumulative impacts of the industry.

6.0 State Government Response

Australian governments are increasingly concerned about the impact that unconventional gas has and may have on the environment and regional communities. In 2013, the NSW Government announced CSG exclusion zones to make certain residential areas 'off limits' to new coal seam gas activity. CSG exclusion zones came into force in October 2013 for existing residential areas in 152 local government areas in NSW, and the North West and South West Growth Centres of Sydney. The exclusion zones banned new CSG activity within a two-kilometre buffer around existing and future residential areas and within the mapped critical industry clusters. In January 2014, the Government introduced CSG exclusion zones for additional future residential growth areas and seven rural villages across NSW, and the equine and viticulture critical industry clusters in the Upper Hunter. [117]

The NSW Gas Plan also established a one-off buy-back of petroleum exploration licences (PELs) for titleholders across the state. This provides an opportunity for holders of PELs to surrender their titles. To date, the NSW Government has bought back and cancelled 15 PELs under the program and is extending the deadline for the buy-back of coal seam gas licences. The Government has reduced the footprint of CSG across the state from more than 60 per cent to 11 per cent.[118]

A moratorium on fracking has been in place in the state of Victoria since August 2012 and Tasmania has announced it will extend its moratorium on fracking for another five years to protect its premium produce reputation. Government inquiries are underway in the other states of South Australia and West Australia.

7.0 Conclusions

Currently, Australian guidelines and standards currently do not take into account low-level, chronic exposure to environmental contaminants even those that demonstrate potential endocrine and epigenetic impacts. To fully assess the impacts of UG development, this would need to be addressed as a priority. Nevertheless, monitoring and regulatory safeguards for unconventional gas exploration and production cannot remove the threat of adverse impacts to water, air quality and to human health. Repeatedly, research and real world experience has pointed to evidence of the adverse impacts of this industry. When so much is at risk, the most simple cost benefit analysis would suggest that this is an industry that represents far too great a risk to people, to agriculture and to the environment.

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