

Inquiry into Unconventional Gas (Fracking) – Pursuant to section 16(1)(a) of the *Parliamentary Committees Act 1991*. Potential risks and impacts in the use of hydraulic fracture stimulation to produce gas in the South East of South Australia

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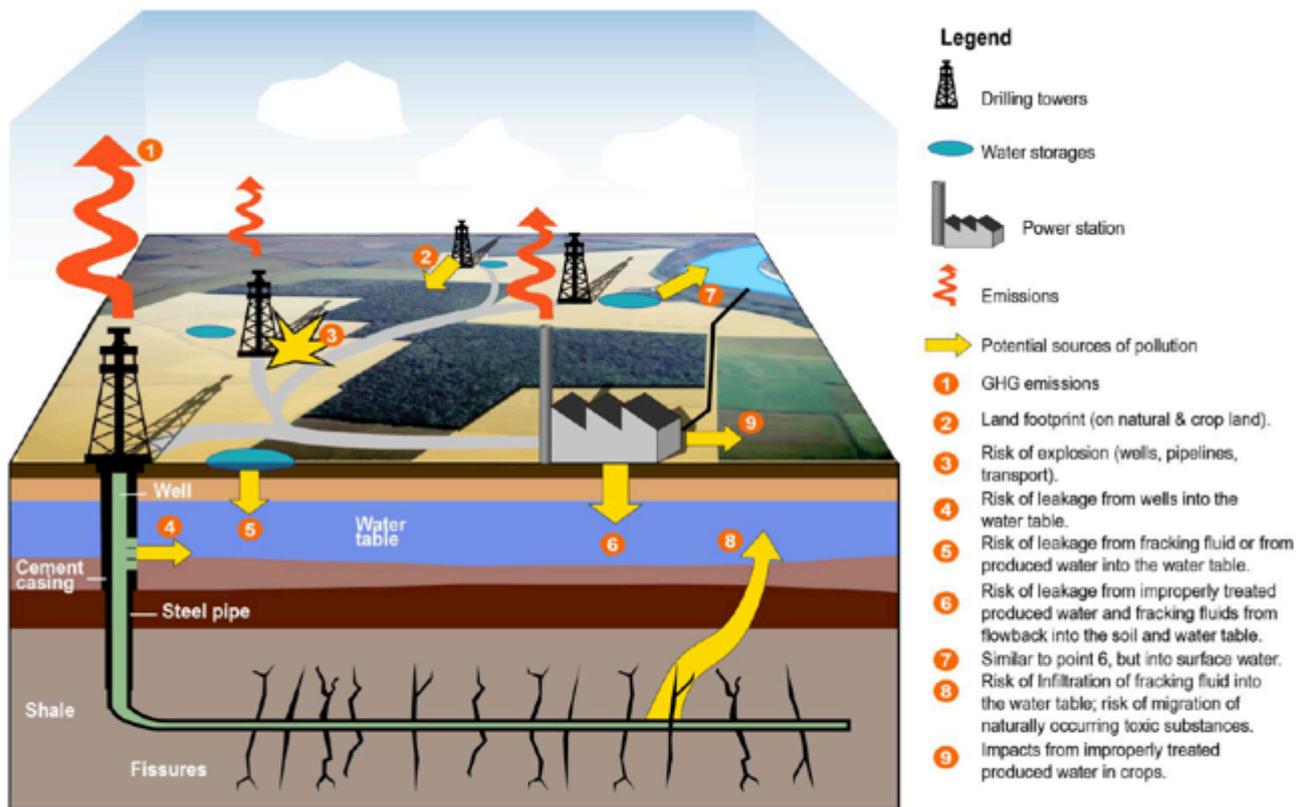


Figure 4: Schematic representation of infrastructures and potential impacts. Source: UNEP/GRID-Geneva, 2012.

PARLIAMENTARY INQUIRY INTO UNCONVENTIONAL GAS (FRACKING) AED

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I wish to thank the Natural Resources Committee of Parliament for the opportunity to put in a submission in regard to the Inquiry into Unconventional Gas (fracking) in the South East. Currently, I am serving as the only agricultural advocate on the Round Table for Unconventional Projects in South Australia that attends. 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 many meetings, conferences and lectures at state and local level, including government. My involvement at all levels 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 cover the topics for this submission in the following order.

Effectiveness of existing legislation and regulation

The potential net outcomes to the region and the rest of the state

Risks of groundwater contamination (part 1 and part 2)

I have treated the legislation and regulation and risks of ground water as my primary topics, that I am very well informed on, having attended lectures, meetings and conferences in these areas. No doubt you will receive many submissions with economic figures. Rather than be repetitive, I have chosen to put in a couple of significant quotes on our food and wine export business. One comes from PIRSA, and a more detailed quote comes from Premier J. Weatherill. Landscape often also crosses over with water and there is no sense in repeating information all over again. There is an excellent section on landscape in the Limestone Coast Protection Alliance submission. I authored 'Risks of groundwater contamination' in the Limestone Coast Protection Alliance submission, and although set out slightly differently as far as topic numbering, the information presented here is the same. At the back of this submission, I have added an article from 'The Tye', 30th January, 2015 regarding an earthquake caused by hydraulic fracture stimulation, that I believe to be important. I presume, being so recent, you will not see this in other submissions. I have also added a final conclusion that does not appear in the Limestone Coast Protection Alliance submission.

SUBMITTED BY:

Anne Elizabeth Daw

SUMMARY:

The South East of South Australia makes up 2.2% of the state (almost half of the State's prime agricultural land). I believe that legislation in South Australia is dysfunctional in regard to unconventional gas and hydraulic fracture stimulation, also known as 'fracking'.

If there is no mention of the words 'fracking' or 'hydraulic fracture stimulation', and no specific description of 'fracking' or 'hydraulic fracture stimulation', in any Acts or in the Petroleum and Geothermal regulations, the question needs to be asked - is hydraulic fracture stimulation legal in South Australia?

Unconventional gas extraction is generally governed by the provisions of the Petroleum and Geothermal Energy Act 2000. There is no specific legislation that deals with hydraulic fracture stimulation or 'fracking' in South Australia. The words 'hydraulic fracture stimulation' do not appear in the Act. The word 'fracking does not appear anywhere in the Act. There is no accurate description anywhere of hydraulic fracture stimulation in the Act.

In the Petroleum and Geothermal Act 2000: Licensing Regulated Activities: Part 3:10 (3) (c) 3 (c) *the injection of water or some other substance into a natural reservoir in order to enhance production of petroleum or another regulated substance*; This section may be viewed as hydraulic fracture stimulation, but should not be interpreted that way. **Proper explicit description for hydraulic fracture stimulation should be included for accuracy. Hydraulic fracture stimulation should be named in a legislative document if this is the true meaning. No mention is made of chemicals and proppant. In other words, 'water or some other substance' could mean anything. There is no mention of substances being injected together. Also, the definition of a reservoir is 'a natural or artificial lake or storage pond'. Shale has minuscule pores between grains that make up the rock matrix. These are not pools or reservoirs, therefore there are no 'natural reservoirs' that are in the shale. The gas is only released after hydraulic fracture stimulation. Therefore, this section of legislation has failed to include hydraulic fracture stimulation under the Petroleum and Geothermal Energy Act 2000.**

Government at all levels in Australia must take responsibility for meeting 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 has not been taken into account across the board.

The Environmental Protection Act does **not apply to petroleum exploration activity** undertaken under the Petroleum and Geothermal Energy Act 2000 or to **wastes produced in the course of an activity** authorised by a lease or licence under the Petroleum and Geothermal Energy Act when produced and disposed of to land and contained within the areas of the lease or licence.

No specific state-wide policy framework exists in South Australia regarding the protection of agricultural land. There is a policy template for S.A., but because there is no clear definition of prime agricultural land, the template cannot be used effectively in response to threats to prime agricultural land.

There is clearly a conflict of interest in regard to mineral and petroleum resources and agricultural land. The Department of State Development is the issuer of licences, the promoter of projects and the regulator. There is no law in South Australia that would preclude responsible development in the public interest. In other words, a lifetime of commitment to agriculture is down the list from the minerals and gas sector.

There are numerous other Acts that should be applied for hydraulic fracture stimulation besides the Petroleum and Geothermal Act 2000 and the Environmental Protection Act 1993. What also needs to be considered is jurisdiction under the United Nations: the Naracoorte Caves National Park is listed internationally under the United Nations Educational and Cultural Organization (UNESCO) agreement.

While petroleum exploration is occurring, contamination, odour and other incidents do not come under the Environmental Protection Act 1993. Pursuant to section 98 of the **Petroleum and Geothermal Energy Act 2000** (the Act) the Minister must classify the regulated activities covered by a prepared Environmental Impact Report (EIR). Exploration of unconventional gas in the South East of SA was rated by the Minister as low impact. Low impact

activities **do not require public consultation** and are subjected to a process of internal government consultation and comment on the EIR and SEO prior to approval. To classify exploration that is going down 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, should not be classified as 'low impact'. **Classification of impact needs to be scrutinized by an independent body and not assigned at the discretion of DSD or Minister.**

This month, there were 400 scientifically peer-reviewed papers published in regard to hydraulic fracturing stimulation activities, with nothing stating that this is a safe process.

The taking of water for petroleum exploration anywhere in the State is authorised without a licence, under Section 128 of the NRM Act. **Regulation guidelines may be formed on the basis of limited or incomplete data, from the petroleum companies themselves.** This is certainly the case in the South East of South Australia.

National Parks and Wildlife Act 1972 and other acts which include the **Crown Land Management Act 2009, Native Vegetation Act 1991 and the Wilderness Protection Act 1992.** All of this legislation is over-ridden by the **Petroleum and Geothermal Act 2000.** Approximately 74 per cent of onshore-protected areas allow access for mineral, geothermal and petroleum exploration and development.

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.

In the DMITRE SUBMISSION TO THE INQUIRY INTO MINERAL AND ENERGY RESOURCE EXPLORATION, DMITRE (DSD) **notes that lack of knowledge should not necessarily lead to a ban on exploration activity.** This is a shocking admission. In other words, it appears that DSD don't want to take on any precautionary principle and just want to go 'blindly ahead'. This is particularly concerning for the South East of SA.

'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 Petroleum Industry at an international level. 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 **unconventional gas has higher production-related greenhouse-gas emissions than conventional gas,** and 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.

The South East of South Australia is on limestone, which may be brittle and porous. Limestone is prone to subsidence and sinkholes and exacerbated by mining, drilling and hydraulic fracture stimulation (please refer to section under Water). The South East is full of fault lines. Already Beach Energy Ltd. has been drilling through the faults. This is unacceptable as plenty of evidence is that hydraulic fracturing stimulation activities, as explained in detail under the topic on water, is triggering earthquakes. The South East has already experienced seawater intrusion and can not afford to be put at further risks with even faster declining aquifer levels as the result of hydraulic fracture stimulation activities.

EVERY ACT 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 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 South East. I recommend, to the Natural Resources Committee based on reliable evidence in my submission, that hydraulic fracture stimulation in the South East of South Australia be banned.

1.0 RESPONSIBILITY 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. I believe the current laws in South Australia fail to address future needs. Legislation needs to be up-dated. Geological science has not been taken into account across the board.

2.0 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.

3.0 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, Local Government and the Department of State Development. The laws were established long before unconventional gas and “fracking” was ever heard of or discussed in the South East of South Australia.

4.0 ‘HYDRAULIC FRACTURE STIMULATION’ DOES NOT APPEAR IN ANY ACT OR REGULATIONS IN SA

If there is no mention of the words ‘fracking’ or ‘hydraulic fracture stimulation’, and no specific description of ‘fracking’ or ‘hydraulic fracture stimulation’, in any Acts or in the Petroleum and Geothermal regulations, the question needs to be asked - is hydraulic fracture stimulation legal in South Australia?

Unconventional gas extraction is generally governed by the provisions of the Petroleum and Geothermal Energy Act 2000 but there is no specific legislation that deals with hydraulic fracture stimulation or ‘fracking’ in South Australia. The words ‘hydraulic fracture stimulation’ do not appear in the Act. The word ‘fracking does not appear anywhere in the Act. There is no accurate description anywhere of hydraulic fracture stimulation in the Act. The definition of PETROLEUM - ‘petroleum means a naturally occurring substance consisting of a hydrocarbon or mixture of hydrocarbons in gaseous, liquid or solid state but does not include coal or shale unless occurring in circumstances in which the use of techniques for coal seam methane production or in situ gasification would be appropriate or unless constituting a product of coal gasification (whether produced below or above the ground) for the purposes of the production of synthetic petroleum;’

Petroleum and Geothermal Act 2000: Licensing Regulated Activities: Part 3:10 (3) (c) (c) *the injection of water or some other substance into a natural reservoir in order to enhance production of petroleum or another regulated substance; This section may be viewed as hydraulic fracture stimulation, but should not be interpreted that way. The wording is not explicit and needs to be explained fully for accuracy. Hydraulic fracture stimulation should be named in a legislative document. No mention is made of chemicals and proppant. In other words, ‘water or some other substance’ could mean anything. There is no mention of substances being injected together. Also, the definition of a reservoir is ‘a natural or artificial lake or storage pond’. Shale has minuscule pores between grains*

that make up the rock matrix. These are not pools or reservoirs, therefore there are no 'natural reservoirs' that are in the shale. The gas is only released after hydraulic fracture stimulation. Therefore, this section of legislation has failed to include hydraulic fracture stimulation under the Petroleum and Geothermal Energy Act 2000.

Hydraulic fracture stimulation for commercial shale gas extraction that commenced in South Australia with the Moomba 1 shale gas well in the Cooper Basin in 2012 has no specific legislation covering it under the Petroleum and Geothermal Energy Act 2000. To allow this technique to be occurring without specific legislation and adequate description begs the question of how lawful this process is. I cannot find hydraulic fracture stimulation mentioned by name in the Petroleum and Geothermal Energy Regulations 2013, or in any other Act in South Australia.

5.0 OTHER LEGISLATIVE FAILURES

Exploration activities that are approved under the Petroleum and Geothermal Energy Act 2000 **do not require approval under the Native Vegetation Act 1991 for clearance of native vegetation.**

The Environmental Protection Act does **not apply to petroleum exploration activity** undertaken under the Petroleum and Geothermal Energy Act 2000 or to **wastes produced in the course of an activity** authorised by a lease or licence under the Petroleum and Geothermal Energy Act when produced and disposed of to land and contained within the areas of the lease or licence. **This legislation is not acceptable.** DSD, the regulator, I believe, has a conflict of interest.

6.0 GEOLOGICAL SCIENCE EVIDENCE

The geological evidence in relation to limestone that is prone **to subsidence and sinkholes, seawater intrusion and fault lines is well documented in the South East.** Because of these reasons alone, not even taking into account the serious health impacts on humans and animals, the land in the South East of South Australia should be exempt from all hydraulic fracture stimulation activities.

7.0 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, as stated by Department of State Development (DSD). **This important point seems to have been lost along the way.** This adds a burden on the Australian economy and will continue to burden the economy as gas projects increase.

8.0 NO SPECIFIC STATE-WIDE POLICY FRAMEWORK EXISTING IN SOUTH AUSTRALIA

Under the Australian constitution, the Australian government does not generally have power to make decisions about land use, although there are circumstances where some powers exist. According to an Australian Farm Institute research paper (May 2012) 4.3.1 *'No specific state-wide policy framework exists in South Australia (S.A.) regarding the protection of agricultural land'*. 4.3.2 There is a policy template for S.A., but because there is no clear definition of prime agricultural land, the template cannot be used effectively in response to threats to prime agricultural land. According to a chart (4.1), S. A. is the only state in Australia to have no specific state policy or state strategy references to agricultural land.

9.0 SOUTH EAST AREA ONLY 2.2% OF THE STATE

According to a recent veterinary publication, **nationally there is only 4% of prime agricultural and cropping land that is not pastoral or irrigation dependant.** Analysis of Agricultural Commodity Statistics 2011 reveal that **South Australia has 4.6% prime agricultural land and cropping areas outside of pastoral areas, and includes irrigation areas.** The South East of South Australia makes up 2.2% of the state (almost half of the State's prime agricultural land)

http://data.daff.gov.au/data/warehouse/agcstd9abcc002/agcstd9abcc0022011/ACS_2011_1.0.3.pdf

10.0 PETROLEUM AND GEOTHERMAL ENERGY ACT 2000:

Petroleum and Geothermal Energy Act 2000 Section 60: Part 10

RIGHT OF ENTRY TO LAND:

A licensee may, subject to this Part:

- (a) enter land to carry out authorised activities on the land; or Petroleum and Geothermal Energy Act 2000—27.9.2012
- (b) enter land for the purpose of gaining access to adjacent land on which the licensee proposes to carry out authorised activities.

Note section (b): The licensee for Petroleum activities is able to enter adjacent land, if the only way they can access their licensed area is through the neighbour's property. This is a failure of the right to say no to access for the adjoining land-owner or farmer, and this legislation needs to be amended.

Petroleum and Geothermal Energy Act 2000 Section 61:

Notice of entry on land:

- (1) A licensee must, at least 21 days before entering land under this Part, give written notice to each owner of the land, in the form required by the regulations—
 - (a) of the licensee's intention to enter the land; and
 - (b) if the licensee proposes to carry out regulated activities on the land—of the nature of the activities to be carried out on the land.

As far as I am aware, there are no access forms produced by DSD for petroleum and geothermal energy exploration, as is the case under the Mining Act 1971 which has Form 21 – entry onto land. Although there are stipulations regarding what is to be included on a form, as far as I am aware, the Petroleum Companies write their own forms for entry onto land. **A formal land access form should be required by legislation under the Petroleum and Geothermal Energy Act 2000.**

11.0 NATURAL RESOURCES AND MANAGEMENT ACT 2004:

Chapter 7—Management and protection of water resources:

Part 1—General rights in relation to water:

124—Right to take water subject to certain requirements:

- (3) However, subject to subsections (4), (6) and (6a)—
 - (b) a person must not take water from a watercourse, lake or well that is not prescribed if to do so—

- (i) would detrimentally affect the ability of another person to exercise a right to take water from the watercourse or lake or from the same underground aquifer; or

- (ii) would detrimentally affect the enjoyment of the amenity of water in the watercourse or lake by the occupier of land

Hydraulic Fracture Stimulation should not be allowed in the South East of SA, because of this section of the NRM Act 2004. **There is no way that petroleum companies can prove that hydraulic fracture stimulation WILL NOT detrimentally affect the ability of another person to exercise a right to take water from.....the same underground aquifer: When looking at peer-reviewed scientific evidence, the complete opposite is the case.**

12.0 ENVIRONMENTAL PROTECTION ACT 1993:

Environmental Protection Act 1993 Part 4:

25 - General Environmental Duty:

(1) A person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

This piece of legislation is weak and needs to be tougher. If there can not be 100% guarantee that there will not be any resulting pollution resulting in environmental harm, as the result of an activity that pollutes or may pollute the environment, then the activity such as hydraulic fracture stimulation should not be allowed to proceed, especially in the South East on prime agricultural land, that depends on the potable underground water. Evidence in peer-reviewed scientific papers show that in fact, the opposite is true. Hydraulic fracture stimulation activities result in air, water and soil pollution.

13.0 CONFLICT OF INTEREST

There is clearly a conflict of interest in regard to mineral and petroleum resources and agricultural land. The Department of State Development (DSD) (formerly known as Department of Manufacturing, Innovation, Trade, Resources and Energy) is the issuer of licences, the promoter of projects and the regulator.

This following statement was made by Geoff Knight, Chief Executive, DMITRE, in the South Australian Major Developments Directory, 2012, 2013. “We are also working closely with investors interested in the potential of mature petroleum-producing basins such as the Otway, Eromanga and Cooper Basins, as well as in frontier plays” **How can a department work closely with investors, and then claim to have the best interests at heart for farmers, vigneron, landholders, orchardists etc.**

14.0 NEED FOR OVERHAUL OF LEGISLATION REGARDING RIGHTS OF LANDHOLDERS

All Acts of legislation that I have looked at do not mention hydraulic fracture stimulation. **These Acts need to be urgently amended in this area to mitigate the industry and DSD issues.** Currently, there appears to be lack of genuine care 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. Both the mining industry and petroleum industry and DSD needs to come under tighter scrutiny. **Up until recently, most farmers and landowners regarded these industries as ‘all powerful’ and based on previous evidence that I have been told in person, that they were unable to fight successfully for their rights to keep mining and petroleum companies off of their valuable land.** I do not believe this should be the case. The other issue is that often landowners do not have sufficient funding for the cost of court cases. Landowners end up in the Wardens Court and are unable to take the case further, as they are up against wealthy mining and petroleum companies who usually end up having the better outcome. In most cases, as I understand, people don’t want to be compensated, they just want to be left alone to get on with farming life, without the interruptions and hazards of the resources industries. I believe it is unconstitutional that the farmers and landowners only own only the top few centimetres of soil. I believe that there needs to be a complete overhaul of the South Australian legislation in regards to farmers’ and landholders’ rights, so that there is an equal playing field. There should also be legislation giving all landowners in the South East the right to say NO to unconventional gas and hydraulic fracture stimulation on their land. This legislation should also apply to neighbours and community to say no as well, as impacts are much further reaching than the landowners who may have gas wells on their properties. The risk is that South Australia could become unsustainable for food security.

15.0 FAST PACE

Instead of taking stock of carefully accessing resources in a world that is becoming depleted of accessible fresh water supplies, and using precautionary principles around uncertainty of long term impacts, the ‘resources’ industry has their **foot on the accelerator**. DSD has introduced their “Plan for Accelerating Exploration”, commonly known as

PACE 2020. This principle is regarded as the mechanism behind 'extraordinary growth in the state's minerals and energy sector'. Yet, viewed from a realistic point, this can be regarded as the 'extraordinary growth into total disaster', as far as gaining consent for hydraulic fracture stimulation in the South East of South Australia.

16.0 NO LAW IN SA THAT PRECLUDES DEVELOPMENT IN THE PUBLIC INTEREST TO THE DETRIMENT OF AGRICULTURE

According to DSD's own site, "**There is no law in South Australia or Australia, constitutional or otherwise that would preclude responsible development in the public interest.** The reason being, the Crown that is the overall community, and South Australia is the owner of the mineral rights including oil and gas, not an individual landowner. Therefore as the owner of those rights, the Crown reserves the right to ensure the general public interest is in no way disadvantaged through vexatious and unreasonable demands from some sectors of the community." **I question 'what is the public interest'. In most cases, the majority of the population in South Australia would not be aware of what is happening in the resource sector. In other words, a lifetime of commitment to agriculture is down the list from the minerals and gas sector. I regard this as a breakdown and failure in democracy for freedom for the right to farm,** uninterrupted by gas and mining projects in their backyard.

17.0 FORGOTTEN ACTS THAT NEED TO BE TAKEN INTO ACCOUNT FOR HYDRAULIC FRACTURE STIMULATION

I believe the current legislative framework applicable to petroleum and associated development does not provide adequate governance of petroleum and associated operations. There are four major pieces of legislation - **the Mining Act 1971, the Development Act 1993, the Petroleum and Geothermal Energy Act 2000 and the Commonwealth EPBC Act amended 2013.** The Development Act 1993 is associated with the **Lands for Public Purposes Acquisition Act 1914** which includes the **Incorporation of Compulsory Acquisition and Land Act 1925.** This is of major concern to the South East residents, with loss of income because of loss of agricultural land needed to support infrastructure such as roads, bridges, and pipes. Further to this, there is an array of other pieces of state legislation that come in to play, including the **Natural Resource Management Act 2004 (amendments are being developed at the time of writing this), Native Vegetation Act 1994, Environment Protection Act 1993, and the Native Title Act 1994** and incorporate the **Water Resources Act 1997.** The Mining Act 1971 is included here, as sand for proppant is required for hydraulic fracturing stimulation. This needs to be mined to supply the petroleum industry for hydraulic fracture stimulation activities. It would be reasonable to assume that if hydraulic fracture stimulation activities were to proceed in the SE, that the sand would be sourced locally to avoid transportation costs from other areas. **The Work Health and Safety Act 2012** should also be included as should the **Dust Diseases Act 2005.** There are documented cases of sand proppant causing silicosis to workers in the 'fracking' industry. Would this act or the **South Australian Public Health Act 2011** adequately cover neighbours, whose properties surround the drilling pad areas, for health impacts caused as the result of contamination to the air, soil and water on their neighbouring properties? Because of possible contamination, the **Food Act 2001, section 7** has a role.

The protection of farm animals from the impacts of hydraulic fracture stimulation must come under the **Animal Welfare Act 1985.** 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.

Under the Livestock Act 1997, Section 5 (1) Livestock are affected with a disease or CONTAMINANT (b) they contain the CONTAMINANT in their body tissues or secretions (2) (a) they come from livestock affected with the disease or CONTAMINANT (3) Land is affected with a disease or CONTAMINANT if the land, any water or vegetation or the land contains or produces a substance of CAUSING LIVESTOCK THAT CONSUME IT OR COME INTO CONTACT WITH IT TO BECOME AFFECTED WITH THE disease or CONTAMINANT. This is already of concern in the South East as I understand that Beach Energy Ltd. are planning to, or already have irrigated the waste pond water from Jolly 1 onto agricultural land. The analysis of the Jolly 1 holding pond 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, fluoroanthrene, 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.**

18.0 POWERS OF UNESCO UNDER THE UNITED NATIONS

What also needs to be considered is jurisdiction under the United Nations: the Naracoorte Caves National Park is listed internationally under the United Nations Educational and Cultural Organization (UNESCO) agreement.

Australia joined UNESCO as a member in November 1946, and would have agreed to the constitution laid out. The Naracoorte Caves National Park is the only UNESCO listed place in South Australia. PEL's go along the boundary of the Naracoorte National Park. Caves have contaminant pathways. If hydraulic fracture stimulation was allowed to proceed in the South East, there is a very real risk that gases such as **carbon dioxide or methane** may be mobilized and travel through contaminant pathways to a number of caves.

The following quotes are taken from UNESCO under the topic - National Protection and International Protection of the Cultural and Natural Heritage:

'Article 6 - Whilst fully respecting the sovereignty of the States on whose territory the cultural and natural heritage mentioned in Articles 1 and 2 is situated, and without prejudice to property rights provided by national legislation, the States Parties to this Convention recognize that such heritage constitutes a world heritage for whose protection it is the duty of the international community as a whole to co-operate....Under the World Heritage Committee signatory countries are required to produce and submit periodic data reporting providing the World Heritage Committee with an overview of each participating nation's implementation of the World Heritage Convention and a "snapshot" of current conditions at World Heritage properties.' It would be assumed that unconventional gas activities within a certain distance of the Naracoorte Caves National Park would be required to be reported to UNESCO. The Mining and Petroleum companies already do not have the best reputation with UNESCO, nor do the countries that allow the mining and petroleum companies to operated anywhere near UNESCO listed places.

'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.'

19.0 SELF-REGULATION BY DSD DURING EXPLORATORY PHASE SHOULD BE ILLEGAL

What is even more concerning, and far from the best interests of South Australia, is that while petroleum exploration is occurring, contamination, odour and other incidents do not come under the Environmental Protection Act 1993. Under Section 7 of the Environmental Protection Act is the heading 'Interaction with Other Acts':

(4) This Act does not apply in relation to—

- (a) petroleum exploration activity undertaken under the Petroleum Act 2000 or the Petroleum (Submerged Lands) Act 1982; or
- (b) wastes produced in the course of an activity (not being a prescribed activity of environmental significance) authorised by a lease or licence under the Mining Act 1971, the Petroleum Act 2000 or the Roxby Downs (Indenture Ratification) Act 1982 when produced and disposed of to land and contained within the area of the lease or licence; or

(c) wastes produced in the course of an activity (not being a prescribed activity of environmental significance) authorised by a lease under the Mining Act 1971 when disposed of to land and contained within the area of a miscellaneous purposes licence under that Act adjacent to the area of the lease.

I was not aware of this exemption for Petroleum Companies until I received a phone call from someone near Jolly 1, to say that there was the smell of rotten egg. I rang one of my colleagues from the EPA, whom I knew through the Round Table for Unconventional Gas Projects. He told me that this was not under the authority of the EPA at the exploration stage and to contact DMITRE. I viewed the Jolly 1 waste-water pond from the immediate neighbour's fence, and was concerned how close to the top the waste-water was. When questioning Beach Energy Ltd. about this, as I recall, I was told the pond size was quite adequate as there were no gutter runoffs into the pond. Around September 2014 (I was overseas at the time), it appears that Beach Energy Ltd. became concerned that heavy rain may cause a problem with overflow of the waste-water holding pond and moved the waste-water to a holding pond at the Katnook Gas storage facility owned by Beach Energy.

20.0 CLASSIFICATION OF LOW IMPACT NOT ACCEPTABLE TO SOUTH EAST RESIDENTS

Pursuant to section 98 of the **Petroleum and Geothermal Energy Act 2000** (the Act) the Minister must classify the regulated activities covered by a prepared Environmental Impact Report (EIR) as either of low, medium or high environmental impact. . Exploration of unconventional gas in the South East of SA was rated by the Minister as low impact as testing (exploration) in the Otway Basin was considered a low environmental impact. According to the EIR of Beach Energy for the Cooper Basin, low impact activities do not require public consultation and are subjected to a process of internal government consultation and comment on the EIR and SEO prior to approval. To classify exploration that is going down 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, should not be classified as 'low impact'. **Classification of impact needs to scrutinized by an independent body and not assigned at the discretion of DSD or Minister.**

21.0 VALID CONCERNS IN THE SOUTH EAST

Valid community concerns exist in the South East 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 the South East is on 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. As mentioned previously, this may be an issue under the **Work Health and Safety Act 2012.**

22.0 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 South East community, in general, is a well-educated community, and not 'a bunch of greenies' as falsely portrayed by some in the resources section of the SA government, and the petroleum industry itself. The South East community wants proof that this 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. In the South East, DSD have lost their credibility, as have the petroleum companies. **This month, there were 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.**”

23.0 TESTIMONIES OF IMPACTED NEIGHBOURS DURING THE DRILLING OF JOLLY 1

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.

At one of the Round Tables for Unconventional Gas Projects, I raised the issue of concerns of landholder in the vicinity of the Beach Energy Ltd. Sawpit 2 exploration well after Barry Goldstein had said that “not a drill head goes in the ground until all the neighbours are informed”. This person told me that there was no awareness of drilling of Sawpit 2, until the operation began. As I recall, the answer I was given was that this should have never occurred and that it is illegal and would be investigated. DSD claim they visited the area and said there had been “no issues”. My information is backed up by other affected landowners at Jolly 1 and the fact that they had not been told of the proposed exploration beforehand. Have Beach Energy Ltd. broken the law in this case? If so, what processes are going to be put in place to prevent this happening again? What were the consequences for Beach Energy’s violation of the law?

If the excessive noise levels had been experienced in urban areas, going 24 hours per day, would these events have come under the Environmental Protection Act 1993, and would charges have been laid if the noise continued to exist? If excessive odour had been experienced in urban areas, 24 hours per day, would these events have come under the Environmental Protection Act 1993 and warnings been given or charges laid if the odour continued. If waste-water was stored within 15 metres of another property, in an urban area, would this have been under the Environmental Protection Act 1993, and if the waste-water was not removed much further away, would charges have been laid?

And yet, this is exactly what has happened around the area of the Jolly 1 drilling site. Distance from the city is no excuse. The drilling rig was around 2 km from the outskirts of Penola as the crow flies. People are people, they should have the same rights in the country as in a built-up urban area. All exploration for minerals or petroleum industries must be made to fall in line with everyone else, and come under The Environmental Protection Act 1993. The immediate neighbour’s property was less than 15 metres from the waste water holding pond. I inspected this myself from the neighbour’s property. A number of neighbours experienced the noise pollution and the odour

pollution. 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.

24.0 SEPARATION DISTANCES

From the South Australian Government Document, EPA GUIDELINES FOR SEPARATION DISTANCES 2007, I quote the following:

Under the *Environment Protection Act 1993* (the Act), industrial emissions are regulated by the requirement to comply with the General Environmental Duty, any relevant Environment Protection Policies and any licence conditions. The use of separation distances is not an alternative to compliance by industry with its statutory obligations, but rather is an aid in locating industry and sensitive land uses to minimise the impacts of noise, odour, polluting air emissions or waste water, which may result from accident, power failure, equipment failure, unusual meteorological conditions or human error, as well as normal operation. Similarly, the use of separation distances is not an alternative to the provision of appropriate policies and zoning schemes in council Development Plans. The guidelines may inform the planning process and should be seen as one of a number of tools available to deal with loss of amenity caused by close proximity of incompatible land uses.

In the case of mining and petroleum activities, in my opinion, these laws are extremely inadequate.

25.0 WATER PROTECTION AREAS

Areas of South Australia that are highly sensitive to potential contamination of water resources, either surface water or ground water, have been declared ‘water protection areas’ under the Environmental Protection Act 1993. Surely, with the abundant evidence of the sensitivity of the South East unconfined and confined Dilwyn aquifers, the declining water levels in the aquifers, and the decreasing rainfall, the South East should come under the water protection area. It is almost 50% of the State’s highest yielding agricultural land that also includes a major wine industry area.

To make things worse, the taking of water for petroleum exploration anywhere in the State is authorised without a licence, under Section 128 of the NRM Act.

- (1) Subject to subsection (2), the Minister may, by notice published in the Gazette, authorise the taking of water from a prescribed watercourse, lake or well, or the taking of surface water from a surface.

Everyone else has to apply for water allocations, and yet here is an industry that appears to have a law unto itself for its own ends.

26.0 REGULATION GUIDELINES FORMED ON BASIS OF LIMITED OR INCOMPLETE DATA

Regulation guidelines may be formed on the basis of limited or incomplete data, from the petroleum companies themselves. This is certainly the case in the South East of South Australia. According to the government document *South Australia – Victoria Border Zone Ground Water Investigation: Results of Pumping Test Program 2011/23*, page 1:

Extensive faulting occurs through the South East and across the border between South Australia and Victoria. Although faulting has a significant impact on lateral flow in both unconfined and confined aquifers, its impact has not been determined. Vertical flow between the Tertiary Limestone Aquifer and the Tertiary Confined Sand Aquifer is likely to be significant, however this is not well understood.

27.0 INQUIRY INTO MINERAL AND ENERGY RESOURCE EXPLORATION

During my extensive research on law for this submission, I came across a ‘DMITRE SUBMISSION TO THE INQUIRY INTO MINERAL AND ENERGY RESOURCE EXPLORATION’ to the **Productivity Commission Inquiry into non-financial barriers to mineral and energy resource exploration** July 2013. As far as I am aware, there was no publicity for people outside the resources sector, that this inquiry was taking place.

The SA Government, through the Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) is committed to continuous improvement of its investment frameworks. There are four broad areas for collaborative improvement by jurisdictions, including the Commonwealth: **reduction of excessive red tape and green tape**, multiple land use, Commonwealth Native Title requirements and Aboriginal Heritage.

DSD (formerly DMITRE) want reduction of red and green tape, when realistically, because of the serious nature of hydraulic fracture stimulation, for accountability, **tape should be increased**.

In the submission, DSD (formerly DMITRE) also comments on each draft recommendation of the Productivity Commission. DSD supported 18 of the 20 draft recommendations. Some of the recommendations are very concerning to say the very least. Part 1 of the submission discusses SA Government activities that are being undertaken to support mineral and energy exploration, including: one-stop-shop approach, land access and further need for red-tape reduction.

Harmonising legislation and standards between States, the Territories and the Commonwealth remains a high priority – with the proviso that harmonisation does not result in retrograde legislation or regulations. **Retrograde legislation or regulations to whom?**

28.0 NATIONAL PARKS AND CONSERVATION AREAS

Under the subject of Land Access, Draft Recommendation 4.1, it is stated that when Government is deciding to declare a new national park or conservation reserve in recognition of its environmental and heritage value, that DSE recommend that the government use *'evidence-based analyses of the economic and social costs and benefits of alternative or shared land use, including exploration.'* National Parks and conservation areas are under the jurisdiction of the **National Parks and Wildlife Act 1972** and other acts which include the **Crown Land Management Act 2009**, **Native Vegetation Act 1991** and the **Wilderness Protection Act 1992**. **All of this legislation is over-ruled by the Petroleum and Geothermal Act 2000**. Approximately 74 per cent of onshore protected areas allow access for mineral, geothermal and petroleum exploration and development. The word protect means aim to preserve (a threatened species or area) by legislating against collecting, hunting, or development. In 1891, a Board of Commissioners was set up for the Belair National Park. In 1966 The National Parks Commission was set up by the South Australian Government. In 1972, as the result of the National Parks Commission work, the Commission was disbanded. The National Parks and Wildlife Act 1972 was legislated. A National Parks and Wildlife Advisory Council was set up. The goal was to protect certain areas of environmental significance forever, which became National Parks.

29.0 CHARACTER PRESERVATION ACT

The Barossa and McLaren Vale Character Preservation Acts 2012 recognise the need to protect these areas from urban encroachment because of "their horticultural production and their iconic tourist, landscape and recreational values" The high yielding agricultural land should be exempt from mining and petroleum activities for the same reasons. Perhaps a South East Character Preservation Act could be considered to protect horticultural production, tourism, landscape and recreational values.

30.0 MULTIPLE LAND USE

According to the draft recommendation, 'SA has long been a pioneer of multiple land use approaches to land use and land access for the minerals and energy resources sectors, including for land designated for conservation purposes.' **This is contradictory.**

In the Draft Recommendation 4.3, it is stated:

Governments should ensure that the development of coal seam gas exploration regulation is evidence-based and is appropriate to the level of risk. The regulation should draw on the guiding principles of the Multiple Land Use

Framework endorsed by the Standing Council on Energy and Resources to weigh the economic, social and environmental costs and benefits for those directly affected as well as for the whole community, and should evolve in step with the evidence.

To accurately weigh up the economic, social and environmental costs and benefits, I encourage DSD and the Government to read and research the aforementioned **400 recently released peer-reviewed reports** on the damage and shocking health impacts and economic problems occurring as the result of hydraulic fracture stimulation. DSD and the government must take into account the huge health costs Australia will have, and already are having, as the result of unconventional gas activity. The health issues are explained in detail and very well, in the submission by the Limestone Coast Protection Alliance. **Disruption to people's livelihoods and the mental anguish must be taken into account. The farmers in the country are the lifeblood to the city. Without food, people in the city cannot survive.** We cannot rely on overseas markets for our main food supply. It is as simple as that. DSD must take into account long-term impacts, long after DSD employees may be gone. **Agriculture and mining cannot co-exist.**

The hype and spin, in my opinion, is very misleading. In the draft recommendation it is stated:

In comparison, deep gas (for example, in the Cooper-Eromanga and Otway basins) has a different footprint that does not inevitably create land access conflicts.

This is just totally inaccurate. The educated SE people would be very disturbed to read this quote. In fact, as outlined in my part under the water heading of the submission, there is plenty of evidence about the shocking footprint left behind around the world, with deep wells. The report done for the **Chief Scientist, NSW gives the correct impression that there is more to be concerned about with shale:**

All shale needs to be fracked. **Because shale is deeper, more water is required at a much higher pressure to fracture the shale.**

The life of an average well that may be hydraulically fracture stimulated several times may use up to 34 million litres of water. THIS PROPOSED ACTIVITY IS CREATING CONFLICT between the water needs for farming and the water needs for hydraulic fracture stimulation.

31.0 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 DSD.

32.0 INDIGENOUS HERITAGE PROTECTION

When addressing **indigenous** groups, DMITRE has made the following statement in the document:

Moreover, DMITRE agrees that in cases where negotiated agreements are not possible, that appropriate mechanisms will be required to address aboriginal heritage protection and other land use (such as mining) in an appropriate way, including by way of government decision-making processes if necessary.

In other words, they have no respect for the decision that the indigenous people make and if the indigenous people do not agree with the government in regard to access, the government will make the decision on their behalf.

33.0 DSD STATES: "LACK OF KNOWLEDGE SHOULD NOT LEAD TO A BAN ON EXPLORATION ACTIVITY"

Draft Recommendation 6.6 is very concerning:

Governments should ensure that when there is scientific uncertainty surrounding the environmental impacts

of exploration activities, regulatory settings should evolve with the best- available science (adaptive Governments should ensure that when there is scientific uncertainty surrounding the environmental impacts of exploration activities, regulatory settings should evolve with the best- available science (adaptivemanagement) and decisions on environmental approvals should be evidence-based. DMITRE **supports** this draft recommendation in-principle, **noting that lack of knowledge should not necessarily lead to a ban on exploration activity.**

This is a shocking admission. In other words, it appears that DSD don't want to take on any precautionary principle and just want to go 'blindly ahead'. This is particularly concerning for the South East of SA.

34.0 THE PETROLEUM AND GEOTHERMAL ENERGY ACT 2000 RECOGNIZES RISK

High-level objectives of the **Petroleum and Geothermal Energy Act 2000** (SA) include: Protect the public's interest in the sustainability of natural, social and economic environments from risks inherent in petroleum and geothermal operations: The legislation acknowledges that there are risks in petroleum and geothermal operations.

35.0 REGULATORY CAPTURE

The report also notes that:

Issues of regulatory capture do not appear to have emerged in South Australia. PIRSA has a clear mandate, clear regulatory responsibilities, good processes to engage with other agencies, and checks and balances that apply in high-risk situations. The theory of regulatory capture is when an industry can benefit from regulation if it can capture the regulatory agency involved. This can happen if the industry's political influence and technical knowledge makes the regulatory agency dependent on it. Political appointees from the industry, along with the agency's need for informal cooperation from the industry, help create a situation in which the agency is captured.

Many farmers and landowners in fact would argue this case and believe there are issues of regulatory capture. The widely held belief across the state that there is a conflict of interest with DSD being the promoter, issuer of licenses and the regulator would fit this category, in many people's opinions.

36.0 GOLDEN RULES FOR A GOLDEN AGE OF GAS

The Golden Rules for a Golden Age of Gas site link is included in the Roadmap For Unconventional Gas Projects in South Australia. 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 (CO₂) (from greater use of energy in the production process, compared with conventional production). Just how much greater these risks may be is uncertain:

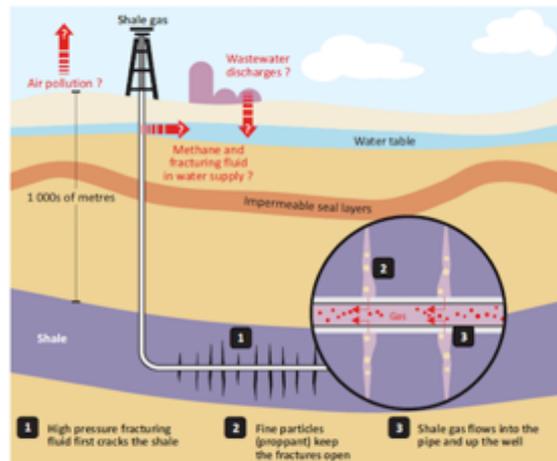
Page 23:

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, **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 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, **landowners have no right to refuse access to the petroleum tenure holder for petroleum operations**; but they do have a claim to compensation for the impact of those operations.

www.worldenergyoutlook.org/media/weowebiste/2012/goldenrules/WEO2012_GoldenRulesReport.pdf

The above excerpts from ‘Golden Rules for a Golden Age of Gas’ clearly shows the industrys’ 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 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.

37.0 HOW THE LEGISLATION NEEDS TO BE CHANGED

The South East of South Australia is on limestone, which may be brittle and porous. Limestone is prone to subsidence and sinkholes and exacerbated by mining, drilling and hydraulic fracture stimulation (please refer to section under Water). The South East is full of fault lines. Already Beach Energy Ltd. has been drilling through the faults. This is unacceptable as plenty of evidence is that hydraulic fracturing stimulation activities, as explained in detail under the topic on water, is triggering earthquakes. In the last week, there was an earthquake near Fox Creek, Alberta of a 4.4 magnitude blamed on hydraulic fracture stimulation activities. Swarms of earthquakes in Ohio and other places are also being blamed on these activities. This is backed up by the Seismological Society of America.

<http://thetyee.ca/News/2015/01/29/Alberta-Fracking-Earthquake/>
http://www.seismosoc.org/society/press_releases/BSSA_105-1_Skoumal_et_al_Press_Release.pdf

The South East has already experienced seawater intrusion and can not afford to be put at further risks with even faster declining aquifer levels as the result of hydraulic fracture stimulation activities.

38.0 EVERY APPLICABLE ACT 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.

39.0 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 South East. I recommend to the Natural Resources Committee that hydraulic fracture stimulation in the South East of South Australia be banned.

LETTER FROM ANGUS RALTON – NEIGHBOUR TO JOLLY 1 EXPLORATION WELL

Sent: Monday, 3 February 2014 8:47 PM

To: 'Anne Daw'

Subject: RE: letter and peat soil

Dear Anne,

In relation to the setting up of the rig and the exploration drilling at the site south of Penola (quite close to our residence and for that matter the town), I believe there was an information session held last year in town however as we work away quite a lot we were not aware of it (it would be interesting to know the numbers of those who did attend). As a result, the first we realised something was going on was around Christmas time 2013 when a road/ pad and camp were installed. Even then we were not sure of the nature of the site until the rig began to arrive and we made some investigations as to what was going on. As for DMITRE, at no stage whatsoever were we directly notified of the drilling and subsequent noise levels (which can be easily heard from our residence 24/7) or the light pollution at night (it looks like a ten storey Christmas Tree from dusk till dawn every night). I believe this lack of consideration has also been shown

to the rest of the people that live in our neighbourhood. As we can see the rig directly from our front door and window, a little courtesy would have gone a long way and if we were not at home our phone number is on a sign on our front gate so it would not have been hard to contact us. Apparently DMITRE states that not a drill goes into the ground until all the neighbours have been notified but I think they may show the same disregard for their own charter as they do to the inhabitants of the areas they wish to drill in. Or maybe that as there is a landowner with a paddock between ourselves and the rig they think that technically they do not have to bother. Either way, the lack of information as to the current exploration drilling AND the proposed 3-4000 wells they wish to see drilled in the future if exploration proves fruitful is extremely concerning. Do we get to see the results of the exploration? Will the region be adequately consulted and informed BEFORE the proposed expansion of Shale Gas Mining? Or is it a case of too bad, so sad? These are very troubling issues that warrant answers from BOTH DMITRE and the State Government.

Regards,

Angus Ralton

The South East of South Australia consists of 2.2% of the land of South Australia. There is only 4.6% high yielding land in the state, which supports agriculture in various forms. The South East is very proud of its 'clean and green' image and export industry to the world. The South East does not want to lose this reputation. If hydraulic fracture stimulation is permitted to go ahead, not only would water, one of the major food bowls for the state, tourism, the wine industry and lifestyle along with existing industry be threatened, but in turn, this would affect the economy, at regional, national and international scales. Rather than go into a lot of detail here which no doubt will be in other submissions, I have preferred to include quotes, one from PIRSA and the other from the State Premier, Mr. Weatherill.

'ECONOMIC PRIORITY 2: PREMIUM FOOD AND WINE PRODUCED IN OUR CLEAN ENVIRONMENT AND EXPORTED TO THE WORLD' 18th December, 2014:

*"The growing world demand for high quality food and wine, combined with our strong reputation for food safety, biosecurity and product integrity, creates significant opportunities for South Australia. Our iconic food and beverage products cement our international reputation as a quality food producer. **We need to maximise the production of value added and differentiated food, with a focus on Asia.** World leading food, wine and agricultural research and production will provide the platform to help us export our ideas, intellectual capital, products and services. The State Government has been working to develop a number of three year and 12 month objectives and actions to deliver on the economic priority. Action areas focus on securing and increasing South Australia's premium status of world class food and wine in selected markets."*

<http://www.foodwine.sa.gov.au/2014/12/economic-priority-2-premium-food-and-wine-produced-in-our-clean-environment-and-exported-to-the-world/>

SOUTH AUSTRALIA IS THE PLACE WHERE PEOPLE AND BUSINESS THRIVE. PREMIER WEATHERILL:

"Premium food and wine produced in our clean environment and exported to the world"

Why is this a priority for South Australia?

*The growing world demand for high quality food and wine, combined with our strong reputation for food safety, biosecurity and product integrity, **creates significant opportunities for South Australia.** Our iconic food and beverage products cement our international reputation as a quality food producer. **We need to maximise the production of value added and differentiated food, with a focus on Asia.** Centres of excellence in food and agricultural research and production will help us export our ideas, intellectual capital, products and services. Premium food and wine produced in our clean environment and exported to the world.*

Why is this a priority for South Australia?

*The growing world demand for high quality food and wine, combined with our strong reputation for food safety, biosecurity and product integrity, creates significant opportunities for South Australia. **The food and wine industry currently generates \$17.1 billion in revenue, employs one in five working South Australians and accounts for over 40 per cent of the state's merchandise exports. Agriculture, forestry and fishing have been the fastest growing segments in the South Australian economy.** We need to ensure that our food and wine producers are competing in global markets on more than just cost. South Australian food, wine and beverages are world class and our unique regions, products and the clean, green environment that they come from provide the competitive edge required to secure and maintain premium status in our markets of choice. Further growth and investment in primary production and processing, the adoption of new technologies, expansion of existing and emerging markets, and realising increased value for our high quality products will be a major economic driver for the state. World leading food, wine and agricultural research will provide the platform from which we will export our ideas, intellectual capital, products and services.*

Our objectives

By 2017 South Australia will:

Increase international exports of differentiated and processed food and wine from \$2.8 billion in 2013-14 to \$3.2 billion in 2016-17
Establish a global reputation for premium food and wine
Create opportunities for food and wine businesses to expand or co-locate
Establish a global reputation for our food, wine and clean technology expertise.

Within 12 months to achieve success in this priority South Australia will need to:

Establish the SA Food Innovation Centre
Increase the use of the South Australian brand by food and beverage businesses
Increase global confidence in the biosecurity, product integrity and food safety standards of our food and wine
Simplify and modernise regulatory arrangements to support innovation and job creation.”

I believe what Mr. Weatherill has stated here is very encouraging for our international markets. If we are to make sure that our international reputation for food and wine in the South East is to continue for many years to come, then hydraulic fracture stimulation must not be allowed to proceed in the South East. If contamination occurred, this would have to be declared on the National Vendors Declaration. Valuable export markets would inevitably be lost. This in turn, would affect economic sectors at many levels, including loss of business and farm income in the South East. Contamination occurrences would also add to the state's economic burden through health costs. The South East tourism industry would also be hit – no-one particularly wants to holiday in a gasfield.

In a world facing water shortages and food scarcity, I believe that the agricultural industry should be our first priority to meet basic human needs of food and clean water locally, as well as to the rest of the world. We cannot rely on getting our food from overseas. In a world of many uncertainties, South Australia must be prepared to be self-sufficient for food and water.

For reasons of sound economics and food and water self sufficiency in uncertain times, hydraulic fracture stimulation should not be allowed in the South East.

<http://economic.priorities.sa.gov.au>

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 losing 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.

South Australia is the driest state in the driest inhabited continent in the world. In 2006 there was no recharge of any aquifer in the entire South East region. We continue to have bushfires. Aquifers in the SE 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 gas well may require up to 34 million litres of water. A document by Frogtech on shale gas commissioned by Vic. and SA government departments, including DEWNR, PIRSA AND SA water, estimated that there will be 3446 shale gas wells in the Otway Basin, most on the South Australian side. The South East people do not want water brought to the surface from deep aquifers, that 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.

Even our own state government acknowledges water shortages ahead. The government released a report on CONSERVING NATURE. ***"Drought conditions are likely to increase in frequency across many parts of South Australia, as a consequence of climate change, particularly in agricultural areas. To this end, Australia's strategy for the National Reserve System recognizes and gives priority to increasing protection for areas that support reliable surface waters and accessible ground water"***.

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.

The South East consists of 2.2% of the state. This is not a lot of land to have exempted from mining and petroleum activities, in one of the most important food bowl and wine regions in the state. **The geological science is already in.** The South East is built on limestone. Limestone is very porous and can be very brittle. Already, there is much subsidence and 100's of sinkholes in the South East. 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.

The Jolly 1 holding pond analysis revealed salinity up to $\frac{3}{4}$ **as salty as seawater**, high barium levels, some heavy metals and toxic chemicals such as **phenanthrene, fluoroanthrene, pyrene and chrysene**. Beach Energy plans to let the holding pond water settle and spray this waste - water on the agricultural land near Penola. This is simply absurd. Even treated reverse osmosis water does not remove all contaminants.

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” was commissioned by WMC in 1982 in limestone country. 30 years later, there was subsidence along side of the casing down 20 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. SA has only 2 logging trucks in operation to audit drill holes and wells. How are they possibly going to keep track of **ALL** previous drill holes and wells from the past, let alone new ones?

Caves and sinkholes have connectivity to each other. The Naracoorte Caves is UNESCO listed. The Petroleum Exploration Licences border the park. Fracking activities may have unwanted consequences on caves including damage to these fragile structures or movement of gases into them.

The South East also had problems with seawater intrusion, particularly in the Donavans area south of Mount Gambier. Here there was over allocation of bore water that allowed seawater intrusion to occur. Bores had to be capped to stop this. Imagine what may happen with the multiplication effect of 100's or even 1000's of wells. Who is going to foot the bill for 1000's of hydrology holes to observe if seawater intrusion is occurring due to fracking activities? How do you get seawater out of an aquifer once it gets in?

There is considerable and unknown vertical leakage between the unconfined and confined Dilwyn aquifers. At a SELGA meeting 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?

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 Salamander 1 holding ponds in the SE, these liners did not last 4 years in the South East. There is also no safe way of disposing of toxic waste - water and drilling muds. Re-injection causes earthquakes and potential contamination.

The South East has numerous fault lines. What is appalling 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.

Health impacts on animals and humans through contamination of water resources, as the result of fracking is a major and serious problem. This is covered in depth in the sections on health and chemicals. The industry is not as “clean” as it claims. At the back of this part of the submission, you will see the incidents that have been occurring in South Australia, which backs up what is written in the rest of this submission. There was an incident with a leaking wellhead in the South East at Salamander 1. There is no way that the state can afford to have fracking in their food bowl, among the wineries of Penola, or in their holiday hotspots of Robe and Penola.

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?

1.0 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. South Australia is the driest state in the driest inhabited continent in the world.

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.”

In 2012, a document by the South Australian Government was released entitled ‘CONSERVING NATURE 2012 – 2020. Page 20 ***Drought conditions are likely to increase in frequency across many parts of South Australia, as a consequence of climate change, particularly in agricultural areas.*** To this end, Australia’s strategy for the National Reserve System recognizes and gives priority to increasing protection for areas that support reliable surface waters and accessible ground water’.

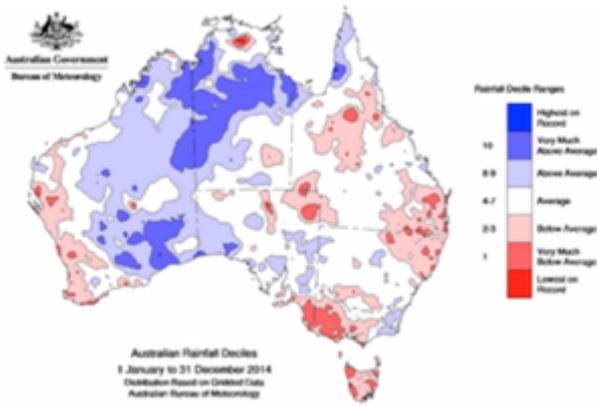
http://www.environment.sa.gov.au/managing-natural-resources/Park_management

Water is very precious in South Australia, and is already under severe stress as prolonged dry periods persist in Southern Australia. 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%.

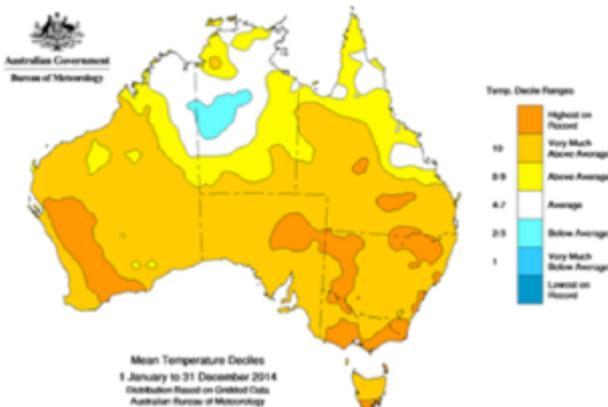
2.0 AUSTRALIAN GOVERNMENT BUREAU OF METEOROLOGY (BOM) ANNUAL CLIMATE STATEMENT 2014

<http://www.bom.gov.au/climate/current/annual/aus/>

The Australian Government Bureau of Meteorology (BOM) released the ANNUAL CLIMATE STATEMENT for 2014 on 6th January 2015. Data collected and analysed by the BOM showed overall that 2014 was Australia's third-warmest year on record. The average temperature was +0.91 °C above average. Rainfall was below to very much below average across the majority of Victoria, southeast South Australia, and other areas of Australia. The map is in the BOM annual climate statement 2014. Most of the SE of SA is covered in dark pink, which shows below average rainfall from 1st January until 31st December 2014. There are predictions from the CSIRO that dry hot spells are going to continue.



The next map from the BOM annual climate statement for 2014 shows that the SE of SA temperatures from 1st January to 31st December 2014 were very much above average, and in the north of the state, the temperatures in the dark orange were the highest on record.



3.0 SOUTH EAST UNCONFINED AND CONFINED DILWYN AQUIFERS

According to the Australian Bureau of Statistics data in 2013, data indicates the SE NRM region supported approximately \$1.0 billion of South Australia’s \$5.6 billion gross value agricultural industry – notably dryland and irrigated agriculture and horticulture, dairy, and forestry.

Most detail regarding the unconfined and confined Dilwyn aquifers in the South East is covered in the section on the Lower Limestone Coast Water Allocation Plan, other than a few key points. There are two underground water systems – the upper unconfined Tertiary Limestone Aquifer consisting of calcareous sandstone and limestone, and the lower Tertiary Confined Sand Aquifer. The aquifers are a finite resource, that require to be managed properly to be sustained for now and future generations to enjoy social, economic and environmental benefits. Underground water is extracted from both aquifers. The confined Dilwyn aquifer contains around 30% of the state’s water.

4.0 SOUTH EAST GEOLOGICAL, WATER, DRILL HOLE, WELL AND POND ISSUES

4.1 NO RECHARGE IN 2006

In 2006, there was no recharge of any aquifer in the whole of the South East. Please see the under the heading Lower Limestone Water Allocation plan that explains in full, policy and also notes concerns in relation to hydraulic fracture stimulation.

4.2 PAST PROOF OF HOW SENSITIVE THE SE AQUIFERS ARE

Already there is proof of the sensitivities of the South East aquifers. 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

4.3 VERTICAL LEAKAGE BETWEEN THE UNCONFINED AQUIFER AND THE CONFINED AQUIFER

I understand it is impossible to measure 'artificial leakage' from one aquifer to another. According to the government document 'South Australia – Victoria Border Zone Ground Water Investigation: Results of Pumping Test Program' 2011/23, page 1 – **“Extensive faulting occurs through the South East and across the border between South Australia and Victoria. Although faulting has a significant impact on lateral flow in both unconfined and confined aquifers, its impact has not been determined. Vertical flow between the Tertiary Limestone Aquifer and the Tertiary Confined Sand Aquifer is likely to be significant, however this is not well understood.”** On page 2, in 2000, DFW carried out an investigation to examine the hydraulic relationship between the two aquifers and estimated recharge rates of the confined aquifer (Brown et al., 2001). The study inferred that recharge to the TCSA is occurring via preferential flow paths (fractures, faults or sinkholes), **however the rate of vertical recharge could not be quantified.**

Therefore, in any situation, regardless of where hydraulic fracture stimulation takes place in high yielding agricultural and cropping areas, how can any modelling for water be accurate? Given these facts, it is impossible to clean up an aquifer once it is contaminated, as the contamination may spread quickly through the vertical leakage to the other aquifer, with the potential to affect agriculture.

4.4 \$5 MILLION TO REHABILITATE LEAKING CONFINED AQUIFER WELLS IN POOR CONDITION

As far as well integrity problems, there is already plenty of evidence in the South East to support that casings and cement for wells do break down. On page 37/196, 3.5 of the Lower Limestone Coast Water Allocation plan done for the Natural Resources Management in the SE, it states

“Prior to 2010, direct leakage of pressure water from the confined aquifer into the overlying unconfined aquifer occurred via a large number of confined aquifer wells in poor condition due to age and construction techniques. During 2001 to 2010, 120 leaking confined aquifer wells in the Kingston-Greenways area were either replaced or back-filled using specialist techniques, as part of the South East Confined Aquifer Well Rehabilitation Scheme. Expenditure on the scheme was estimated to be \$5.5 million over nine years, including \$1.3 million funding from the Natural Heritage Trust, \$1.1 million from State investment and a financial commitment from landowners of up to \$3.1 million.

Imagine the costs of in time of repairing every drill hole for unconventional gas in the SE that are in the ground down to around 4 km and extending horizontally, with the casing and cement that does not last for ever'. Who will foot the bill in 30 – 50 years if these companies are no longer around?

4.5 SEA WATER INTRUSION

There is evidence of a direct hydraulic connection of the Dilwyn aquifer to the sea. in the form of tidal pressure effects. In recent years, bores had to be capped in the Donovan's area near Mount Gambier, because of over-allocation of water and seawater intrusion. **A document recently released is called “Preliminary Investigation of**

Seawater Intrusion into a Freshwater Coastal Aquifer: Lower South-East, September 2012” This was also a concern 32 years ago, and is today with the proposed Kingston lignite project. In the summary - “This fresh groundwater aquifer is vulnerable to salinisation by seawater intrusion due to over exploitation of the resource and climatic changes, which may respectively cause the lowering of the groundwater hydraulic head, and reduced recharge into the unconfined aquifer.” “Evidence of a dynamic freshwater-saltwater interface occurs in the Eight Mile Creek area, where groundwater salinities are slowly increasing and salinity profiles show seasonal changes.”

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 following government document “LOWER LIMESTONE COAST PRESCRIBED WELLS AREA UNCONFINED AQUIFER GROUND WATER LEVEL AND SALINITY STATUS REPORT, 2012 reported the two sobering paragraphs –
Page 1 - Analysis of climatic trends in the South East has revealed a general drying trend since the early 1950s. This is reflected in most groundwater hydrographs and a strong relationship has been demonstrated between decreases in average annual rainfall and declining water levels measured in observation wells for both the confined and unconfined aquifers over the last 40 years.

Page 2 - Declines in groundwater levels predominantly occurred along the eastern border of the PWA, with the largest declines recorded between Naracoorte and Penola. The Donovans Management Area remains at risk of seawater intrusion due to an overall decline in groundwater levels in the area. The overall decline in groundwater levels across the Lower Limestone Coast PWA is the likely result of the increase in extractions and below-average rainfall.

https://www.waterconnect.sa.gov.au/Content/Publications/DEWNR/Lower_Limestone_Coast_PWA_Unconfined_Aquifer_GSR_2012.pdf

What will replace the SE water supplies, if hydraulic fracturing stimulation proposed projects go ahead and sea - water intrusion does occur as fracture stimulation activities? 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?

4.6 SALT MOBILISATION

The Qld. study on Healthy Headwaters was done in 2012. The study refers to the fact that it is impossible to predict the amount of salt that will be mobilized as the result of coal seam gas activities in the headwaters of the Murray River, and therefore it is impossible to know the impacts in the future, on the Murray Darling Basin and river systems, which, I believe, without a doubt, will impact the River Murray in South Australia. **What studies have been done into possible salt mobilization as the result of unconventional gas extraction in the South East? It is believed that not doing impacts on salt mobilization before any exploration drilling is irresponsible.**

<https://www.dnrm.qld.gov.au/water/catchments-planning/healthy-headwaters/coal-seam-gas-water-feasibility-study>

4.7 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. Beach Energy Ltd. have plans for a shale exploration gas well near Robe, and Rawson Resources plan to drill a shale gas

exploration well 16 km west of Mount Gambier and 18 km south east of Robe. Given the evidence in Gippsland, this is concern in regard to possible coastal subsidence.

4.8 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.

4.9 SEISMIC SURVEYING BY BEACH PETROLEUM IN THE 1960'S

Beach Petroleum, now Beach Energy, as I understand, was involved with seismic surveys in the SE in the 1960's that covered extensive distances. I recently visited a property near Robe. A number of holes, set distances apart and approximately 15 metres deep were drilled and left uncased. I was able to observe one of these old drill holes. Detonator wire left on the property, was used to connect the holes and place down 5 pounds of explosive geofex. Please see attached specimen of original detonator wire with the hard copy of the submission.

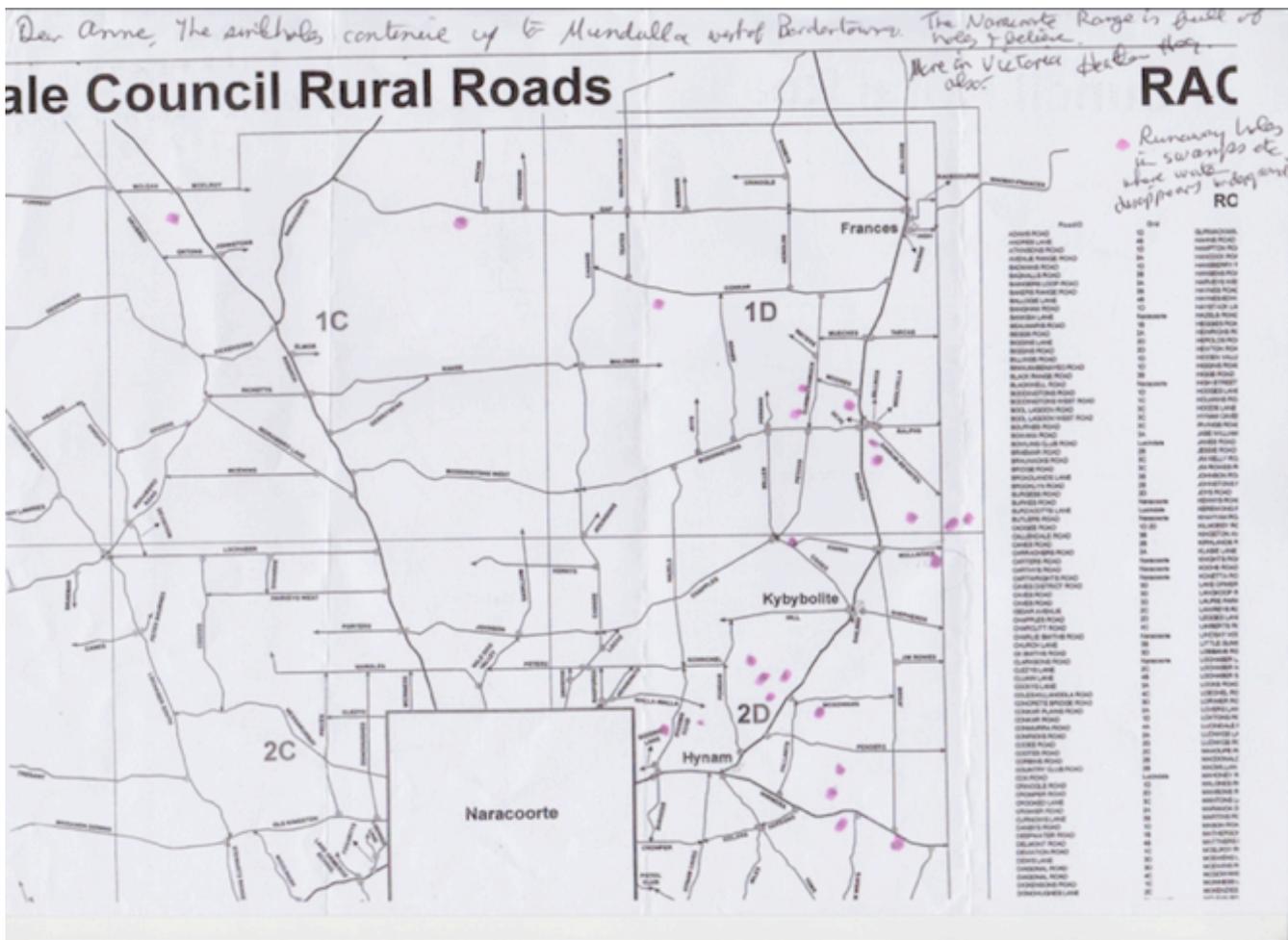
4.10 AQUIFER BARRIER FRACTURED

Questions have been raised if there was any damage to the aquifer barrier that may have been caused by these seismic activities. Rosemary Brojatsch has written a testimony of her family experience back in the 1960's. At that time Beach Petroleum was searching for oil on properties in the Beachport area. Her father, the late Mr. Bert Bowman, moved the family to a property on the Beachport-Penola road in 1958. There was good underground water supplied from a windmill near the house. After the area was tested 'anywhere and everywhere' by the mining company on a quest for oil, drill holes were put down in lines, as explained above, and detonation took place for a seismic read out. No thought was given about any damage that may occur to the underground water. Two wells were also drilled on the property near Lake George, which is in the vicinity of the state's biggest earthquake in 1897. There are numerous fault lines in this area. As it is a fragile area, it is Rosemary's belief that damage was done as the connectivity between the aquifers were shaken and fractured, causing salt water to infiltrate the freshwater confined aquifer. To this very day, the underground water in this area has never recovered and still remains saline. Fresh bore water cannot be found in the area today. As the result of this occurring, there was no compensation. After drilling ceased, Mr. Bowman approached Beach Petroleum to cap the well at artesian level, which was done. Water was then piped across to their house at the family expense. At that stage, people did not voice out their opinions and were too trusting of the powers in charge.

4.11 SINKHOLES AROUND THE SOUTH EAST

One of the major geological scientific reasons that hydraulic fracture stimulation should not be allowed in the South East, or any major mineral mining for that matter, is because the South East is built on limestone. Limestone is very brittle in its nature, and does not lend itself to be drilled, mined or fracked without the risk of exacerbating subsidence and sinkholes. There are various reports of 100's of sinkholes around the South East of South Australia. One property owner has stated there is one on her property "about 70 feet deep and opens out at the bottom with water, and there is a windmill over it.

Another property owner from the Kybybolite area has reported that he has lost count of subsidence holes on his property. They range in size from 1 metre to 3-4 metres across. These sinkholes have been happening for over 70 years. The property owner has observed that a lot more have appeared in the last 6 years. There are many sinkholes around Wrattobully and Comaum, north east of Penola. There are around 350 known sinkholes in the Mount Gambier area alone.



PINK DOTS SHOW KNOWN SINKHOLES IN NARACOORTE AREA TO THE EAST. THERE ARE 1000'S MORE

4.11.1 HATHERLEIGH STORY

In March 2014, there was a report in the SE TIMES regarding a Hatherleigh farmer who narrowly escaped being buried alive when the ground collapsed under his tractor to form a 1.5 metre deep sinkhole on his property. The sinkhole opened up suddenly without warning. It subsided down another 0.5 metres and had 10 cm of water in the bottom. According to the owner of the property, Mr. Lance Skeer, sinkholes occur all the time around the Mount Gambier and Glencoe area all the time. Kevin Mott of the South Australia Cave Exploration Group said that it was a normal occurrence in the geological limestone-based form of the South East. He stated the following "Limestone in the region has been formed under stress and there's a lot of cracks and faults in the stone" "Often if you get a little water or acid from the soil into the crack, it slowly erodes the rock. Over time, the stuff in between of the rocks opens them up and sometimes it can be sitting there for years. All it takes is a little pressure to collapse. There have

been similar tubes in the forest that have done the same thing, extra weight from a tractor puts pressure on the already stressed formation and suddenly you drop your wheels into a hole.” Ian Lewis, geologist, said that the pressure caused by the machinery may have formed the sinkhole. Lewis thought is sounded like a type of cavity referred to as a solution tube. These are found everywhere in limestone, and there are thousands of them around the South East.

This is a major reason why hydraulic fracture stimulation should not go ahead in the South East. Aside from the drilling and the hydraulic fracture stimulation itself, the waste - water re-injection can exacerbate subsidence and sinkholes in limestone. This is a clear example that the shear pressure of heavy machinery can also be a major issue. The weight of the waste - water in the holding pond would also be putting a considerable amount of pressure on geology system.

4.11.2 CHANNEL 7 STORY ON SINKHOLES INCLUDED MOUNT GAMBIER

In 2014, Channel 7 had a program on sinkholes, which included footage in USA and Mount Gambier in the SE. The link is still active –

<https://au.news.yahoo.com/sunday-night/features/article/-/22907841/the-truth-about-sinkholes/>

The gas industry is mentioned and blamed for sink holes at around 10 minutes and 30 seconds from the beginning. The end of the film shows the Mt. Gambier sinkholes, 11 minutes 40 seconds along.

4.11.3 BEACHPORT EAST 1 DRILL HOLE PUT DOWN IN 1983 NOT DECOMMISSIONED AND LEAKING NOW

Below is a picture of the leaking well. It is Beachport East 1. It was drilled to 1428m on 25 Aug 1973 but only cased to 610m so the production zone would be in the confined aquifer. The well had been abandoned, not backfilled. It is presumed the leaking is a result of the pressure from the confined aquifer. The valve is open and should be shut off. This may be difficult with the current infrastructure as it has been left open for a number of years and would be hard to operate.



BEACHPORT EAST 1 ABANDONED WELL

4.12 EARTHQUAKES IN THE SOUTH EAST OF SOUTH AUSTRALIA

Earthquakes may appear to be an odd subject under the topic of water, but the reason it is here, is because contaminant pathways between the aquifers and the faults as the result of fracture stimulation activities possibly exposing radionuclides, volatile organic compounds and heavy metals to impact the aquifers. Below is a map of South Australia showing the major seismic zones. Please note the South East area. **What is very important to realize is that we have no control over what is happening underground. We cannot control earthquakes, and we cannot control impacts on wells under the ground. We cannot say that wells or pipes won't bend or rupture during an earthquake that occurs naturally or is seismically induced as the result of hydraulic fracture stimulation activities.** We cannot say that bacteria attacking the casings and cement will not happen. It is as simple as this – it does.



Map of the 4 most seismic areas in South Australia – The Mining Department

The epi-centre of South Australia’s biggest earthquake between Kingston SE and Beachport occurred in 1897, magnitude 6.5, intensity 9. It was felt in Port Augusta and Melbourne, toppled chimneys in Adelaide and there was massive damage around Beachport, Kingston and Robe and liquefaction occurred. Another 5.6 magnitude earthquake occurred in the same area in 1949. Other numerous earthquakes have occurred in the South East including in recent years. The lower South East is 4th most seismically active in the state. This is another major reason why there should be no unconventional or unconventional gas, or mining exploration and projects in the lower SE. With many fault lines already existing in the Lower South East, if hydraulic fracture stimulation took place, naturally occurring earthquakes or those stimulated by hydraulic fracture stimulation activity, may result in contaminant pathways opening up as fault lines may then join up which reach the aquifers. The picture below is of slumping just outside of Robe (1897)



Slumping possibly due to liquefaction. (Photo 44184)

http://www.pir.sa.gov.au/_data/assets/pdf_file/0020/10829/rb1995_047_earthquakes.pdf

The University of Western Australia compiled a report on volcanoes and earthquakes in the SE of SA. Although there have been numerous other earthquakes in the SE, earthquakes of magnitude 5 or more were May 1897 SA’s biggest earthquake 6.5 between Beachport and Robe, May 1899 5.3 magnitude Robe, July 1903 5.3 magnitude over the border at Warrnambool, Vic., August 1948 Robe and December 1960 Cape Otway. Concerns have also been raised for the community for current offshore exploration for oil and gas a few km off of Robe, given the highly fractured area under the sea.

“Sites will also be chosen to minimise any possibility of triggering seismic i.e. (earthquake) activity or reactivating any fault.”

One of the members of LCPA received the following email from Barry Goldstein, Executive Director, Energy Resources DMITRE regarding the fault lines and CCS in the South East.

“It remains my personal view as an experienced geologist that the nature of faulting in this location is interpretable to be less than perfect geologic circumstance for lowest cost and highly extensive CCS. Others may reach an alternative conclusion, but I was unsurprised no bids were lodged.” Barry A Goldstein

If the faults are a problem for CCS, then surely they are a bigger problem for invasive, high volume, high pressure, multi - stage’ slick water fracture stimulation.

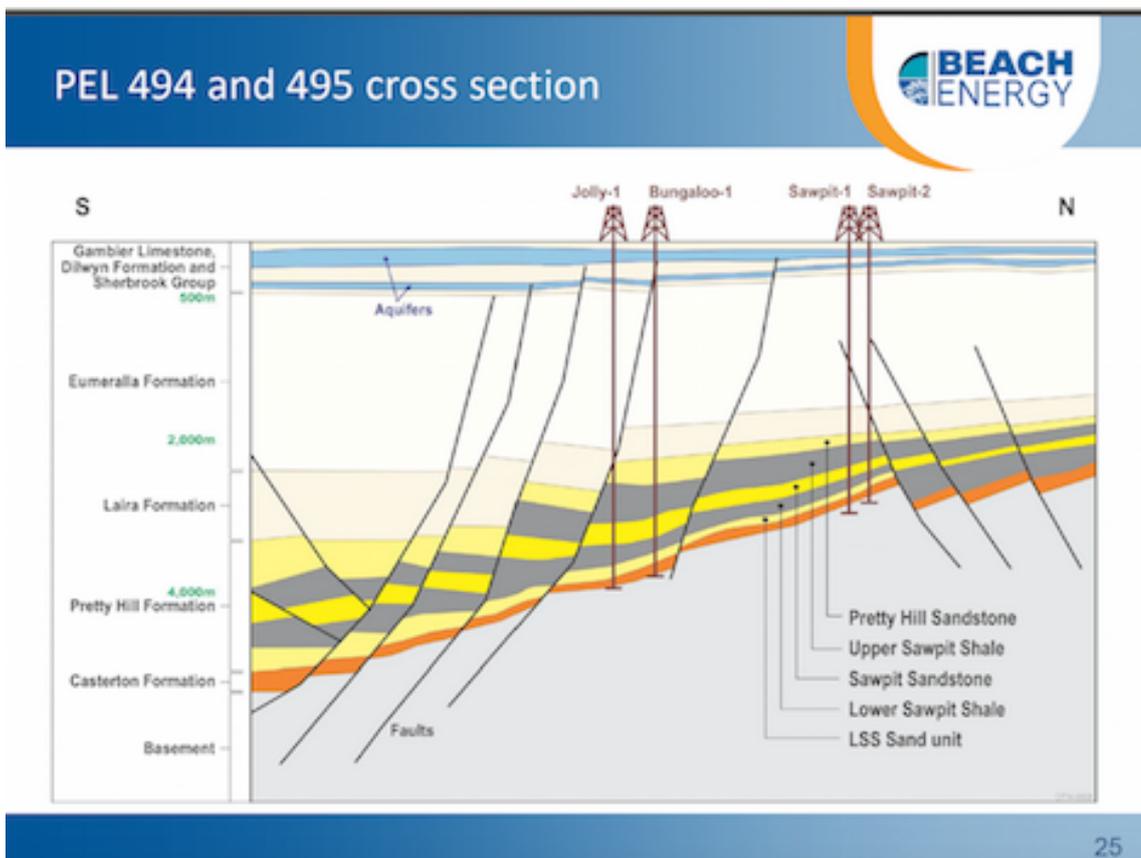
4.17 BEACH ENERGY DRILLS THROUGH FAULT LINES NEAR PENOLA

The South East of South Australia is heavily faulted. 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.

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 the SE, with so many faults, and the fact that Beach Energy Ltd. has been drilling through fault lines and that these fault lines are vertical, and in some cases, extend into both the confined and unconfined aquifers.**



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

4.18 ROADMAP OF UNCONVENTIONAL GAS PROJECTS IN SA

According to the Roadmap for Unconventional Gas Projects in South Australia, under the heading of ‘Shale Gas Play in the Otway Basin’, there are targets for shale in the onshore Otway Basin. The Otway Basin extends into Victoria. These areas include the Robe Trough, Penola Trough, and the St. Clair Trough, which are expected to be gas prone with liquids potential. The prospective for shale oil for the Robe, Penola, Rivoli and St. Clair troughs is between 2.3 km and 3.8 km. Targets depths are up to 4 km. Tight gas potential is in the deeper areas of the Robe and Penola Troughs. Tight gas still requires hydraulic fracture stimulation.

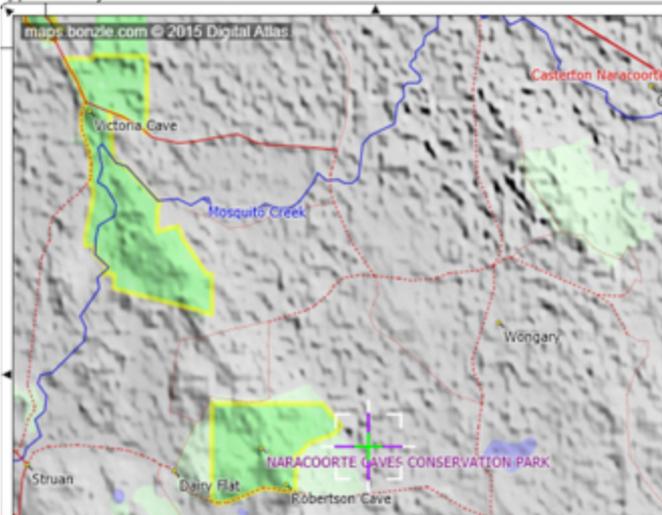
It is stated in The Roadmap **“complex faulting from rift tectonics could be advantageous for unconventional gas through enhancement of natural fracture networks that would improve connection with, and drainage of the rock matrix.”** Given the evidence on risks of hydraulic fracture stimulation in regard to earthquakes, and migration of methane and other highly toxic substances into aquifers, this should be of major concern that the Department of State Development and the industry’s attitude is that faults are seen as an advantage for the petroleum industry. http://www.pir.sa.gov.au/petroleum/prospectivity/basin_and_province_information/unconventional_gas/unconventional_gas_interest_group/roadmap_for_unconventional_gas_projects_in_sa

4.19 PELS BACK ONTO NARACOORTE CAVES NATIONAL PARK (UNESCO LISTED)

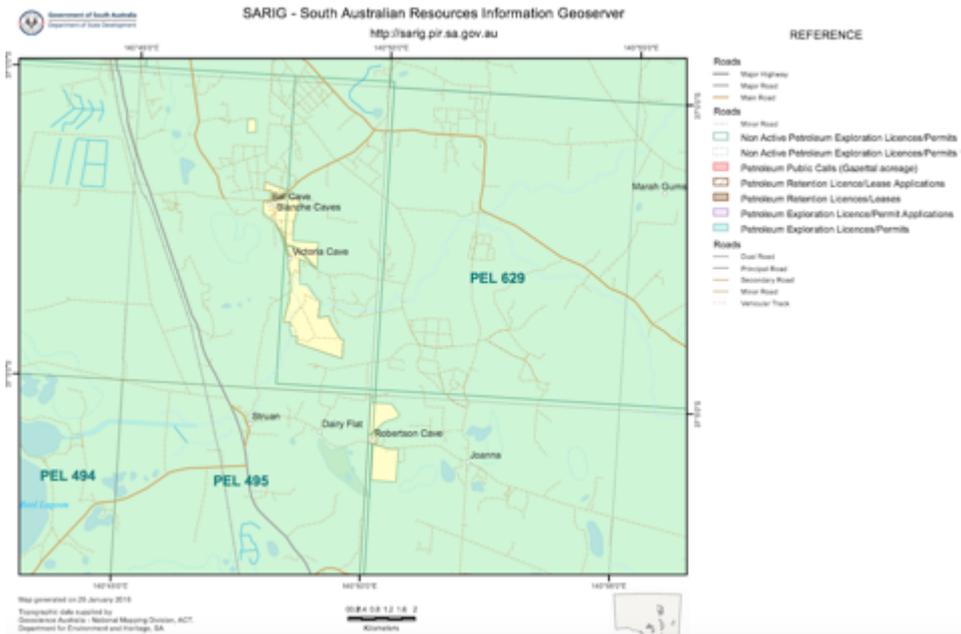
The Naracoorte Caves National Park is world famous and a wonderful draw card for international and national tourists. It is South Australia’s only United Nations Educational Scientific and Cultural Organisation UNESCO listed national park. The Naracoorte Caves National Park is listed as UNESCO because of the importance of fossils in the caves. The park is home to 100 known fossil deposits and for preservation of bones of mega - fauna that became extinct roughly 60,000 years ago. The caves acted as pitfall traps, collecting animals for at least 500,000 years, preserving the most complete fossil record we have. It covers several ice ages and arrival of humans. Bones include those of the Marsupial Lion, Thylacine and Zygomaturus and Sthenurine Kangaroos.

PEL 495, and PEL 629 have longitudes and latitudes that appear to be very close to the caves. See the purple and green cross on the map. As the Naracoorte Caves are UNESCO listed, petroleum and mining licences should not be allowed anywhere near the Naracoorte Caves. Contaminant pathways are a major issue with hydraulic fracture stimulation activities. There are numerous fault lines, subsidence, caves and sinkholes that are in the South East that are part of the limestone. Hydraulic fracture stimulation, mining and drilling in limestone exacerbates subsidence and sinkholes. If contaminant pathways open up to the caves, carbon dioxide and methane could pose a problem. Potentially this could be a problem with caves right across the Lower South East. Often caves are also connected by pathways, as are areas of subsidence.

The point you have clicked on (37° 05.453' S 140° 50.858' E) has an estimated altitude of approximately 80.8km northeast from the coastline of South Australia.



Cross showing PEL 495 in extremely close vicinity of UNESCO Naracoorte Caves National Park



SARIG showing PEL 495. The boundary runs up the west side of the reserve then turns west till it meets PEL 494. PEL 629 covers the rest of the map.

4.20 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.

4.21 JOLLY 1 WASTE WATER HOLDING POND ANALYSIS

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, fluoroanthrene, 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 due to the presence of high contaminants.

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 house 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

4.22 TOXIC WASTE WATER HOLDING PONDS IN THE SOUTH EAST

According to a letter written from Beach Energy on 22nd August 2014, to John Best at the Wattle Range Council, regarding the Katnook gas facility, acquired by Beach Energy Ltd, raw gas, free condensate and produced water are separated at the front end of the plant in a High Pressure Separator, produced water from the plant inlet High Pressure Separator is then directed to the liquids handling tank to enable hydrocarbon gas and liquids to be separated from the water under atmospheric condition. The water from the liquids handling tank then gravity flows to the Evaporation Pond 1 via the Katnook interceptor tank as a final hydrocarbon reduction measure. Water from Evaporation Pond 1 is transferred to Evaporation Pond 2 as required. During times of the year when water production and gas processing and rainfall exceed the evaporation capacity, excess water is disposed of to an EPA licensed facility on a batching disposal basis. **Given the contamination of produced water, the Limestone Coast Protection Alliance would like to know exactly how this water is disposed of, including the concentrated high saline brine, heavy metals, etc. The letter goes on to say that due to the time of the year, the drill sump contents associated with some of these wells has not yet evaporated and given current and predicted rainfall rates, it was considered a risk to keep the drilling sump waste water in situ. To avoid over topping, Beach Energy Ltd (under the name of Adelaide Energy acquired EPA emergency authorization 45682 to enable Katnook to receive and temporarily store up to 1 ML of drilling sump waste water from the Bungalow 1 and Jolly 1 exploratory drilling well sumps. Beach Energy Ltd now seek to amend the EPA licence 23644 associated with the existing gas production facility at Katnook to include the receipt of fluids from their other licenced operations in the area.**

4.23 WASTE WATER FROM HOLDING PONDS REMOVED TO KATNOOK

In September 2014 Beach Energy Limited had moved the toxic and highly water from the holding ponds to the Katnook gas storage facility pond. How can there be any confidence in the regulatory system and “world’s best practice”, when estimating the correct size of a holding pond cannot be determined properly? The ridiculous part is that then the water, according to the information above may have to be sent of to an EPA facility. The more contaminated water is handled, the more likely it is to be spilt.

<http://www.naracoortelucindale.sa.gov.au/webdata/resources/minutesAgendas/September%202014%20Attachme%20Items%2011%20to%2014.pdf>

4.24 JOLLY 1 HOLDING POND WASTE – WATER TO BE SPRAYED ON AGRICULTURAL LAND IN SE

The LCPA understand that the holding ponds waste - water is being allowed to settle the drilling muds and then the water will be used for irrigation on agricultural land in the area. This is absurd, given the holding ponds analysis, shows high salinity and other contaminants. The CSG industry ‘treats its water’ for use. Despite this, the treated CSG water flowed into the Condamine River, still releasing 13 contaminants. Treated water for shale gas would not be any different as the same contaminants are usually present.

No one has answered the question on how disposal in the South East of SA, of shale gas produced water (concentrated brine, heavy metals, radionuclides, salt, etc. in the water left behind after water treatment) was going to be dealt with, as the result of exploration or during the process of hydraulic fracture stimulation. There isn’t any environmentally acceptable solution. At a meeting of international hydrologists on “Fracking, Friend or Foe”, it was confirmed re-injection causes earthquakes. There were 3 members of LCPA present at this meeting.

4.25 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>

4.26 NO ACCEPTABLE ANSWER FOR TOXIC DRILLING MUDS AND WASTE WATER IN THE SOUTH EAST

Injection wells are also a major problem. Hence, what do they do with the disposal of drilling muds and waste - water in the South East? 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

4.26.1 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>

4.26.2 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.

4.27 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 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.**

4.28 ROTTEN EGG SMELL COMING FROM AREA OF JOLLY 1 WELL

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. This toxic air pollution did not come under the regulation of the Environmental Protection Authority, but DMITRE while at the exploration stage.

4.29 LETTER TO THE BORDER WATCH SUMARIZING HEALTH IMPACTS SOUTH EAST MAY FACE

Health issues will be under the heading of HEALTH IMPACTS, but I will include a quote from a letter to the editor of The Border Watch from Dr. Michelle Sherriff of Portland, which provides a great summary. LCPA has had access to the documents quoted to establish that the facts in the letter are correct. The letter was refuting statements made by Stedman Ellis, a paid representative of the Petroleum industry, regarding health and environmental concerns. In Sept. 2014, a study by Yale University found that people living near gas wells had a higher prevalence of skin conditions and upper respiratory conditions that lived closer to the wells. In Jan. 2014, a study published in the Environmental Health Perspectives showing an association between congenital heart defects and possible neural tube defects of newborn babies increasing with density and proximity of gas wells of the mother's home. At the same time, preliminary data from Princeton University, Columbia University and MIT showed low birth weight in the same circumstances. October 2013 Cornell University also found decreased birth weight and premature birth.

4.30 WHO IS GOING TO LOSE OUT ON WATER ALLOCATION - GROUNDWATER (BORDER AGREEMENT) ACT 1985

Confined and unconfined aquifers in the LLC PWA areas are under the jurisdiction of the Groundwater (Border Agreement) Act 1985. No new allocations should be granted or temporary allocations renewed, where the limit to the volume of water to be extracted from licensed wells in the relevant Zone of the Designated area would be exceeded, under the Groundwater (Border Agreement) Act 1985. **If this is the case, who will lose their water allocation to provide the petroleum companies with their requirements if fracking is allowed?**

4.31 3,446 SHALE GAS WELLS PREDICTED AND THE RED QUEEN EFFECT

According to a study done by FROGTECH, "Potential Geological Risks Associated with Shale Gas Production in Australia, January 2013", Council of Learned Academics, which states **3,446 SHALE GAS** wells are estimated for the Otway Basin. Most of the wells would be on the South Australian side of the border. This report was commissioned by Dept. of Sustainability and Environment, Vic, PIRSA, VIC DPI, Geoscience Australia, DEWNR, and SA Water. Therefore this is a credible government document. This, without a doubt, will have huge impacts on the ground water, with levels of water within the aquifers dropping.

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>

It would be assumed, based on the ‘Red Queen Effect’, this is why FROGTECH has come up with this figure. 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.

4.32 WOULD THE SE ALSO EXPERIENCE UP TO 82% DECLINE IN PRODUCTIVITY IN 3 YEARS

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 includes 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 FORECASTS 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

5.0 CONVENTIONAL AND UNCONVENTIONAL GAS BOTH CAN HAVE HYDRAULIC FRACTURE STIMULATION

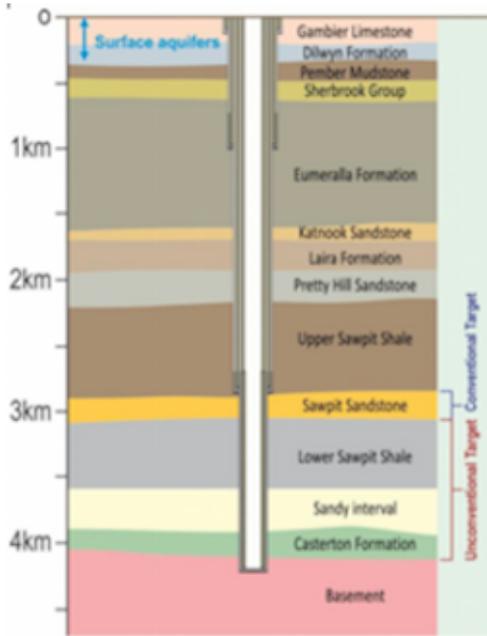
On the next page is an illustration out of an ASX report from Beach Energy Ltd. It clearly shows the shale is either side of the sandstone and in the Casterton Formation. It would require little effort to become a horizontal well. The drill head just needs to be lifted up or down very little. **Hydraulic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

6.0 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

7.0 HORIZONTAL ARMS MAY BE DRILLED 1000 METRES IN SE



www.beachenergy.com.au/IRM/Company/ShowPage.aspx/PDFs/345156505461/PromisingresultsfromOtwayBasinExplorationDrilling

According to “THE ENVIRONMENTAL IMPACT REPORT, OTWAY BASIN DRILLING” for Beach Energy Ltd., page 11, a well may be **drilled horizontally for up to 1000 metres** before being cased and cemented.

8.0 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.**

9.0 SOUTH EAST INDUSTRY AND AGRICULTURE ALREADY DEPENDENT ON UNDERGROUND WATER

According to the South Australian Centre for Economic Studies, Regional Development Australia – Limestone Coast, the Limestone Coast covers an area of 21,330 square km, which accounts for ONLY 2.2% of the state’s land mass. This is a very small area that should be exempt from unconventional gas, for protection of prime agricultural land, being one of the most diverse and productive areas in South Australia. Industry and agriculture that are dependent on these aquifers include irrigation of crops, pastures, vineyards, beef cattle, sheep (meat and wool), organic crops, trees and vineyards, dairy industry, fruit and vegetables, aquaculture, forestry, tourism and domestic and town water. Water for fire fighting should also be taken into account. Already by 13th January 2015, the South East of SA has experienced a number of bushfires for the year. There is a considerable amount of peat soil in the South East. Peat soil is highly flammable and often fires around the world have burnt underground in peat soil. With venting and flaring and the chance of explosions happening in the gas industry, which have happened overseas, these operations may be putting the SE at further risk with fire. Oils, grains, wines, spirits and wood products also contribute to the South East economy. The combined gross regional product for the South East is around \$1,438,200,000.

https://www.adelaide.edu.au/saces/economy/regionprofiles/Fact_sheet_RDA_Limestone_Coast_Final_May_2012.pdf

9.1 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 South East.

9.2 IF RATES OF FLOW ARE ALTERED IN THE SOUTH EAST

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.”*

10.0 KEEPING OUR NATIONAL AND INTERNATIONAL EXPORTS MARKET IN PLACE

The state government produced a document on food and wine, entitled ‘ECONOMIC PRIORITY 2: PREMIUM FOOD AND WINE PRODUCED IN OUR CLEAN ENVIRONMENT AND EXPORTED TO THE WORLD’.

The document states that there is a world demand for high quality food and wine and we have a strong reputation for food safety, biosecurity and product integrity. There is a focus on Asia.

<http://www.foodwine.sa.gov.au/2014/12/economic-priority-2-premium-food-and-wine-produced-in-our-clean-environment-and-exported-to-the-world/>

Premier Jay Weatherill is quoted as saying *“The growing world demand for high quality food and wine, combined with our strong reputation for food safety, biosecurity and product integrity, creates significant opportunities for South Australia.”* *“The food and wine industry currently generates \$17.1 billion in revenue, employs one in five working South Australians and accounts for over 40 per cent of the state’s merchandise exports. Agriculture, forestry and fishing have been the fastest growing segments in the South Australian economy”.*

If we are to maintain this reputation and our export markets are to continue to grow, we must keep our image as ‘clean and green’. Credible, scientific peer evaluated papers showing serious concerns and effects on health, water, soil, air and agricultural issues must be heeded as warning bells.

11.0 FOUR HUNDRED PEER-REVIEWED PAPERS SHOWING FRACKING ISSUES ARE OF THE MOST SERIOUS NATURE

There are now around 400 peer-reviewed papers that have been evaluated in USA regarding unconventional gas and fracking issues that are of the most serious nature. These can be found at the following link.

<http://www.ernstversusencana.ca/state-of-science-on-harms-by-fracking-to-public-health-and-water-health-professionals-scientists-release-analysis-of-400-peer-reviewed-studies-on-fracking-along-with-major-scientific-compendium> 73% of all available scientific peer-reviewed papers have been published in the past 24 months. The credible scientific report is available now to prove that hydraulic fracture stimulation is having massive detrimental effects. Not only that, the geological science in the SE is established as well in relation to limestone, faults and seawater intrusion.

12.0 HYDRAULIC FRACTURE STIMULATION CAN NOT CO-EXIST WITH AGRICULTURE

Hydraulic fracture stimulation and unconventional gas projects cannot successfully co-exist with farming and agriculture. We have a choice – either an industrialized gas field over time, or having a pristine agricultural food bowl and wonderful tourism destination for ourselves and for the rest of the world to enjoy. It is as simple as this – one or the other.

Provided that the precious South East water, soil and air is not exposed to contamination through unconventional gas projects, agricultural industry should be allowed to continue to provide an extremely important food bowl for Australia and the world for now many years to come. Gas projects using hydraulic fracture stimulation are generally expected to have a short - term life for usually around 15 - 30 years at most. South Australia must have a long- term

vision, which prioritizes providing for food and water security. Without good food and water, human life cannot be sustained.

13.0 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

RISKS OF GROUND WATER CONTAMINATION – Parliamentary Inquiry

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 contaminated 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.

14.0 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.

15.0 IMPACTS ON HUMANS AND ANIMALS

IMPACTS OF GAS DRILLING 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

16.0 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. Gerylne 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>

17.0 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

18.0 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>

19.0 HIGH RISK INCIDENT WITH JETISONED 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.

20.0 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 perforating 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. Sintered 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**

21.0 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. Loeth 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

22.0 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.

23.0 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. This will impact the South East of South Australia. The more a government then sources (imports) extra freshwater supplies from alternative sources that contributes to compaction weight.

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>

23.1 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

23.2 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.

23.3 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>

24.0 UNDERSTANDING THE RISKS OF HYDRAULIC FRACTURE STIMULATION AND EARTHQUAKES

24.1 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

24.2 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.

24.3 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

24.4 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.

24.5 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."**

24.6 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 earthquakes could occur and damage surface structures."

When the industry is prepared to admit, as the result of scientific testing, that there is a relationship between hydrocarbon recovery, which includes shale gas, then all activities relating to shale gas and tight gas in the SE of SA must cease.

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.

25.0 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.

26.0 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.**

27.0 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

28.0 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

29.0 BAD CEMENT BEHAVIOR AND LONG TERM CONSEQUENCES

“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.

29.1 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.”

29.2 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. 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.”**

29.3 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

29.4 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>

30.0 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

31.0 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. Please note Beach Energy Limited have stated the possibility of deviated wells in the South East of South Australia. 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_NUWyk He discusses the relationship with earthquakes.

32.0 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

33.0 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.



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

36.0 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

37.0 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.

38.0 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 moratorium. The Victorian moratorium will remain in place until the state inquiry brings back its findings at the end of this year. It is a suspension on the issuing of licenses, on the process of fracking and now the issuing of works plans for unconventional gas drilling. Tasmania has a 12month moratorium until 16th December 2014, to enable a review on fracking. 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.

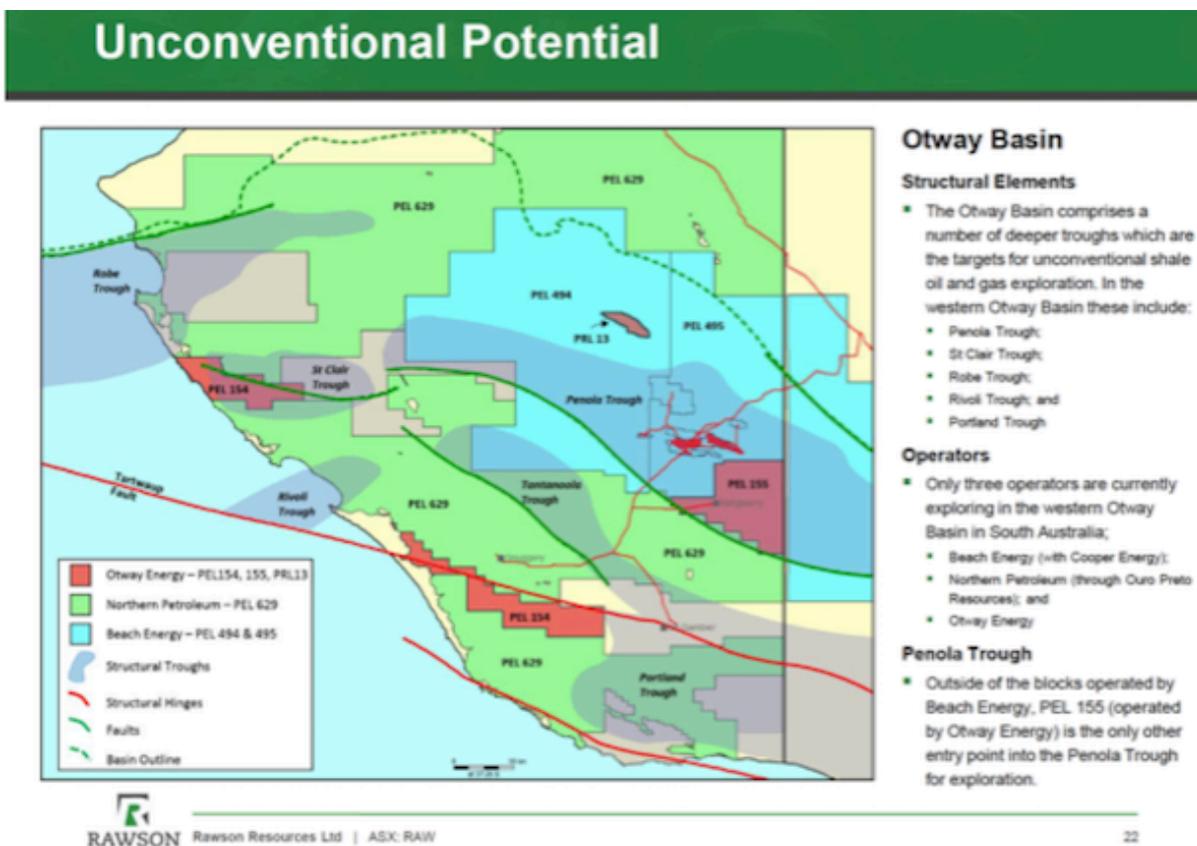
<http://rt.com/usa/fracking-texas-activists-concerned-510/>

39.0 INSTITUTIONAL FAILURE IN SOUTH AUSTRALIA

Although not related to unconventional gas, it is important to mention that there are problems state wide. The LCPA understand that only two government logging trucks operating in South Australia. There are thousands of drill holes around the state, including mineral exploration and hydrology observation drill holes. All auditing for both Mineral and Petroleum drill holes comes under the Department of State Development. This shows an inadequacy of auditing previous drill and hydrology observation holes, let alone hundreds more, including gas drill holes and wells in the future including for generations to come.

On Eyre Peninsula, farmers forced DMITRE to do an audit on Eyre Iron. They only looked at 136 of the 406 drill holes. 109 were non compliant. As far as LCPA are aware the remaining 270 drill holes were never audited. DSD is the regulator of licences, the promoter and the regulator. This is clearly a conflict of interest.

40.0 MAP OF PELS IN SOUTH EAST OF SOUTH AUSTRALIA



Map of Petroleum Exploration Licences that cover nearly all of Lower South East South Australia

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

41.1 PETROLEUM AND GEOTHERMAL ENERGY ACT COMPLIANCE REPORT 2011

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-STABILISED REINFORCED POLYETHYLENE LINER.**

<http://www.beachenergy.com.au/IRM/Company/ShowPage.aspx/PDFs/37191000000/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 13 $\frac{3}{8}$ " 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 13 $\frac{3}{8}$ " 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 13 $\frac{3}{8}$ " casing shoe into an unidentified aquifer.

In September - LINC ENERGY reported an uncontrolled formation water flow through the 7" and 46" annulus during the cementing operation of the 46" 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 46" 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.

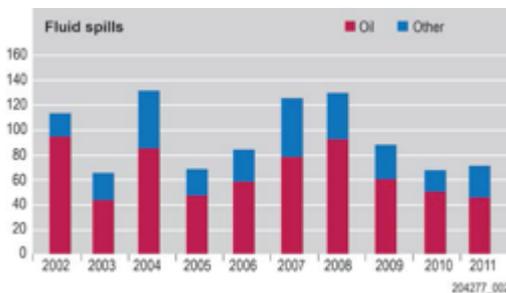
On 6 June ORIGIN ENERGY was issued a formal notice of noncompliance for the inappropriate disposal of wastewater at Celcius 1 well site.

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 is 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 contaminants. 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.

41.2 PETROLEUM AND GEOTHERMAL ENERGY ACT COMPLIANCE REPORT 2012

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.

41.3 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.

41.4 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

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.

South Australia is the driest state in the driest inhabited continent in the world. In 2006 there was no recharge of any aquifer in the entire South East region. We continue to have bushfires. According to the Lower Limestone Coast Water Allocation Plan, aquifers in the SE are already in decline. No one can give us a guarantee that there won't be eventually 1000's of wells. The government commissioned document by Frogtech points out that there may be 3446 shale wells in the Otway Basin, mostly on the South Australian side. While Beach Energy Ltd. claim there won't be many wells, a truth yet to be proved, they may on sell their licence to the next petroleum company which intends to put in 100's or 1000's of gas wells.

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. The South East people do not want to risk losing the 'clean green image' which would impact local, national and international trade. The South East has a myriad of wonderful tourist destinations. This includes the UNESCO listed Naracoorte Caves National Park, where Petroleum Exploration Licences run along the boundaries of the park. This is not just a local issue, but also of international concern, and would come under the United Nations jurisdiction. Many caves are interconnected. Most people do not want to holiday in gas fields. Most people don't like to live in a gasfield. The South East should not be regarded as a 'gasfield'.

Already the South East people are disturbed that the government is permitting the irrigation of Jolly 1 holding ponds wastewater on agricultural land. The Jolly 1 holding pond analysis revealed salinity up to $\frac{3}{4}$ as salty as seawater, high barium levels, some heavy metals and toxic chemicals such as **phenanthrene, fluoroanthrene, pyrene and chrysene**. There have been serious incidents in the South East, including high-density polyethylene pond liners breaking down at the Salamander 1 well site. The Salamander 1 wellhead leaked. There has been subsidence of the hydrology drill hole in limestone country.

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 do we get water from once it is contaminated? We must have a vision for now and future generations to come which includes a clean and green food bowl and clean water. The choice is a gas field or agriculture. It cannot be both. A gas field and agriculture in the South East simply cannot co-exist.

“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

WATER ALLOCATION PLAN FOR THE LOWER LIMESTONE COAST PRESCRIBED WELLS AREA PREPARED BY THE SOUTH EAST NRM BOARD. November 2013 prepared by the Natural Resources Management Board

<http://www.naturalresources.sa.gov.au/southeast/water-and-coast/water-allocation-plans/lower-limestone-coast>

SUMMARY FOR THIS SECTION – please see link above for LLC WAP

This is intended to be a brief precis and does not cover many points in the document. These are policies taken in order that the policies appear from the LLC Water Allocation Plan. To support the argument for exempting the South East from hydraulic fracture stimulation, parts of the policy are highlighted, and in some cases, comments added in brackets. Part 1 addresses the issues with hydraulic fracture stimulation.

There are 2 aquifers – the unconfined and confined Dilwyn – they are a finite resource. For the last decade underground and surface water hydrology of the SE region has changed with reduced water inflows. The SE Water Science Review states that the SE is experiencing prolonged dry conditions and increasing salinity. There are dropping groundwater levels – the SE does not need intensive water use from hydraulic fracture stimulation to add to this burden.

This resource needs to be managed properly for future generations.

A study done by FROGTECH, commissioned by PIRSA, DEWNR, SA Water and other departments estimates there may be 3,446 shale gas wells in the Otway Basin, mainly on the SA side.

There are many faults in the SE. Hydraulic fracture stimulation should not be near any faults – there is risk to contaminant pathways and activating earthquakes.

There are numerous sink holes in the SE. The SE is on limestone which is prone to subsidence and sink holes and exacerbated with mining, drilling and hydraulic fracture stimulation.

Much water in the confined aquifer is 25,000 years old.

Near Tarpeena and Nangwarri, vertical underground water recharge to the confined aquifer is via fractures, faults or sink holes. There would be other areas as well. Hence these should not be put at risk for hydraulic fracture stimulation that may cause contaminant pathways.

Aquifers below 4000 metres increase salinity with depth. This water should not be brought to the surface for hydraulic fracture stimulation activities, risking contamination of potable surface and aquifer water and soil. It would most certainly contain heavy metals, radionuclides, volatile organic compounds and be very high in salinity.

Underground water in the confined aquifer is under pressure.

Declines of water levels are occurring in both the unconfined and confined aquifers due to less rainfall, underground water extraction and interception of recharge.

There is moderate to good hydraulic connection between the two aquifers – if one gets contaminated it is very likely both will become contaminated.

Livestock, cropping, commercial forests, irrigation, dairy, beef, sheep, horses, grapes, lucerne, fruit and vegetables, seed crops and cereals, olives, the organic sector, domestic and town water supplies, tourism, flora, fauna, and eco-systems as well as fire fighting water all rely on the water resource from both aquifers.

Hell's Hole, Ewens Pond and Piccaninnie Ponds are on the Register of the National Estate.

Piccaninnie Ponds, Hacks Lagoon and Bool Lagoon are on the list of Wetlands of International Importance

(RAMSAR)

During 2001 to 2010, there were 120 leaking aquifer wells in the SE that had rehabilitation costing \$5.5 million. (please note, imagine the costs of in time of repairing every drill hole for unconventional gas in the SE that are in the ground down to around 4 km and extending horizontally, with the casing and cement that does not last for ever'. Who will foot the bill in 30 – 50 years if these companies are no longer around?

There are issues with sea water intrusion and the unconfined aquifer South of Mount Gambier. Fresh underground water in coastal aquifers is vulnerable to salinisation by seawater intrusion due to increasing underground water extraction and climate changes, which can cause the lowering of the underground water hydraulic head and reduced recharge to the unconfined aquifer.

“Is there the potential that current levels of allocation and extraction in management areas in the Lower Limestone Coast will lead to (further) declines in water tables and resource quality, which could detrimentally impact the community and industries dependent on the groundwater?”(note this exact question should be asked of unconventional gas projects.

Over the last 10 years, rainfall has been lower than longer-term averages, with a noticeable decline in groundwater tables compared to the previous three decades”.

Below are important points in relation to the Lower Limestone Coast taken from ‘THE WATER ALLOCATION PLAN FOR LOWER LIMESTONE COAST PRESCRIBED WELLS AREA’. Please note I have important points, and my comments in brackets in bold text. Not only is the underground and surface water important for agriculture and agricultural industry in the South East of S.A., but also for ecology, bio-diversity, which in turn is important for the SE Tourism industry. Hence I am highlighting all these areas in the water allocation plan. There is no copy right on the LLC WAP document.

Background to the Water Allocation Plan - page 8/196

“The aquifers of the Lower Limestone Coast (LLC) Prescribed Wells Area (PWA), located in the South East of South Australia, provide the region with large volumes of high quality water. However, this finite resource requires careful management to ensure that future generations can enjoy.”

“The LLC contains significant, often high quality, underground water resources in the form of unconfined and confined aquifers. A core objective of the Plan is to manage these resources for the continued social, economic and environmental benefit of current and future generations.”

The Prescribed Wells Area - page 9/196

“The LLC PWA covers an area of approximately 1,450,000 hectares. The PWA is bordered to the north by the Padthaway and Tatiara PWAs, and to the east by the state border with Victoria. It incorporates the city of Mount Gambier (population ~ 23,000), and the major townships of Naracoorte and Millicent (population ~ 5,000 each) .” (as of November 2013)

Confined and unconfined aquifers in the LLC PWA areas are under the jurisdiction of the Groundwater (Border Agreement) Act 1985. No new allocations should be granted or temporary allocations renewed, where the limit to the volume of water to be extracted from licensed wells in the relevant Zone of the Designated area would be exceeded, under the Groundwater (Border Agreement) Act 1985. (note – with the ‘red queen effect, explained in other documentation of the submission, according to a study done by FROGTECH, “Potential Geological Risks Associated with Shale Gas Production in Australia, January 2013”, Council of Learned Academics, which states 3,446 SHALE GAS wells are estimated for the Otway Basin. This report was commissioned by Dept. of Sustainability and Environment, Vic, PIRSA, VIC DPI, Geoscience Australia, DEWNR, and SA Water. Therefore this is a credible government document.)

http://www.acola.org.au/PDF/SAF06FINAL/Frogtech_Shale_Gas_Geology_and_Risks_Jan2013.pdf

There are two underground water systems – the upper unconfined Tertiary Limestone Aquifer consisting of mainly calcareous sandstone and limestone, and the lower Tertiary Confined Sand Aquifer. Underground water is extracted from both aquifers within the Murray Basin (NE) and the Gambier Basin of the Otway Basin. There are different formations, both in higher inland plains and low-lying flats. There are also remnant sand dune ridges.

Unconfined Aquifer - page 9/196

The unconfined aquifer consists mainly of calcareous sandstone and limestone. It incorporates the Gambier and Murray Group Limestones in the higher inland plains in the east of the region, and the younger Coomandook, Bridgewater and Padthaway Formations in the low-lying flats, which are interspersed with a series of northwest-trending remnant sand dune ridges. **In the NE of the PWS, the flow of underground water in the confined aquifer generally goes from east to west. Underground water flow in the unconfined aquifer in the north east of the PWA is generally from east to west.** Underground water flow radiates out from the Nangwarry/Tarpeena area in a northerly, westerly and southerly direction, that is, water flows approximately east to west throughout the northern three quarters of the PWA and from north to south in the lower South East. **There are a number of major faults in the area** which impact on underground water flow and gradient. Two prominent faults are the Kanawinka Fault and the Tartwaup Fault, referred to as the Tartwaup Hinge. **(I understand based on evidence document in the submission, that fracture stimulation should not occur near faults).**

The thickness of the unconfined aquifer varies from ~10 metres thick north west of Mount Gambier, increasing to more than 300 metres thick south of Mount Gambier. The depth to water varies throughout the PWA relative to topography. Generally the depth to water is less than five metres on the plains, up to 20 metres in the ranges and more than 40 metres in the Mount Burr Range (Figure 12, Appendix of Figures and Tables). **In the southern portion of the PWA there are numerous karst (dissolution) limestone features, of which Ewens Ponds, Piccaninnie Ponds and Hell's Hole are examples. (please note that most of the South East is on limestone. Limestone is prone to subsidence and sinkholes and exacerbated by drilling, mining and fracking.)**

Confined Aquifer - page 10/196

The confined aquifers are separated from the unconfined aquifers by a **low permeability aquitard (or confining layer)**, comprised mainly of glauconitic marl and dark brown carbonaceous clay. The combined thickness of the aquitard is generally more than 20 metres. The confined aquifer consists of non-calcareous quartz sands, interbedded with dark brown carbonaceous clays. Together these units make up the Dilwyn Formation, which was deposited during the early part of the Tertiary Period (approximately 50 million years ago). **Much of the water in the confined aquifer is over 25,000 years old.** For management purposes, the confined aquifer is treated regionally as one aquifer, but is actually a complex multi-aquifer underground water system (Cobb and Brown 2000).

Recharge to the confined aquifer occurs largely via lateral through-flow, with the main recharge area thought to be the Dundas Plateau in Western Victoria (Cobb and Brown 2000). A 2001 study by the former South Australian Department for Water Resources into **vertical underground water recharge to the confined aquifer concluded that at the study sites near Tarpeena and Nangwarry, recharge occurred via preferential flow (fractures, faults or sinkholes)** rather than via diffuse recharge processes through the soil and overlying clay aquitard (Brown et al. 2001).

Beneath the Dilwyn Formation is a number of deeper aquifers from the Late Jurassic, Early and Later Cretaceous and Tertiary ages of variable water quality and lateral extent down to 4000+ metres, **which demonstrate increasing salinity with depth.** These aquifers are not used for irrigation, industrial or town water supplies due to their depth and **generally high salinity.**

The aquifers within these deeper formations are of potential value as targets for petroleum and geothermal exploration and production. **(please note that the SE land owners are not happy about this highly saline water**

coming to the surface, or being used in any activities for drilling or fracking. This water would most certainly contain heavy metals, volatile organic compounds and radionuclides.)

The Tertiary and Late Cretaceous formation aquifers below the Tertiary Dilwyn formation for alternative water supplies has not been investigated and evaluated. **As well as salinity issues, there may be a risk of depressurization associated with extractions from these aquifers.**

Underground water flow for the confined aquifer systems originates from the Dundas Plateau located in Western Victoria. From there, underground water flows radially southwest to the coast and into the marine environment, and northwards to the Murray Darling Basin. Due to the confining layer, the **underground water in the confined aquifer is under pressure**, and in some parts of the South East is artesian (i.e. flows to the surface without pumping) (Cobb and Brown 2000).

Aquifer interaction - page 11/196

Declines in the unconfined aquifer water level have been observed along the border between South Australia and Victoria. **These declines have been attributed to a combination of reduced rainfall, underground water extraction and interception of recharge to the aquifer.** Although there is little water extracted from the deeper, underlying confined aquifer, similar declines to those in the unconfined aquifer have been observed. Funding support was sought from the National Water Commission by the former DFW in South Australia and the Department of Sustainability and Environment in Victoria to study the interaction between the unconfined and confined aquifers

The study involved the drilling of eight sites into the confined aquifer to carry out pumping tests from the aquifer, while monitoring drawdown of water levels in the unconfined aquifer, to determine the degree of connection between the two aquifers. The project resulted in a three dimensional model and revealed that there **is moderate to good hydraulic connection between the two aquifers. (please note, if there is contamination of one aquifer, both aquifers may be contaminated)** The results indicate that the two aquifers are **more highly connected** than assumed in previous models.

Water and land use - page 12/196

The total area of the Limestone Coast Region is 2,345,937 hectares, which extends beyond Keith, according to PIRSA 2010. Land use in the Limestone Coast- livestock grazing of modified pastures, cropping, commercial forests both hardwoods and softwoods, irrigated crops for pasture for dairy, beef, prime lamb production, wine grapes, lucerne pasture/hay, potatoes, lucerne seed, and cereals. Industry and public water supply are other major users.

Surface Water Resources - page 12/196

Apart from an extensive drainage system, there are surface water resources. These consist of a number of ephemeral (seasonally flowing) creeks including Glenroy Creek, Mosquito Creek, Naracoorte Creek and Morambo Creek. 4 km of the Glenelg River flows through the SE. South of Mount Gambier, there are a number of drains and coastal springs, fed by discharge from the unconfined aquifer. These include Piccaninnie Ponds (**an important tourism area**), Deep Creek, and Eight Mile Creek.

Other important surface water areas are Reedy Creek, Bakers Range, West Avenue, Taratap and Marcollat watercourses, which consist of a series of wetland complexes and floodplains. Coastal lakes extend from Port MacDonnell in the south through to the Coorong. There has been an indication of increasing interest in surface water for consumptive uses.

Assessment of the needs of water dependent ecosystems - page 13/196

NRM Act 2004 Section 76(4)(a)(i) (amended in 2013) of the Act provides that a water allocation plan must include an assessment of the quantity and quality of water and times or period needed by the ecosystems that depend on the water resource.

NRM Act 2004 Section 76(4)(aab) of the Act also requires a water allocation plan to include:

(i) an assessment of the capacity of the water resource to meet environmental water requirements;

(ii) information about the water that is to be set aside for the environment including, insofar as is reasonably practicable, information about the quantity and quality, the time when that water is expected to be made available, and the type and extent of the ecosystems to which it is to be provided; and

(iii) a statement of the environmental outcomes expected to be delivered on account of the provision of environmental water under the plan. Environmental water requirements and environmental provisions for the PWA are described in Sections 2.2.1 and 2.2.2, respectively. The environmental water provisions for the PWA do not aim to return water-dependent ecosystems to a pristine condition, but to keep them at an acceptable level of risk. This is achieved by setting aside a portion of recharge for through flow purposes, the maintenance of water tables and underground water salinity and the reduction of allocations in management areas at high or very high risk from current allocation and extraction, as well as reducing the impact of any further development in the vicinity of high ecological value underground water dependent ecosystems by means of setback distances for new water use activities.”

Ecosystems dependent upon underground water in the Lower Limestone Coast PWA - page 13/196

As well as the hydrological component, underground water contains physio-chemical properties and dissolved nutrients that are important for ecosystem processes. There are five types of underground water dependent ecosystems which **include Karst, streams/watercourses, wetlands, phreatophytic vegetation and marine environment.**

Karst - Karst (aquifer) ecosystems occur within the voids (solution features) that have developed within the carbonate rocks making up the unconfined aquifer of parts of the South East. The **limestone** units of the LLC PWA geology **have numerous sinkholes, cenotes, caves** and other karst features, **many of which intersect the underground water table. (please note, limestone is prone to subsidence and sink holes and exacerbated by mining, drilling and fracture stimulation, according to Pennsylvania Department of Environmental Protection).** The underground water dependent ecosystems present within the volcanic crater lakes (e.g. the Blue Lake and Valley Lake) around Mount Gambier bear many similarities to those found within the limestone karst systems **found elsewhere throughout the region.** **Karsts in the vicinity** of Mount Gambier include Bottlebrush Sinkhole, the Valley Lake, Grundy’s Woodland, Caverton Park Estate Cave, the Blue Lake, Sheathers Cave, Engelbrecht Cave and Hells Hole.

The underground water contained in these systems supports aquatic stygobites that are endemic to the South East, including syncarids, amphipods and stromatolite communities. In a number of features, including the Blue Lake, the surface opening is substantial and provides a **lake** habitat which supports benthic algae, phytoplankton, invertebrates, fish and birds. **Hell’s Hole is listed on the Register of the National Estate for its biological significance, due in part to the presence of the endangered fern Pteris tremula , which may be dependent on the underground water fed lake environment.**

Page 15/196 - Toward the coast, further **south** from Mount Gambier are **other caves and sinkholes** which have underground water on which ecosystems and stygobite communities are dependant on. These include Fossil Cave, Gum Road Cave, The Pines Cave, Tea Tree Sinkhole, Horse and Cart Sinkhole, Mushroom Cave, The Shaft, Hereford Stream Cave, Allendate Sinkhole, Gouldens Hole and Morgans Cave. Hereford Stream Cave extends for over 250 metres and has **eight permanent pools.** At the southern end of the system, water flows out through a permanent underground stream that is up to one metre deep.

Sinkholes and Karsts of significance west of Mount Gambier include Bullock Hole, One Tree Sinkhole, Ten Eighty Sinkhole, Benara Sinkhole, Alleyn’s Cave (Death Cave), Little Blue Lake, Green Lake, Woolwash Cave, The Sisters, The Black Hole, Mud Hole and Tank Cave. Many of these systems feature wetland habitats at their surface,

Page 18/196 - **South** of Mount Gambier in the **coastal region, the Karst** features fall into two categories – **caves – and sink holes which lie inland and rising springs along the coast** which provide discharge points for the water table. The cavities themselves support important and well preserved habitats and also form underground water

dependent surface habitats generally comprising a permanent lake, fringing wetland vegetation and a stream draining to the sea. **Underground water is the most important source of water in these ecosystems**, and small local catchments provide limited and intermittent surface runoff. **Sinkholes** in this area include Pretty Pond, Stratmans Pond, Fifty Four Foot Pond, Unnamed pond, Fel Pot Pond, Bugga Bush Pond, Piccaninnie Ponds, Tadpole Pond, Crescent Pond, Bones Pond, and Ewens Pond. Some of these ponds discharge into creeks or drains.

Karst ecosystems which include the Shaft, Allendale Sinkhole and Black Fellows Cave. Ewens Ponds, Piccaninnie Ponds, Crescent Pond and Hammerhead Pond are found within Conservation Parks and provide well preserved **examples of an integrated surface and subsurface underground water dependent ecosystem. Other karst ecosystems** include the Shaft, Allendale Sinkhole and Black Fellows Cave. Ewens Ponds, Piccaninnie Ponds, Crescent Pond and Hammerhead Pond are found within Conservation Parks and provide well preserved examples of an integrated surface and subsurface underground water dependent ecosystem. **Both Ewens and Piccaninnie Ponds are listed on the Register of the National Estate for their biological significance. In addition Piccaninnie Ponds was included on the List of Wetlands of International Importance (Ramsar List) in 2013. The Ramsar list also includes the Hacks and Bool Lagoons in the LLC PWA.** The Ramsar Convention of Wetlands is an inter-governmental treaty that provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. **(please note these areas are all recognized as very important tourism areas)**

The permanent discharge of underground water to the surface supports reed and sedge vegetation (*Phragmites australis*/*Typha domingensis*) on the fringes of pools and tea-tree fen closed scrub (*Leptospermum lanigerum*/*Melaleuca squarrosa*) in the wetland areas. The open water of the ponds supports aquatic biota including vascular plants (e.g. *Triglochin procerum*), algae and mosses and a variety of fauna including fish, tortoises, water birds and crustaceans.

The endangered marsupial mouse, Swamp Antechinus (*Antechinus minimus*), has been recorded in Piccaninnie Ponds Conservation Park, as well as the nationally listed fish Dwarf Galaxias (vulnerable) and nationally listed Spiny Crayfish (endangered), while the Maroon Leek-orchid *Prasophyllum frenchii* (endangered) is found on the wetland margins. Ewens Ponds provides habitat for vulnerable fish species, including the endemic Ewens Pygmy Perch (*Nannoperca varigata*) and the Australian Grayling (*Prototroctes maraena*).

Karst faunal communities can be impacted by groundwater level decline, which may cause stranding if the decline occurs at a rate greater than that with which the animals are able to move downwards; **loss of connectivity** between cavities; and an increase in the distance between the aquifer ecosystem and the source of carbon, reducing the amount of organic matter available to aquifer food webs.

Streams, watercourses and drains - Page 19/196

Streams, watercourses and drains are dependent on underground water where the discharge contributes to the flow of the stream, watercourse or drain, or to permanent pools or water quality. The stream and permanent pools support threatened fish communities.

Wetlands - Page 19/196

Wetlands can be supported by the discharge of underground water to the surface (or near surface) by creating a damp, saturated or inundated soil environment. Surface runoff also contributes to the water in wetlands, but underground water influences the timing, duration and extent of wet conditions during dry periods. Wetlands support particular plants and animals, such as frogs, invertebrates and water birds. **Since European settlement, there has been a reduction from 44% to less than 6% of wetlands** in the South East because of drainage and land clearance. This is in the SE NRM region. **Less than 10% of these remaining wetlands are intact.** The majority of **remaining wetlands have some dependence on the unconfined aquifer.** The South East Water Science Review (DFW 2010) reports that the majority of wetlands in the South East **(77% of wetlands by number and 96% of wetlands by area) are highly likely to be dependent on underground water.** This relationship is consistent for the LLC Prescribed Wells Area. Since the introduction of the **Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)**, the inclusion of a wetland on the Ramsar List entails specific management obligations, namely the maintenance of the ecological character of the site and the wise use of

resources.

Wetlands supported by underground water within the PWA contain populations of EPBC Act listed threatened species, including the nationally vulnerable Southern Bell Frog (*Litoria raniformis*) in Bool and Hacks Lagoons, Lake Ormerod, and Rocky Swamp in the north and north east of the PWA. Populations of nationally vulnerable native fish species Yarra Pygmy Perch (*Nannoperca obscura*) also occur within Bool and Hacks Lagoons. In the region of the PWA adjacent to the border of South Australia and Victoria, a large number of wetlands are semi-permanent and interact with the water table by forming underground water mounds or by receiving underground water discharge in springs. Penola Conservation Park, which includes Green Swamp, has representative wetland vegetation containing Prickly Tea-tree (*Leptospermum continentale*) and Swamp Gum (*Eucalyptus ovata*).

There is much more information in the Water Allocation Plan document in regard to wetlands, threatened plant and animal species and ecosystems which all rely on underground water, either directly or indirectly through other plant associations that are directly dependent on underground water. I do not intend to include it all here.

In the last decade, the underground and surface water hydrology of the South East region has **changed, with reduced water inflows**. This has resulted in a change in the floristic composition of wetlands, with salt sensitive species present pre-2000 being lost and salt tolerant species now occurring.

Phreatophytic vegetation – Page 21/196

Phreatophytic vegetation is vegetation which exists specifically due to the presence of underground water which sustains deep-rooted plants in an otherwise dry environment. Phreatophytic vegetation is often closely associated with wetlands. *Eucalyptus camaldulensis* (in the northern area) is the dominant tree species in many wetlands, depressions and water courses where the underground water table is less than 10 metres below the surface. These trees are likely to be dependent on underground water in many areas, varying from permanent use to temporary dependence during dry periods. Remnants of *Eucalyptus camaldulensis* woodland are also present, along with other communities which are likely to be underground water dependent including *Melaleuca halmaturorum* tall shrubland, *Typha domingensis* closed sedgeland, *Eucalyptus ovata* / *E.viminalis* woodland and *Pteridium esculentum* closed fernland with emergent *Eucalyptus* species. In the region of the PWA adjacent to the South Australian and Victorian border, there are substantial remnants of vegetation that are likely to be dependent on underground water, including *Eucalyptus ovata*, *E. viminalis* woodland, *Xanthorrhoea caespitosa*, *Leptospermum continentale* open shrubland, *Melaleuca brevifolia* low shrubland and *Eucalyptuscaldulensis* var. *camaldulensis* woodland. **(please note trees are necessary for stock weather shelter)**

Marine environment – Page 21/196

The marine environment receives a significant quantity of underground water from aquifer discharge and through baseflow discharging to watercourses which then flow to the ocean. The influx of fresh water will affect the marine habitat along the coast **and may support particular species or communities**. Some of these freshwater beach springs and ecosystems that are supported by underground water derived surface water flows are south and south west of Mount Gambier. **(please note, the aquifers extend under the sea, so in the likelihood of contamination of aquifers occurring on the land, then this also may impact the ocean as well)**

Assessment of the quantity and quality of water needed by water dependent ecosystems Page 22/196

NRM Act 2004 Section 76(4)(a)(i) of the Act requires a water allocation plan to provide an assessment of the underground water quantity and quality needed by the ecosystems that depend on the water resource and the times at which, or periods during which, those ecosystems will need that water. **(please note, how can this assessment accurately occur in the event that there are thousands of unconventional gas wells in the SE, as predicted in a document “Potential Geological Risks Associated With Shale Gas Production in Australia”, January 2013, Project Code AA S801, by FROGTECH, commissioned by PIRSA, VIC DPI, Goescience Australia, DEWNR, SA Water and DSE. It is stated that 3,446 SHALE GAS wells are estimated for the Otway Basin, most being on the South Australian side.**

The Act defines 'environmental water requirements' to mean: "those water requirements that must be met in order to sustain the ecological values of ecosystems that depend on the water resource, including their processes and biodiversity, at a low level of risk". The exact environmental water requirements of groundwater has not been fully studied for wetlands in the South East of South Australia, however, the South East Water Science Review (DFW 2010) states that wetlands in the South East are experiencing prolonged dry conditions and increasing salinity. These ecosystems are at risk due to dropping groundwater levels and/or increases in underground water salinity. An increase in depth to the water table of 1.5 metres past current levels is expected to result in total loss of a wetland. (NB this should be a wakeup call not to allow fracture stimulation and unconventional gas projects to go ahead, because of the high water requirements and the extreme likelihood of contamination occurring, given the limestone properties and numerous faults in the SE)

Environmental water provisions – Page 23/196

NRM Act 2004 Section 76(4)(b)(i) of the Act provides that a water allocation plan must achieve an equitable balance between environmental, social and economic needs for water. For the purposes of the Plan 'environmental water provisions' mean those parts of environmental water requirements that **can be met at any given time**, with consideration of existing users' rights and social and economic impacts. Despite the above studies, the exact level of dependence solely on underground water of ecosystems in the LLC PWA has not been fully studied. As a result, the Plan proceeds on the basis that to conserve ecosystems dependent upon underground water, **the current quality and quantity of that underground water must be conserved**. The Plan accordingly sets principles for water management that aim to maintain the current quantity and quality of underground water available for these ecosystems by virtue of:

- **no further declines and, where possible, recovery in underground water table levels, to ensure underground water dependent ecosystems can continue to access this resource;**
- **no significant increases in underground water salinity, to ensure no detrimental impact on species that are sensitive to salinity levels; and**
- **the maintenance of lateral through-flow of underground water, in order to prevent recycling of irrigation water (which can lead to increases in salinity), and to ensure that salts are flushed from the region.**

Assessment of effects on other water resources – Page 33/196

As required by the **NRM Act 2004 section 76(4)(a)(ii)** of the Act, this section provides an assessment as to **whether the taking or use of water from the resource will have a detrimental effect on the quantity or quality of water that is available from any other water resource**. This section looks at the potential detrimental impacts of taking or using water from the LLC PWA upon the quantity or quality of water from other water resources in the LLC PWA and adjacent PWAs. Within the PWA, it considers the potential for impacts upon streams, springs, rivers, wetlands, drains and other surface water bodies, and the possibility of impacts arising from the relationship between the two aquifers.

Science has shown that plantation forestry expansion can significantly impact surface water catchment yield and underground water recharge and that, under some circumstances, plantation species can extract water directly from shallow water tables (Benyon and Doody 2004, Benyon et al. 2006, Benyon et al. 2008). The impacts of this on dependent environmental ecosystems are not yet known but will be considered during the implementation of the Plan. **(please note, invasive, high water usage, high pressure multi-well slick water fracture stimulation may possibly cause declining aquifer levels)** There are a number of wetlands, springs, streams, drains, other surface water bodies and the Glenelg River that are reliant on water from the LLC PWA.

Springs and Wetlands- Page 33/196

Wetlands in the LLC PWA vary in terms of their relationship with, and reliance on, underground water. It is likely that the taking and use of underground water will have a detrimental effect on these wetlands. Where springs and wetlands (known to be dependent on underground water) exist in close proximity to water affecting activities, such as underground water pumping or forestry, it is likely that these activities will affect the quantity and quality of water available to these ecosystems. The extent to which it will detrimentally affect these systems is unknown. Currently, **little information is available for identifying the relationship between underground water extraction**

and impact on wetlands and drains in the LLC PWA. (please note, how can accurate assessments be made in relation to unconventional gas projects going ahead, when it is clear that knowledge is already lacking, before unconventional gas projects even come into the picture)

There has been a **long term decline in water levels** in the area surrounding Mount Gambier. The primary influences on the underground water level are assumed to be climate (e.g. rainfall amount and timing) and the rate of extraction of underground water from the aquifer. A slight decline in water levels has been noted within the southern coastal region. This slight decline can also be largely attributed to a **period of consecutive dry years**. **Underground water extraction may be a contributing factor to this slight decline, but the extent of this contribution is unknown.** (please note unconventional gas projects should not be allowed to add to problems of already declining water levels)

The Blue Lake and Other Surface Water Bodies – Page 35/196

The Blue Lake, located in the centre of Mount Gambier, is a source of water for the city's population of approximately 23,000 people. Underground water from the unconfined aquifer provides the inflow to the Blue Lake. The lake level reflects the underground water table of the unconfined aquifer. Water levels in the Blue Lake and the surrounding Mount Gambier area have been in long term decline since 1925 and hydrographs show that the water levels **have declined approximately 3.5 metres since 1972** (South Australian-Victorian Border Groundwaters Agreement Review Committee 2008). The downward trend in Blue Lake water level since the early 1990s **can be linked to a long term declining rainfall trend.**

Unconfined Aquifer – Page 37/196

Prior to 2010, direct leakage of pressure water from the confined aquifer into the overlying unconfined aquifer occurred via a large number of confined aquifer wells in poor condition due to age and construction techniques. During 2001 to 2010, 120 leaking confined aquifer wells in the Kingston-Greenways area were either replaced or back-filled using specialist techniques, as part of the South East Confined Aquifer Well Rehabilitation Scheme. Expenditure on the scheme was estimated to be \$5.5 million over nine years, including \$1.3 million funding from the Natural Heritage Trust, \$1.1 million from State investment and a financial commitment from landowners of up to \$3.1 million.

(please note, imagine the costs of in time of repairing every drill hole for unconventional gas in the SE that are in the ground down to around 4 km and extending horizontally, with the casing and cement that does not last for ever'. Who will foot the bill in 30 – 50 years if these companies are no longer around. An audit should be done on EVERY existing drill hole and hydrology drill hole associated with past mining and petroleum exploration or production in the SE now. Until this is done, one cannot say that every drill hole and hydrology observation hole is in order. Judging from a DMITRE spread sheet on drill holes in the SE, there are a number that appear missing. I question the records storage system)

Unconfined Aquifer - Page 40/196

In the majority of the management areas, a declining trend in depth to water has also been observed in the last five years. There are three principal factors affecting the extensive underground water level decline in the LLC PWA:

- **underground water extraction;**
- **reduced rainfall and hence recharge; and**
- **the effects of land use change, particularly the establishment of commercial forests.**

In the Mount Gambier area the underground water levels have been in long-term decline since 1925, as observed by the water level in the Blue Lake. **Impacts from forestry, variability of rainfall and its incidence, and increased underground water extraction have contributed to this decline. In addition, the level of stock and domestic water use around Mount Gambier is estimated to be high.**

On page 41/196, The South East Water Science Review (DFW 2010) that states that the water table has been declining approximately 0.5 metres/year (Figure 5, to the underground water table has been increasing by

approximately 0.5 metres/year.

Risk of seawater intrusion south of Mount Gambier – Page 43/196

The coastal area south of Mount Gambier includes sites of underground water discharge such as Piccaninnie Ponds. The water levels in the coastal area were relatively stable up until 1997 with negligible seasonal fluctuation. Since 1997 underground water levels have fluctuated seasonally. **The South East Water Science Review (DFW 2010) identified the area south of Mount Gambier as an area subject to specific risks. A seawater-freshwater interface in the unconfined aquifer has been detected about 1.5 kilometres inland and 150 metres below the surface, indicating the potential for seawater intrusion in the Donovans management area. Fresh underground water in coastal aquifers is vulnerable to salinisation by seawater intrusion due to increasing underground water extraction and climate changes, which can cause the lowering of the underground water hydraulic head and reduced recharge to the unconfined aquifer.**

Saline underground water intrusion has the potential to result in significant economic and environmental impacts. It is estimated that approximately 2,527 hectares of agriculture may be at risk, equating to a potential current regional economic impact of \$31 million (Department of Planning and Local Government 2011). Underground water dependent ecosystems such as the internationally important karst wetland system Piccaninnie Ponds, and the nationally important karst wetland system, Ewens Ponds, may also be at risk.

A recently completed study into the risk of seawater intrusion into the unconfined aquifer in the LLC (Mustafa et al.2012) was recently completed. Coastal monitoring wells reveal salinity levels exceeding 25,000 mg/L, with the highest risk for seawater intrusion considered to be irrigation extraction which could cause a reversal of underground water movement (currently towards the coast). **The freshwater-saltwater interface has been detected at four locations:** Eight Mile Creek, Port MacDonnell, Piccaninnie Ponds/Pick Swamp complex and the area west of the township of Port MacDonnell.

Present and future needs of needs of water users – Page 44/196

NRM Act 2004 Section 76(4)(c) of the Act requires that a WAP must take into account the present and future needs of the occupiers of the land in relation to existing requirements and future capacity of the land, and the likely effect of those provisions on the value of the land. In terms of providing for future expansion in water use, the Plan provides for **limited new allocations** from the Crown from the unconfined aquifer, including to some existing section 128 authorisations and temporary allocations for mining purposes, **(please note how can water use for unconventional gas projects be classed as temporary)** subject to a number of conditions.

Mining – 44/196

Action 48 of the Water for Good Plan (Government of South Australia 2010) relates to water used for mining and **requires “mining ventures to provide their own water supplies within the sustainable framework of natural resources management planning and regional water demand and supply plans”.** (NB the SE land owners do not want water brought up from deep below that will be contaminated with heavy metals, radionuclides etc. and exposing it to the landscape i.e. holding ponds and movement on holding ponds water if accidents happen, or drill holes to get to this water that will have to go through the potable aquifers. Casings and cement do not last forever)

There are a number of extractive mineral mines in the LLC PWA, extracting limestone, sand, and/or gravel. Additionally, a lignite (coal) mine is proposed for an area northeast of Kingston SE. **(Please note this exploration licence should have never been allocated to Strike Energy Ltd. In 1982, pumping tests were performed over 8 days for Western Mining Corporation, with serious consequences. Several bores lost pressure and one had to be pumped to regain pressure for many weeks. A direct connection through the breach of the wall between the Dilwyn confined aquifer and the Mepunga confined aquifer from where Kingston SE gets it's water, was discovered. The EIS was found to be fundamentally flawed as proven by the United Farmers and Stockowners of South Australia Watchdog Committee of Kingston S.E.)**

The Plan allows for allocation of water for the purpose of mining provided that an equivalent volume to that allocated above the TML (if any), is returned to the source aquifer from which the water was originally extracted, with no detrimental change to the quality of the water in the source aquifer, and subject to a number of other conditions. **(please note the analysis of Jolly 1 holding pond in the submission, therefore there will be changes in the quality of the water).**

There is currently a Ministerial authorisation under section 128 of the Act (South Australian Government Gazette, 30 August 2001, page 3442) for the taking of water in relation to a hydrocarbon exploration well under the **Petroleum Act 2000 (now Petroleum and Geothermal Energy Act 2000)**. A hydrocarbon includes petroleum, natural gas and coal seam gas. Water extracted during the drilling process comes from the unconfined aquifer. Petroleum and carbon dioxide is sourced from the deeper confined aquifer(s) which may result in co-produced water (water taken as a by-product of petroleum or carbon dioxide extraction), being extracted during the production process. **(Please note Jolly 1 holding pond analysis – this water should not be returned anywhere)**

Indigenous and cultural needs – Page 62/196

Access to, and use of, water from prescribed water resources by Aboriginal people is exempt from licensing for the purpose of social, cultural or spiritual use, provided that the taking does not involve stopping, impeding or diverting the flow of water for the purpose of collecting the water or diverting the flow of water from water resources. The Minister has issued a statewide authorisation (under section 128 of the Act) to take water for Native Title purposes. The traditional owners of the land that is now the LLC PWA are the Tanganekald, Meintang, Bungandiji, Potaruwutj and Marditjali people. A number of culturally significant underground water-dependent ecosystems have been identified through members of this Group, including the Crater Lakes (Blue Lake, Valley Lake, Leg of Mutton Lake and Browns Lake), Little Blue Lake, Bool and Hacks Lagoons, the Coastal Lakes (including Lake George) and the wetlands of the upper northwest of the LLC including the management areas of Duffield, Landseer, Peacock and Marcollat.

Limestone Coast Groundwater Risk Assessment - confined aquifer – Page 76/196

The risk assessment was done for the confined aquifer resource in regard to what is considered at risk of degradation from the current level of demand. In regard to the confined aquifer, the LLC PWA risk assessment poses the following question for each management area: **“Is there the potential that current levels of allocation and extraction in management areas in the Lower Limestone Coast will lead to (further) declines in water tables and resource quality, which could detrimentally impact the community and industries dependent on the groundwater?”**(note this exact question should be asked of unconventional gas projects) Sources of risk which could lead to adverse impacts on the confined aquifer resource, and therefore its users (water dependent industries, stock and domestic water users), were identified as: groundwater extraction and interception, climate variability, drought, and climate change.

Climate change – Page 78/196

Climate change presents a **significant challenge** to South Australia. While the water policy decisions included in the Plan were based on the most recent meteorological, hydrological and hydrogeological information and trends, **the effects of climate change are not yet clearly understood and therefore knowing the consequences for future water allocation demand is difficult.** **(please note, again why allow fracture stimulation which requires vast amounts of water, when already it is difficult to ascertain the consequences for future water allocation demand)**

Climate modeling in the South East region has indicated a significant variation from the current weather pattern. A continuation of the increasing temperature trend and an overall decreasing annual rainfall trend, most significantly in the spring is predicted. **Annual decreases in rainfall of one to 10% are predicted for 2030 and two to 30% by 2070 in the South East NRM region** (Suppiah et al. 2006).

The close relationship between climate and underground water levels in the unconfined aquifer, will in-turn, continue to have a negative impact on the underground water resources in the LLC PWA.

The South East Water Science Review (DFW 2010) examined the historical rainfall record for evidence of climate change in the South East. They found that **“Over the last 10 years, rainfall has been lower than longer-term averages, with a noticeable decline in groundwater tables compared to the previous three decades”**.

While the CSIRO has tried to make an assessment of declines in rainfall by downscaling the global climate models, **there is still a high degree of uncertainty.**

Transfer Criteria – Unconfined Aquifer – page 124/196

Objectives

The objectives of the unconfined aquifer transfer criteria are:

- a) To manage the underground water resource of the unconfined aquifer so that it may continue to be available for the social, economic and **environmental needs of current and future generations.**
- b) To protect the environment generally by ensuring that the taking and use of underground water from the unconfined aquifer **does not cause significant degradation of any other resource such as soils or other water resources.**
- c) To maintain and/or improve the availability of underground water for ecosystems dependent on underground water.
- d) To provide flexibility and equity in access to the underground water resource of the unconfined aquifer.
- e) To minimise constraints on transfers of water allocations so that these are available to sustain economic development.**
- f) To ensure that allocations resulting from transfers remain within the sustainable limits of the unconfined aquifer in the relevant management area.
- g) To provide for the transfer of volumetric allocations from the unconfined aquifer.

147. In management areas subject to reductions in allocations, if a licensee applies in writing to the Minister, the Minister may transfer in an allocation from the same management area exempt from principles 58-65 (Hydrogeological effects and assessment) and principles 2-5 (**Protection of ecosystems dependent on underground water – extraction from licensed wells**). **(please note how can what is happening under the ground be observed EVERYWHERE for contamination at the same time? Usually when contamination occurs it is found some time after the contamination first began.)**

Allocation Criteria – Confined Aquifer page 132/196

Objectives

The objectives of the confined aquifer allocation criteria are:

- a) To cautiously manage the confined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.
- b) To protect the resource locally, throughout each management area, and throughout the entire PWA.
- c) To provide flexibility and equity in access to the underground water resource of the confined aquifer.
- d) To protect the environment generally by ensuring that the taking and use of underground water from the confined aquifer does not cause significant degradation of any other resource and other water resources.**
- e) To bring at-risk and/or over-allocated management areas back to environmentally sustainable levels of allocation.
- f) To provide for the implementation of the volumetric conversion of confined aquifer allocations.

Allocations for the purpose of mining page 139/196

214. Water from the confined aquifer may be allocated upon application in writing to the Minister, for the purpose of mining, subject to the following:

- c) all water extracted is returned to the same source aquifer from which water was originally taken pursuant to a permit in accordance with section 10.5 (Managed Aquifer Recharge: Draining or discharging of water into a well) of the Plan, with no detrimental change to the quality of water in the source aquifer; **(note how can this be done given the analysis of the Jolly 1 holding pond)**
- d) no weakening or fracture of the confining layer between the unconfined and confined aquifers (given the nature of fracking and seismicity produced, there is no proof that this can be safely done without weakening or fracturing the confining layer)**
- e) water allocated under this principle is exempt from principles 220 - 222

Allocation for the purpose of petroleum or carbon dioxide production

215. Water from the confined aquifer may be allocated above the TML for the purpose of water taken as a by-product of petroleum or carbon dioxide production (known as coproduced water), including allocation to water users producing co-produced water as a by-product of petroleum or carbon dioxide production in existence at the date of adoption. **(please see attached Jolly 1 holding ponds analysis)**

217. Allocations made in accordance with principle 215 shall be exempt from principles 220-

222 (Hydrogeological effects and assessment) and shall expire on the 30 June following the cessation of the activity authorised under the Petroleum and Geothermal Energy Act 2000 .

Hydrogeological effects and assessment page 140/196

220. No allocation of water from the confined aquifer shall be made which appears, in the opinion of the Minister, to have potential to:

a) **adversely affect the quality of water in the confined aquifer** to a significant extent, and in **particular shall not cause or contribute to an increase in salinity;**

b) cause or contribute to a long term decline in the potentiometric level of the confined aquifer by causing or being likely to cause a mean (arithmetic) decrease in the potentiometric level of the confined aquifer: **(note this is questionable with fracking activities)**

i. within the vicinity of the point of taking (including neighbouring properties and the nearest potentiometric level monitoring wells), **(please note fracking activities usually do affect neighbouring properties – there are a number of examples)**

ii. within the relevant confined aquifer management area; of greater than 0.1 metres per year (measured over the preceding five years);

c) adversely affect to a significant extent, or have the potential to adversely affect to a significant extent, the structural integrity of the aquifer;

d) adversely affect to a significant extent any other water resource inside or outside of the PWA;

f) adversely affect to a significant extent ecosystems dependent on underground water.

Page 140/197

221. In areas where the existing confined aquifer potentiometric level is greater than the unconfined aquifer potentiometric level, the allocation of water from the confined aquifer shall not occur if it has, in the opinion of the Minister, the potential to cause the confined aquifer potentiometric level to permanently fall below the unconfined aquifer potentiometric level.

222. The allocation of any water from the confined aquifer shall not, in the opinion of the Minister, have the potential to cause a seasonal drawdown at any point beyond the two kilometre radius from the point(s) **(please note – a number of wells with multi-drill pads have the potential of causing aquifer problems. This is all unknown as to the full potential risks)**

Restrictions on use - page 141/196

226. Water shall not be allocated from the confined aquifer for a purpose that produces tail water unless: **(please note could tail water also be interpreted as co-produced or produced water as the result of unconventional gas activities)**

c) the disposal of tail water will not cause:

i. an acceleration in salinity increase in either aquifer; or **(please see Jolly 1 holding pond analysis)**

ii. pollution of either aquifer by the tail water; or

iii. pollution of either aquifer by any other substance; and

d) the ponds, tanks, vessels, or other places for the keeping of any water for that purpose have no significant hydraulic connection with either aquifer.

227. For the purpose of principle 226, tail water is water that flows out of a system once it has flowed through any ponds, tanks, vessels or other places, including places for the keeping of farmed aquatic species.

Managed Aquifer Recharge: Draining or discharging of water into a well - page 151/196

The following objectives and principles apply to permits required for the draining or discharging of water directly or

indirectly into a well (“artificial recharge”) (**section 127(3)(c) of the Act**). These objectives are additional to those expressed for all water affecting activities. In addition to any permit required to drain or discharge water directly or indirectly into a well, additional authorisations may be required under the **Environment Protection Act 1993**. Water drained or discharged into a well must comply with the Environment Protection Act 1993 and any associated policy. **(please note, is re-injection into the ground regarded as down a well, as this toxic water is re-injected through a purpose built well – the industry admits re-injection causes earthquakes)**

Objectives – Page 151/196

- a) To protect the underground water resource **from waste or pollutants** (as defined in the Environment Protection (Water Quality) Policy 2009 under the Environment Protection Act 1993) to the receiving underground water resource during the draining or discharging of water into a well. **(please note there are many issues with well integrity, casings and cement breaking down e.g. as the result of hydrogen sulphide, contaminant pathways opened up through fracture stimulation with existing or new faults)**
- b) To provide for the draining or discharging (artificial recharge) of water directly or indirectly into a well in a manner that does not have the potential to adversely affect:
- i. the quality of surface water and underground water resources;
 - ii. the integrity of the relevant aquifer (including, but not limited to, the ability of the aquifer to transmit water);
 - iii. water tables (particularly where the adverse effect might include water logging, land salinisation or damage to infrastructure (roads, buildings, foundations, etc.)
 - iv. any water-dependent ecosystem or ecologically sensitive area that depends on the underground water resource;
 - v. the ability of other persons to lawfully take from that underground water; **(please note what has happened in Australia with coal seam gas, and with shale gas – aquifers have become contaminated in Australia and overseas and petroleum companies overseas are now being sued because of this)**

266. The relevant authority will not grant a permit if the salinity of the drained or discharged water exceeds:

- a) 1500 mg/L TDS; or
- b) where the ambient background underground water salinity levels are less than 1500 mg/L TDS - the ambient background underground water salinity level.

267. A permit to drain or discharge water into a well will not be issued unless a risk assessment is undertaken to the satisfaction of the Minister. **(note – re-injection is proven to cause earthquakes, other documentation will be supplied).**

268. This risk assessment must be consistent with the National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health & Environmental Risks, Phase 1 2006, and must include:

- a) an investigation into the suitability of the draining or discharging site, including but not limited to tests for transmissivity, effective porosity and storage coefficient, maximum injection pressures and calculated likely impacts on the integrity of the well and confining layers, and impacts of potentiometric head changes to other underground water users;

Identification of knowledge gaps and further research required - Page 159/196

Current knowledge gaps with respect to the needs of water dependent ecosystems include: **(please note with current knowledge gaps the government should take the precautionary principle and not allow fracture stimulation in the SE)**

1. Intrinsic knowledge of underground water dependent ecosystems underground water/surface water interaction and dependency including:
 - a) water level and quality thresholds; and
 - b) long term implications of climate change.
3. Definition of the threatening processes, the risks they pose and the consequences of not addressing them including:
 - a) development of shallow and deep drains; and
 - b) land use change (including cross-border issues).
4. Intrinsic knowledge of cause-and-effect relationships and the development of effective management tools to address the following issues:
 - a) declining underground water discharge due to interception of recharge in inland areas by high water use crops

and commercial forests;

- b) **declining underground water discharge due to lowering of the water table as a result of climatic trends;**
- c) increasing salinity due to landward migration of the boundary between fresh underground water (associated with declining water table elevations in the unconfined regional aquifer); and
- d) contamination of the aquifer, particularly with nitrates.

5. The development of environmental response functions for individual ecosystems dependent on underground water is required to better inform the determination of environmental protection policy. Environmental response functions describe the relationship between ecosystem function and water regimes in which the ecosystems exist (e.g. depth to water table fluctuations, soil water content, soil water and underground water salinity).

There is much more information in this section of the LCC WAP.

<http://www.naturalresources.sa.gov.au/southeast/water-and-coast/water-allocation-plans/lower-limestone-coast>

FRACKING EARTHQUAKE WORLD RECORD: THE TYEE NEWS

<http://thetyee.ca/News/2015/01/29/Alberta-Fracking-Earthquake/>

Did Alberta Just Break a Fracking Earthquake World Record? Regulator says drilling likely triggered 4.4 temblor.

By Andrew Nikiforuk, 29 Jan 2015, TheTyee.ca

Hydraulic fracturing, a technology used to crack open difficult oil and gas formations, appears to have set off a swarm of earthquakes near Fox Creek, Alberta, including a record-breaking tremor with a felt magnitude of 4.4 last week. That would likely make it the largest felt earthquake ever caused by fracking, **a development that experts swore couldn't happen a few years ago.**

Fracking operations in British Columbia's Montney shale **generated similar seismic activity of that magnitude last year**, and earthquake scientists at Ontario's Western University are still analyzing the two events to see which is the largest.

"The location of the earthquake is consistent with being induced by hydraulic fracturing operations," confirmed Peter Murchland, a spokesman for the Alberta Energy Regulator. "The AER regards all changes in seismicity that have the potential to indicate an increased risk associated with hydrocarbon production seriously," Murchland added.

Jeffrey Gu, a physics professor at the University of Alberta, said the Alberta Geological Survey and other agencies were investigating the Fox Creek swarm, which hit about 260 kilometres northwest of Edmonton. But Gu said he could not disclose their findings at this time. He offered no details on the scale or scope of the investigation.

Alberta experienced more than 400 small earthquakes between 1985 and 2010. But according to the Alberta Geological Survey, felt earthquakes are uncommon. "There have been fewer than 15 catalogued events greater than magnitude 3.5 since 1985," it has stated.

For years industry and fracking experts argued the technology wouldn't cause quakes that could be felt on the surface. But specialists in earthquake hazards such as Gail Atkinson, who holds the Canada Research Chair in Induced Seismicity Hazards at Ontario's Western University, **argued the opposite.** "I have consistently maintained this kind of thing can happen," said Atkinson. "With fracking, the magnitudes have been increasing every year."

Natural Resources Canada reported a swarm of at least 15 earthquakes this January west of Fox Creek in a region where **Encana, Talisman, Apache, Chevron Canada and ExxonMobile intensified the drilling and fracking of two-kilometre-long horizontal wells nearly a year ago.**

The companies are cracking rock in the unconventional Duvernay shale at a depth of 3,000 metres in order to extract condensates, a product typically worth more than oil and used to dilute heavy bitumen for pipeline transport.

An investigation by Atkinson last year into a **related swarm of 25 small earthquakes in the same area ranging in magnitude from 2.5 to 3.5 between 2013 and 2014 found that the events also corresponded "closely to hydraulic fracture treatments of oil and gas production wells in the immediate vicinity."**

LAST FRIDAY'S SHAKER

Since Dec. 2014, a second swarm of earthquakes has rattled the region within a 50-kilometre radius of the community of Fox Creek, an oil and gas town with a population of 2,000 people in northern Alberta. The community is about 260 kilometres north of Edmonton. The largest Fox Creek quake registered **4.4 magnitude** and caused walls to shake and beds to move. It became the source of constant social chatter on Friday, Jan. 23.

"When we hit a magnitude of 3.8 this month, I'd thought for sure that the industry would stop and take a smoke break to figure out what's going on," said 57-year-old Barb Ryan, a Fox Creek resident who has been keeping an eye on resource development. "But they didn't. Many are in denial here." Ryan has pressed for more transparent monitoring over the fracking industry's growing impacts on water, air and public health, but said she has faced resistance from local authorities. (She also graphed the Fox Creek swarms using coordinates from Natural Resources Canada.)

The earthquakes have mostly taken place in the province's first "play based regulation pilot," a geographical area where the regulator has given blanket approval to the development of the formation as opposed to approving one well at a time. The Alberta Energy Regulator says the strategy "results in regulatory efficiencies," but critics call it a new form of deregulation. Ryan said that most people in Fox Creek know little to nothing about the first or second earthquake swarm, because there has been no public reporting on the events.

To recognize the risk of earthquake hazards in Alberta might put livelihoods on the line and businesses at risk, she said. "Cognitive dissonance prevents some communities from admitting or even discussing the resource industry's impacts. The topic is very divisive."

Many Alberta geologists did not answer Tye queries on the earthquake swarms. Based on public data from Natural Resources Canada, Ryan estimates the region around Fox Creek has recorded approximately 94 small quakes since 1990. "We've had more than **70 of those quakes since Dec. 2013**," she said. "We once averaged zero to three quakes a year. Since the initial swarm, we've averaged zero to four quakes a day."

A BRIEF HISTORY OF ALBERTA'S MAN-MADE QUAKES

Alberta's oil and gas industry has caused both small and significant earthquakes throughout the province since the 1960s. The rapid extraction of sour natural gas from the Strachan pool near Rocky Mountain House set off a 4.0 magnitude quake in 1974 followed by 146 tremors in the 1980s, including a 3.4 magnitude tremor.

In 1970, the **pumping of water into depleted oil fields near Snipe Lake likely triggered a 5.1 magnitude earthquake**, perhaps the largest in the province's history.

A 1990 report by the U.S. Geological Survey noted that this earthquake **"is considered to be the first and largest known Canadian example of an earthquake induced by fluid injection in a producing oil field."** The injection of steam to melt 400-metre deep bitumen formations in Cold Lake can lift and then drop the land by as much as 10 to 30 centimetres over a month. The heaving of the ground creates a constant stream of micro-earthquakes and frequently fractures well casings. Since 1958, the industry has pumped more than 2 million barrels of water into old oil formations to coax out more petroleum. In addition, the province has more than 2,500 wastewater disposal wells. — Andrew Nikiforuk

RISE OF 'MAN-MADE' QUAKES

Overwhelming scientific evidence from the U.S. Geological Survey now shows that the fracking industry and its need for huge wastewater disposal wells have fostered unprecedented "man-made earthquakes" in the eastern and central U.S. In the process the industry has rewritten seismic records in Ohio, Oklahoma, Colorado, Kansas, Arkansas and Texas. Some experts now argue that **man-made industry quakes are more dangerous than natural ones**. Western University's Atkinson said that "the hazards may be significant, depending on the proximity of infrastructure, and should be carefully evaluated... the hazard is concentrated close to the activity [within about five kilometres], because the motions die off with distance."

Added Atkinson: "The earthquake hazard from induced seismicity in places like Alberta where seismicity is being triggered is greater than the natural earthquake hazard... it will take regulators in the United States and Canada a while to figure this out." Experimental frack operations typically require up to 18,000 horsepower to pump 18,000 barrels of water and between 100 and 165 tonnes of rock crack openers, sand

or "proppants" as many as 40 times to create fractures along one lateral well.

Alarmed by the industry's ability to trigger earthquakes, regulators in B.C. and Colorado recently introduced a seismic traffic system. Whenever fracking operations or injection wells activate felt earthquakes greater than a **magnitude of 4.0, operations must shut down to prevent more serious shaking.**

Alberta has no such policy. Operations that currently generate earthquake swarms can do so with impunity, though that may soon change, according to a spokesman for the province's energy regulator. "The AER is developing a scientifically-based protocol for addressing anomalous seismicity that is appropriate for Alberta," Murchland said.

At one time, industry experts and lobbyists maintained that "seismic activity caused by hydraulic fracturing is not a hazard or nuisance."

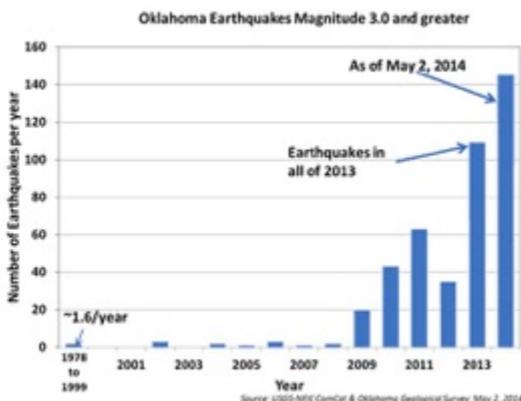
But the complexity of geology has confounded the industry. While inducing micro-earthquakes to open rock pores, a frack job perturbs the stress of the rock. **Injected fluids can then find faults and cause slips, resulting in earthquakes.** "We don't know the magnitude limits for these earthquakes or how big an event can get," said Atkinson, who has analyzed seismic hazards for dams, buildings and offshore platforms. "We also don't know if we can predict in advance the likelihood of triggering such an event, either. And we don't know if we can image the faults before fracking and avoid them, or how they'll behave if we hit them."

INJECTIONS REACTIVATE FAULTS: EXPERTS:

The Alberta Energy Regulator told The Tye that it is also investigating another swarm of earthquakes that shook up Cardston, Alberta. **That incident "was likely induced by hydraulic fracturing,"** a spokesperson said. In 2012, as many as four earthquakes rattled an area near the Blood Indian Reserve, or Kainai Nation. The tremors ranged from 2.4 to 2.7 in magnitude according to data captured by the U.S. Geological Survey in Montana. It shook homes on the reserve where many residents remain opposed to fracking. The province has yet to issue a report on the earthquake swarm.

Injecting fluids into shales to create fractures can create a chaotic and uncontrollable network of cracks that can connect to fault zones. The **reactivation of these faults can then trigger an earthquake,** scientists say. The disposal of toxic wastewater extracted from fracking **jobs into deep formations can also cause swarms of earthquakes by the same mechanism.** Injection wells, with names like King Kong and Deep Throat, **can trigger earthquakes up to 20 kilometres away.** The wells may inject more than 150,000 barrels of waste into the ground a month. **Years may pass before the fluids migrate or change rock pressure, activating nearby faults and fractures.**

Between 2010 and 2013, the U.S. Midwest, home to **extensive fracking, has experienced more than 100 induced and felt earthquakes over a magnitude of 3.0 per year, compared to the normal average of 21. Oklahoma, once a seismically quiet region, has now become the most earthquake prone jurisdiction in the Lower 48 due to fracking and the injection of its associated wastewater. It now records more earthquake activity than California.**



Due to a 50 per cent increase of quakes greater than a magnitude of 3.0, the U.S. Geological Survey issued

residents of the state an unprecedented advisory last year: prepare for **"increased hazard" from industry-made quakes.**

"Building owners and government officials should have a special concern for older, unreinforced brick structures, which are vulnerable to serious damage during sufficient shaking," said the warning.

The earthquake swarms have produced lawsuits in Oklahoma, Texas and Arkansas alleging that oil and gas companies are responsible for making earthquakes that have caused property damage and personal injury. In Oklahoma, there has been a rush on earthquake insurance.

Due to growing concerns about public health, groundwater contamination and man-made earthquakes, New York state banned the mining of shale basins last year. The governments of the Yukon, New Brunswick, Newfoundland and Labrador and Nova Scotia have placed moratoriums on the technology. A new group in Prince Edward Island is calling for a complete ban.

BC FRACK QUAKE MONITOR HIRED

Industry-made quakes in northern B.C. have become such an ongoing concern that the Induced Seismicity Monitoring Network Consortium, which represents government, industry and regulators, recently hired a seismologist for two years.

The earthquake hazard expert will "monitor induced seismicity from natural gas development in northeast B.C. and study the relationship between fluid injection and potential large-magnitude seismic events."

To date, B.C. fracking operations **have tried to avoid faults** by reducing frack stages, or using less proppant to keep cracks open, **but to no avail.** "The success of these mitigation measures is difficult to ascertain," stated the B.C. Oil and Gas Commission in its latest earthquake report.

Unlike other geological agencies on the continent, the Alberta Geological Survey, an arm of the industry-funded Alberta Energy Regulator, does not report on induced seismicity in a timely fashion. There is little data available from 2010 to 2014 when hydraulic fracturing took off in the province. Residents north of Cochrane claim that seismic activity caused by the fracking of the Cardium oil formation not only cracked foundations and broke windows, but has not been properly investigated.

When a possible earthquake uplifted Ann Craft's mobile home in 2012 during the fracking of four shallow coal bed methane wells, the province agreed to do a study and then reneged on its promise. Members of the Alberta Geological Survey say that provincial seismic monitoring is inadequate: "[I]t is likely that network coverage in the Western Canadian Sedimentary Basin is too sparse to consistently detect" small events caused by injection wells, land subsidence or hydraulic fracturing, said one recent study.

A 2014 report by the Alberta Energy Regulator concluded that the risk of industry-caused earthquakes was low, but added that its monitoring capacity was not up to the task: "[I]f it becomes necessary to verify or refute a definitive causal correlation, it would be hard to do so with the currently available data. In the areas of concern, more work is needed to expand the array of seismic stations to precisely detect the epicentre and hypocenters of an earthquake."

'MINOR ANOMALOUS SEISMICITY': CAPP

The Canadian Association of Petroleum Producers describes hydraulic fracturing as a "safe and proven" technology to extract natural gas and oil, even though one recent Alberta fracturing incident broke cap rock and released nearly **12,000 barrels of bitumen into aquifers** (see my comments at end of article) and the boreal forest at a Canadian Natural Resources Ltd. operation.

But CAPP adds that "certain oil and gas basins, such as the Horn River Basin of British Columbia, have a distinctive geology, and hydraulic fracturing has caused rare and minor anomalous seismicity."

Earthquake hazard scientists argue the industry has routinely underestimated the complexity of geology for unconventional hydrocarbons everywhere, and is now encountering unknown faults and triggering earthquake swarms by negligent design.

In Australia, one group of scientists at Southern Cross University recently argued that the fracking industry has moved as fast as a hare, while public policy and good baseline science has proceeded with the pace of a tortoise.

FINAL CONCLUSION

There is documented evidence overseas now linking earthquakes and activities of hydraulic fracture stimulation. Currently, there is a lawsuit in Oklahoma against oil and gas companies for hydraulic fracture stimulation activities (waste-water disposal) causing a 5.6 magnitude earthquake in 2011. Ohio and Texas have also been experiencing earthquakes that are linked to hydraulic fracture stimulation. These warnings should be heeded as far as the South East of South Australia.

GIVEN THE EVIDENCE ON GEOLOGICAL HAZARDS IN THE SOUTH EAST, INCLUDING FAULTS, LIMESTONE WHICH IS PRONE TO SUBSIDENCE AND SINKHOLES AND SEA-WATER INTRUSION, PLANNING FOR UNCONVENTIONAL GAS AND MINING DEVELOPMENT SHOULD BE BASED ON THE SUITABILITY OF THE GEOLOGY RATHER THAN THE EXTRACTIVE WORTH OF THE LAND. THIS MEANS THIS LAND SHOULD BE EXEMPT AND PROVISIONS SHOULD BE MADE IN BOTH THE ENVIRONMENT ACT AND THE PLANNING ACT.

If hydraulic fracture stimulation is allowed to occur in the South East of South Australia, and there are serious outcomes, which, as evidenced, there clearly will be, who will ultimately be responsible to face enormous costs to try and sort this out? It must be taken into account, that once water is gone from the aquifers, it may never be replenished, if droughts continue, as predicted by our own state government. Are DSD, DEWNR (the taxpayers money), local councils, state or federal governments ultimately responsible? Who will cover the insurance for the economic burden, e.g. loss of potable water, loss of productive agricultural land, loss of income by farmers and other industry in the South East through contamination issues, loss of export trade through losing the South East clean and green image and the huge cost of health burdens, both physical and psychological, attributed to this industry? While government may see "a financial nest egg as the result of the hydraulic fracture stimulation in the South East", in reality, based on evidence in this submission, this would be far from the truth. In fact, over time the detrimental costs of this industry would far outweigh any economic benefits.

Hydraulic fracture stimulation is a complex activity. If allowed in the South East of South Australia, it will negatively affect many communities.

I wish to thank the Natural Resources Committee for reading my submission. I am happy to answer any questions.

Anne Daw