INDEPENDENT SCIENTIFIC PANEL INQUIRY INTO HYDRAULIC FRACTURE STIMULATION IN WESTERN AUSTRALIA

Potential environmental impacts, regulation and management of hydraulic fracture stimulation

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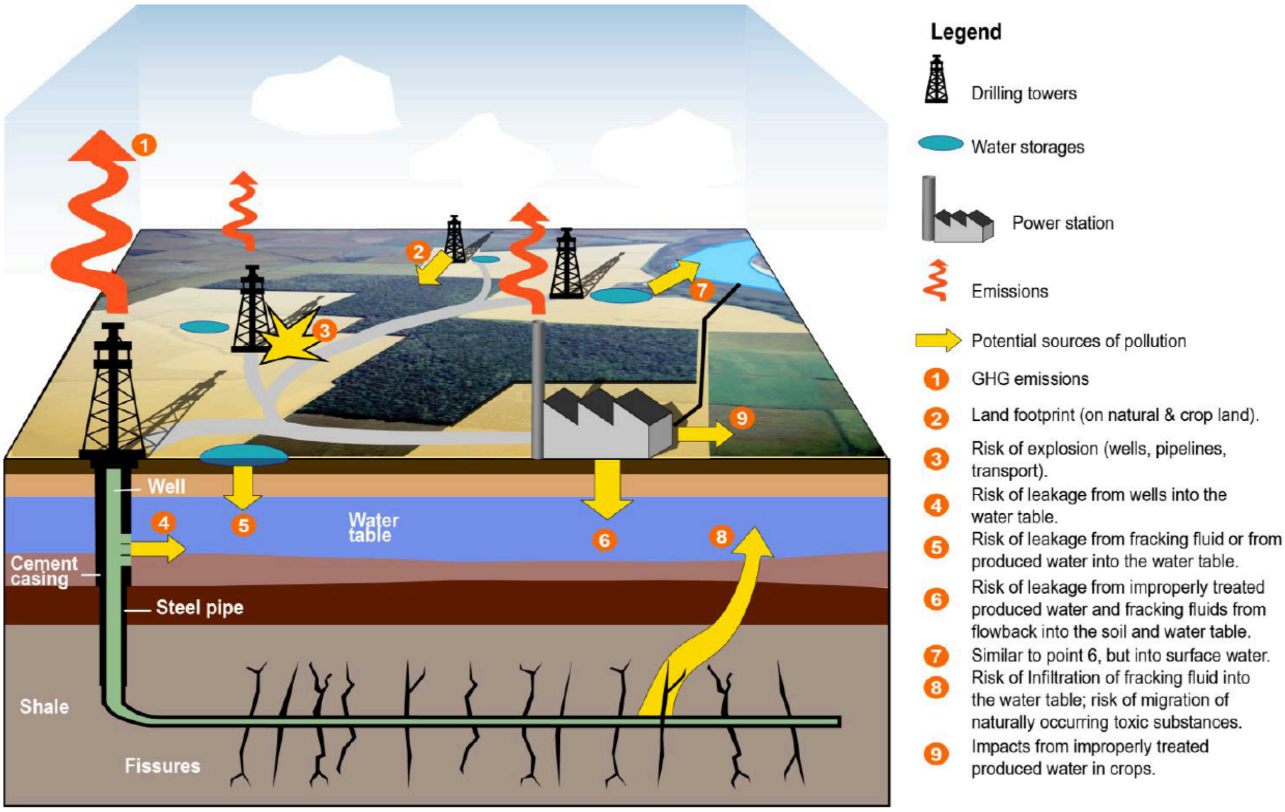

Figure 4: Schematic representation of infrastructures and potential impacts. Source: UNEP/GRID-Geneva, 2012.

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ILLUSTRATION FROM UNITED NATI0NS ENVIRONMENT PROGRAMME   GLOBAL ENVIRONMENTAL ALERT SERVICE

INTRODUCTION

I wish to thank the Western Australian Independent Scientific Panel for the opportunity to put in a submission in regard to the Inquiry into Hydraulic Fracture Stimulation in Western Australia. Currently, I am serving as the only agricultural advocate on the Round Table for Oil and Gas in South Australia, which, in reality, is a national round table consisting of petroleum executives, associated industries connected with the petroleum industry, and state government. Various attendees also fly in from overseas to attend.

I had input into the Roadmap for Unconventional Gas Projects in South Australia – my name is included in the hard copy of this book, which confirms this. I also served on the national Round Table for Health and Energy Policy in Canberra in February, 2013 (the only South Australian represented on this Round Table). I also was joint winner for the Jill Hudson state award in 2013, for my work on environment. As well as the two Round Tables, I have attended or presented to many meetings, conferences and lectures at state and local level, including government. My involvement at all levels, including United Nations, has given me a depth of knowledge and understanding in the area of hydraulic fracture stimulation. My concerns are for food sustainability, accessibility to clean water, and health issues.

I will not attempt to go into Western Australian legislation as I am not an expert. However, as far as South Australia, I am well versed in legislation and regulations. As each state differs, I believe there are others that are best to cover Western Australian legislation in a more expert manner. The case I present is to show that hydraulic fracture stimulation cannot be done with adequate safety or zero risk.

As far as risks to ground water, that I am very well informed on, having attended lectures, meetings and conferences in these areas. I regularly attend lectures at the National Centre for Groundwater Research and Training. http://www.groundwater.com.au Although I do not have a degree in hydrology, I have the respect of hydrologists, because of the knowledge I have gained.

SUBMITTED BY:
Anne Elizabeth Daw
[redacted]

SUMMARY:

Government at all levels in Australia, including Western Australia, must take responsibility for prioritising the needs for food and clean water now and in the future to sustain the predicted population growth. This includes updating laws to protect our potable water and sustainable agricultural areas. Geological science, I believe, has not been taken into account across the board.

There is clearly a conflict of interest in regard to Petroleum resources and agricultural land, as well as Aboriginal land.

Both conventional wells and wells that have hydraulic fracture stimulation may go down over 4 km through fault lines, bringing up toxic saline water and drilling muds, causing toxic diesel and poisonous rotten egg smell odours, creating noise 24 hours a day, and light pollution at night, all of which disturbed neighbours in the vicinity of the drilling platform. Most gas is sourced where there are fault lines, which present huge risks in themselves.

There have been well over 400 scientifically peer-reviewed papers published in regard to hydraulic fracturing stimulation activities, with nothing stating that this is a safe process. Please be aware any drilling through geological formations and aquifers is not safe, including conventional wells. All provide contaminant pathways into aquifers.

Long-term impacts must be taken into account. In relation to aboriginal heritage protection and other land use (mining or gas) if negotiated agreements do not succeed, the government makes the final decision over-ruling the indigenous decision.

'Golden Rules for a Golden Age of Gas' is included as a link in the Roadmap for Unconventional Gas Projects. The book was written by the Petroluem Industry at an international level, including Australia. Admissible evidence from within the industry is included in the book with concerns of environmental problems, including green house gases, chemicals, contamination, dropping water aquifer levels and geology challenges. Petroleum companies are asked to properly survey the geology of the area to make smart decisions about where to drill and where to hydraulically fracture and **assess the risk that deep faults or other geological features could generate earthquakes or permit fluids to pass between geological strata.** The book states that releases of methane, wherever they occur in the gas supply chain, are particularly damaging, given its potency as a greenhouse gas. **Unconventional gas production can result in higher airborne emissions of methane, a potent greenhouse gas, of volatile organic compounds (VOCs) that contribute to smog formation, and of carbon dioxide.**

The scale of the industrial operation for unconventional gas and environmental footprint is **much larger** than for conventional gas and the industry states it is **more invasive.** There **is the need for more wells, and that unconventional fields might need more than one well per square kilometer.** The associated use and release of water **gives rise to a number of environmental concerns, including depletion of freshwater resources and possible contamination of surface water and aquifers.**

The industry admits that shale gas wells typically exhibit a burst of initial production and then a steep decline, followed by a long period of relatively low production. Output typically **declines by between 50% and 75% in the first year.** The extraction of water for drilling and hydraulic fracturing can have broad and **serious environmental effects,** lowering **the water-table, affecting biodiversity and harming the local ecosystem.** It can also reduce the availability of water for use by local communities and in other productive activities, such as **agriculture.**

Water contamination occurs through spills of **drilling fluids, fracturing fluids, water and produced water, hydrocarbons and solid waste** at the surface as well as leakage of **fracturing fluids, saline water from deeper zones or hydrocarbons into a shallow aquifer through imperfect sealing of the cement column around the casing.**

Leakage of hydrocarbons or chemicals into to shallow aquifers through the rock and discharge of insufficiently treated waste-water into groundwater or, even, deep underground is mentioned.

Methane escapes through venting and incomplete burning, leaks in pipelines, valves or seals. This may be the result of corrosion or faulty equipment. NO WELL CAN BE GUARANTEED 100% WELL INTEGRITY. Pipelines, well isolation

and pressurized tanks have erupted.

The above excerpts from 'Golden Rules for a Golden Age of Gas' clearly shows the industry's own admissions of the serious issues and impacts as the result of the gas industry and hydraulic fracture stimulation. The fact that landowners have no rights to refuse petroleum tenure holders on their own land is abhorrent. This should be questioned in an international court of law in reference to **Resolution 64/292**, of the United Nations General Assembly, that explicitly recognizes the human right to water and sanitation and acknowledging that clean drinking water and sanitation are essential to the realisation of all human rights.

If there is drilling through limestone, which may be brittle and porous, impacts are exacerbated. Limestone is prone to subsidence and sinkholes and exacerbated by mining, drilling and hydraulic fracture

EVERY ACT IN AUSTRALIA GOVERNING MINING AND PETROLEUM ACTIVITIES SHOULD BE AMENDED AND HAVE FOLLOWING WORDS INSERTED:

Where there is limestone (prone to subsidence and sinkholes and exacerbated by mining, drilling and hydraulic fracture stimulation), OR where there are faults and fault-lines OR where there is a risk of seawater intrusion, then this agricultural land shall be exempt from all mining and petroleum exploration and projects.

ECOCIDE

Ecocide is a legal term meaning the extensive damage to, destruction of or loss of ecosystem(s) of a given territory, whether by human agency or by other causes, to such an extent that peaceful enjoyment by the inhabitants of that territory has been or will be severely diminished. This is how many people view the possibility of hydraulic fracture stimulation in the Kimberley area. I recommend, to the Independent Scientific Panel, based on reliable evidence in my submission, that hydraulic fracture stimulation in any area of Western Australia be banned.

RESPONSIBILILTY FOR IMPROVED GOVERNANCE IN A WORLD OF INCREASING POPULATION

According to the UNESCO MEDIUM TERM STRATEGY 2014 – 2021, page 7 – Since 1945 the world's population has tripled. There are now 7 billion inhabitants. There is intensifying urbanization, over–exploitation of natural resources, accelerating pollution and environmental degradation, and aging populations. Half the world's population is under 25 years of age, and set to rise 89.5% in 2025. This is a sobering thought. **"**The world is now reaching its biophysical limits. The current scales of unprecedented exploitation of our natural resources calls for improved governance and stewardship of the world's natural resources."

http://unesdoc.unesco.org/images/0022/002278/227860e.pdf

Government at all levels in Australia must take responsibility for a vision for the future, to meet the needs for food and clean water to sustain the predicted population growth. This includes updating laws to protect our potable water and sustainable agricultural areas. How do the current laws in Western Australia address future needs? Legislation needs to be up-dated in most states to protect our agricultural land. Geological science has not been taken into account seriously, across the board, as it has largely been ignored.

FOOD SECURITY AND NATURAL DISASTERS

According to the Queensland University of Technology National Climate Change Adaption Research Facility, Urban Food Security, Urban Resilience and Climate Change:

> "Food security is increasingly recognised as a problem in developed countries like Australia …. Moreover, whole urban populations have found their food supply lines severely compromised by major disasters such as floods and cyclones which are expected to have greater impacts as the climate changes."

INSTITUTIONAL FAILURE IN SOUTH AUSTRALIA

I believe that there is clearly institutional failure in respect to current legislation for high yielding agricultural land and petroleum activities. This is at all levels – Commonwealth, State, and Local Government.

DECLINING RAINFALL, AQUIFER LEVELS AND HEALTH

Declining rainfall and declining aquifer levels should be taken into account. So should the **health aspects,** as far as serious impacts as the result of **both conventional and unconventional gas production, both of which may have hydraulic fracture stimulation. This adds a burden on the Australian economy and will continue to burden the economy as gas projects increase.**

NEED FOR OVERHAUL OF LEGISLATION REGARDING RIGHTS OF LANDHOLDERS

Currently, there appears to be lack of genuine care around Australia for other stakeholders in the region. Long range development plans need to be put in place for preservation of high yielding agricultural land and potable water, as well as areas of environmental significance.

One area that needs to have the spotlight on is in regard to the protection of farm animals from the impacts of hydraulic fracture stimulation and petroleum activities. When farmers and graziers sell their stock in Australia they are already required to fill out and sign **the Livestock Production Assurance National Vendors Declaration (LPA NVD), accompanied by the National Animal Health Statement**. The LPA NVD is the main document behind the livestock food safety reputation for Australia. It also shows movement of stock i.e. to processors, sale yards or between properties. Any contamination is required to be stated on the NVD.

Farmers are required to fill out the National Vendors Declaration and Livestock Production Assurance Program to state that there is no stock contamination. If gas activities cause contamination, the farmers cannot move or sell their stock. This affects our clean & green image and our export markets. This would include the organic sector.

INSURANCE FOR PROPERTIES IN A GAS FIELD

An insurance company specialist from the Sydney area investigated ALL insurance options internationally and found that there is not one insurer prepared to cover ANY form of future risk environmental liability anywhere in the world.

WHAT HAS BEEN FOUND IN WASTE WATER IN THE SE OF SOUTH AUSTRALIA

The analysis of the Jolly 1 holding pond testing data has showed that the waste water was **half to three quarters as salty as seawater with high levels of potassium and virtually no calcium and magnesium.** There were **elevated levels of metals above the recommended drinking water guidelines for arsenic, barium, chromium, manganese, nickel and lead. The water also contains trace amounts of organic substances including phenol, phenanthrene, fluroanthrene, pyrene and chrysene**. Many of these substances and all of the metals are persistent pollutants and some are **known to cause cancer as well as other human health effects. The amount of Barium is 20 times the recommended amount, high levels of barium can cause low potassium, increasing risk of heart arrhythmias and death in some people**. **Page 2 of the analysis report of the Jolly 1 waste-water pond sample states that there was a poor matrix spike recovery (see Water topic for explanation) due to the presence of high contaminants.**

UNITED NATIONS

On 28 July 2010, through **Resolution 64/292**, the United Nations General Assembly explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realisation of all human rights. The Resolution calls upon States and international organisations to provide financial resources, help capacity-building and technology transfer to help countries, in particular developing countries, to provide safe, clean, accessible and affordable drinking water and sanitation for all.'

VALID CONCERNS IN WESTERN AUSTRALIA

Valid community concerns exist in WESTERN AUSTRALIA in regard to social, environmental, economic, water security, sustainable food bowl, local, national and international export markets, and tourism. People are concerned with demographic changes, associated strain on community services, loss of lifestyle as they now know it, and insecurity regarding their futures. Impacts on landscape, triggering of earthquakes, seawater intrusion and the fact that much of Western Australia has limestone with a number of caves, fault lines, sinkholes and subsidence all present a huge problem which cannot be solved. Limestone subsidence and sinkhole formation are hastened by unconventional gas activities, both through stimulation of earthquakes, and the weight of heavy machinery and ponds. Infrastructure such as roads and bridges are put at risk. Subsidence in Gippsland, Victoria has been blamed in part on oil and gas extraction, particularly along the coast. This results in loss of landscape.

Health risks arising from dust, (sand proppant causes silicosis), contaminated water, soil and air as the result of heavy metals, radionuclides, volatile organic compounds, methane and other pollutants

SCIENTIFICALLY PEER REVIEWED PAPERS SHOW NOTHING GOOD ABOUT HYDRAULIC FRACTURE STIMULATION

As the community has become more informed with reliable, peer-reviewed evidence, regarding the impacts on hydraulic fracture stimulation, well-founded concerns have grown. The Western Australian community wants proof that any type of gas extraction, including the hydraulic fracture stimulation process is 100% safe. That guarantee cannot be given, based on substantial and reliable evidence. For DSD or any government minister to state that there are no or few problems in the petroleum industry is simply a myth. **As stated there have been over 400 scientifically peer-reviewed papers published in regard to hydraulic fracturing stimulation activities, with nothing stating that this is a safe process.** In fact, quite the opposite was found. These findings should never be discounted. Please see the following site under the heading of 'Documentation'.

http://concernedhealthny.org/health-professionals-scientists-release-analysis-of-400-peer-reviewed-studies-on-fracking-along-with-major-scientific-compendium-update-new-analysis-and-science-answer-governor-cuomos-conce/

"96% of all papers published on health impacts indicate potential risks or adverse health outcomes.
87% of original research studies published on health outcomes indicate potential risks or adverse health outcomes.
95% of all original research studies on air quality indicate elevated concentrations of air pollutants.
72% of original research studies on water quality indicate potential, positive association, or actual incidence of water contamination. There is an ongoing expansion in the number of peer-reviewed publications on the impacts of shale and tight gas development: approximately **73% of all available scientific peer-reviewed papers have been published in the past 24 months, (2014) with a current average of one paper published each day."**

UNCERTAINTY OF GROUND WATER MODELLING AND PUMPING.

I attend presentations when I can at the National Groundwater Centre for Research and Training, which is based in Adelaide and headed up by Professor Craig Simmons. Professor Simmons won South Australian Scientist of the Year in 2015.

6 hydrologists took part recently in one presentation on the uncertainty of groundwater modelling and groundwater pumping. This presents key issues. Modelists cannot provide certainty. There is groundwater uncertainty because of allocation, demand, use, eflows and other management initiatives. We don't know what emissions are going to do because of climate change. Rainfall predictions will all be wrong in some way. Actual future climate, aquifer recharge, pumping, etc. will differ from scenarios. Traditional guidelines are not the best starting point. We don't know what is going to happen in the future.

There are an infinite number of prediction scenarios that could be run in relation to pumping tests, recharge, etc. Pumping rates also change over time. Changes in recharge and pumping regimes could invalidate model predictions. The question is asked, how well did the model predict the drought three years later? Models assume wrongly that pumping is going to be the same for the next 30 years. Clients are now asking more complex questions. **Wrong modelling impacts economic and ecological areas. There is no capacity to deal with uncertainty.** The amount of recharge in aquifers continues to change. The chance of three average years of weather conditions including rainfall, occurring in a row, is very low. Modellers should be quantifying how much their predictions may be wrong.

One of my questions on this is how often modelling takes into account the possibility of earthquakes, which also impacts contamination pathways for aquifers, and further vertical leakage, resulting in the change of water levels in the aquifers. We only have to look at the methane bubbling in the Condamine River, which has been well publicised. What most people don't understand, is that the methane bubbling up was not caused by hydraulic fracture stimulation, but in fact was caused by depressurisation due to dewatering of the coal seam. This in turn impacted the faults because of the changes underground, triggering the small fault line in the base of the Condamine River. Anyone who advocates against hydraulic fracture stimulation but thinks even conventional gas wells are fine for the South East, clearly shows lack of knowledge on both geology and water, and has not done any reading or research on this.

Both conventional, unconventional and exploration drill holes penetrate geological formations and aquifers, including faults. Unfortunately, we do not know what damage has been done, other than what I have presented in my original submission, as no base levels were taken that I am aware of (even if they had been, it would be safe to presume the tests would not have been exhaustive and not included testing for all possible contaminants as was the case for Beach Energy testing which I will go into.) Wells and drill holes are meant to be decommissioned (there would be a number, it would be safe to say, based on the Kingston SE lignite 950 drill holes that haven't been) with cement plugs, the cement and casings break down, and as all of this is underground, we have no way of knowing what detrimental affects have already been or will occur.

Hydraulic fracture stimulation requires large volumes of water. Going deeper into saline aquifers that would even be more toxic, to use this water, is not the answer and should not be risked. Bringing this water to the surface for this use would be extremely risky, through surface spills, overflowing of pond water through large amounts of rain and flooding, and also with loss of integrity of the drill hole, contaminate pathways of allowing this toxic and saline water to escape, would be a further issue. This factor is such a huge factor to be taken into account just on its own merit, therefore as no modelling can be done with any accuracy, no further petroleum activities should be allowed in Western Australia.

All aquifers and bodies of water are usually interconnected, including confined aquifers, as there are breaches in the aquifer walls. Aquifers that are already under significant stress and should not be put under further stress as the result of allowing unconventional gas projects to go ahead.

TESTIMONIES OF IMPACTED NEIGHBOURS DURING THE DRILLING OF JOLLY 1 IN THE SE OF SOUTH AUSTRALIA

Other concerns that have been voiced in the South East are noise pollution, the smell of what seemed to be hydrogen sulfide (rotten egg smell) and the smell of diesel, all of which was experienced by residents around Jolly 1 exploration drilling. I also witnessed the smell of diesel and the noise from the road, myself**. These same residents were not notified that there was going to be unconventional gas exploration in their area.** Please see attached letter. One neighbour, whose fence was around 3 metres from the waste-water holding pond, and a few more metres from the drilling rig, was not aware of what was going on until the rig platform was built. This was mentioned publically at Penola at the public SELGA meeting. Beach Energy Ltd., I understand, visited the landowner afterwards, in regard to this incident. Another neighbour living around 1 km had no idea what was going on. He noticed around Christmas, 2013, that a road, drill pad and camp were being installed. The family suffered from light pollution at night, as well as noise, the smell of diesel and the rotten egg smell. The family noticed formerly placid cows were stirred up easily, after the exploration project began. One of the concerns regarding animals being within the gas exploration/ production area experiencing agitation was potential loss of milk, as well as exposure to contaminants. The cows went to the other end of the paddock particularly when the odour pollution persisted for several days from the drilling muds that had been returned to the surface.

FRACKING SCHOOL – (THE CENTRE FOR ONSHORE PETROLEUM EXCELLENCE)

I have toured 'Fracking school' – the Onshore Petroleum Centre of Excellence, based in Adelaide, during an excursion with the Round Table for Oil and Gas Projects in SA (formerly known as the Round Table for Unconventional Gas Projects in SA). People who are connected in any way to the Petroleum industry, especially in regard to hydraulic fracture stimulation in Australia, come to Adelaide for training and certification. One of the heads admitted to me that hydrogen sulphide and anaerobic bacteria are the industry's biggest problem, and they cause corrosion and breakdown of the cement and casings. He had assumed I was with the government, and when I told him I was an agricultural advocate, he looked less than happy that he had revealed this information to me. This conclusively confirms that no one can guarantee well integrity in both the short-term future and long term, long after the Petroleum companies have left the production/exploration areas.

Anne Daw attended 'fracking school', 2015 with Round Table for Oil & Gas Projects in South Australia.

The following information is from "MICROBES – OILFIELD ENEMIES OR ALLIES." (Oilfield Review Summer 2012, 24 no. 2), published by Schlumberger. Although under 'oilfield', I understand the same applies for any petroleum activities. Bacteria and Archaea (a type of microorganism) form that are known as prokaryotes. Microbes are always present during exploration and production. They live in extreme conditions and produce hydrogen sulphide. **The prokaryotes can remain dormant for 1000's of years, but can reactivate rapidly in days or weeks**. Some microbes are indigenous to reservoirs while others may be introduced during drilling, workover or water injection. (According to Oil Voice, work over is "*Re-entry into a completed field well for modification or repair. Restoring well productivity by cleaning out accumulations of sand, silt or other substances that clog production tubing.")* These single-cell life forms have an innate tendency to cling to rock and metal surfaces and assemble into masses called biofilms, which provide a safe harbor and growth and may eventually lead to serious problems in both equipment and reservoirs. Microbiologically Influenced Corrosion (MIC) can occur anywhere during the production environment in downhole tubulars, topside equipment and in pipelines. **What is of concern is the fact that as these microbes can recover, and what exactly may have been spread on the agricultural land or even will become reactivated after time!** This type of corrosion can cause ruptures that seriously impede operations. Biocides are used and only kill a portion of the microbe population, but microbe survivors may recover between doses.

http://www.slb.com/~/media/Files/resources/oilfield_review/ors12/sum12/1_microbes.pdf

JOLLY 1 WASTE WATER HOLDING POND ANALYSIS IN SE OF SA – likely to apply in Western Australia

The exploration well at Penola (Jolly 1) produced about 1,000,000 litres of highly saline water and this has been stored in holding ponds at the well site. Water quality testing data has shown that this water is **half to three quarters as salty as seawater with high levels of potassium and virtually no calcium and magnesium.** There are **elevated levels of metals above the recommended drinking water guidelines for arsenic, barium, chromium, manganese, nickel and lead. The water also contains trace amounts of organic substances including phenol, phenanthrene, fluroanthrene, pyrene and chrysene**. Many of these substances and all of the metals are persistent pollutants and some are **known to cause cancer as well as other human health effects.**
The amount of Barium is 20 times recommended amount, high levels of barium can cause low potassium, increasing risk of heart arrhythmias and death in some people. **Page 2 of the analysis report states that there was a poor matrix spike recovery <u>due to the presence of high contaminants.</u>**

Page : 2 of 7
Work Order : EM1404169
Client : BEACH ENERGY LIMITED
Project : Jolly

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In I developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG035T: Sample EM1404169 #1 and #2 has been diluted for mercury analysis due to sample matrix. LOR's have been raised accordingly.**
- **EP071: Poor matrix spike recovery due to sample (EM1404169_001) heterogeneity. Insufficient sample remains to confirm by re-extraction and re-analysis.**
- **EP071: Sample (EM1404169_001,002) shows poor duplicate precision due to sample heterogeneity. Insufficient sample remains to confirm by re-extraction and re-analysis.**
- **EP075(SIM): Sample EM1404169-002 shows poor matrix spike recovery due to the presence of high level contaminants.**
- **Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.**

Page 2 of Jolly 1 wastewater analysis – 2nd from bottom – presence of high-level contaminants

WHAT HAPPENED IN NEW ZEALAND WHEN DRILLING MUDS WERE LAND FARMED

In the Taranaki area of New Zealand, where fracture stimulation is taking place on prime agricultural land, a process called 'land farming' of oil and gas-drilling waste is spread across farming land where it is covered and pastured. It was costing Fonterra $80,000 per year to test the milk from these areas for contaminants. Fonterra no longer accept milk from these areas.

http://www.stuff.co.nz/taranaki-daily-news/business/8817459/Fonterra-to-halt-future-landfarm-collections

NO ACCEPTABLE ANSWER FOR TOXIC DRILLING MUDS AND WASTE WATER

Injection wells are also a major problem. Hence, what do they do with the disposal of drilling muds and waste - water in Western Australia. This illustrates the point that drilling muds and waste - water should not be disposed of through re-injection, nor should the waste water with high saline levels be used to be sprayed on agricultural land or roads. Casings and cement also break down over time, so there is simply no way to dispose of drilling muds or waste - water in any acceptable manner. Spills or leaks can also occur during mixing and storage of the water and flowback, transportation, overflowing waste water ponds, damaged plastic liners that break down in less than 4 years e.g. Salamander 1 in the SE of SA. Between 2008 and 2010, there were 1435 violations served to Marcellus Shale gas drillers, including 952 that were considered 'likely' to be detrimental to the environment. (Gilliland 2012)

http://na.unep.net/geas/archive/pdfs/GEAS_Nov2012_Fracking.pdf

DRILLING WASTE

The **American Petroleum Institute (API)** estimates that approximately 1.21 barrels of total drilling waste are generated for every foot drilled in the United States. Of this total drilling waste, nearly 50% is solid drilling waste. The accumulated volume of solid drilling waste generated yearly is approximately 139,961,305 barrels, which is equivalent to 29,097,984 cubic yards of solid drilling waste -- enough generated waste to fill almost 9000 Olympic swimming pools. This is a sobering thought, considering that people were initially told in USA that there would only be a few drill pads. http://www.oilandgasbmps.org/resources/solidwaste.php

RADIONUCLIDES

Shale may contain very high levels of Radioactive Radium 226. Once removed from its source deep within the earth and exposed to water and air, radium decays rapidly, becoming radon gas. Radium 226 is over one million times more radioactive than the same mass of uranium and has a half- life of 1600 years.

CLEANING UP LARGE CONTAMINATION IN AQUIFERS MAY BE AN IMPOSSIBLE – EPA AT PENOLA MEETING

The question of cleaning up aquifers was raised at a public meeting in Penola in South Australia in April 2014. As recalled, the EPA representative admitted that small contaminations can be cleaned up, but not large contaminated areas. What was perplexing was the explanation of how contamination of aquifers was dealt with. According to the EPA representative, as recalled by attendees, the water and contamination is pumped out of the aquifer. **The question is, what is then done to dispose of the contaminated water once at the surface? Even with the water being treated, there is always a second lot of residue water in a concentrated form that will always remain. The same would apply in Western Australia.**

ROTTEN EGG SMELL COMING FROM AREA OF JOLLY 1 WELL IN SOUTH AUSTRALIA

During the drilling of Jolly 1 well near Penola, there was a strong rotten egg smell coming from the holding pond and extending across the paddocks of the property next to the drilling rig. The holding pond was located about 3 metres from the neighbour's fence. DMITRE said it was from polymers. Upon further investigation it appears that the answer given was not logical, and more than likely it was stemming from hydrogen sulfide.

WATER SPREAD ON AGRICULTURAL LAND, AND MANY TESTS FOR POSSIBLE CONTAMINENTS NOT DONE FOR BEACH ENERGY BY ASL LABORATORY

I am including the following information, as I would expect similar results in some areas of Western Australia. The holding ponds waste-water has been irrigated on agricultural land in the area. This is absurd, given the holding ponds analysis, as explained earlier, showed high salinity and other contaminants. Farmers in the South East were been lead to believe that the waste water from the Jolly 1 well was meant to be an acceptable procedure. "Irrigation" is to supply the land with water. Whether it is a once off, or done more than that, the fact is, waste-

water has been spread or "irrigated" over 3 properties in the SE as a means of disposal. This procedure was, in my opinion, not properly addressed in the operator's Environmental Impact Report that was approved by the regulator. The excuse of 'fertiliser', when facts are clearly assessed, is, in my opinion, unacceptable. From my extensive research, it is clear to see that the waste-water should not have been spread on the 3 areas in the South East for disposal. What social license to 'aid and abett' the spread of surficial salinity (air current aerosols) up and down an agriculturally fragile catchment, did the landowners have? What does Western Australia plan?

SODIUM ADSORBTION RATIO

The sodium adsorbtion ratio in the waste-water analysis was 238, which is very high and would literally hammer the soil. According to a Western Australian Government site (appendix 1), the most tolerant plants for agriculture are at 102 maximum level. Clover (pasture) is between 18 and 46.

ACCEPTABLE AND NON ACCEPTABLE LEVELS FOR µS/cm (micro Siemens per cm) (salinity measurement)

Jolly One analysis for waste-water was 31,700 µS/cm and 20,600 TDS. (appendix 1) Yet here, we can do a comparison with Dr. Ian Wilson's statement - (when he was with the Department of Environment and Resource Management in Queensland). He is well qualified to make correct comments.

https://www.linkedin.com/in/ian-wilson-1154647a

Prior to the role of Director of the EPA in Queensland., he was Principal Geologist with the Department of Mines in Queensland. Wilson states that The beneficial use Guideline would not allow water containing more than about 1000 mg/L to be used for irrigation ("irrigation water shall not exceed 1,500 µS/cm'') And yet, the reading for the waste water is 31,700 µS cm. This is 20 x the recommended limit for irrigation. On the Victorian government site (appendix 1): 3000 µS/cm is considered not suitable for human consumption. Some stock can use up to 10,000 µS/cm. Again the pond water was 3 x this. Over 10,000 µS/cm is not suitable for irrigation at all.

BORON LEVELS

Boron level from the waste-water of Jolly 1 is .33 mg/L. In the NATIONAL WATER QUALITY MANAGEMENT STRATEGY PAPER No. 4 Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3 Primary Industries — Rationale and Background Information (Irrigation and general water uses, stock drinking water, aquaculture and human consumers of aquatic foods) (Chapter 9), the long term trigger value in irrigation water is .5mg/L. The cumulative contaminant loading in soil receiving irrigation water has not yet been determined, which is of concern. It is toxic to all plants when present in excess. High boron concentrations in soils have been shown to cause plant toxicity in Northern Victoria.

DANGERS OF POLYNUCLEAR AROMATIC HYDROCARBONS

Please see the link from the South Australian Government site on the dangers of Polynuclear Aromatic Hydrocarbons.

http://www.health.sa.gov.au/pehs/PDF-files/ph-factsheet-PAHs-health.pdf

There was also heavy metals contamination in the Jolly 1 waste-water analysis. The levels are compared the Australian Drinking Water Recommended Guidelines. Of most concern are the following:

Arsenic should be .007	Jolly 1 (1) .024	(2) .064
Barium (20x over) should be .7	Jolly 1 (1) 14.5	(2) 9.65
Chromium should be .05	Jolly 1 (1) .614	(2) .07

Also the following are over the recommended level, but it depends on what the soil levels are, as to any impacts if they that may occur.

Manganese should be .5	Jolly 1 (1) .995	(2) 2.82

Nickel should be .02 Jolly 1 (1) .046 (2) .07

TESTINGS OMITTED IN THE JOLLY 1 HOLDING POND ANALYSIS

The following items, as far as I am aware, were not listed on the analysis done for Beach Energy Ltd. The biggest problem the Petroleum industry has admitted it faces with corrosion – hydrogen sulfide and anaerobic bacteria. There is nothing to indicate on the Beach Energy analysis report to show the following items had been tested. Hydrocarbon utilizing bacteria, sulfate reducing bacteria, iron reducing bacteria, acid producing bacteria, de-nitrafying bacteria, a total anaerobic count, aluminium, antimony, bromine, fluorine, iron, tin, sulfur, sulfate, phosphorus, halogenated aliphatics, acetone, formaldehyde, the specific chemicals used in drilling the drill holes, hydrogen sulfide scavangers and defoamers. Please see a detailed list on the next page.

Solid wastes, cuttings, sludges, efflorescences, mineral and chemical dusts and powders (especially those that can be blown around by the wind), reaction products including flocs, polymers and precipitates all should be taken into account and tested. Gas and volatile wastes, fuel and chemical vapours, machinery particulate (from diesel that was easily detected by nose from the highway), noise levels, micro-seismic activity, cleaning, de-scaling, degreasing and other maintenance chemicals should be tested for. If any of these things were monitored or tested, then the results should be made public. There was certainly no monitoring over the neighbour's fence, when I inspected the rig and waste-water pond at close range, and there was an absence of 'foghorn' noise measuring devices.

Solid, liquid and gaseous phases of matter, as I understand, co-exist and interact. Slurry or sludge comprises water, suspended solid particulates, organic matter and dissolved gases also may be present. The atmosphere may entrain (pull or draw along after itself), dusts and condensates. As I understand, a 'holistic' environmental survey of any one environmental compartment will involve assaying solid, liquid and gaseous species. **In the very least, there should have been the necessity of a 'frame of reference' via duplicated, repeated, testing of uncontaminated, off-site groundwater bore waters.**

Other possible contaminants that I was unable to find in the ASL waste-water analysis are as follows. (THIS LIST IS NOT EXHAUSTIVE)

THE INCLUSIVITY OF THIS LIST OF CHEMICALS IS IN PART DUE TO:

a. coal chemistry (coal in SE http://www.ga.gov.au/data-pubs/data-and-publications-search/publications/australian-minerals-resource-assessment/coal)
b. natural organic and inorganic hydrogeochemistry and microbiology at depth
c. natural organic and inorganic hydrogeochemistry and microbiology on or near the Earth's surface (the oxygen interface)
d. the variety of chemical species introduced to aid gas extraction (esp. in drilling and fracking), and the variety of reaction and synthesised products resulting from same.
e. the various proposed usages of the co-produced fluids (eg. surface-spreading; release into waterways; water treatment; irrigation; domestic; ...).
f. the organic and microbiological chemistry resultant of water treatment (eg. the introduced chemicals, heat and pressures of RO process chains)]

SURFACE SOLIDS AND LIQUIDS (SOME ARE AIR AS WELL)

Given threshold changes in temperature, pressure, chemical conditions and chemical concentrations, there is often a continuum in nature between solid, liquid and gaseous states of matter. E.g. formerly hydrostatically retained hydrocarbons and noble gases diffusing into the atmosphere; precipitants; condensates; VOCs; etc.]
Halogenated (esp. chlorinated) C2, C12 alkanes and alkenes
Monocyclic aromatic compounds.
Halogenated (esp. chlorinated) monocyclic aromatic compounds
Heterocyclic aromatic compounds
Alcohols
Diols
Aldehydes

Aldenhydes
Carboxylic Acids
Esters
Ethers
Ketones and cyclic kentones
Organo-sulphur compounds
Organo-nitrogen compounds (e.g. CS_2, simple thiols)
Organo-metal compounds
Terpenes
Regulated solid chemical waste suite

MICROBIAL OUTBREAK, HUMAN AND ANIMAL HEALTH, BOTANICAL IMPACT

Corrosion inhibitors
Friction Reducers
Microbial
Biocides – these were used on drilling muds to stop the rotten egg smell for Jolly 1. Bacteriacides
Dusts and respirable suspended particles - WHAT DUST MONITORING WAS PUT IN PLACE FOR THE NEIGHBOUR'S PADDOCK OVER THE FENCE? I DID NOT SEE ANY SIGN OF ANY MONITORING DEVICE WHEN I DID AN INSPECTION.

GENERAL

Total Cyanide
Total Dissolved Solids
Total Suspended Solids
(Prefiltered total metal)
(Unfiltered total metal)
Total Cations
Total Anions
Ionic Balance

CARBON

Total Carbon
Total Inorganic Carbon
Total Organic Carbon
Dissolved Organic Carbon
Dissolved CO_2
Free CO_2
Total CO_2
Hydrocarbon fractions
Volatile acids as acetic acid

OXYGEN

Dissolved Oxygen
Biological Oxygen Demand
Chemical Oxygen Demand
Ozone

INORGANIC CHEMISTRY

Ferrous
Ferric
Arsenic III and arsenic V

Ammonium
Hydroxyammonium
Nitrate
Nitrite
Cyanate
Thiocyanate
Sulphide
Sulphite
Bisulphate
Thiosulphate
Persulphate
Borate
Flouride
Iodide
Bromide
Bromate
Reactive phosphorus (ortho-phosphorus)
Aluminium
Antimony
Bismuth
Gallium
Indium
Iron
Lithium
Molybdenum
Nickel
Rubidium
Silver
Sulphur
Tellurium
Tin
Titanium
Caesium
Carbon (Carbon -12, Carbon – 13)
Hydrogen (Protium, Deuterium)
Helium
Ozone
Bromine
Phosphorus
Carbon Monoxide
Carbon dioxide
Nitrous Oxide
Nitrogen monoxide
Nitrogen dioxide
Hydrazine (diazane)
Hydrogen sulphide
Disulphur monoxide
Sulphur monoxide
Sulphur Dioxide
Hydrogen halides

ALKANES

Methane
Ethane
Propane

2-Methylpropane
Butane
2-Methylbutane
2,2-Dimethylbutane
2,3-Dimethylbutane
Pentane
2-Methylpentane
3-Methylpentane
2,3-Dimethylpentane
2,4-Dimethylpentane
2,2,4-Trimethylpentane
2,3,4-Trimethylpentane
Hexane
2-Methylhexane
3-Methylhexane
2,3-Dimethylhexane
Heptane
2-Methylheptane
3-Methylheptane
2,2,4,6,6-pentamethylheptane
Octane
2-Methyloctane
Nonane
Decane
Undecane
Dodecane

CYCLOALKANES

Cyclopentane
Cyclohexane
Methylcyclopentane
Methylcyclohexane

HALOGENATED ALKANES

Chloromethane
Dichloromethane
Chloroform
Chlorodifluoromethane
Dichlorofluoromethane
Dichlorodifluoromethane
Trichlorofluoromethane
Carbon tetrachloride
Bromomethane
Bromochloromethane
Bromodichloromethane
Dibromomethane
Dibromochloromethane
Bromoform
Chloroethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,1,2-Tetrachloroethane

1,1,2,2-Tetrachloroethane
1,2-Dichloro-1,1,2,2-tetrafluoroethane
1,1,2-Trichloro-1,2,2-trifluoroethane
1,2-Dibromoethane
1,2-Dichloropropane

ALKENES

Ethylene
Propene
1-Butene
cis-2-Butene
trans-2-Butene
Isobutylene
1-Pentene
trans-2-Pentene
cis-2-Pentene
1-Hexene
2,4-Dimethyl-1-hexene
2,3,3- Trimethyl- 1 – Pentene (Trimethyl pentene)

HALOGENATED ALKENES

Vinyl chloride
Vinyl bromide
1,1-Dichloroethylene
trans-1,2-Dichloroethylene
cis-1,2-Dichloroethylene
Trichloroethylene
Tetrachloroethylene
1,1-Dichloropropene
trans-1,3-Dichloropropene
cis-1,3-Dichloropropene
3-Chloropropene

ALKYNES

Acetylene

ALLENES, DIENES AND CUMULENES

1,3- Butadiene
3- Chloropropene
2- Chloroprene
Hexachlorobutadiene
2,4 Hexadiene
2-Methyl- 1,3 – pentadiene
1,3-Butadiene
2-Chloroprene
Hexachlorobutadiene
2-Methyl-1,3-butadiene

MONOCYCLIC AROMATIC COMPOUNDS

Styrene
Cumene

Propylbenzene
2-Ethyltoluene
3-Ethyltoluene
4-Ethyltoluene
1,2,3-Trimethylbenzene
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Cymene
Butylbenzene
sec-Butylbenzene
tert-Butylbenzene
1,3-Diethylbenzene
1,4-Diethylbenzene
Chlorobenzene
Benzyl chloride
2-Chlorotoluene
4-Chlorotoluene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
Bromobenzene

HETEROCYCLIC AROMATIC COMPOUNDS

2-Ethylfuran
Tetrahydrofuran
Benzothiazole
Phenylmaleic anhydride
Dioxins
2,3,7,8 - Tetrachlorodibenzo-p-dioxin
2,3,7,8 – Tetrachlorodibenzofuran
3,3', 4, 4', 5,5' – Hexachlorobiphenyl
1,4 – Dioxane

HALOGENATED AROMATIC COMPOUNDS

Chlorobenzene
Bromobenzene
1,2 – Dichlorobenzene
1,3 - - Dichlorobenzene
1,4 – Dichlorbenzene
1,2,3 – Trichlorbenzene
1-3-5 – Trichlorbenzene
1,2,3,4 – Tetrachlorbenzene
1,2,3,5 - Tetrachlorbenzene
1,2,4,5 - Tetrachlorbenzene
Pentachlorobenzene
Hexachlorobenzene
2 – Chlorotoluene
4 – Chlorotoluene
Benzyl chloride

PHENOLIC AND HALOGENATED PHENOLIC COMPOUNDS

2 – Methyl – 4.6 dinitrophenol
4 – tert- octylphenol
Dinoseb
2 – Cyclohexyl – 4 .6 Dinitrophenol

ALCOHOLS

Methanol
Ethanol
2 – Butoxyethanol (Ethylene glycol monobutyl ether)
Isopropanol
n-Propanol
Isobutanol
n-Butanol
tert-Butyl alcohol (TBA)
Hexanol (2-ethyl-1-hexanol
Methanol
Ethanol
Isopropyl alcohol
Isobutanol
tert-Butyl alcohol
1-Methoxy-2-propanol
Hexanol
2-Butoxyethanol

DIOLS

Methanediol
Ethane – 1,2 – diol (Ethylene glycol)
Propane – 1,2 – diolButane – 1, 4 – diol
Butane – 1, 4 diol
Bisphenol A (BPA)

ALDEHYDES

Formaldehyde (Methanal)
Acetaldehyde
Acrolein (Propenal)
Propionaldehyde
Crotonaldehyde
Butyraldehyde
Isovaleraldehyde
Hexaldehyde
Formaldehyde
Acetaldehyde
Acrolein
Propionaldehyde
Crotonaldehyde
Methacrolein
Butyraldehyde
Benzaldehyde
Isovaleraldehyde
Valeraldehyde
3-Methylbenzaldehyde
4-Methylbenzaldehyde
Hexaldehyde

CARBOXYLIC ACIDS

Formic acid
Acetic Acid
Monochloroacetic acid (MCA)
Dechloracetic acid (DCA)
Trichloracetic acid (TCA)
Monobromoacetic acid (MBA)
Dibromoacetic acid (DBA)
Trifluoroacetic acid
Oxalic acid
Pentanoic acid (Valeric acid)
Benzoic acid
Acrylic acid (prop-2enoic acid)Phthalic anhydride
Polyacrylic acid
Fumaric acid (trans-Butenedioic acid)

ACETATES

Ethyl acetate
Vinyl acetate
Butyl acetate
1-Methoxy-2-propyl acetate

ACYL CHLORIDES

Acetyl chloride
Carbonyl dichloride

ESTERS

Ethyl acetate
Vinyl acetate
Methyl methacrylate
Bis(2-ethylhexyl) phthalate
Polyacrylates

ETHERS

Ethylene oxide
Propylene oxide
Diethyl ether
1,4 – Dioxane
Methyl tert-butyl ether (MTBE)
Ethyl tert-butyl ether (ETBE)
Ethylene Glycol mono-Butyl Ether
Tert-Amyl methyl ether (TAME)
Tert-Amyl ethyl ether (TAEE)
Diisopropyl ether (DIPE)
2 – Chloroethyl Vinyl Ether
Oxirane
Propylene oxide
1,4-Dioxane
Methyl tert-butyl ether
Ethyl tert-butyl ether
tert-Amyl methyl ether

Di-isopropyl ether
2-Chloroethyl vinyl ether

KETONES AND CYCLIC KETONES

Acetone
Methyl ethyl ketone (2-Butanone) (MEK)
Methyl butyl ketone (2-Hexanone) (MBK)
Methyl isobutyl ketone (MIBK)
Acetophenone
Cyclopentanone
Cyclohexanone

ORGANO-SULPHUR COMPOUNDS

Carbonyl sulphide (OCS)
Carbon disulphide
Dimethyl sulphide (DMS)
Dimethyl disulphide (DMDS)
Polysulphides
Methanethiol (MeSH)
Ethanethiol
Methylthiobutane
Dimethyl sulphoxide (DMSO)
Dimethyl Sulphate
Thiophene (thiofuran)
2 – Methylthiophene
3 – Methylthiophene
Methyl methanesulphonate (MMS)
Ethyl methanesulponate (EMS)
Perfluorooctane sulphonate (PFOS)
Perfluorooctanoic acid (PFOA)
Thiourea
Carbonyl sulphide
Carbon disulphide
Dimethyl sulphide
Dimethyl sulphoxide
Methanethiol
Ethanethiol
1-Propanethiol
2-Propanethiol
Ethyl methyl sulphide
1-Butanethiol
Diethyl sulphide
Thiophenol

ORGANO-NITROGEN COMPOUNDS

Acetonitrile
Acrilonitrile
Acrylamide
Formamide (Methanamide)
Dimethyl formamide
Acrilonitrile
Diethanolamine (Bis(hydroxythyl)amine)
Nitrilotriacetic acid

N-Methyl-2-pyrrolidone
Nitroaromatics

MICROBES

Heterotroph counts
Blue-Green Algae
Hydrocarbon Utilising Bacteria (HUB)
Naphthalene Utilising Bacteria (NUB)
Methanogens
Methanotrophs
Sulphate-Reducing Bacteria (SRB)
Sulphur-Oxidising Bacteria (SOB)
Iron-Reducing Bacteria (IRB)
Iron-Oxidising Bacteria (IOB)
Acetate Utilising Bacteria
Methanol Utilising Bacteria
Formate Utilising Bacteria

BIOCIDES AND BACTERIACIDES

This next group are Biocides and Bacteriacides and would be dependent on what was used to overcome the rotten egg smell, so what ever was used out of these should have been tested to see if still present in the waste water.

Glutaraldehyde
Sodium hypochlorite
Phosphonium sulphae
Tetrakis hydoxymethyl phosphonium sulfate (THPS)
2 – Bromo – 2 – nitro – 1, 3 – propanediol (Bronopol)
2,2 – Dibromo – 3 – nitrilopropionamide (DBNPA)
5 – chloro – 2 – methyl – 2h- isothiazolol – 3 – one
2 – ethyl – 2h – isothiazol – 3 – one

If industry and Government had been doing their jobs correctly, these substances should have also been included to be tested in the first place. Not to do this, is no excuse for ignorance.

WESTERN AUSTRALIAN GOVT. SITE (SAR)

https://www.agric.wa.gov.au/fruit/water-salinity-and-plant-irrigation The direct toxic effects of sodium concentrations in irrigation water on different plants are shown in Table 1, which lists the effect of the sodium adsorption ratio (SAR) of the irrigation water. The SAR measures the relative percentage of sodium ions in water to calcium and magnesium ions. A high SAR indicates there is potential for sodium to accumulate in the soil. This can degrade soil structure by breaking down clay aggregates, which results in waterlogging and poor plant growth.

Table 1 Tolerance of crops to sodium Tolerance Sodium adsorption ratio of irrigation water.
Crops Very sensitive 2-8 Avocado, citrus, deciduous fruits and nuts
Sensitive 8-18 Beans Moderately tolerant 18-46 Clover, oats, tall fescue, rice
Tolerant 46-102 Barley, beets, lucerne, tomatoes, wheat

Salinity effect Plant roots generally take up moisture through membranes in root cells by osmosis. This is a natural process where water, passing through a semi-permeable membrane, moves from a solution of low levels of dissolved salts to one with higher salts. This continues until the plant cells become full. If the irrigation water is moderately saline, the plant has to work harder to absorb water from the soil and growth is slowed, with reduced yields. If highly saline irrigation water is used, the process of osmosis can reverse. Where the solution outside the plant roots is higher in salt concentration than that of the root cells, water will move from the roots into the surrounding solution. The plant loses moisture and suffers stress. This is why symptoms of high salt damage are

similar to those of high moisture stress.

Toxicity effect Excessive concentrations of sodium and chloride ions in irrigation water can cause toxicities in plants. These ions can be taken up either by the roots or by direct contact on the leaves. More damage is caused by direct absorption through the leaves.

UNITED STATES ENVIRONMENTAL PROTECTION AUTHORITY TAKEN TO TASK FOR DISMISSING EVIDENCE.

The U.S. Environmental Protection Agency Science Advisory Board (SAB) has finalized its review of the EPA's June 2015 draft study of fracking's impacts to drinking water resources. For over a year, A panel of 30 scientists, engineers and industry consultants have been reviewing the details of the 1,000-page draft report, for over a year. *"The panel has taken particular issue with a finding that seemingly came out of left field: the agency's statement that fracking has not led to "widespread systemic impacts" in the U.S."*

It was regarded that the EPA had dismissed fracking impacts stating there were no widespread systemic impacts, without any clear, scientific basis of support. The U.S. Environmental Protection Agency Science Advisory Board has taken the agency to task. Independent peer-reviewed studies and the EPA have identified many examples of contamination, such as spills, well cementing failures below ground, and complications with waste disposal. The EPA found there was around 15 spills every day somewhere in the U.S., yet chose to dismiss those daily incidents as not a sign of "widespread, systemic" problems.

"Affected individuals, public interests groups, and now the independent EPA Science Advisory Board, comprised of the EPA's own scientists, are calling on the EPA to "clarify" and "quantify" the controversial "widespread, systemic" line, or drop the language altogether. The panelists joined affected individuals and various independent experts who submitted comments in taking issue with how the agency ignored three high-profile contamination cases in its study—notably Dimock, Pennsylvania; Parker County, Texas; and Pavillion, Wyoming. The agency's omissions were contentious in part because in each case, the EPA prematurely abandoned investigations. Now, the EPA SAB has recommended that the agency include detailed summaries of these critical cases."

As I understand, the EPA chose politics over science. It also mislead the public, and one could say, the petroleum industry itself. The EPA draft report was quoted by industry at presentations for the inquiry, and what the industry has stated is now shown to be unreliable in regard to the EPA report.
51% of Americans, in a March 2016 Gallop Poll, showed they oppose fracking. Only 36% were for fracking. "*A recent peer-reviewed analysis of the science on unconventional oil and gas extraction, of more than 680 peer-reviewed studies, found that, "The great majority of science contains findings that indicate concerns for public health, air quality and water quality."*

http://www.ecowatch.com/epa-science-advisory-board-fracking-study-water-contamination-1968795058.html

I have included the link if the committee would like to look at the document in its entirety, for the U.S. Environmental Protection Agency Science Advisory Board (SAB), and added some quotes here. There is much detail in the document of what the SAB require the EPA to do.

"Page 2: The SAB recommends that the EPA revise the major statements of findings in the Executive Summary and elsewhere in the final Assessment Report to clearly link these statements to evidence provided in the body of the final Assessment Report. The SAB also recommends that the EPA discuss the significant data limitations and uncertainties, as documented in the body of the draft Assessment Report, when presenting the major findings.

Page 3: These local-level impacts, when they occur, have the potential to be severe, and the final Assessment Report needs to better recognize the importance of local impacts. In this regard, the SAB recommends that the agency should include and critically analyze the status, data on potential releases, and any available findings from the EPA and state investigations conducted in Dimock, Pennsylvania; Pavillion, Wyoming; and Parker County, Texas, where many members of the public have stated that hydraulic fracturing activities have caused local impacts to drinking water resources.

The SAB is concerned that the EPA had planned to but did not conduct various assessments, field studies, and other research, and the SAB recommends that the EPA delineate these planned activities within the final Assessment Report and discuss why they were not conducted or completed.

For example, the agency should include additional major findings associated with the higher likelihood of impacts to drinking water resources associated with hydraulic fracturing well construction, well integrity, and well injection problems. These findings should discuss factors and effects regarding the severity and frequency of potential impacts from poor cementation techniques, hydraulic fracturing operator error, migration of hydraulic fracturing chemicals from the deep subsurface, and abandoned/orphaned oil and gas wells. The agency should also provide more information regarding the extent or potential extent of the effects of chemical mixing processes from hydraulic fracturing operations on drinking water supplies. The EPA should provide additional detail on the extent and duration of the impacts of spilled liquids and releases of flowback and produced waters when they occur. Furthermore, the agency should also include additional major findings associated with the effects on drinking water resources of large spill events that escape site containment, and sustained, undetected leaks.

Page 1 next section: In general, the SAB finds the EPA's overall approach to assess the potential impacts of hydraulic fracturing water cycle processes involved in oil and gas production on drinking water resources, focusing on the individual stages in the HFWC, to be comprehensive but lacking in several critical areas.

However, the SAB has concerns regarding various aspects of the draft Assessment Report and has recommendations for changes to its text and follow-on activities to address gaps that the SAB has identified.

Page 2: In its draft Assessment Report, the agency sought to draw national-level conclusions regarding the impacts of hydraulic fracturing on drinking water resources. The SAB finds that several major summary findings do not clearly, concisely, and accurately describe the findings as developed in the chapters of the draft Assessment Report, and that these findings are not adequately supported with data or analysis from within the body of the draft Assessment Report. The SAB finds that these major findings are presented ambiguously within the Executive Summary and appear inconsistent with the observations, data, and levels of uncertainty presented and discussed in the body of the text.

The SAB expresses particular concern regarding the draft Assessment Report's high-level conclusion on page ES-6 that "We did not find evidence that these mechanisms have led to widespread, systemic impacts on drinking water resources in the United States." The SAB finds that the EPA did not support quantitatively its conclusion about lack of evidence for widespread, systemic impacts of hydraulic fracturing on drinking water resources, and did not clearly describe the system(s) of interest (e.g. groundwater, surface water), the scale of impacts (i.e., local or regional), nor the definitions of "systemic" and "widespread."

I am sure the Independent Scientific Panel will be able to gather from this information, that what has been perpetrated as the result of the careless quote by the EPA, and quoted by the Petroleum Industry, needs to be ignored.

https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebReportsLastMonthBOARD/BB6910FEC10C01A18525800C00647104/$File/EPA-SAB-16-005+Unsigned.pdf

HOW LONG THE LIFE OF A WELL IS

At one of the Round Tables, I asked the petroleum companies to explain to me how long the life of a well is, long after the company has gone, bearing in mind, once a well has been put down, it is there forever. **They were unable to give me an answer because they simply couldn't.** They have no idea. I believe this reveals that long-term impacts 100 years down the track are not even in the radar of Government departments and Petroleum companies.

GOLDEN RULES FOR A GOLDEN AGE OF GAS – international document

This book was published by the International Energy Agency with many people having input. The following excerpts taken from this document:

Page 13:

Watch where you drill:

Choose well sites so as to **minimise impacts** on the local community, heritage, existing land use, individual livelihoods and ecology.

Properly survey the geology of the area to make smart decisions about where to drill and where to hydraulically fracture: **assess the risk that deep faults or other geological features could generate earthquakes or permit fluids to pass between geological strata.**

Monitor to ensure that hydraulic fractures do not extend beyond the gas producing formations.

Page 14:

Treat water responsibly:

Minimise use of chemical additives and promote the development and use of more environmentally benign alternatives.

Page 17:

Highlights:

Unconventional gas has higher production-related greenhouse-gas emissions than conventional gas, but the difference can be reduced and emissions of other pollutants lowered by eliminating venting and minimising flaring during the well completion phase**. Releases of methane, wherever they occur in the gas supply chain, are particularly damaging, given its potency as a greenhouse gas.**

Pages 18, 19

The environmental Impact of unconventional gas production:

The main reason for the **potentially larger environmental impact of unconventional gas** operations is the nature of the resources themselves: **unconventional resources** are less concentrated than conventional deposits and do not give themselves up easily. They are difficult to extract because they are trapped in very tight or low permeability rock that impedes their flow. **Since the resources are more diffuse and difficult to produce, the scale of the industrial operation required for a given volume of unconventional output is much larger than for conventional production.** This means that drilling and production activities can be considerably **more invasive, involving a generally larger environmental footprint.**

One feature of the greater scale of operations required to extract unconventional gas is the need for more wells. Whereas onshore conventional fields might require less than one well per ten square kilometres**, unconventional fields might need more than one well per square kilometre (km2), significantly intensifying the impact of drilling and completion activities on the environment and local residents**. A satellite image from Johnson County in Texas, United States illustrates this point, showing the density of well sites producing from the Barnett shale (Figure 1.1). An image highlights **37 well sites in an area of around 20 km2, with each well site potentially having more than one well.** Another important factor is the **need for more complex and intensive preparation for production.** While hydraulic fracturing is already used on occasions to stimulate **conventional** reservoirs, tight gas and shale gas developments almost always require the use of this technique in order to generate adequate flow rates into the well. ….**The associated use and release of water gives rise to a number of environmental concerns, including depletion of freshwater resources and possible contamination of surface water and aquifers.**

Page 20:

The production of unconventional gas also contributes to the atmospheric concentration of greenhouse gases and affects local air quality. In some circumstances, unconventional gas production can result in higher airborne emissions of methane, a potent greenhouse gas, of volatile organic compounds (VOCs) that contribute to smog formation, and of carbon dioxide (CO_2) (from greater use of energy in the production process, compared with conventional production). Just how much greater these risks may be is

uncertain:

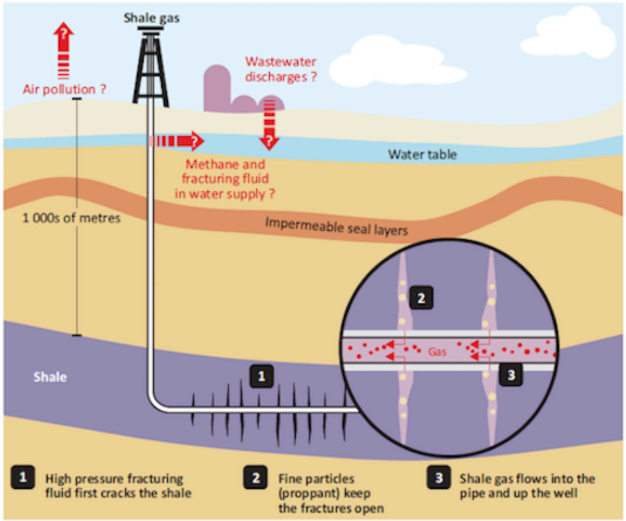
Page 23:

Once drilling starts, it is generally a **24-hour-per-day operation, creating noise and fumes from diesel generators, requiring lights at night and creating a regular stream of truck movements during mobilisation/demobilisation periods.**

Page 25:

Diagram showing environmental hazards from 'Golden Rules for a Golden Age of Gas'.

Figure 1.3 ▷ Shale gas production techniques and possible environmental hazards



Source: Adapted from Aldhous (2012).

Note: The possible environmental hazards discussed in the text are shown with red arrows. Although the figure illustrates a shale gas well with multi-stage hydraulic fracturing, some similar hazards are present with conventional gas wells, and with tight gas developments.

Page 26:

Unconventional gas production and earthquake risks:

There have been instances of earthquakes associated with unconventional gas production, for example the case of the Cuadrilla shale gas operations near Blackpool in the United Kingdom, or a case near Youngstown, Ohio, in the United States, which has been provisionally linked to injection of waste water, an operation that is similar in some respects to hydraulic fracturing**…. Larger seismic events can be generated when the well or the fractures happen to intersect, and reactivate, an existing fault.** This appears to be what happened in the Cuadrilla case.

Page 27:

Production:

The production phase is the longest phase of the lifecycle. For a conventional well, production might last 30 years or more. For an unconventional development, the productive life of a well is expected to be similar, but **shale gas wells typically exhibit a burst of initial production and then a steep decline, followed by a long period of relatively low production.** Output typically **declines by between 50% and 75% in the first year** of production, and most recoverable gas is usually extracted after just a few years (IEA, 2009).

Page 31:

In areas of water-scarcity, the extraction of water for drilling and hydraulic fracturing …. can have broad and **serious environmental effects.** It can lower **the water-table, affect biodiversity and harm the local**

ecosystem. It can also reduce the availability of water for use by local communities and in other productive activities, such as **agriculture.**

Page 35:

The risk of water contamination:

Significant concern has been expressed about the potential for contamination of water supplies, whether surface supplies, such as rivers or shallow freshwater aquifers, or deeper waters, as a result of all types of unconventional gas production. Water supplies can be contaminated from four main sources:
Accidental spills of fluids or solids **(drilling fluids, fracturing fluids, water and produced water, hydrocarbons and solid waste) at the surface.**

Leakage of fracturing fluids**, <u>saline water from deeper zones</u> or hydrocarbons into a shallow aquifer through imperfect sealing of the cement column around the casing.**

Leakage of hydrocarbons or chemicals from the producing zone to shallow aquifers through the rock between the two.

Discharge of insufficiently treated waste-water into groundwater or, even, deep underground. None of these hazards is specific to unconventional resources; they also exist in conventional developments, with or without hydraulic fracturing.

Page 39:

Methane and other air emissions:

Methane emissions along the gas value chain (whether conventional or unconventional) come from four main sources:

Intentional venting of gas for safety or economic reasons. Venting during well completions falls into this category, but venting can also take place as part of equipment maintenance operations.

Fugitive emissions. These might **be leaks in pipelines, valves or seals, whether accidental (e.g. corrosion in pipelines)** or built into the equipment design (e.g**. rotating seals, open tanks**).

Incidents involving **rupture** of confining equipment (**pipelines, pressurised tanks, well isolation**).

Incomplete burning. The effectiveness of gas burning in gas flares varies according to wind and other conditions and is **typically no better than 98%.**

Page 132:

Regulatory Framework:

Under Australian law, hydrocarbon resources are owned by the state (at federal, state or territory level) on behalf of the community, and governments at all levels have a "stewardship" role in petroleum resource management (AGPC, 2009). **Farmers or graziers may hold freehold or leasehold title to land, but generally do not have rights to mineral or petroleum resources** – these are subject to petroleum tenure rights granted by the state or territory governments. Underlying native title can coexist with other land title rights. In general**, <u>landowners have no right to refuse access to the petroleum tenure holder for petroleum operations</u>**; but they do have a claim to compensation for the impact of those operations.

www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/WEO2012_ GoldenRulesReport.pdf

<u>The above excerpts from 'Golden Rules for a Golden Age of Gas' clearly shows the industrys' own admissions of the</u>

serious issues and impacts as the result of the gas industry and hydraulic fracture stimulation. The fact that landowners have no rights to refuse petroleum tenure holders on their own land is abhorrent and needs to be questioned in an international court of law in reference to **Resolution 64/292**, the United Nations General Assembly explicitly recognizing the human right to water and sanitation and acknowledging that clean drinking water and sanitation are essential to the realisation of all human rights.

LEGISLATION IN EVERY STATE NEEDS TO INCLUDE THE FOLLOWING:

Where there is limestone (prone to subsidence and sinkholes and exacerbated by mining, drilling and hydraulic fracture stimulation), OR where there are faults and fault-lines OR where there is a risk of seawater intrusion, then this agricultural land shall be exempt from all mining and petroleum exploration and projects.

ECOCIDE

Ecocide is a legal term meaning the extensive damage to, destruction of or loss of ecosystem(s) of a given territory, whether by human agency or by other causes, to such an extent that peaceful enjoyment by the inhabitants of that territory has been or will be severely diminished. This is how many people view the possibility of hydraulic fracture stimulation in WESTERN AUSTRALIA. I recommend to the Independent Scientific Panel that hydraulic fracture stimulation in Western Australia be banned.

RISKS OF GROUND WATER CONTAMINATION

Clean, potable water is our most valuable resource on earth. Without it, we cannot survive. Adult bodies are made up of about 60% of water. Without it, we cannot grow food. Already, there are 700 million people in 43 countries of the world that are suffering from water stress and scarcity. This is only going to increase, particularly as salinity increases, rainfall decreases, we face a hotter climate, the population grows and precious lakes, streams, rivers and aquifers continue to be polluted, much at the expense of big industry, including mining and petroleum industries. Even our own state government acknowledges water shortages ahead.

Lack of water also affects the economy. Polluted water and soil means that we lose our 'clean, green image' for our wonderful food bowl and wines that our state premier holds in high esteem and sells to the world. Polluted water and soil means that we would face loosing our local, national and international trade and export. Polluted water and soil would have a major impact on our tourism. After all, who really wants to holiday in a gas field? Who wants to live next door to a gas field? Who wants to buy property or a house next to a gas field? We ask the committee to ponder these questions. Would you like your grandchildren to live in a gas field area? This is the question the Mayor of New York asked himself and replied in the negative.

Aquifers in much of Australia are already in decline. By permitting highly water intensive hydraulic fracture stimulation to proceed, declining aquifer water levels may continue to fall at a much quicker rate. Over a life time, a "fracked" shale or tight gas well may require up to 34 million litres of water or more, depending on the number of fracks. Water brought to the surface from deep aquifers, may possibly be extremely saline as well as containing heavy metals, radionuclides, volatile organic compounds and other pollutants. When any substance, whether it is fluid or solid, is removed from under the ground, a void is left. What is going to fill that void? Voids may lead to compaction, creating an unwanted chain of events.

Currently, the world population is a bit over **7 billion.** It is estimated at the current growth patterns that by 2050, the population may be around 9.3 billion people. The United Nations Food and Agricultural Organization has estimated that to be able to meet the needs, food production will need to increase by 2050, 70%. China is looking to Australia for its food bowl security. Most people in Australia have already seen the impacts on air pollution in China, often caught on TV. If our water and soil become polluted, where are we going to source our food? Certainly, we cannot rely on overseas markets in a world where the demand is already exceeding production.

Drilling and fracking in limestone areas exacerbates subsidence and the formation of sinkholes. Normally, under natural conditions, subsidence and sinkhole formations may take scores of years to occur. Man-made causes, such as drilling, mining, fracking, buildings, heavy equipment and dams hasten the time span for subsidence and sinkholes

to occur. What also needs to be taken into account is that when pressure through weight is exerted on land, such as dams and heavy equipment, this may also trigger subsidence.

Well integrity failure is a real issue. There is already evidence of this occurring in the South East. A drill hole is a drill hole, whether for mining exploration or shale gas exploration and production. It goes through aquifers and geological formations, regardless of the depth. The deeper the drill hole, the more there is to be concerned about. The famous "Nulty hydrology observation drill hole" in the South East was commissioned by Western Mining Corporation in 1982 in limestone country. 30 years later, there was subsidence along side of the casing down 22 metres to the unconfined aquifer. As the water levels dropped in the aquifer, the limestone roof became exposed, leaving a weak spot allowing subsidence to occur. What proof has the Western Australian Government got to show this hasn't happened there too.

Caves and sinkholes have connectivity to each other. Fracking activities may have unwanted consequences on caves including damage to these fragile structures or movement of gases into them.

Usually, there is considerable and unknown vertical leakage between unconfined and confined aquifers that may be present. At a South East Local Government meeting in South Australia in April 2014, the question was asked to the EPA representative of how to clean up an aquifer once it is contaminated. He stated that it is impossible to clean up a large contamination area. He also stated that smaller contaminated areas are cleaned up by removing the contaminated water from the aquifer. The question begs, what is done with the contaminated water once it is above ground in Western Australia?

The highly toxic wastewater is stored in holding ponds that usually have high-density polyethylene (HDPE) plastic liners that are meant to protect the environment from seepage. As evidenced with photos in this document with the Salamader 1 holding ponds in the SE of SA, these liners did not last 4 years. There is also no safe way of disposing of toxic waste - water and drilling muds. Reinjection causes earthquakes and potential contamination.

Most areas where gas is sourced have numerous fault lines. What is appalling in the South East of South Australia, is that Beach Energy Ltd. has already been drilling through vertical fault lines that rise upwards and in some cases, to the confined and unconfined aquifers. As you will see by documented evidence in this submission, that hydraulic fracture stimulation should never be allowed near faults. Earthquakes are triggered by both the fracturing itself and waste water re-injection. This in turn causes contaminant pathways**.** How do you plug up a contaminant pathway forever? Is it possible to even find all contaminated pathways underground? It is impossible.

There are numerous sources of potential contamination to our water through fracking activities. Chemical spills occur on the surface that may reach the unconfined aquifer. Flow-back water is full of contaminants and may be spilled or leak. Holding pond wastewater overflows have occurred due to heavy rains. Well integrity is a huge problem. No well can be guaranteed 100% integrity. Six (6) % usually fail in the first year. Once a well is put down, it is there forever. Eventually, all wells will fail. It does not matter how many layers of casings and cement there are. They break down even from the inside layers because of hydrogen sulfide and anaerobic bacteria. Also, when cement is being poured down the drill hole it may hit methane under pressure, causing cement channelling, not allowing sealing between the rock matrix and the outer layer of cement. All causes are too numerous to list in this summary.

NO ONE CAN CONTROL WHAT IS HAPPENING UNDER THE GROUND. How do we stop subsidence and earthquakes from occurring? Who is going to foot the bill for problems in the future, which may occur long after the companies?

WATER SCARCITY

For human survival, we need clean water, clean air and a clean green food supply. This means maintaining and keeping our precious aquifers, surface water, soil and air and food protected from pollution.

According to Elizabeth Hameeteman, of The Global Water Institute, in her paper entitled "Future Water (In)security: Facts, Figures, and Predictions", 2013, she is quoted as *saying "More than 2.8 billion people in 48 countries will face water stress or conditions of scarcity by 2025. By the middle of this century, this will have reached almost 7 billion. …* ***Approximately 700 million people in 43 countries are currently suffering from water stress and scarcity.*** *It is*

projected that by 2025 water withdrawals will have increased by 50%, mainly in low-income nations or in countries and regions with absolute water scarcity. Two- thirds of the world population is at risk of being stained by water scarcity."

There is sufficient credible documentation sounding the warning bells that potable water sustainability is a problem both at state level, through to a world wide problem. Taking into account the figures on water security in the quotes by Hameeteman, it would be astute to assume that the potable water problems around the world are not going to improve, and in fact get worse. Australia will not be able to source much food from overseas. Therefore, it is of the utmost urgency that our potable water resources in the SE are protected forever, and are never exposed to the risks of unconventional gas production. Our precious food and water resources should be **preserved for generations to come.** Currently, the world population is a bit over **7 billion.** It is estimated at the current growth patterns that by 2050, the population may be around 9.3 billion people. The **United Nations Food and Agricultural Organization** has estimated that to be able to meet the needs, food production will need to increase by 2050, 70%.

SEA WATER INTRUSION

Has the Independent Scientific Panel looked into the impacts of removal of water for use for hydraulic fracture stimulation in coastal areas in relation to sea water intrusion? There may be direct hydraulic connections of the aquifers to the sea, in the form of tidal pressure effects?

Seawater Intrusion into a Freshwater Coastal Aquifer: Lower South-East, September 2012 is worth looking at.

Page 2 "Fresh groundwater in coastal aquifers is vulnerable to salinisation by seawater intrusion due to increasing extraction of the resource and climatic changes, which causes the lowering of the groundwater hydraulic head and reduced recharge into the unconfined aquifer. The threat of sea level rise, which could increase the risk of inland salt water migration into the aquifer, is a potential threat to coastal groundwater resources. Saline groundwater intrusion has the potential to result in significant economic and environmental impacts. "Reduced recharge due to climate change may further exacerbate this process**. Recent years with below-average annual rainfall has resulted in reduced recharge to the unconfined aquifer and also increased extraction." The same may apply to areas on the coast of Western Australia, if hydraulic fracture stimulation was allowed to proceed.**

How much would it cost the state to put in hundreds of hydrology observation points along the coast and monitor them daily? How do you collect the salt from the aquifers, once seawater intrusion has taken place? How do you clean up not only one but 2 aquifers if contamination occurs?

LIMESTONE AND SUBSIDENCE

Subsidence causes cracking, ground movement, damage to buildings, pipes, roads and railways, groundwater system changes, flooding, sinkholes, coastal impacts, increases in seawater intrusion, and can reactivate faults. Land subsidence on the coast is cumulative to climate change effects with sea level rises and future coastal erosion.

PAST PROOF OF HOW SENSITIVE THE SE AQUIFERS ARE

Although this is a story from the SE of SA, I believe it is worth mentioning as further evidence in relation to areas of limestone in Western Australia. In 1979, Western Mining Corporation (WMC) discovered lignite north east of Kingston SE, covering an area 30 km x 5 km. The lignite is between the unconfined aquifer and the Dilwyn confined aquifer. In 1982, pumping tests performed by W.M.C. were found to significantly interfere with the artesian water in the area, particularly with the potable Dilwyn confined aquifer. The Watchdog committee found serious errors in modelling mine dewatering and associated impacts on underground water resources. Serious issues that occurred which included a large drop in pressure heads of bores several km away that ceased flowing and very slow pressure head recovery. One bore had to be pumped for a number of weeks before regaining pressure. During the trial, the loss of pressure and downward water leakage from the unconfined aquifer was evident. There was an immediate revelation of a direct interconnection between the Mepunga and Dilwyn aquifers, with evidence at one bore site that there was an absence of separating clays between the aquifers. If the project had proceeded, Kingston's town water supply would have been at great risk.

'A submission to THE HONOURABLE THE MINISTER OF ENVIRONMENT AND PLANNING By the Kingston Branch of the United Farmers and Stockowners of South Australia on The Kingston Lignite Project Draft Environmental Impact Statement Researched by the Kingston UF & S Watchdog Committee' 1983

NULTY OBSERVATION HYDROLOGY DRILL HOLE SUBSIDANCE 31 YEARS AFTER WMC COMMISSIONED IT

NULTY SUBSIDED HYDROLOGY OBSERVATION DRILL HOLE PUT DOWN IN 1982 BY WMC

This drill hole, pictured above, is on the property of the Nulty family. It was commissioned by Western Mining Inc. to be drilled in 1982. The drill had never been inspected since, and it is highly likely that none of the drill holes or hydrology observation holes in the Kingston SE area (950 of them) have never been audited since 1982. Please note the hole at the side of the casing. The hole was around 30 x 46 cm at the top and went down for 20 meters to the unconfined aquifer. As the water levels in the aquifer drops, the limestone roof may be exposed. There may be a weakness in the roof, which allows the subsidence to occur. This is the most likely scenario of why the earth around the casing collapsed. This is in limestone country. The rest of the South East has limestone. There is no proof that inspections have been done of the other 950 drill holes including 92 that were cored. No one could prove that this type of event would not happen in areas of Western Australia, with drill holes going down.

WHAT HAS HAPPENED IN THE SOUTH EAST OF SOUTH AUSTRALIA WHEN DRILLING THROUGH FAULT LINES

The South East of South Australia is heavily faulted, as is much of Western Australia. Beach Energy has been intersecting faults according to their own information.
http://bpt2.live.irmau.com/IRM/Company/ShowPage.aspx/PDFs/329741383964/MonthlyDrillingReportJanuary2014

There was a mechanical drill problem, described by locals as 'the drill head getting stuck', which was not disputed when mentioned to Beach Energy Ltd at the SELGA day at Penola, and as a result, a side track around the problem had to be drilled. This occurred at 2,406 metres, and on the drawing showing the intersecting of faults, this appears to be right where the drill intersects a fault. Yet again, during the drilling of Haselgrove 3, the drill head became stuck.

The fractures in the shale caused by HFS are only meant to extend for around 100 metres. However, this is not always the case**. This may result in contaminant pathways up to aquifers if drilling too close to fault lines. This is of particular concern in Western Australian areas.**

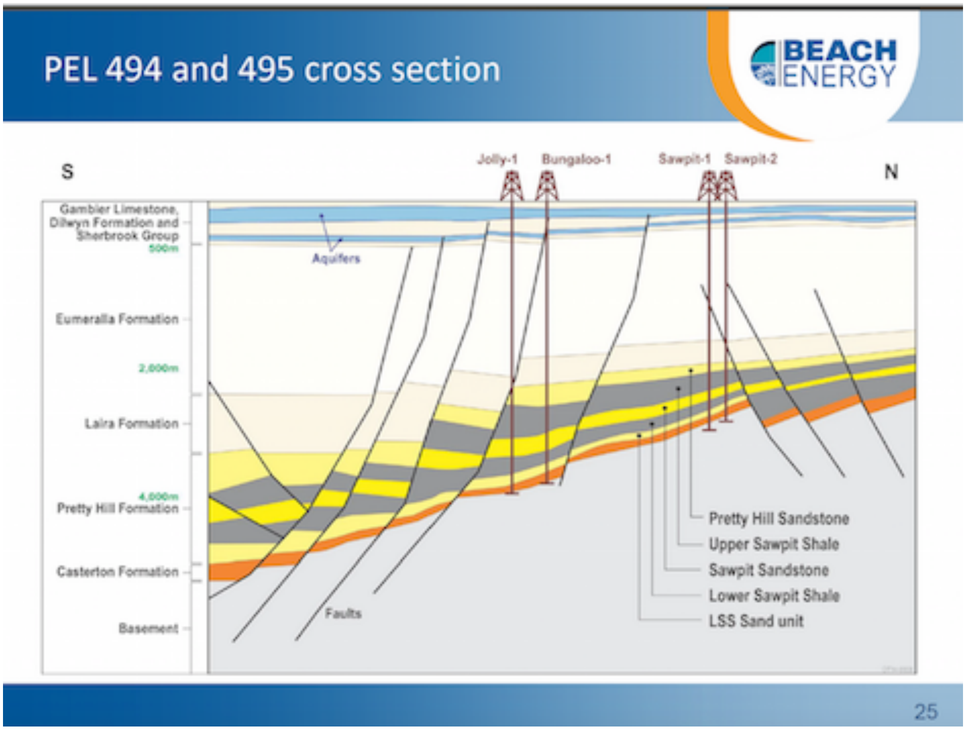


ILLUSTRATION FROM BEACH ENERGY NON DEAL ROADSHOW 23RD – 27TH JUNE 2014, PAGE 46

http://www.asx.com.au/asxpdf/20140623/pdf/42qchljrwj1c00.pdf

PANAX GEOTHERMAL – HDPE LINERS DON'T LAST 4 YEARS FOR HOLDING PONDS

Salamander-1 well was drilled in the Otway Basin near Nangwarry in the SE of SA in 2010 by Panex Geothermal (RAYA Limestone Coast Project). The well was drilled to 4,000 metres. The project halted, because the rocks were not impervious. Left behind was a drilling mud area and 2 holding ponds**. One holding pond contained a severe algae bloom, and the HDPE plastic liner, less than 4 years old, contained large holes and tears**. The Stock Journal published a story on 30th January 2014, with a photo of SE local identity in front of the muddy tailings. It appears that the same day, DMITRE liaised with the RAYA group to clean this up as reported in the ASX Raya report – see link.

The pond with the algae bloom was pumped dry. The thick layer of dried drilling mud was taken to an EPA landfill known as Telford's Quarry. The landfill operator kept the waste separate and it is not known whether the drilling muds have disposed of properly yet. Concerns were raised about how much contaminant dust may have been blown over the district during transportation. The question is how much has leached down through the soil from the holding ponds themselves because of the plastic liner breaking down

http://www.asx.com.au/asxpdf/20140131/pdf/42mfs60t5v6tdn.pdf

Picture previous page shows holding ponds at site of Salamander 1 near Nangwarry. Right side shows algae bloom. Left side note hose in right hand corner pumping out the last of the pond water. Please note the same tears in the HDPE plastic liner with before and after photos. This scenario would apply anywhere in Australia.

RED QUEEN EFFECT

From a site geology.com, a credible geoscience news and information site, I quote the following.

"Imagine that an oil and gas company drills fifty wells during their first year in a new shale play. They contract with a pipeline company who will transmit that gas to market. One year after these wells are drilled their production rate has fallen by 60 to 80%. So, to meet the amount of gas promised to the pipeline the oil and gas company must drill at least 30 to 40 new wells to make up for the drop in production. At the end of the second year the company has first year production drops on all of its new wells and second year production drops on all of the wells drilled in the first year. This forces the oil and gas company to drill, drill, drill to keep up with its promise to the pipeline. Many people in the oil and gas industry call this the "Red Queen Effect".

http://geology.com/royalty/production-decline.shtml

According to THE NEW INTERNATIONALIST magazine, page 5, they confirm the "Red Queen Effect". As Fracked shale gas and oil wells don't appear to be productive for long, as extraction levels drop swiftly –new wells have to be dug continually just to try to maintain levels. In the US, 30-50% of shale gas production needs to be replaced each year that equals around 7,000 new wells. In a report by the Energy Policy Forum, it is scathing about the US Energy Information Administration. The EPF conclude that the US shale oil and gas reserves have been over stated by between 100% and 500% of what is really there.

David Hughes is a geoscientist who has studied the energy resources of Canada for forty years. He was also with the Geological Survey of Canada as a scientist and research manager and served as Team Leader for Unconventional Gas on the Canadian Gas Potential Committee. David has a large CV that also incudes a current board member of Physicians, Scientists & Engineers for Healthy Energy (PSE Healthy Energy). He has written a report on '"DRILLING DEEPER – A REALITY CHECK ON US GOVERNMENT FORECASTES FOR A LASTING TIGHT OIL AND SHALE GAS BOOM". Each shale production area in USA has well decline areas. Hughes reports on each shale area separately and the results are similar. According to his report, vertical and directional wells have much lower productivity than horizontal wells and are being phased out. (page 263). Decline rates occur the quickest in the first year**. Over the first three years, between 74% and 82% is the amount of decline that takes place for an average well life**. **Why would Beach Energy then be considering using directional drilling?**

http://www.postcarbon.org/wp-content/uploads/2014/10/Drilling-Deeper_PART-3-Shale-Gas.pdf

CONVENTIONAL AND UNCONVENTIONAL GAS BOTH CAN HAVE HYDRAULIC FRACTURE STIMULATION

On the next page is an illustration out of an ASX report from Beach Energy Ltd. It clearly shows the shale is either side of the sandstone and in the Casterton Formation. It would require little effort to become a horizontal well. The drill head may just need to be lifted up or down very little. **Hydraulic fracture stimulation is also done in conventional wells.**

REPORT FOR THE CHIEF SCIENTIST OF NEW SOUTH WALES – DIRECTIONAL DRILLING

According to the NSW Chief Scientist report, "INDEPENDENT REVIEW OF CSG ACTIVITIES IN NSW – FRACTURE STIMULATION ACTIVITIES" Sept. 2014 'Horizontal drilling' is a form of 'directional drilling' in which the well being drilled is deviated onto a horizontal plane (Carter, 2013). Usually beginning as a vertical bore, the well can extend hundreds to thousands of metres underground, bending until it runs parallel with the gas seams. From the point of deviation from the vertical, multiple radials can branch out, tapping multiple seams, or can be directed and drilled within a single seam, providing greater exposure to the target reservoir and maximising the gas extracted which can decrease the need to use fracture stimulation (Carter, 2013; Pinczewski, 2012). Copy and paste link below.

http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0008/56924/140930-Final-Fracture-Stimulation.pdf

NATIONAL VENDORS DECLARATION AND NATIONAL ANIMAL HEALTH STATEMENT (NHS)

When farmers and graziers sell their stock in Australia they are required to fill out and sign the Livestock Production Assurance National Vendors Declaration (LPA NVD), accompanied by the National Animal Health Statement. The LPA NVD is the main document behind the livestock food safety reputation for Australia. It also shows movement of stock i.e. to processors, sale yards or between properties. Any contamination is required to be stated on the NVD. **How will farmers feel, if their stock becomes contaminated as the result of hydraulic fracture stimulation activities, stating their stock has been contaminated as the result of drinking contaminated water or contaminated pasture? This would affect their income and also put at risk our national and international export market.**

IF RATES OF FLOW ARE ALTERED

Where the rate of flow in an aquifer is increased, such as removal for hydraulic fracture stimulation, this can increase the risk of subsidence, as I understand from one of my engineering colleagues. I have spoken to a geophysicist in regard to this, and he has stated to me the following *"there is no question in my mind that anything that weakens Earth structure, e.g., fracking, will increase rate of events where they are already prevalent."*

PROMINENT SOUTH AUSTRALIAN INVOLVED IN SHEEP GENETICS DISCOVERS DEAD SHEEP BY WELL IN CHILE

Brian Jefferies, AM, well known in the sheep industry in South Australia, nationally and internationally, visited a property in Chile in 2012. The owner and Brian visited an area of the property where gas was being extracted. 12 dead pregnant ewes were found 200 metres from contaminated water. Brian attended the autopsy and the blood was extremely pale and stank of hydrogen sulfide.

The Editor of the Stock Journal,
123 Greenhill Road,
Unley SA 5061

23/9/12

Dear Deanna, TOXIC WATER

On Landline on Sunday 23/9/12, the 94 year old inventor and entrepreneur, Roy Eykamp, from Quirindi,NSW, on the rich Liverpool Plains, stated that he fears for the future of Agriculture, Irrigation and Livestock production on these rich soils. Here he could make an excellent income from a 600 acre farm.

He said that the proposal of 'Frakking for coal gas' is likely to contaminate the whole aquifer of underground water in this prime agricultural region.

Now, I have just returned from a trip to South America when I flew down to Southern Chile to assess the genetic progress in the three new sheep breeds that I established there between 1995 and 2007 I handed this project over to Andrew Michael from Leahcim, Snowtown.

While there we drove to my former client's Eastern Property, Canadon Grande (74,000 hectares with 32,000 sheep) which runs along the Southern border between Argentina and Chile. Chile's gas supply is dwindling rapidly so ENAP are extracting all the gas that they can find. They have pumps to extract the gas and then separate the mud and water from the gas. The water then runs into settling ponds.

However, we were confronted with 12 dead pregnant ewes, . close together and only 200 metres from one of these ponds of contaminated water. These 12 Patagonian Meat Merinos were part of a flock of 7000 ewes in this large paddock. A veterinarian could not find any pathological cause for their death and some were blown up with gas.. All organs were normal but I have never seen blood of such a light crimson colour and it smelt of gas. This was due to the sheep drinking contamimated water. ENAP immediately fenced off the contaminated water from the sheep.

Miners beware! You could start something that you cannot control! Stop Frakking on good Agricultural land!!

Brian C. Jefferies.

Yours sincerely,

Brian C. Jefferies, A.M.

COW LOST ITS TAIL AS RESULT OF FRACKING IN NORTH DAKOTA

The picture is self - explanatory. http://www.thenation.com/article/171504/fracking-our-food-supply#

Schilke ranch cow that has lost its tail, one of many ailments found in cattle following hydrofracturing of the Bakken Shale in North Dakota. There is now evidence showing stock dying in vicinity of gas wells.

IMPACTS ON HUMANS AND ANIMALS

IMPACTS OF GAS DRILLLING ON HUMAN AND ANIMAL HEALTH - A Report has been done by Dr. Michelle Bamberger, a veterinarian, and Robert Oswald, Professor of Molecular Medicine at Cornell College of Veterinary Medicine. They both have documented cases of animals and their owners with health problems that have potential links to gas drilling. Many cases are in litigation. They found that conventional wells also had faulty well casings and failure of blowout preventers, leading to contaminated water. They also included horizontal wells. The wells were both deep and shallow. Wastewater had been **spread on agricultural land** and dumped in creeks, wells and spring water. There was also surface contamination through drilling fluid spills. Humans, deer, cows, horses, fish, dogs, poultry and birds were all affected. Sudden deaths occurred in birds and poultry. Body condition, reproduction, milk production, neurological, gastrointestinal, dermatological and immunological health disorders were found. More on health impacts is found under that topic in the submission.

http://www.psehealthyenergy.org/data/Bamberger_Oswald_NS22_in_press.pdf copy and paste

HEALTH RESEARCH IN THE KOGAN, MONTROSE AND TARA RESIDENTIAL ESTATES AREAS

DSD (formerly DMITRE) cite a flawed draft health report based on environment as assurance there are no problems. The Queensland government report was based on minimal non-systematic sampling, relying on the inadequate industry commissioned data (subsidiary of Metgasco as understood by LCPA). This investigation was very underfunded and understaffed, and no medical staff actually visited the site. Only 15 people were examined clinically. Volatile chemical findings were dismissed even though they cause major health impacts. Dr. Geralyn McCarron did her own independent research on patients around the Tara rural residential estates. Her report 'SYMPTOMATOLOGY OF A GAS FIELD' showed that the Queensland Health Report had no credibility at all. 35 households in the Tara residential estates and the Kogan/Montrose region were surveyed in person and telephone interviews were conducted with 3 families who had left the area.

82.58% of residents surveyed reported that their health was definitely adversely affected by CSG, whilst a further 19% were uncertain. This included adults and children. All groups "reported increases in cough, chest tightness, rashes, difficulty sleeping, joint pains, muscle pains and spasms, nausea and vomiting." A number of children complained of spontaneous nose - bleeds, skin and eye irritation. Other symptoms could be related to neurotoxicity - severe fatigue, weakness, headaches, numbness, pins and needles, burning or tingling were reported. Severe headaches, severe fatigue, difficulty concentrating, twitching, unusual movements, clumsiness or unsteadiness were also reported.

As reported in peer reviewed papers from the USA, there are just as many or maybe even more health issues with shale gas production as there is with coal seam gas production. Quoting the draft Queensland Health Report by DSD is insidious as to what the real effects on health area. More is covered in this submission under health and chemicals.

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

REPORT FOR THE CHIEF SCIENTIST OF NEW SOUTH WALES – POTENTIAL IMPACTS

It has been quoted by the industry, that because the shale is located much deeper than coal seam gas, and further away from aquifers, there are not the problems associated with shale gas. To say that there are not serious problems with shale gas production is simply a myth. The following quotes in italic are from the "LIFE CYCLE OF CSG PROJECTS: TECHNOLOGIES AND POTENTIAL IMPACTS" June 2013 for the Report For The New South Wales Office Of The Chief Scientist And Engineer, prepared by Professor Peter J Cook CBE, FTSE June 2013**". This document alludes to the fact, that there may even be more problems associated with shale gas production.** There are some statements regarding coal seam gas that are quoted, but upon examining these quotes, it is easy to also apply them to shale gas. This comes under the topic of 'Cumulative Impacts'.

Page 70 - "Many parts of eastern Australia are being subjected to a range of developmental issues and cumulative impacts relating to urban growth, transport, increased water needs, mining, agriculture, tourism and forestry. These activities impact on biodiversity, vegetation, flora and fauna species, soils and local water supplies for ecosystems, on people and other industries. CSG developments add to these cumulative impacts through surface activities (roads, drill pads, storage areas, water storage and use, pipeline installation, processing plants) and subsurface activities (production of CSG, production of water, disposal of water, fracking). Therefore it is important to extract CSG in a manner and in locations that do not unduly compromise agriculture, water resources, alternative land uses, and landscape function (O'Neill, et al., 1997; Tongway, 2005) using knowledge of Australian landscape processes, together with specific landscape, geological and hydrological data. These and other elements are all components of a highly connected and complex landscape system and it is important to take account of the cumulative impacts on this connected landscape that are important."

*Page 44 - "A site with complex hydrogeology is likely to be avoided because of the difficulties in aquifer management that might be encountered during the dewatering process. **A major fault zone will almost always be avoided because of the difficulties in predicting the subsurface conditions of the site and the prospect of this leading to increased risk and uncertainty.** There is also the possibility that hydraulic fracturing or disposal of waste water at such a site could lead to induced seismicity."* Page 54 - *"Hydraulic fracturing does not have the significance for CSG production **that it has for shale gas production."***

*Page 72 - **All shale gas plays need to be hydraulically fractured (fracked) to stimulate gas production. Many of these wells need to be fracked multiple times. ….shale gas wells often require many phases of fracking." "The pressure required to frack shale is high due to the depth of the rock (2-3000m), the relative strength of the shale rock and the need to maximise the reach of the hydraulic fractures. In contrast, the fracking pressure used for CSG is low due to the rock being shallower (less than 1000m), the comparative weakness of coal and the need to restrict the reach of the hydraulic fractures because the coals are generally much thinner than the shales.***

*Page 73 - **It is also possible for fractures to propagate towards an aquifer along a pre-existing transmissive fault.** This possibility can be minimised by undertaking geomechanical modelling to predict fault orientation behaviour and avoid fracking in the vicinity of faults using high resolution seismic surveys to accurately map faults."*

http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0010/31321/Life-Cycle-of-Coal-Seam-Gas-Report_FINAL_PJC.pdf

PROFESSOR BILL FISHER SAYS NEVER DRILL NEAR A FAULT

I have attended a lecture given by Professor Bill Fisher, when he visited Adelaide and I had the opportunity to question him. In my submission, I presented evidence of how Beach Energy have drilled through vertical fault lines that extend up into the potable aquifer, for both Jolly 1 and Bungaloo 1 exploration wells. Professor Fisher is the past president of the American Association of Petroleum Geologists, member of the National Academy of Engineering and serves currently as a member of the National Petroleum Council.

I do not agree with everything he says as I have conflicting evidence. However we were both in agreement in

relation to faults and earthquakes. I was surprised when he mentioned there could be up to 60 stages of fracking. http://www.groundwater.com.au/videos I have put the approximate times of the video stages for the important points. At 8 mins 33 secs Re injection of waste water. ***"If you re-inject near some geological faults you can lubricate the fault and create earthquakes."*** At 16 mins 52 seconds - can be 60 stages of fracking. At 41 minutes 36 seconds ***"If drilling near faults, and there is a high enough amplitude on vertical fracture patterns this can cause leakage up into the aquifers……. Hydraulic fracturing can potentially give rise to induced seismicity if it hits a pre-existing fault*……. *Blackworth in Great Britain - they drilled into a fault* ***- one of the things you do when hydraulic fracturing is never drill into a fault…... You stay away from a fault because it is likely to set off an earthquake***". Hydraulic fracture stimulation should not be near any faults – there is risk to contaminant pathways and activating earthquakes. This should be taken seriously by the Petroleum Industry, as Professor Fisher is considered the Petroleum Industry's 'one of their own'.

SANTOS CONTAMINATES AQUIFER

A $1500 fine was issued to SANTOS when its joint venture partner, Eastern Star Gas allowed water to seep from one of its CSG water holding ponds into a shallow aquifer. The EPA chief environmental regulator Mark Gifford, confirmed the contamination included uranium levels 20 times higher than safe drinking water guidelines, lead, aluminium, arsenic, barium, boron and nickel, all at elevated levels above livestock, irrigation and health guidelines.

http://www.smh.com.au/environment/santos-coal-seam-gas-project-contaminates-aquifer-20140307-34csb.html

HIGH RISK INCIDENT WITH JETISONNED DRILL PIPES FLYING OUT THE GROUND

A high-risk incident occurred on 14th July, 2013. 18 drill pipes were ejected from a conventional gas well, over 2000 metres deep, (Kingfisher E01) near Casino, NSW. The well was being de-commissioned at the time. The incident occurred due to an unplanned release of gas at high pressure. There was significant damage to equipment. There was loss of integrity that had occurred during the working life of the well that resulted in gas under pressure migrating up between the inside and outside of the casing.

BASIC EXPLANATION OF HYDRAULIC FRACKING STIMULATION (FRACKING, FRACCING)

Although 'fracking' has been around for many years, the industry fails to be up front about the type of hydraulic fracture stimulation used now. Multi stage slick water, horizontal, invasive, high volume, high pressure, fracture stimulation has only been used since 2002, and not 60 years. Multi well pads have only been in use since 2007. According to a United Nations Environment Programme document, between 15 and 30 million litres of highly pressured water used per fracked well.

http://na.unep.net/geas/archive/pdfs/GEAS_Nov2012_Fracking.pdf

The extremely low permeability (how easily fluid can flow through a rock of the rock – low means very hard to flow through) means that shales must be artificially stimulated (fractured) to enable the extraction of natural gas. An individual well pad may typically have 6 to 10 wells, although 20 wells have been reported as being on one drill pad.

Without going into all the technical detail, a basic explanation is as follows. The well is drilled down through many geological layers including the aquifers, limestone and sand stone to reach the shale. Drill cuttings are brought to the surface as drilling is done. My question is what is in these drill cuttings – are there contaminants, heavy metals or radio-nuclides and how are they disposed of in the South East. 3 layers of casings are usually put down, then cement poured down between the casings and surrounding rock. The horizontal bore is drilled through the shale. This report states that there is no casing for the horizontal section. Other reports state there is. On report states that shaped charges are pushed down the pipe to perforated holes at various locations. Another report states that a perorating gun is inserted into casing. An electric charge is sent by wire to detonate a charge in the perforating gun, which in turn, blasts small holes through the casing and cement into the shale. At this stage, large volumes of water, chemicals and sand acting as proppant (to keep the shale fissures open) are pumped down the well under very high pressure. Sinitered bauxite or ceramic beads may also be used as a proppant. The fractures allow natural gas and oil to flow from the rock into the well. A wellhead is then installed. Please see section under health relating to chemicals. Some of the above information is from Methodology on Hydraulic Fracking Stimulation- **Report for**

European Commission DG Environment AEA/R/ED57281 Issue Number 11 Date 28/05/2012

FRACTURES CAN EXTEND 600 - 900 METRES

In the report "SUPPORT TO THE IDENTIFICATION OF POTENTIAL RISKS FOR THE ENVIRONMENT AND HUMAN HEALTH ARISING FROM HYDROCARBON OPERATIONS INVOLVING HYDRAULIC FRACTURING IN EUROPE" done for the European Commission DG Environment, 2012, on Page 6 states that the "toe" of the horizontal leg can be up to 3 km from the vertical leg (Zoback et al., 2010 NPR). This suggests that a typical horizontal section can be expected to be 1200 to 3000 metres in length. This document also states that in a report by Fisher and Warpinski, 2012, a vertical fracture extended around 600 metres.
http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf

RJ Davies prepared a document "MARINE AND PETROLEUM GEOLOGY". Page 3 – Unintentional hydraulic stimulated fractures can occur, such as an underground blowout (e.g. Tingay 2003), or through injection of waste - water at high enough rates to generate pore pressures which exceed pressure required for hydraulic fracturing (e.g. Loseth et al., 2011). Page 5 – A petroleum company in the Tordis field offshore from Norway injected produced wastewater from oil production 900 metres below the surface. **This caused hydraulic fractures to extend 900 metres to the seabed.** This caused fracturing of the overburden. As the result the injection only lasted 5 ½ months and leakage to the seabed may have occurred for up to 77 days. One of the concerns is that if hydraulic fracture stimulation is allowed in the SE, then there is nothing to say that drilling down vertically onshore and then horizontally drilling under the sea will not occur in the future. **(NB fractures may extend to existing fractures creating pathways to SE aquifers)**

http://www.shale-gas-information-platform.org/fileadmin/ship/bilder/news/Davies_uncorr_proof_2.pdf

DEEPEST AND LONGEST HORIZONTAL WELL IN THE WORLD

It is interesting to note that the deepest and longest horizontal well is the Odoptu OP-11 well is NE of Sakhalin Island, part of Russia. It was drilled down 12.3 km. on shore and then horizontally drilled 11.5 km under the sea. Exxon Mobile has this project. It is interesting to note that this is just above Japan where earthquakes occur frequently, the biggest being magnitude 9 on March 11th, 2011.

http://news.exxonmobil.com/press-release/sakhalin-1-project-drills-worlds-longest-extended-reach-well

Odoptu 11 deepest and horizontally longest gas hole in the world, just above earthquake prone Japan.

UNDERSTANDING THE GEOLOGY OF SUBSIDENCE AND SINKHOLES

Sinkholes are depressions in the ground formed when Earth surface layers collapse into caverns below. They usually

form without warning. According to the Pennsylvania Department of Environment Protection sinkholes are all about water. Water dissolves minerals in the rock, leaving a residue and open spaces within the rock, known as weathering. Lowering of ground water levels also is another cause, causing loss of support for the soft material in the rock spaces that lead to collapse. It is believed that this is what happened in the case of the Nulty drill hole – the aquifer dropped, exposing the limestone roof leading to the collapse of soil down the side of the casing into the aquifer. If the groundwater gradient is changed because of removing or introducing water to the system, this can also cause loose material to flush out quicker from the voids and result in surface collapse. Putting more water in or taking it may lead to instability of the hydrologic system, leading to sinkholes. Sinkholes can result from season to season changes in the groundwater table, drought and heavy rain. Karst landscapes develop naturally through the weathering process so a sinkhole can be considered a natural occurrence. **But, human influence causes sinkholes to occur where they might not naturally have happened**.

Typical activities that can lead to sinkholes are:

- Decline of water levels - drought, groundwater pumping (wells, quarries, mines)
- Disturbance of the soil - digging through soil layers, soil removal, drilling
- Point-source of water - leaking water/sewer pipes, injection of water
- Concentration of water flow – storm water drains, swales, etc.
- Water impoundments - basins, ponds, dams
- Heavy loads on the surface - structures, equipment
- Vibration - traffic, blasting
-

All of these activities are part of the activities of hydraulic fracture stimulation, including waste - water - holding ponds. **A sinkhole is not a hole in the rock.** Sinkholes that have collapsed and subsided that are seen on the ground surface are because of the hole in the rock below. Often, you can only see soil in the hole and not the actual hole in the rock itself because the rock is too far below.

Pennsylvania department of environmental protection
http://www.portal.state.pa.us/portal/server.pt/community/sinkholes/10637/what_causes_a_sinkhole_/554362

It is clearly evidenced that a mass volume be it groundwater, oil or gas, can not be removed without there being a degree of subsidence. It is to the weight of the compaction layer, formation of subsurface and time frame of extraction that determines the severity of subsidence.

A document "DEVELOPMENT OF SINKHOLES RESULTING FROM MANS' ACTIVITIES IN THE EASTERN UNITED STATES" by John G Newton, states that **induced sinkholes result in water pollution.** Millions of dollars may be required to repair sinkhole damage i.e. houses, roads, bridges etc. **As well as loss of buoyant support from water – level declines, increase in velocity of water movement, water – level fluctuations and induced recharge result in sinkholes.** Newton says on page 1, "The most predictable development results from dewatering by wells, quarries, and mines." Sinkholes occur in soluble carbonate rocks such as limestone and dolomite (sedimentary rocks), and marble (metamorphic rock). "A natural collapse is a product of a process that can span many thousands of years. This time - frame, can be reduced to hours or days by man's activities.

According to SINKHOLES IN PENNSYLVANIA: PENNSYLVANIA GEOLOGICAL SURVEY, W F Kochanov limestone can be thick or thin, laminated, folded, faulted, fractured, or it can have various combinations of these characteristics. In addition, layers of limestone can alternate with layers of dolomite or other rock types. It is mostly calcium carbonate, we can deduce that the more calcium carbonate in a rock, the greater its reaction will be with certain acids. This is a concern with fracking chemical spills with acid. One of the chemicals used for drilling is hydrochloric acid. **Hydrochloric acid dissolves the sediments and mud solids that inhibit the permeability of the rock, to enlarge the natural pores and stimulate the flow of hydrocarbons. As it etches and dissolves limestone**, this is also another concern in the South East because if spilt at the surface, this may cause a problem with unintentional dissolving of limestone).

https://www.rigzone.com/training/insight.asp?insight_id=320&c_id=4

The BRITISH GEOLOGICAL SURVEY confirms that when there is drought or groundwater abstraction, this can cause **sinkholes because of the level of the water – table changing**. They also confirm that mining can be a factor causing sinkholes from dewatering (i.e. for mining or gas) or intercepting clay filled voids, which then collapse. **As with the likely event of what happened with the Nulty drill hole, the buoyant water support is no longer there for the cavity.** Draining the cavities will cause collapse.

http://www.bgs.ac.uk/caves/sinkholes/home.html

BAYOU CORNE SINKHOLE

NASA RADAR DEMONSTRATES ABILITY TO FORESEE SINKHOLES by Staff Writers Pasadena CA (JPL) Mar 11, 2014 Data was collected as part of an ongoing NASA campaign to monitor sinking of the ground along the Louisiana Gulf Coast. The Bayou Corne sinkhole formed unexpectedly Aug. 3, 2012. There had been weeks of minor earthquakes and bubbling natural gas. Investigations **concluded it was caused by the collapse of a sidewall of an underground storage cavity connected to a nearby well operated by Texas Brine and owned by Occidental Petroleum.** The investigation revealed the storage cavity, located more than 3,000 feet (914 meters) underground, had been mined closer to the edge of the subterranean Napoleonville salt dome than thought. The sinkhole, which filled with slurry -- a fluid mixture of water and pulverized solids -- has gradually expanded and now measures about 25 acres (10.1 hectares) and is at least 750 feet (229 meters) deep. It is still growing.

Aerial photo of a 25-acre sinkhole that formed unexpectedly near Bayou Corne, La., in Aug. 2012. New analyses of NASA airborne radar data collected in 2012 reveal the radar-detected indications of the sinkhole before it collapsed and forced evacuations. Such data may someday help foresee sinkholes. Image courtesy On Wings of Care

http://www.spacedaily.com/reports/NASA_Radar_Demonstrates_Ability_to_Foresee_Sinkholes_999.html

GIPPSLAND SUBSIDENCE

The 2008 Gippsland Coastal Board reported that land subsidence has occurred over 40 years because of the **extraction of underground water, oil and natural gas resulting in a relatively rapid collapse (compaction) of underlying strata**. Pages 4 and 32 - COASTAL SUBSIDENCE ALONG THE GIPPSLAND COAST.

There is now an increase in seismic activity in Gippsland. Land subsidence along the Gippsland coast will exacerbate the effect of sea level rise and future coastal erosion. Questions are being asked if depletion of the Latrobe Aquifer combined with land subsidence is causing seismic reactions. According to a CSIRO document "SIMULATION OF COASTAL SUBSIDENCE AND STORM WAVE INUNDATION RISK IN THE GIPPSLAND BASIN" Falling water levels in the Gippsland region have been observed since the late 1960's. There have been **associated impacts on irrigators and the wider community through potential land subsidence**. The Hatton Report concluded that fluid extraction activities have geographically variable impacts on the Latrobe Aquifer water levels.

SUBSIDENCE IN CALIFORNIA

LAND SUBSIDENCE ALONG THE DELTA-MENDOTA CANAL IN THE NORTHERN PART OF THE SAN JOAQUIN VALLEY, CALIFORNIA, SCIENTIFIC INVESTIGATIONS REPORT 2013–5142 By Michelle Sneed, Justin Brandt, and Mike Solt Page 7 - Large-scale groundwater development started around 1860 for urban and agricultural use in the northern part of the San Joaquin Valley. As the result, groundwater levels and flow patterns prior to 1860 have altered throughout the Central Valley. Groundwater levels have declined. Page 47 – Because of the extensive withdrawal of ground water in the valley, this has resulted in widespread land subsidence. The subsidence from groundwater pumping started in the mid 1920's. By 1970, subsidence had exceeded 8.8 metres, reaching 9 metres by 1981. A Canal and aqueduct as well as the associated decrease in the groundwater accounted for subsidence. Page 48 - There was a steady recovery of water levels in some areas. However during the drought periods of increased groundwater pumping resulted in declining water levels. Subsidence has affected irrigation channels.

http://pubs.usgs.gov/sir/2013/5142/pdf/sir2013-5142.pdf

In a recent agricultural magazine, an article entitled MERCED COUNTY IS SINKING; RESEARCHERS BLAME OVER-PUMPING OF GROUNDWATER by J.N. SBRANTI in 2014, the report confirms the article above. Locals are concerned with impacts of subsidence on roads, dams, railway lines, pipes and bridges. According to Michelle Sneed, the USGS hydrologist, there is a 12" of subsidence a year. USGS officials said they fear sinking ground levels will **wreak havoc on economically vital man-made structures** like the Delta-Mendota Canal, the California Aqueduct and irrigation canals that serve Merced and Madera counties. The sinking soil – called subsidence – also could **damage dams, roads, railroads, pipes and bridges.**

"Is there any concern about such undersea aquifers subsiding or collapsing when water is pumped out? A news story in Modesto, California, reported that the USGS found the ground levels above that farming region is now sinking almost a foot a year in some areas! The USGS hydrologist states that pumping apparently has increased so much that groundwater levels have fallen to new lows in Merced County. ***Sneed said that's causing layers of clay to collapse beneath the surface, which is compressing the land above. Once that happens, the aquifers can never be refilled."*** *Considering also that water weight is about the same as soil, the beginning depth of drilling would be added to the feet underneath the seabed. If part of the aquifer collapsed to allow saltier water to mix, whoever relied on that water could suddenly have serious problems."* ***"The subsidence is permanent,"*** **Sneed warned.**

http://www.modbee.com/news/business/agriculture/article3156994.html#storylink=cpy

UNDERSTANDING THE RISKS OF HYDRAULIC FRACTURE STIMULATION AND EARTHQUAKES

CHIEF SCIENTIST OF NSW WARNS THAT MAJOR FAULT LINES WILL ALMOST ALWAYS BE AVOIDED

According to "Life Cycle of Coal Seam Gas Projects: Technologies and Potential Impacts. Report for the New South Wales Office of the Chief Scientist and Engineer" prepared by Professor Peter J Cook CBE, FTSE June 2013, Cook states ***"It is also possible for fractures to propagate towards an aquifer along a pre-existing transmissive fault.*** "Cook also **states** ***"A site may be preferred because it is geologically simple; extensive folding or faulting may add***

considerably to the cost of development or limit the volume of gas-bearing coal that can be easily accessed. A site with complex hydrogeology is likely to be avoided because of the difficulties in aquifer management that might be encountered during the dewatering process. A major fault zone will almost always be avoided *because of the difficulties in predicting the subsurface conditions of the site and the prospect of this leading to increased risk and uncertainty. There is also the possibility that hydraulic fracturing or disposal of waste water at such a site could lead to induced seismicity."* **The question needs to be asked, why are licences given out in the SE that has so many faults?**

http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0008/56924/140930-Final-Fracture-Stimulation.pdf

DEEP INJECTION RISKY DUE TO FAULT LINES

There will be effects on the landscape. As previously stated, there is no adequate disposal method for brine and contaminated drilling muds. Deep injection is not acceptable, due to existing fault lines. HDPE liners in holding ponds do not last long, as demonstrated by the holding pond liners at the Panax Geothermal well of Salamander 1 – not lasting 4 years. As well as infrastructure, drilling pads, holding ponds, transport corridors will take up inappropriate areas. No well can be guaranteed 100% integrity, or be guaranteed to last 100 years or more.

SEISMOLOGICAL SOCIETY OF AMERICA – HYDRAULIC FRACTURING ITSELF ALSO CAUSES EARTHQUAKES

In January 5th 2015, a document released by the Seismological Society of America **showed that the fracking process itself, and not water re-injection, was responsible for a series of earthquakes occurring near Poland Township in Ohio.** One had a magnitude of 3 and occurred within 1 km of a group of oil and gas well where hydraulic fracturing was taking place at the time. There were pre - existing faults in the area. The activity did not create a new fault, but reactivated an existing fault. **This should serve as a warning bell with all the faults in the SE of SA.** 77 earthquakes with magnitudes from 1.0 to 3.0 occurred between March 4th and 12th 2014. The earthquakes coincided temporally and spatially with hydraulic fracturing at specific stages of stimulation.
http://www.seismosoc.org/society/press_releases/BSSA_105-1_Skoumal_et_al_Press_Release.pdf

EARTHQUAKES OVERSEAS BLAMED ON FRACKING ACTIVITIES

In the "COMPENDIUM OF SCIENTIFIC, MEDICAL, AND MEDIA FINDINGS DEMONSTRATING RISKS AND HARMS OF FRACKING (UNCONVENTIONAL GAS AND OIL EXTRACTION)" December 2014, it is stated that "A growing body of evidence, from Ohio, Arkansas, Texas, Oklahoma and Colorado, links hydraulic fracture stimulation wastewater injection (disposal) wells to earthquakes of magnitudes as high as 5.7, in addition to "swarms" of minor earthquakes and fault slipping." http://concernedhealthny.org/wp-content/uploads/2014/07/CHPNY-Fracking-Compendium.pdf

There are reports of hydraulic fracture stimulation leading to earthquakes in Canada and across the Atlantic in the United Kingdom. Since 2008, when hydraulic fracture stimulation has been taking place for shale, earthquakes have spiked in central and eastern United States. Before 2008 Oklahoma averaged just one earthquake greater than magnitude 3.0 a year. So far this year there have been 430 of them, Holland said. (2014)

http://phys.org/news/2014-11-scientists-fracking-earthquakes-heartland.html#jCp

In an article "INJECTION INDUCED EARTHQUAKES by Dr. William L Ellsworth, of the Earthquake Science Centre, Ellsworth reports that injection into deep wells can induce large earthquakes as is a higher risk and causes larger earthquakes. There was a 5.6 magnitude earthquake in central Oklahoma that destroyed 14 homes, along with other earthquakes in 2011 and 2012. This was blamed on injection wells. This activity appeared to weaken a preexisting fault by elevating the fluid pressure. If the deeper aquifer system is under-pressured with the right circumstances, this can cause fault failure by raising the water table and the pore pressure acts on the faults**. Beach Energy Ltd. has indicated that the waste - water may be re-used. Even if this is so, the used waste - water has to go somewhere eventually.**

50 earthquakes were recorded in Oklahoma in 2009. The following year, there were over 1000 but most were not felt in 2013 there were 253. According to seismologist Austin Holland of the Oklahoma Geological Survey told Reuters: "We have had almost as many magnitude 3 and greater already in 2014 than we did for all of 2013… We

have already crushed last year's record for number of earthquakes."

There have been 1562 earthquakes in past year in Oklahoma. According to the Washington Post, there were 183 earthquakes with a magnitude over 3 between October 2013 and October 2014. These have all been blamed on fracking. According to the Journal of Geophysical Research, Prague, 44 km from Oklahoma City had a 5.6 magnitude earthquake blamed on fracking activities.

http://earthquaketrack.com/p/united-states/oklahoma/recent

A 2011 fracking operation in the Bowland Shale near Blackpool, England set off 50 minor earthquakes.
In British Columbia, the industry, which uses three times more water and often at higher pressures than other shale gas formations, set off more than 200 quakes in the Horn River Basin between April 2009 and Dec. 2011.
At least 19 of the quakes ranged between a magnitude of two and three, and one reached a magnitude of 3.8, an event that surprised most scientists.

In Azle, Texas and other shale fractured landscapes, scientists suspect the culprit may not be fracking but its companion industry: dirty water disposal. A 2012 study by Cliff Frohlich, a senior researcher at the University of Texas in Austin, noted that a swarm of tremors in the Barnett Shale near Dallas were all located near deep well disposal sites. "You can't prove that any one earthquake was caused by an injection well," said Frohlich. "But it's obvious that wells are enhancing the probability that earthquakes will occur." William Ellsworth, a geophysicist with the USGS, argues that several of the largest earthquakes in the U.S. Mid-continent in 2011 and 2012 were probably triggered by the practice of disposing of salt and drilling fluids more than 10,000 feet underground in disposal wells.

HYPO-CENTRES OF EARTHQUAKES OCCUR WITHIN DISPOSAL FORMATIONS BETWEEN 2 AND 5 KM IN DEPTH

A paper "EARTHQUAKES BLAMED ON FRACKING ACTIVITIES SINCE 2008" by Keranen, Weingarten, Abers, Benkins and Ge, from the following institutions respectively - Department of Earth and Atmospheric Sciences, Cornell University, Department of Geological Sciences, University of Colorado and Lamont-Doherty Earth Observatory of Columbia University **it is stated that earthquake hypo-centres occur within disposal formations and upper basement, between 2 and 5 km depth.**

According to seismologist Dave Wolney**: "If you are doing deep well injection, you are altering the stress on the underlying rocks and at some point, (it) will be relieved by generating an earthquake."**

SCHLUMBERGER AND THE RUSSIAN ACADEMY OF SCIENCES DO STUDY ON PRODUCTION AND SEISMICITY

SEISMICITY IN THE OIL FIELD – by Vitaly Adushkin, Vladimir Rodionov and Sergey Turuntaev, Institute of Dynamics of Geospheres, Russian Academy of Sciences Moscow, Russia – it is stated that in some regions, hydrocarbon production can induce seismic activity. To help understand how production affects seismicity, a recording network was installed in a producing field in Russia. In a cooperative project between Schlumberger and the Institute of Dynamics of Geospheres at the Russian Academy the findings on page 16 were "**Few will deny that there is a relationship between hydrocarbon recovery and seismic activity, but exactly how strong a relationship exists has yet to be determined. Furthermore, what can or should be done about it sparks another debate."**

In regions of high tectonic potential energy, hydrocarbon production can cause severe increases in seismic activity and trigger strong earthquakes, as in Gazli, Uzbekistan (magnitude 7.3). In regions of lower tectonic stress, earthquakes of that magnitude are less likely, but relatively weak earth- quakes could occur and damage surface structures."

http://www.slb.com/~/media/Files/resources/oilfield_review/ors00/sum00/p2_17.ashx

There are a number of other earthquakes around the world that have also been blamed on fracking activities, including Holland but too much to include here.

LOSS OF WELL INTEGRITY

The industry likes to reassure the public that there are no problems with well integrity, because there are 3 layers of casings and three layers of cement. In fact, the opposite can be said. While cement is being poured down during construction of the well, it may hit methane under pressure. This in turn causes cement channeling to occur, and prevents proper sealing of the annulus, as the **outside layer of cement does not adhere to the rock matrix**. According to the McGraw-Hill Dictionary of Scientific and Technical Terms, the cement slurry does not rise uniformly, leaving open spaces and thus preventing a strong bond.

REPORT FOR EUROPEAN COMMISSION ON METHODOLOGY OF HYDRAULIC FRACTURING STIMULATION

As quoted from Methodology on Hydraulic Fracking Stimulation- **Report for European Commission DG Environment AEA/R/ED57281 Issue Number 11 Date 28/05/2012**

Page 36 – "Poor well construction can have important environmental consequences due to the effect that inadequate design or execution can have on the risks associated with hydraulic fracturing. The causes of groundwater contamination associated with the well design, drilling, casing and cementing stage generally relate to the quality of the well structure. **(NB added in - deterioration and age of the wells need to be also taken into account, as well as earthquake activity that can affect well integrity)** Poor casing quality can thus lead to pollution of groundwater during subsequent well development stages, such as hydraulic fracturing, flowback or gas production activities. **(NB added in - age, bacteria and hydrogen sulfide also play a role in well integrity)** The risks to groundwater posed by well construction for HVHF during the well construction stage are similar to those posed by well construction for conventional natural gas extraction."

Page 62 –" methane may have leaked from leaky gas casings at depths of up to hundreds of metres below ground, followed by migration of the methane both laterally and vertically towards the water wells." According to Considine, there were **2,988 violation notices issued between 2008 and 2011 by the Pennsylvania Department for Environmental Protection. There were 845 environmental issues.**

LOST CIRCULATION

In a document entitled "A SAFETY NET FOR CONTROLLING LOST CIRCULATION" by various authors in the petroleum industry prepared for Schlumberger, on page 20, lost circulation is defined as reduced or total absence of fluid flow up the formation casing or casing – tubing annulus when fluid is pumped down drill pipe or casing. **This is a familiar hazard when drilling and cementing in highly permeable reservoirs, depleted zones and in weak or naturally fractured vugular (small cavity in rock) or cavernous formations.** This should sound warning bells for the SE of SA, which is built on limestone and is very cavernous. Lost circulation is also referred to as seepage. Page 21 "If the borehole does not remain full of fluid, then the vertical height of the fluid drops and the pressure exerted on exposed formations decreases. As the result, another formation can flow into the well bore while the primary loss zone is taking fluid. **A catastrophic loss of well control can occur.** During cementing operations lost circulation commonly leads to inefficient cement fill in the annulus, either because of leak-off during the pumping stage or cement fall back after the pumps are shut down. When this happens, the final cement level is below the planned placement level. Lost circulation during cementing may lead to drilling difficulties in subsequent sections of the borehole or to inadequate zonal isolation. Fluid leakage or corrosion caused by poor cement placement around the casing **might not be evident for years by which time these problems become impossible to fix**. **Total lost circulation can result in a blow out.**

https://www.slb.com/~/media/Files/resources/oilfield_review/ors03/win03/p20_27.pdf

SOME DAMAGE MAY NOT BE EVIDENT FOR YEARS

"THE COSTS OF FRACKING – THE PRICE TAG OF DIRTY DRILLING'S ENVIRONMENTAL DAMAGE" – prepared for Environment Maryland Research and Policy Centre. Page 31 highlights that harm may not be detected straight away. Polluted water can often be detected early. Other damages, including health and ecosystems may not become evident for years, even decades, long after the companies and responsible individuals have left the scene. This is very serious and the Natural Resources Committee need to be very aware of this. Who will pay down the

track for damage that may not become evident for many years? We could be leaving future generations with an enormous burden, not only on health, but reliable clean water and food sources.

http://www.pennenvironment.org/sites/environment/files/reports/The%20Costs%20of%20Fracking%20vPA_0.pdf

BAD CEMENT BEHAVIOR AND LONG TERM CONSEQENCES

"WHY OIL WELLS LEAK: CEMENT BEHAVIOUR AND LONG TERM CONSEQUENCES" – by Dusseault, Gray and Nawrocki and prepared for the Society of Petroleum Engineers International. This paper also explains on page 1 that oil and gas wells can develop gas leaks along the casing years after production has stopped and the well has been abandoned and plugged. Reasons included are poor cake removal, channelling, high cement permeability and cement shrinkage. Cement leakage leads to surrounding fractures that are extended upward by the slow accumulation of gas under pressure behind the casing. The following facts are very concerning, and please note that this paper has been written for the petroleum industry. There are literally tens of thousands of abandoned, inactive or active oil and gas wells including gas wells that leak gas to the surface in North America. This is as the result of cement shrinkage. Whilst North America is the other side of the world, what needs to be considered are the 120 artesian wells that were in a poor state in the SE of SA and had to be rehabilitated. The SE cannot be thought of as exempt from the problem of cement shrinkage over time. According to this petroleum paper, much of the gas enters the atmosphere directly, contributing to greenhouse effects. Some of the gas gets into shallow aquifers where traces of sulfurous compounds cause the water to be non-potable. The methane can generate unpleasant effects such as gas locking of household bores, or gas entering household systems and coming through the taps. Because of the nature of the mechanism, according to this paper, the problem is unlikely to decrease and in fact the gas **RISKS** concentration in the shallow aquifers will increase with time.

SCHLUMBERGER REPORT – PROBLEMS EVEN AFTER A FLAWLESS CEMENT JOB

According to an OILFIELD REVIEW for Schlumberger, Autumn 2003, page 65, "even after a flawless cement job, the cement can still be damaged by the routine operation of the well. Also the mechanical properties of casing and cement vary over time. Differential expansion and contraction due to temperature, pressure or vibration can cause the bond between casing and cement to fail."

COOPER BASIN PROBLEMS – VERY MISLEADING TO SAY THERE HAVE BEEN NO PROBLEMS

There have been problems in the Cooper Basin. Please refer to the list at the end of this topic. A document "DOWNHOLE ENVIRONMENTAL RISKS ASSOCIATED WITH DRILLING AND WELL COMPLETION PRACTICES IN THE COOPER/EROMANGA BASINS" by Damien Mavroudis was written in 2001. **To say that there have never been problems in the Cooper Basins is misleading.** Although written in 2001, from other up to date reports, I understand **these problems still exist today.** On page 7, drilling fluids was seen as a problem because of the potential to infiltrate fresh water aquifers, particularly the Great Artesian Basin. Other issues, as highlighted by recent documents included microbial contamination in aquifers, biocide contamination and poor mud cake removal. Page 8 - **effectiveness of cements in achieving long-term isolation in the well bore is a major concern.** Failure mechanisms that were identified included potential mechanisms of cement failure. Other mechanisms identified included **cement carbonation due to chemical reactions, high cement permeability, sour and sweet conditions, high temperature, cement shrinkage, and formation damage**. Uncontrolled drilling fluid invasion into reservoirs penetrated by the well is another concern.

On page 19, Damien states that it is **difficult to put a time limit on the life of cement.** The cement is what provides the hydraulic seal between the formations penetrated in the well bore. On page 23 - Casing corrosion as the result of cement failure occurred as the result of exposure of the casing to corrosion mechanisms**. A blowout occurred on Della 1 in 1987. Page 25 "External corrosion of the surface casing by groundwater was thought to be the most likely** cause for the Della 1 failure. Recovered casing from Della 15 indicated that corrosion of the surface casing was from the inside and that the attack on the production casing was much more severe than that on the surface casing." Corrosive chemicals in the drilling mud that were left in the well at the time of completion were thought to be the likely cause of the corrosion**. Formation waters containing corrosive compounds were also a possible reason for failure, particularly lignosulphates in the mud, which, as they decompose, release carbon dioxide and hydrogen sulfide.** Page 30 Damien discusses **poor mud displacement** resulting in a primary cement job failing.

Voids, pockets or channels are left behind in the casing for a failed primary cementing job is poor mud displacement, which resulting insufficient hydraulic isolation between the various permeable zones. Page 45 – **carbon dioxide can cause leaching of the cement.** It also causes a corrosive environment, when it reduces the ph. of water to below 7. Page 48 – **The Della 15 well started to fail 15 years after the cement had been put in place.** Deterioration is thought to have occurred long before this time. **"Absolute favourable conditions would need to be present to ensure that cement integrity is maintained for an infinite time after well abandonment. This is never likely to occur since wellbore cement is exposed to dynamic conditions and streams of potential corrosive compounds. <u>This needs to be taken into account with 4 km drill holes in the SE, as a big question remains unanswered over the length of time casings and cement will last before inevitable well integrity failure.</u>**

INDUSTRY ADMITS ANAEROBIC BACTERIA AND HYDROGEN SULFIDE CAUSES PROBLEMS FOR WELLS

According to the document "BACTERIA IN THE OIL FIELD – THE TECHNICAL REVIEW" by Schlumberger pages 48,49 **anaerobic (free of oxygen) sulphate reducing bacteria are common and troublesome organisms.** Anaerobic bacterial metabolism has 3 main products – hydrogenase, acetic acid and hydrogen sulfide. Hydrogenase is an enzyme that causes oxidation of hydrogen in even an oxygen free environment. This converts iron from a metallic state to an ionic state that forms corrosion. **Stainless steel (used for casings) is an iron alloy with 10.5% chromium. Acetic acid forms pockets of corrosion when interfaced with iron sulfide and metallic iron. Hydrogen converts metallic iron to iron sulfide flocs. Most bacterial corrosion detected by the casing evaluation tool is caused by anaerobic bacteria. Aerobic bacteria oxidise iron causing rust. Corrosion is hastened by oxygen concentrating beneath aerobic biofilms covering metal surfaces.** As well as causing corrosion, bacteria can plug rock pores by releasing hydrogen sulfide that causes precipitation of iron sulfide flocs and by creation of **bacterial slimes.**

http://www.slb.com/~/media/Files/resources/oilfield_review/ors89/jan89/4_bacteria.pdf

Schlumberger are also responsible for another document – 'CORROSION IN THE OIL INDUSTRY". This document also covers gas. The following is quoted from the document, page 1**. 'Corrosion, the deterioration of its metals and its properties – attacks every component at every stage in the life of every oil and gas field.** From casing strings to production platforms, from drilling through to abandonment, corrosion is an adversary worthy of all the high technology and research we can throw at it…..Drilling muds left untreated will not only corrode the well casing, but also drilling equipment, pipelines and mud handling equipment. **Water and carbon dioxide – produced or injected for secondary recovery – can cause severe corrosion of completion strings. Acid – used to reduce formation damage around the well or to remove scale - readily attacks metal. Completions and surface pipelines can be eroded away by high production velocities or blasted by formation sand.'**

Page 7 'While a well is being drilled, stress is applied not only to the rig structure, but also to the drilling equipment. **Drill pipe is probably the most harshly treated of all equipment. It is exposed to formation fluids and drilling mud, subjected to stress corrosion and erosion by cuttings. Joints of drill pipe are made from hardened high strength steel and are likely to suffer from fatigue failures started by deep corrosion pits caused by oxygen, either from the mud itself or from being stacked wet.** Drill pipe is sometimes coated internally with baked resins or fusion bonded epoxies, to counteract corrosion. Once this coating has disappeared, corrosion can be rapid.

http://www.slb.com/~/media/Files/resources/oilfield_review/ors94/0494/composite.pdf

EFSA SCIENTIFIC REPORT – BIOCIDES AFFECT AQUATIC HABITATS AND ECOSYSTEMS

The adverse effects on aquatic habitats and ecosystems is a major concern. In a peer reviewed *Summary of the EFSA Scientific Report* (2008) 214, 1-54 Conclusion on the pesticide peer review of didecyldimethylammonium chloride (DDCA) prepared by Michael Morrison for the European Food Safety Authority, after testing, he found that higher concentrations of all biocides, except didecyldimethylammonium chloride, were required to kill planktonic cells of G20 that were exposed to humic acid. These results clearly indicate that biofilm formation by sulfate-reducing bacteria, as well as organic loading rates, negatively impact the desired result of biocides. DDCA was found very toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment"). This subject will be discussed further under the topic Holding Ponds. http://www.efsa.europa.eu/fr/scdocs/doc/s214r.pdf

ACCORDING TO DEP 6% OF WELLS FAIL IN THE FIRST YEAR

According to a survey on leaking wells in the Pennsylvania Marcellus shale play based on violations issued by the DEP (Dept. Environmental Protection), 6% of wells fail in the first year and the numbers climb as the wells age each year.

http://www.marcellus-shale.us/pdf/Violations_Jan-to-6-18-10_DEP.pdf

INSIGHTS FROM PROFESSOR ANTHONY INGRAFFEA Ph.D., PE

INSIGHTS ON UNCONVENTIONAL NATURAL GAS DEVELOPMENT FROM SHALE: AN INTERVIEW WITH ANTHONY R. INGRAFFEA: Professor Ingraffea is a founding board member of Physicians, Scientists, and Engineers for Healthy Energy (PSE). This board was established to have all kinds of technical expertise to observe, determine cause and prove effect. He is the Dwight C. Baum Professor of Engineering Emeritus and Weiss Presidential Teaching Fellow at Cornell University, and has taught structural mechanics, finite element methods, and fracture mechanics at Cornell for 33 years.

Page 204 -People can be exposed to the toxic chemicals in the slick water, drilling muds, flow-back water or emissions a number of ways – from deep underground, the surface and the air. On the surface, chemicals are transported to the well pad and way from the well pad with other waste products from the well pad. This involves transportation and storage. This risks spills of hazardous materials. It will involve lots of trucks and pipelines. Other contaminants come out along with the methane, and not all of it goes into the pipeline. The wells and their ancillary infrastructure, such as pipelines, storage units, compressor stations and processing stations leak. This all contributes to climate change. Page 205 - **Professor Ingraffea believes that most wells will fail eventually, during the life time of a human, leaving behind tens of thousands of leaky gaskets. Which means that everything [that] was down there sequestered now (under the earth) has a pathway upwards into an underground source of drinking water or all the way to the surface.** http://courses.washington.edu/envir300/papers/Law_and_Hays_2013.pdf

FLUID MIGRATION MECHANISMS DUE TO FAULTY WELL DESIGN AND/OR CONSTRUCTION: AN OVERVIEW AND RECENT EXPERIENCES IN THE PENNSYLVANIA MARCELLUS PLAY BY ANTHONY R. INGRAFFEA, PH.D., P.E. JANUARY, 2013 – page 2 – **"Failure to isolate sources of hydrocarbon either early in the well construction process or long after production begins has resulted in abnormally pressurized casing strings and leaks of gas into zones that would otherwise not be gas bearing.** According to page 8, violations issued by the Department of Environmental Protection and well inspector comments, 1609 wells were drilled in the Marcellus Shale in 2010, there were 111 well failures and 6.9% rate of failure. 1979 wells were drilled in the Marcellus Shale in 2011. There were 142 well failures and 7.2% well failure. **1346 wells were drilled in the Marcellus Shale in 2012. There were 120 well failures that resulted in 8.9% rate of failure**. Violations included gas and fluids from lower formations entering fresh ground water, failure to cement and case properly through storage reservoir or storage horizon, incorrect diameter of bore hole, excessive casing seat pressure, improper casing to protect fresh ground water, improper coal protection casing and cement procedures, inadequate, insufficient and or properly installed cement, failure to report defective, insufficient or improperly cemented casing, failure to case and cement to prevent migrations into fresh ground water.

More wells had failed cement jobs that reported in the above violations. Page 8 – All inspection reports as of January 2013, for more than 6000 wells drilled in the Marcellus Shale in Pennsylvania were reviewed. Many failed wells were not issued violations. They received a 'violation pending' indicated that a 'squeezing' cement repair procedure would be or was done if there was leaking on the outside of well's production casing, or comments that repairs were underway for a perforated casing, or comments that gas was detected at the well head or above the lower explosive limit**. It can not be assumed that because the well looks okay at the well head, that everything is okay that can't be seen underground. Fluid migration can occur a significant distance away from the wellhead of the well that appears, when inspecting the wellhead, that there is structural integrity.**

Key factors found by researches as having a negative influence on well integrity included rapid development of a field, disturbance of young cement due to adjacent drilling activities on the same well pad, presence of 'shallow' high-pressure gas horizons and the need for deviated wells.

According to a survey on leaking wells in the Pennsylvania Marcellus shale play based on violations issued by the DEP (Dept. Environmental Protection), 6% of wells fail in the first year and the numbers climb as the wells age each year.

http://www.marcellus-shale.us/pdf/Violations_Jan-to-6-18-10_DEP.pdf

According to a report 'DOES THE NATURAL GAS INDUSTRY NEED A NEW MESSENGER" CBN news, 29th Nov. 2011 (NB in USA all gas including shale gas is referred to as natural gas) interviewing Professor Anthony Ingraffea, the industry's PR is built on myths. Myths have at least a kernel of truth. Many highly qualified people in different fields, including the former head of the EPA, Lisa Jackson, want questions answered. **Fluid migration is not rare.** In 2009, 352,000 Canadian wells were examined, according to A SOCIETY OF PETROLEUM ENGINEERS PAPER, 2009 by Watson and Bachu. There was sustained casing pressure and gas migration. Watson and Bachu found about **12% of newer wells leaked** (even more than older wells). These industry researchers found that a substantial amount of wells leak initially, an even higher amount of wells leak eventually, and now more wells are leaking than in the past, with the problem increasing.

According to Professor Ingraffea, clustered multi-well drill pad sites are now taking up **to 10 acres or more. Some sites in Canada are taking up to 50 acres.** Drew Shindell, a NASA climate scientist shows that **methane – natural gas is 105 times more powerful than carbon dioxide as a global warming contributor over a 20 year time line, and 33 times more powerful over 100 years.** Unconventional gas drilling techniques leak MORE methane than conventional techniques. The leaks occur during drilling, fracking and flowback operations, liquid unloading, processing, and along pipelines and at storage facilities.

The leakage rate varies **between 3.6% to 7.9% during the lifetime of production of a shale gas well.** This means that from 3 to 200% greater leakage rate than from conventional gas wells. Production of shale gas creates a greater problem of global warming than coal or oil.

FLUID MIGRATION MECHANISMS DUE TO FAULTY WELL DESIGN AND/OR CONSTRUCTION: AN OVERVIEW AND RECENT EXPERIENCES IN THE PENNSYLVANIA MARCELLUS PLAY BY ANTHONY R. INGRAFFEA, PH.D., P.E. JANUARY, 2013 – page 5 - Duke University published a paper (Warner *et al.,* 2012) that documented geochemical evidence possible for natural migration of Marcellus formation brine to shallow aquifers in Pennsylvania. In 2011, the US Environmental Protection Agency released a report on Pavilion, Wyoming, showing substances used in hydraulic fracture stimulation might migrate into adjacent water-bearing strata. Methane from gas wells to nearby drinking water wells was clearly evidenced. This was caused by inadequate well construction, deficient cement work, and spills have been implicated in various states in a large number of cases of migration of drilling related substances into nearby drinking water. According to the Department of Environment on 30th June 2010, there were 565 violations for the first 6 months of June.

http://www.marcellus-shale.us/pdf/Violations_Jan-to-6-18-10_DEP.pdf

On January 9th, 2015, the latest interview from Professor Ingraffea was released on the following link. https://www.youtube.com/watch?v=fU-9_NUWyxk He discusses the relationship with earthquakes.

REPORT FROM FROGTECH ON RISKS – COMMISSIONED BY SA AND VIC GOVERNMENT DEPARTMENTS

This report was commissioned by This report was commissioned by Dept. of Sustainability and Environment, Vic, PIRSA, VIC DPI, Geoscience Australia, DEWNR, and SA Water.

The document "POTENTIAL GEOLOGICAL RISKS ASSOCIATED WITH SHALE GAS PRODUCTION IN AUSTRALIA, JANUARY 2013", page 2 " There are potential parallels with the coal seam gas industry but there are also important differences as well. However, much of the work developed for the Bioregional Assessment process for assessing the impact of CSG by the Office of Water Science may also be applicable for shale gas." The document goes on to say that 100% of shale wells need to be fracked, and that shale gas wells produce much smaller volumes of produced water (water that comes back out with contaminants etc. AED) Although it may be very saline (greater than three times seawater) and the water may contain a range of harmful chemicals which will limit treatment and reuse possibilities.

Page 18 states “The stimulated fractures may extend up to several hundred meters into the rock (Royal Society and Royal Academy of Engineering, 2012), as demonstrated by Davies et al., (2012) who reported maximum upward propagation of fractures of ~588m and ~536m in the Barnett and Marcellus Shales in the US, respectively.” “Because of the potential health and environmental risks due to induced seismicity from fracking, a blanket ban on hydraulic fracturing has been imposed in France and Bulgaria.

http://www.guardian.co.uk/world/2012/feb/14/bulgaria-bans-shale-gas-exploration”

On page 30 of the report is the following “Shales naturally have inherent low permeability and will generally act as aquitards or aquicludes limiting ground water flow. However, faults, fractures and lithological heterogeneities in the **shale and overlying and underlying units may act as preferential ground water pathways** (Myers 2012). In the document “SUPPORT TO THE IDENTIFICATION OF POTENTIAL RISKS FOR THE ENVIRONMENT AND HUMAN HEALTH ARISING FROM HYDROCARBONS OPERATIONS INVOLVING HYDRAULIC FRACTURING IN EUROPE” 2012 REPORT FOR EUROPEAN COMMISSION DG ENVIRONMENT on page ix, is the following quote –“However, the potential of natural and manmade geological features to increase hydraulic connectivity between deep strata and more shallow formations and to constitute a risk of migration or seepage needs to be duly considered.”

Also included in the report on page 62 - “the fracturing process could create new fracture pathways from the shale to the aquifer and methane gas being released to solution due to pressure reduction during extraction. This could then allow gas phase methane to migrate through the fissure network…and where the overlying formations are naturally highly fractured, and faulted.

http://www.acola.org.au/PDF/SAF06FINAL/Frogtech_Shale_Gas_Geology_and_Risks%20Jan2013.pdf

REPORT BY TOM MYERS, HYDROLOGIST

In the document “GROUNDWATER – POTENTIAL CONTAMINANT PATHWAYS FROM HYDRAULICALLY FRACTURED SHALE TO AQUIFERS” By Tom Myers, hydrologic consultant, quotes on page 3 that Osborn (2011) found systematic circumstantial evidence for higher methane concentrations in wells within 1 km of the Marcellus shale gas wells. Advective transport through sedimentary rock, faults and fractures, open boreholes and abandoned wells form potential pathways. Gas movement through fractures depends on the width of the fractures and is also a concern for carbon capture and storage. (Annunziatellis 2008 and Natural Gas storage Breen 2007). Improperly sealed water and gas wells as well as open boreholes can be highly conductive pathways. He says “Pathways for gas suggest pathways for fluids and contaminants, if there is a gradient”. **Please note natural gas is the term used in USA that also covers shale gas.**

http://www.scribd.com/doc/90528680/Fracking-Aquifers

34.0 PICTURE OF A DRILLING PAD FROM A DISTANCE OF 5,000 FEET

The following shows the aerial impact of a drilling pad from a distance of 5,000 feet.

Previous page: Drilling pad from a distance of 5,000 feet. Permission for use – Sarita Rose Upadhyay, Cornell University

35.0 REPORT FOR EUROPEAN COMMISSION DG ENVIRONMENT AEA/R/ED57281 ISSUE NUMBER 11 DATE 28/05/2012

The document "SUPPORT TO THE IDENTIFICATION OF POTENTIAL RISKS FOR THE ENVIRONMENT AND HUMAN HEALTH ARISING FROM HYDROCARBONS OPERATIONS INVOLVING HYDRAULIC FRACTURING IN EUROPE" - **Report for European Commission DG Environment AEA/R/ED57281 Issue Number 11 Date 28/05/2012** prepared for the European Commission DG Environment states the following –

Page 29 – "shale gas installations have greater scope for habitat impacts directly associated with stormwater runoff, through the impact this has on the erosion of streams, sediment build-up, water quality degradation and potentially flooding." **Page 36** - During the well construction and development phase there is a risk of subsurface groundwater contamination due to drilling muds, additives and naturally occurring chemicals in well cuttings. New York State DEC (2011 PR p6-40) identifies these risks as: suspension of solids within the water supply arising from aquifer penetration, flow of fluids into or from rock formations and natural gas migration to water supplies poses a hazard because it is combustible and an asphyxiant. The root cause lies in well integrity. . New York State DEC 2011 PR cites the preceding GEIS (New York State 1992 PR) **Page 37** –" During the drilling stage, contamination can arise as a result of failure to maintain stormwater controls (potentially leading to site-contaminated runoff), ineffective site management, inadequate surface and subsurface containment, poor casing construction or more generally well blowout or component failure events (New York State 2011 PR page 6-15)."

Page 43 – "Hydraulic fracturing can also affect the mobility of naturally occurring substances in the subsurface, particularly in the hydrocarbon-containing formation (EPA 2011a PR). The substances of potential concern include the chemical additives in hydraulic fracturing fluid, produced water, gases, trace elements, naturally occurring radioactive material and organic material. Some of these substances may be liberated from the formation via complex biogeochemical reactions with chemical additives found in fracturing fluid (Falk et al., 2006 PR; Long and Angino, 1982 PR quoted in EPA 2011a PR). If fractures extend beyond the target formation and reach aquifers, or if the casing around a Page 44 - wellbore is inadequate in extent or fails under the pressure exerted during hydraulic fracturing, contaminants could potentially migrate into drinking water supplies.

Page 46 – "Besides leakage through artificial pathways, Warner et al (2012 PR) show that there is also a possibility of leakage of fluids or gases through natural geological structures, cracks, fissures or interconnected pore spaces."

Page 48 –" New York State DEC 2011 PR (page 6-15) highlights that other spillage events could arise from tank ruptures, piping failures, equipment or surface impoundment failures, overfills, vandalism, accidents, fires, drilling and production equipment defects or improper operations." Spills of water and flowback water are also risks.

Page 49 - 'The hydraulic fracturing process is water-intensive and therefore the risk of significant effects due to water abstraction could be high where there are multiple installations. A proportion of the water used is not recovered.

Page 50 - If water usage is excessive, this can result in a decrease in the availability of public water supply; adverse effects on aquatic habitats and ecosystems from water degradation, reduced water quantity and quality; changes to water temperature; and erosion. Areas already experiencing water scarcity may be affected especially if the long - term climate change impacts of water supply and demand are taken into account. Reduced water levels may also lead to chemical changes in the water aquifer resulting in bacterial growth causing taste and odour problems with drinking water. The underlying geology may also become destabilised due to upwelling of lower quality water or other substances. Water withdrawal licences for hydraulic fracturing have recently been suspended in some areas of the United States.'

http://na.unep.net/geas/archive/pdfs/GEAS_Nov2012_Fracking.pdf

ENGINEERING REPORT ON AMOUNT OF CHEMICALS REQUIRED FOR HYDRAULIC FRACTURE STIMULATION

According to a New York City Environment Protection document Final Impact Assessment Report, December 2009 by

Hazen and Sawyer, Environmental Engineers and Scientists, a variety of chemical additives are added to fracking fluid to control fluid properties. Chemicals are often cited as making up 0.5 to 2.0 percent of the fracking fluid. For a four million gallon (15,142,000 litres) fracture operation, this translates to 80 to 330 tons (160,000 to 660,000 lbs.) (72,574.8 – 299,371 kilograms) of chemicals per well**. With this type of fracture stimulation, there has been insufficient time to conduct scientific investigations of impacts due to the process itself and unforeseeable accidents**

The exact chemical composition of many additives is not known. This is because the chemicals are listed as proprietary. As one of the LCPA members recall, this discussion came up at one of the Round Tables that she attended. As far as public knowledge, one of the companies represented on a panel was happy to have the ingredients declared to DSD, then known as DMITRE, but not for public knowledge!!
http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/12_23_2009_final_assessment_report.pdf

PICTURE OF SHALE GAS HOLDING POND

Photo 003
Distance: 3.0 miles

Shale gas holding pond in USA – permission for use Sarita Rose Upadhyay, Cornell University, New York State – please note that this picture was taken from 3 miles away.

WHERE HYDRAULIC FRACTURE STIMULATION HAS BEEN BANNED

THE NEW INTERNATIONALIST magazine, December 2013 on page 5 points out that as people are becoming more knowledgeable about the true facts on fracking and are not prepared to stand back. Resistance to this activity is in almost every country where fracking has been launched. The unconventional gas industry has painted success stories, when in fact, there are countless stories and documents now arising in the public arena on the shocking impacts that are being left behind. Bans or moratoriums are currently in place in France, Ireland, Romania, Bulgaria and parts of Canada, Spain, Argentina, and the USA. New York State has banned any potentially gas drilling for several years as data becomes available. Denton in Texas, the birth - place of fracking, has a ban. Victoria in Australia has a ban on fracking and a moratorium on conventional gas Fracking has been blamed for a number of earthquakes around the world, including Holland, the USA and other countries. It is interesting to note that in 2012 Western Australia government put a freeze on coal mining in the Margaret River area, because of concerns of aquifer and soil contamination.

http://rt.com/usa/fracking-texas-activists-concerned-510/

THE DIRTY INCIDENTS IN SOUTH AUSTRALIA THAT THE INDUSTRY DOES NOT WANT US TO KNOW ABOUT

PETROLEUM AND GEOTHERMAL ENERGY ACT COMPLIANCE REPORT 2011

Although these incidents are in South Australia, I include them because WA I believe, would be no exception.

January – (SANTOS) Separated hydrocarbon in groundwater 22 m below ground level and dissolved phase hydrocarbons in the groundwater. These were detected beneath a decommissioned burn pit adjacent to the Toolachee gas processing facility in PPL 14 in the Cooper Basin. Discovered when SANTOS was carrying out internal rehabilitation process on decommissioned sites. Root cause was because of absence of impermeable liner not installed in pit as not required in 1980's**.**

PICTURE OF SUMP WASTE WATER POND IN COOPER BASIN USED IN BEACH ENERGY SLIDE SHOW DECEMBER 2014

Since the late 1980s the main preventive action taken to prevent the reoccurrence of contamination incidents is that all interceptor and sludge storage pits and ponds must have installed a UV-stabilised reinforced polyethylene liner. One of the members contacted DSD regarding the picture of the sump waste - water pond in the Cooper Basin that has no HDPE plastic liner. Part of the reply is as follows **"**Egis Consulting (2001) undertook a risk based study into the potential for the bioaccumulation of contaminants in the meat of cattle to detectable levels following exposure to drilling fluids, cuttings and other materials associated with well completion activities for Santos Ltd. The results of the study indicated the following.

Constituents from which drilling muds are formulated are generally nontoxic or have a low effective chronic toxicity at the concentrations present in the drilling mud. They also have chemical properties, which indicate that they are unlikely to bioaccumulate in the meat of cattle. **WHAT THE PICTURE DEPICTS, ACCORDING TO THE COMPLIANCE REPORT MEANS THAT THIS IS ILLEGAL, ESPECIALLY GIVEN THAT IN THE COMPLIANCE AUDIT REPORT THAT SINCE THE LATE 1980'S ALL INTERCEPTOR AND SLUDGE STORAGE PITS MUST HAVE INSTALLED A UV-STABLISED REINFORCED POLYETHYLENE LINER.**

http://www.beachenergy.com.au/IRM/Company/ShowPage.aspx/PDFs/371910000000/BeachEnergyInvestorPresentation25November2014

In February – (SANTOS) Phase separated hydrocarbon was in groundwater 16 m below ground level adjacent to the fire water tank in the Moomba crude oil tank farm area. The contamination was attributed to a failure that occurred in November 2009 of a crude return line that connected the storage tank 1000 to the Crude Stabilisation Plant within the Moomba plant. Because of heavy rain throughout 2010, the site was inaccessible to ascertain the depth of contamination.

In March - (SANTOS) Corrosion leak on its Tantanna to Gidgealpa oil trunk line at a location 3 km from the Gidgealpa oil satellite.

In May – (SANTOS) Phase separated hydrocarbon in groundwater underneath decommissioned oily sludge storage pit – Moomba plant facility. The Moomba plant had leaked during operation. Vertical migration of contaminants through the soil profile seeped into the underlying aquifer.

In September - SANTOS reported a similar incident to the February incident in the vicinity of storage tank 1000. Then in October it was reported that 1.2 m of phase separated hydrocarbon was in the groundwater in the vicinity beneath this next leak.

In May - LINC ENERGY reported an observed uncontrolled flow of water to surface from its hydrogeological monitoring piezometer well, Orroroo 5 P2, in the Walloway Basin (within PEL 120). The source of the leak to surface was identified to be from a failed joint in the PVC casing below the surface and the primary root cause of this failure was attributed to a design flaw in well construction.

In June - LINC ENERGY reported an uncontrolled water flow to surface from 13⅜ ” and 20” casing annulus during the drilling of Hayack 1 in PEL 121. The flow rate was estimated to be ~12 L/h. The cause was identified to be a small hole in cement between 13⅜ ” and 20” casing rings.

In June - LINC ENERGY reported an uncontrolled discharge of formation water from a lined sump at Hayack 1 in PEL 121 into an area beyond the well site that had not been culturally cleared and into an adjacent mud flat. The primary cause of the discharge was inadequate design of the sump coupled with an unexpected large flow of water from Hayack 1 when drilling out the 13⅜ ” casing shoe into an unidentified aquifer.

In September - LINC ENERGY reported an uncontrolled formation water flow through the 7” and 4ó” annulus during the cementing operation of the 4ó” casing at its Wirrangulla 1A well in PEL 122. The cause of the uncontrolled flow was identified as a breakdown of formation at a weak zone below the 7” casing shoe causing the level of cement in the 4ó” and 7” annulus to drop. The subsequent drop in annulus pressure as a result of this is believed to have then allowed formation water higher up the annulus and not covered by cement to flow to surface.

In October - the APA Group identified a weeping crack on the Moomba to Sydney gas pipeline (PL 7), 91.1 km from Moomba (in SA).

In September - SANTOS reported a leak adjacent to crude oil storage tank 1000 on a separate buried crude line to that which failed in November 2009. In addition, on 9 December Santos reported a failure detected on its 10” buried crude run down line from the crude stabilisation plant to tank 3000. In the case of the 9 December crude line failure, the pipeline was immediately hydrostatically tested after the clamp was installed. Subsequent hydrostatic testing revealed another two leak locations along the line that were excavated and repaired. The primary root cause of these buried pipeline incidents was attributed to the absence of cathodic protection on the buried sections of these lines and defects in the corrosion protective polyethylene wrap at the locations where the pipes failed. Furthermore, another cause was the fact that the ongoing inspection of these lines was limited to assessments of the condition of the above ground sections with inspections of the buried sections restricted to planned excavations.

On 19 March SANTOS reported a corrosion leak on its Tantanna to Gidgealpa oil trunk line at a location 3 km from the Gidgealpa oil satellite.

On 21 April BEACH ENERGY was issued with a formal notice of noncompliance for the commencement of construction of water storage ponds at the Holdfast 1 well site without an activity notification having been submitted to DMITRE, thereby breaching section 74(3) and regulation 18 under the Act.

On 4 May BEACH ENERGY was re-issued with a formal notice of noncompliance in relation to the commencement of earthworks in the establishment of a contractors camp in PEL 92 without an activity notification having been submitted to DMITRE, thereby breaching section 74(3) and regulation 18 under the Act.

On 6 May SENEX ENERGY was issued a formal notice of noncompliance for the commencement of earthwork activities at its Growler 9 well site within Petroleum Retention Licence 15 prior to receiving written approval from the Minister, thereby breaching section 74(3) and regulation 19 under the Act.

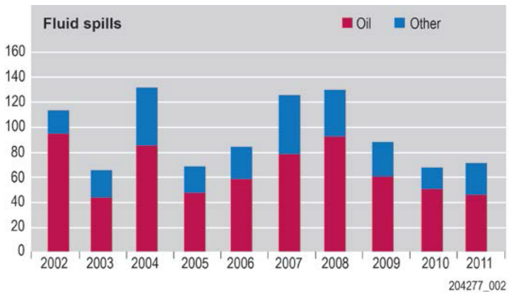
On 6 June ORIGIN ENERGY was issued a formal notice of noncompliance for the inappropriate disposal of wastewater at Celcius 1 well site.

On 8 July AHAVA ENERGY was issued with a formal notice of noncompliance when a DMITRE inspection at the Trainor Echo 1 well site (PEL 138) identified that an animal had become trapped in an open container of sump oil and subsequently died. The findings highlighted a breakdown in Ahava's management system resulting in the fauna mortality which was a clear breach of Objective 3 of the APY Lands Exploration Drilling Activities SEO.

On 18 July BEACH ENERGY was issued with a formal notice of noncompliance for extracting water from the Cooper Creek without submitting an activity notification, thereby breaching section 74(3) and regulation 18 under the Act. The incident involved four tanker loads of water being extracted from the Cooper Creek near Beach Energy's Butlers oil facility due to operational problems with the reverse osmosis plant.

On 8 August ADELAIDE ENERGY was issued with a formal show-cause letter requesting why Adelaide Energy should not be directed by DMITRE to appoint an independent and competent third party to undertake a comprehensive review of the company's management systems to demonstrate that they are fit for purpose.

On 16 September EPIC ENERGY was issued with a formal notice of noncompliance for the extraction of five tanker loads of water from the Cooper Creek near the Innamincka causeway by one of Epic's contractors without an activity notification having been submitted to DMITRE, thereby breaching section 74(3) and regulation 18 under the Act. This extraction of water from the Cooper Creek was for use during construction of the QSN3 pipeline project under PL 18.Figure 10 is a graph of all fluid spills reported since 2002 to end 2011 for the onshore petroleum and geothermal industries in South Australia. The graph shows the portion of these spills that are oil as opposed to other contaminates. The relative frequency of types of fluids spilled in 2011 is shown in Figure 11.



RED IS OIL SPILLS AND BLUE IS OTHER SPILLS

There were higher percentages of oil spills in 2001 and 2002 with two major spill incidents that occurred in those years – a pipeline leak in 2001 released 500 m3 and a breach in an oil interceptor pond wall in 2002 released 200 m3 of oil. Between 2001 and 2008 only one incident was deemed as having the potential to cause serious environmental harm and was hence treated as a serious incident under the Act.

Gas release incidents relate to uncontrolled and unintended gas releases at processing facilities and pipelines. Such incidents may be indications of equipment integrity issues that may have security of supply and/or safety implications. Eight incidents were reported during 2011, the risks associated with these releases were considered to be tolerable and hence did not warrant concern and further investigation by DMITRE.

During 2011 the four OHS&W incidents related to two small fires, a dangerous occurrence on a drilling rig and failure of a fan on a condensing unit in a gas plant. In all these cases no injuries were sustained.

Other incidents relate to all other incidents not specific to the other categories but which have the potential to adversely affect the environment and third parties (workforce, public and landowners) if no action is taken. Examples include landowner complaints, road incidents and heritage disturbance. In 2011 these included the heritage disturbance and uncontrolled flow and discharge incidents detailed in Sections 4.2 and 4.3.

During 2012 a number of serious incidents were reported under the *Petroleum and Geothermal Energy Act 2000*, and details of these incidents are provided in Section 4. These included potential aquifer contamination, potential cultural heritage disturbance, uncontrolled flow and pipeline integrity incidents.

There were failures that occurred on Santos' glass reinforced epoxy pipelines.

In August 2012 Santos had commenced the construction of the Cook (Qld) to Merrimelia (SA) pipeline (PL 20) in the Cooper Basin. This pipeline was of interest to DMITRE due to the increased inherent risk associated with the environmental sensitivity of the route and the relatively new construction material (spoolable composite pipe) used. Santos and its joint venture partners, as licensees of the now expired PELs 5 and 6, have set aside funds to offset the residual environmental effects of their seismic exploration activities in the Merninie Range, to the north of Innamincka.

During 2012 Beach Energy separately reported two cultural heritage incidents. On 21 June 2012, during the final phase of the Boston 1 well lease construction within PEL 218, sump spoil was pushed over a cultural heritage exclusion zone while the flare pit was being excavated. − _On 13 August 2012, during the construction of the Marble 1 well lease access within PEL 218, a cultural heritage exclusion zone was disturbed. A 6.5 m wide access track was constructed where a condition exists for a width restriction of 3 m access.

On 3rd July 2012 DMITRE inspected Panax Geothermal Salamander 1 well site and detected a gas leak from the wellhead. A subsequent inspection showed a second smaller leak. Gas sampling found the gas methane rich. The cause of the leak was due to a short un - cemented section behind the 9 . 5/8" casing below the 13.3/8" shoe and failure of the 9.5/8" liner packer resulting in a loss of pressure containment.

On 9 January 2012 Santos reported a leak on the Carmina 1 flow line, made of glass-reinforced epoxy.

In 2012 Santos reported 17 flow line failures (pinhole leaks) on their 5000 km steel flow line network in the Cooper Basin. Such failures are defined as serious incidents under the currently gazetted Cooper Basin Processing and Production SEO. The failure mechanisms related to internal and external corrosion, with the primary root cause being inadequate monitoring and maintenance.

On 18 and 20 November 2012 Beach Energy reported two pipeline failures during the commissioning of the Lycium to Moomba pipeline.

In September 2011, Santos reported a leak adjacent to crude oil storage Tank 1000 on a separate buried crude line to that which failed in November 2009. December 2011 Santos reported a failure detected on its 10" buried crude run down line from the crude stabilization plant to Tank 3000. These incidents were attributed to the absence of cathodic protection on the buried sections of these lines and defects in the corrosion protective polyethylene wrap at the locations where the pipes failed.

On 12 January 2011 Santos reported that phase separated hydrocarbon on groundwater at ~22 m below ground level and dissolved phase hydrocarbons in the groundwater had been detected beneath a decommissioned burn pit adjacent to the Toolachee gas processing facility within Petroleum Production Licence 14 in the Cooper Basin. May 2011 Santos reported phase separated hydrocarbon on groundwater underneath another decommissioned pit – the oily sludge storage pit at the Moomba plant facility.

The primary root cause for the Toolachee incident was the absence of impermeable liners in the pit, as this was not a design requirement at the time the pit was constructed in the early 1980s. The oily sludge pit at the Moomba plant is lined but leaked during operation. This allowed for vertical migration of contaminants through the soil profile and hence seepage into the underlying shallow aquifer. **The main preventive action taken to prevent the recurrence of such incidents is the requirement since the late 1980s that all interceptor and sludge storage pits and ponds must have a UV stabilised reinforced polyethylene liner installed.**

On 12 September 2011 Santos reported a second buried line leak adjacent to crude oil storage Tank 1000 on a separate crude line to that which failed in November 2009. As a result of this line failure, on 17 October Santos

reported that 1.2 m of phase-separated hydrocarbon was detected on groundwater in the vicinity beneath the location of this leak.

On 28 November 2012 Santos was issued with a formal notice of noncompliance for undertaking an activity, the partial replacement of 2 km of the Moomba to Port Bonython liquids pipeline, **without distributing formal notice of entry letters to relevant landowners, thereby breaching section 61 of the Act.**

On 15 November 2012 Acer Energy was issued a formal notice of noncompliance for the construction of Cypress 1 Well lease within PEL 103 **without issuing relevant notice of entry letters to landholders**. A notice of entry letter issued did not reference Cypress 1 well lease or illustrate the location of the well lease. This is a breach of section 61 of the Act and regulation 22 detailing the required contents of written notice of entry on land.

On 15 November 2012 Senex Energy was issued a formal notice of noncompliance for the construction of Tomcat A well lease within PEL 111 without written approval by the Minister, thereby breaching section 74(3) of the Act and Regulation 19. Senex Energy had been given approval to construct a different well lease, Tomcat 1.

On 19 March 2011 Santos reported a corrosion leak on its Tantanna to Gidgealpa oil trunk line at a location 3 km from the Gidgealpa oil satellite.

Gas release incidents relate to uncontrolled and unintended gas releases at processing facilities and pipelines. Such incidents may be indications of equipment integrity issues that may have security of supply and/or safety implications. In the case of the 15 incidents reported during 2012.

PETROLEUM AND GEOTHERMAL ENERGY ACT COMPLIANCE REPORT 2009

On the 24th April 2009, the Habanero 3 well within Geothermal Retention Licence (GRL) 3 near Innamincka in the north east of South Australia operated by Geodynamics Ltd experienced a serious failure at the surface and intermediate casing strings just below the well head. This resulted in an uncontrolled flow (blow-out) of steam and 14 ML of produced water to the surface, hence constituting a serious incident under the Petroleum and Geothermal Energy Act. Subsequent investigation into the incident revealed that the principal cause of the failure was hydrogen embrittlement of the 9 5/8 and 13 3/8 inch casing strings within the well. It was found that two factors most contributed to material failure of the casing deployed in Habanero 3; the high carbon steel casing composition combined with the operating conditions (and in particular heat flux) in the well made the casing susceptible to hydrogen embrittlement.

In April 2009, through routine monitoring, a minor uncontrolled water leak to surface was detected and reported to PIRSA by Santos at its abandoned Tirrawarra 3 well site. The source and location water leak was due to a lack of isolation integrity of existing perforations below 5400 feet.

In August and September 2009 two spills of bore water from storage ponds into adjacent salt lake areas from the Chiton and Murninnie exploration well sites operated by Beach Energy Ltd within its PEL 91 and 92 exploration areas respectively in the Cooper Basin were reported. In both cases the spills constituted a serious incident mainly as a result of the spills encroaching onto areas that were outside the area specifically cleared for the well lease.

On the 4th October 2009, a leak was detected followed by an investigation and analysis concluding that the Habanero 3 well had a leaking annulus and the gas contained 98% methane. The manifestation of the leak was benign and small (less than 0.0012 Million standard cubic feet per day) with a low flowing pressure. The gas was making its way up through the annulus between the 9-5/8 inch and 13-3/8 inch casing strings.

PETROLEUM AND GEOTHERMAL ENERGY ACT COMPLIANCE REPORT 2008

Drilling rig PDI 709 fatality, 27 January. On 27 January 2008 a fatality occurred on drilling rig PDI 709 while contracted to Santos for drilling Mudera 12 in the Cooper Basin.

Moomba Plant gas supply outage, 18 August. At 1 pm on 18 August 2008 gas supply from the Moomba Plant into the Adelaide and Sydney pipelines ceased as a result of a detected gas leak in the main sales gas line immediately

upstream from the Adelaide (MAP) and Sydney (MSP) pipelines' flow control valves. The leak was a result of a crack on a weld connecting a small bore gas-sampling line to the sales gas line.

Victoria Petroleum NL (Victoria Oil Exploration (1977) Pty Ltd) — Tigershark 1 abandonment noncompliance. Victoria Petroleum was noncompliant with the 'South Australian Cooper Basin drilling and well operations SEO' (November 2003) during the abandonment of Tigershark 1 (PEL 104) by not setting a plug isolating the Birkhead–Hutton–Poolowanna units from the basement (Warburton Basin). PIRSA issued a letter of noncompliance on 21 November. **There were other incidents as well for 2008, 2007 and 2006 including the leaking wellhead at Salamander 1 well in the South East. Do the residents of the South East want to risk contamination in their water and on the land and have similar incidents happening as listed in this submission? The answer is a clear no. Even in South Australia there is clear evidence, from the government's own site, to show the flaws in the system and contamination that should have never happened. For other evidence found in government annual compliance reports, please click on the following link –**

http://www.pir.sa.gov.au/petroleum/legislation/compliance/petroleum_act_annual_compliance_report

AUSTRALIA HAS BEEN AT RISK BEFORE OF LOSING ITS CLEAN AND GREEN IMAGE AND EXPORT MARKETS

1987 – ORGANOCHLORINE residues detected in beef shipped to USA. Since then Aust. Beef exporters have lost $millions due to chemical contamination concern. http://www.ibiblio.org/london/agriculture/forums/sustainable-agriculture2/msg00757.html

1994 – HELIX (CHLOROFLUAZURON) cotton chemical contamination near Moree. Cattle contaminated from eating cotton trash. USA, Japan, Canada, Taiwan & Korea impounded 60,000 tonnes Aust. Beef for testing. Japan took beef off the shelf. 1996 calves were contaminated with chlorofluazuron from mothers.

1996 – ENDOSULFAN contaminated beef in Moree area again. 30 herds of cattle and also 100 carcasses were destroyed.

My father, a grazier, had lucijet banned. Japan would not buy any Australian wool that had been sprayed with it.

HUMAN RIGHTS

The Australian Human Rights Commission Act 1986 needs to be taken into account by the Federal Government. 'No one shall be subjected to torture, or to cruel, inhumane or degrading treatment or punishment. No one shall be subjected without his free consent to medical or scientific experimentation', yet this is exactly how families are feeling in the vicinity of gas and mining operations. Their lives are degraded and they are the guinea pigs without giving permission. At the Federal Level, the Australian Government has an obligation, under international law, to respect, protect and fulfil human rights. The Government must also refrain from action that would breach people's rights.

https://www.humanrights.gov.au/our-work/legal/legislation

LEGISLATION FOR ACROSS AUSTRALIA

I believe that I have presented enough clear, concise, and irrefutable evidence here to show that legislation and regulations are totally inadequate and failing across Australia. Having the EPBC Act 1999, the Biodiversity Act 1993, and the Native Title Act at the Commonwealth level is meant to serve as a stop-gap, but appears ineffective in protecting our environment. I believe other legislation needs to be tightened at State level, and come in to play at a Federal level, to mitigate further unacceptable disasters that have already occurred across Australia.

Australia does not need any more Chinchilla episodes, both from the coal seam gas activities and underground gasification, and any further suicides. What the governments fail to recognise is the emotional toil and stress on many thousands of Australians, who are doing their very best at standing up for our precious land and water. I know I have had enough of this nonsense for 9 years and believe many others feel the same. Most of us don't get paid, and the financial costs are high. The personal sacrifices and man-hours have been enormous, and it would be great if

we did not have this cloud over our head, and we could get on and enjoy family life and pleasures, and continue to farm, grow sustainable clean and green food, and enjoy life without the interference of inappropriate gas and mining activities.

http://www.todaytonightadelaide.com.au/stories/fracking-investigation Professor Ingraffea

http://www.todaytonightadelaide.com.au/stories/fracking-debate Anne and Mariann Lloyd Smith

http://www.abc.net.au/landline/content/2014/s3955001.htm Story on SE drill hole subsidence.

CONCLUSION

Clean, potable water is our most valuable resource on earth. Without it, we cannot survive. It is necessary to sustain us for food and drinking. Already there are 700 million people in 43 countries of the world that are suffering from water stress and scarcity. This will increase, particularly as salinity increases, rainfall decreases, we face a hotter climate, the population grows and precious lakes, streams, rivers and aquifers continue to be polluted, much at the expense of big industry, including mining and petroleum industries. Even our own state government acknowledges water shortages ahead.

As the science is already in on scarcity of water, and predicted climate change with increasing temperatures and forecasts of declining rainfall, the government in South Australia needs to put preservation of water at the top of its agenda. Lack of water also affects the economy.

Is the Western Australian Government going to permit the irrigation holding ponds wastewater on agricultural land?

No one can control what is happening under the ground. Who is going to foot the bill for problems in the future, which may occur long after the companies are gone? Where does Western Australia get water from once it is contaminated?

The following quote also applies to Western Australia:

"Healthy water is fundamental to our way of life and environment. It underpins our economy and growth in population which are critical to South Australia's future prosperity."

Quote from SCOTT ASHBY, Former Chief Executive, Department For Water, South Australia