Review of CSG activities in NSW - Submission

Joy Oddy to: csg.review 13/05/2013 03:28 PM

History: This message has been replied to and forwarded.

Please find attached submission from Doctors for the Environment Australia.

Could you please notify me by return email to confirm the submission has been received.

Kind regards,

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Review of CSG in NSW - Chief Scientist Submission 05-13.pdf

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Submission
on the
Review of Coal Seam Gas Activities in NSW
By the
NSW Chief Scientist and Engineer

8th May 2013

Submission from
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Doctors for the Environment Australia (DEA) is a voluntary organisation of medical doctors in every state and territory working to protect health through care of the environment.

DEA has presented evidence to two parliamentary committees that it considers *the current level of assessment, monitoring and regulation of CSG exploration and mining activities to be inadequate to protect the health of current and future generations of Australians*. While some important progress has recently been made in NSW, we submit that greater protections are still required.

- DEA's Senate and NSW Government submissions are available at http://dea.org.au/images/uploads/submissions/MDB_CSG_Senate_submission_June_2011.pdf and http://www.parliament.nsw.gov.au/prod/parlment/committee.nsf/0/f96d076732225603ca25791b00102098/$FILE/Submission%200412.pdf

DEA also has policies and information resources on this issue:

- Gas as a replacement fuel: Discussion paper on the health aspects of gas http://dea.org.au/images/general/Gas_and_Health_Report_01-2012.pdf

- Video clip on CSG's potential health implications http://dea.org.au/resources/file/csg_undermining_our_food_bowls_dr_helen_redmond

Health impacts of Unconventional Gas Development

Recently the Chief Medical Officer of New Brunswick, Canada released a report detailing concerns about the development of the unconventional gas industry there. She emphasised that even though there may be economic benefits from gas development, "unless proper controls are put in place there is a risk of spoiling any benefits from economic gains through adverse health outcomes". The same set of issues apply in an Australian context, and to coal seam gas (CSG) expansion in NSW.

Chief Medical Officer of Health's Recommendations Concerning Shale Gas Development in New Brunswick, Canada. Sept 2012 : http://www.damascuscitizensforsustainability.org/wp-content/uploads/2012/10/Recommendations_ShaleGasDevelopment.pdf

Health is not merely the absence of disease, but requires clean air, safe food and water and ecosystem services in an environment conducive to physical and mental health. There is the potential for health to be affected by CSG directly and indirectly through chemical exposures, threats to food and water security and wider cumulative, psychological and social impacts.

Using a similar framework to the New Brunswick report, we can summarise these threats to health as:

(1) Physical eg. accidents, chemical exposure, worker health
(2) Environmental - impacts mediated through air, water, soil, food
(3) Impacts on psycho-social wellbeing and mental health
(4) Cumulative risks from CSG in a climate changing world

(1) Physical

The procedure of hydraulic fracturing, involves the pressurised injection into rock of fluids comprising water and chemical additives, and sand, to open up or enlarge fractures. When the underground rock formation is fractured, the propping agent pumped into the fractures keeps them open and allows gas to flow. A proportion of the fracturing fluids is then returned to the surface and needs to be treated or disposed of in some way. The gas extraction process requires coal seams to be depressurised through the withdrawal of water. As the water pressure is reduced the gas is released from the coal. Depressurisation affects the water levels in coal seams and can potentially affect interconnected aquifers overlying or underlying the coal seam, and water supply to water bores in the surrounding area.

There is a significant potential for accidents and spills to occur throughout this process. A US EPA document notes:
"*Large hydraulic fracturing operations require extensive quantities of supplies, equipment, water and vehicles, which could create risks of accidental releases, such as spills or leaks. Surface spills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents, ground fires, or improper operations. Released fluids might flow into a nearby surface water body, infiltrate into soil and near-surface ground water, potentially reaching drinking water aquifers".*
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711-08.pdf

In Australia, sixty-one environmental incidents were reported to the peak industry body APPEA in the 2011–12 year, and it notes, "The Australian industry still has some way to go to match safety performance in other parts of the world".
http://www.appea.com.au/images/stories/Policy_-_Safety_and_Health/2012%20appea_hse.pdf

The Queensland government reported that in the first six months of 2011 there were 45 CSG compliance-related incidents, including spills and uncontrolled discharges of CSG water, exceedance of discharge limits, overflows of storage ponds, and other incidents relating to vegetation clearing and BTEX contamination. For 2011 the stated plan was to track and manage the environmental performance of the CSG industry in relation to fracking activities with 10 unscheduled audits and inspections. In fact no unscheduled audits of fracking activities were actually carried out "due to occupational health and safety difficulties associated with attending unscheduled fracking operations".
http://www.ehp.qld.gov.au/management/non-mining/documents/csg-compliance-report-jan.pdf

Recently 10,000 litres of saline water leaked at the Narrabri CSG Project, operated by Eastern Star Gas. The incident was not reported at the time despite an obligation to do so under the conditions of the petroleum exploration license.
http://www.smh.com.au/environment/water-issues/arsenic-and-lead-found-in-contaminated-water-leak-at-coal-seam-gas-drill-site-20120209-1rx7s.html

Research in Colorado has found "that surface spills are an important route of potential groundwater contamination from hydraulic fracturing activities and should be a focus of programs to protect groundwater."
http://www.tandfonline.com/doi/abs/10.1080/10962247.2012.759166

Occupational health

There has to our knowledge been no published medical research on the occupational health of workers in the unconventional gas industry in Australia. However the mining industry has the highest injury and fatality incidence rates reported to Workcover in NSW.
http://www.workcover.nsw.gov.au/formspublications/publications/Documents/statistical_bulletin_2008_2009_2810.pdf

Information from overseas also indicates cause for concern. In the USA, the annual fatality rate of workers in the oil and gas industry during 2003—2006 was estimated to be approximately seven times the rate for all US workers.
http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5716a3.htm

As well as transportation and heavy equipment accidents, there are concerns associated with exposures to chemical mixtures of fracking fluids. Health professionals are concerned that their patients could be exposed to unknown or inadequately documented chemicals, making treatment of accidents difficult and potentially hazardous. An example of this occurred in 2008 when a nurse in the US became very ill from chemical exposure after treating a gas field worker who presented to hospital soaked in chemicals.
http://wsrl.org/pdfs/drilling-fluids.pdf

As sand is used as a proppant in fracking, huge quantities may be moved around and generate dust containing respirable crystalline silica. It has been reported that the National Institute for Occupational Safety and Health (NIOSH) collected air samples at 11 different fracking sites in 5 different US states to evaluate worker exposure to crystalline silica. At each of the sites, they consistently found levels that exceeded relevant occupational health criteria. NIOSH concluded that there continues to be a need to evaluate and characterize exposures to these and other chemical hazards in fracking fluids.
http://www.apha.org/advocacy/policy/policysearch/default.htm?id=1439;
http://blogs.cdc.gov/niosh-science-blog/2012/05/silica-fracking/

Drilling and maintaining a well can expose workers to TENORM (technologically enhanced naturally occurring radioactive material) by disturbance and mobilisation of radioactive compounds in strata beneath the earth's surface. This can be by excess salt that precipitates out on surfaces, recycling water (radioactive salts are not easily filtered out of water), filter, sludge, equipment etc.
http://ohsonline.com/articles/2012/10/01/radiation-sources-in-natural-gas-well-activities.aspx?admgarea=ht.PPE

Health effects of chemicals used in or generated by CSG operations and hydraulic fracturing

Effects on human health of chemicals depend on a range of factors including dose, route and duration of exposure. Long-term concerns of some chemicals used in or generated by CSG mining include hormonal system disruption, fertility and reproductive effects, and development of cancer. These types of effects may not be immediately obvious, but can nevertheless occur with very low chemical exposures and have far reaching consequences.

It is currently not possible to undertake adequate health risk assessments of these operations as insufficient information has been gathered on the nature and doses of chemicals entering water and air and the exposures of people to these chemicals. One of the biggest problems is the lack of transparency around the chemicals used, and the lack of monitoring under the normal protections afforded to drinking water supplies.

A recent report by a US House of Representatives Committee noted *"As the use of hydraulic fracturing has grown, so have concerns about its environmental and public health impacts. One concern is that hydraulic fracturing fluids used to fracture rock formations contain numerous chemicals that could harm human health and the environment, especially if they enter drinking water supplies. The opposition of many oil and gas companies to public disclosure of the chemicals they use has compounded this concern."*
http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic-Fracturing-Chemicals-2011-4-18.pdf

That committee's inquiry found that over a four year period, 14 leading oil and gas companies used more than 2,500 hydraulic fracturing products containing 750 chemicals and other components, which constituted (excluding water added at the well site) 780 million gallons of hydraulic fracturing products. A number of these chemicals were known to be hazardous to health through release into water and/or air including endocrine-disrupting and cancer-causing agents.

Colborn et al attempted to review the chemicals used in gas extraction and found the available data fraught with gaps. However, they managed to independently compile a list of 944 products used, containing a total of 632 chemicals. They noted that more than 75% of the chemicals could affect the skin, eyes, respiratory and gastrointestinal systems. Approximately 40-50% could affect the brain and nervous system, immune and cardiovascular systems and kidneys. Over a third could affect the endocrine (hormonal) system and a quarter could lead to cancer and mutations.
http://www.endocrinedisruption.com/files/Oct2011HERA10-48forweb3-3-11.pdf

A recent UK study reviewed information on chemicals supplied to New York State using a European chemical substances database and found that 58 of the 260 substances listed were of concern: 17 were classified as toxic to aquatic organisms, 38 were classified as acute toxins to humans, 8 were known carcinogens, 6 were suspected carcinogens, 7 were classified as mutagenic and 5 were classified as having reproductive effects.
http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf

Lloyd-Smith found extremely limited data available about fracking fluids used in Australia and a lack of any comprehensive hazard assessment of the chemical mixtures used and their impacts on the environment or human health. Only two of the 23 most commonly used fracking chemicals said to be used in Australia have been assessed by the National Industrial Chemical Notification and Assessment Scheme (NICNAS), and neither of these has been specifically assessed for use in fracking. This leaves the population vulnerable to a range of potential health threats. Although NICNAS is currently in the process of assessing many thousands of chemicals, some of which are used in fracking, this process is occurring over years and there is no publicly available comprehensive list of fracking chemicals.
http://www.ntn.org.au/wp/wp-content/uploads/2013/04/UCgas_report-April-2013.pdf

APPEA has listed 45 compounds used during fracking in Australia and companies frequently infer safety of these products due to the fact some are components of household products. However any poisons information centre will advise to store household chemicals safely out of reach in a locked cupboard. Just because we may have hair bleach or antifreeze in the cupboard does not mean it is safe to drink it. Specific chemical names and CAS numbers are frequently not provided to communities, making it almost impossible for residents to obtain independent information and advice.

For example, persulfate salts are used as fracking agents. A NICNAS assessment of persulfate salts used in hair bleaching preparations state they are "*hazardous chemicals and ...harmful if swallowed, irritant to the skin and eyes and able to cause allergic responses*". Companies and government agencies rarely provide this sort of information to the public.
http://www.nicnas.gov.au/Publications/CAR/PEC/PEC18/PEC_18_Full_Report_PDF.pdf

CSG companies argue that only a very small percentage of fracking fluids consist of these chemicals, but because of the huge volumes of fluids used, the cumulative chemical load is actually considerable.

Some compounds such as benzene can present a risk to health even in minute concentrations. Benzene and other BTEX chemicals (benzene, toluene, ethylbenzene and xylene) are frequently found in petroleum compounds and can be mobilised during CSG operations. They are in a class of chemicals known as volatile organic compounds which easily vaporise so people can be exposed through drinking water, bathing or breathing in vapour.

Long-term exposure to benzene can affect the bone marrow, causing anaemia, and increasing the risk of leukaemia, and can affect unborn children.
http://www.atsdr.cdc.gov/tfacts3.pdf

The Australian drinking water guidelines for benzene state "no safe concentration for benzene in drinking water can be confidently set" so the guideline is set at below the level of detection, which is 1ppb (the equivalent of a drop of water in a swimming pool).
http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh34_adwg_11_06.pdf

Toluene and ethylbenzene can damage the nervous system, liver and kidneys and ethylbenzene is a possible human carcinogen. http://www.atsdr.cdc.gov/tfacts110.pdf, http://www.atsdr.cdc.gov/tfacts56.pdf

A 2010 assessment of the impacts of proposed coal seam gas operations in the Murray-Darling Basin noted: "*No data have been made available to examine the possible implications of hydrocarbons, eg, BTEX, in associated water*"
http://www.environment.gov.au/epbc/notices/assessments/pubs/coal-seam-gas-operations-impacts.pdf

A range of other hazardous chemicals are reported to be used in Australian fracking operations, for example ethylene glycol, glutaraldehyde, fumaric acid, methanol and 2-butoxyethanol.

Ethylene glycol is used to make anti-freeze. When ethylene glycol breaks down in the body, it forms chemicals that crystallize, collecting in the kidneys and affecting kidney function. It also forms acidic chemicals in the body, affecting the nervous system, lungs

and heart.
http://www.atsdr.cdc.gov/tfacts96.pdf

Glutaraldehyde is very irritant to skin, eye, throat and lungs. Repeated skin contact can cause allergic reactions. http://www.cdph.ca.gov/programs/hesis/Documents/glutaral.pdf

Fumaric acid is an irritant of skin and mucous membranes.
http://www.sciencelab.com/msds.php?msdsId=9927173

2-butoxyethanol is easily absorbed and rapidly distributed in the human body and is particularly toxic to red blood cells, carrying the risk of haemolysis, and damage to spleen, liver and bone marrow.
http://www.atsdr.cdc.gov/toxfaqs/tfacts118.pdf

Methanol is readily absorbed after oral, inhalation, or dermal exposure. It is metabolised to formaldehyde and formic acid in the body and is toxic in very small doses if ingested. Death can be caused by ingestion of only 80 ml. Chronic exposure to methanol can cause headache, insomnia, gastrointestinal problems, and blindness in humans and hepatic and brain alterations in animals.
http://www.epa.gov/chemfact/s_methan.txt

It is clear that chemical compounds used in fracking are not all the innocuous substances that they are commonly portrayed to be. In addition, it should be noted that with any chemical mixture it is not only the effects of each chemical which may be problematic, but also the potential for multiple unpredictable chemical combinations.

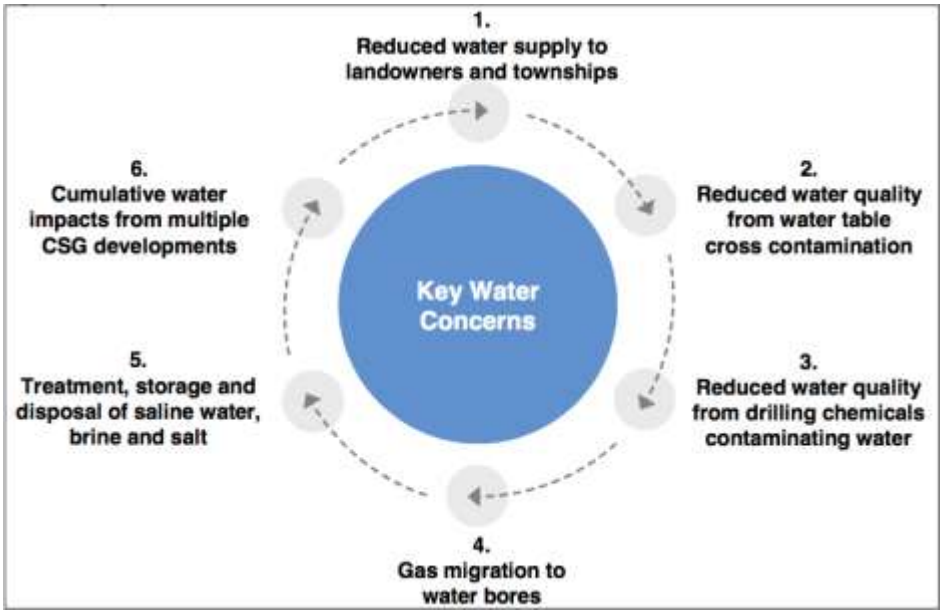
A recent article in the American Journal of Public Health (Finkel & Law, 2011) called for the precautionary principle to be used in relation to fracking, stating *"of concern is that endocrine-disrupting chemicals may alter developmental pathways, manifesting decades after exposure*".
http://ajph.aphapublications.org/cgi/content/abstract/101/5/784

(2) Environmental Impacts

(a) Water

The National Water Commission warns that" the Coal Seam Gas industry… if not adequately managed and regulated, …risks having significant, long-term and adverse impacts on adjacent surface and groundwater systems".
http://www.nwc.gov.au/__data/assets/pdf_file/0003/9723/Coal_Seam_Gas.pdf

Key water concerns have been documented in a number of reports, including one by JP Morgan (see figure below). These include reduced water supplies to communities, reduced water quality from water table cross contamination, reduced water quality from drilling chemical contamination, gas migration to water bores, treatment storage and disposal of wastewater and salt, cumulative water impacts from multiple developments.
http://www.smh.com.au/business/coal-seam-gas-a-risk-jpmorgan-20101215-18xzw.html
http://www.isf.uts.edu.au/publications/rutovitzetal2011sydneycoalseamgasbkgd.pdf



Key water concerns

Sheriff, Benjamin Wilson & Jason Steed. ESG and the energy sector. Water concerns: Queensland Coal Seam Gas Developments Report Summary. J.P. Morgan Securities Australia Limited, Sydney 2010

Reduced water quality

Contamination of surface and ground water is the greatest concern with CSG, particularly in relation to a drinking water source. This can occur from the chemical additives used during drilling and hydraulic fracturing, degradation products, and also the compounds that are mobilised from sediments during the mining process. These chemicals can include toxic, allergenic, mutagenic and carcinogenic substances as well as methane. Waste water coming to the surface may contain volatile organic compounds, high concentrations of ions, heavy metals and radioactive substances.

There are already examples in the US and in Australia where harmful chemicals, such as benzene, have been found in ground water subsequent to coal seam gas exploration and mining.
http://www.scientificamerican.com/article.cfm?id=chemicals-found-in-drinking-water-from-natural-gas-drilling;
http://www.propublica.org/article/buried-secrets-is-natural-gas-drilling-endangering-us-water-supplies-1113;
http://www.smh.com.au/environment/toxins-found-at-third-site-as-fracking-fears-build-20101118-17zfv.html;
http://news.smh.com.au/breaking-news-national/carcinogens-found-in-csg-project-20110828-1jg77.html

The US EPA is currently studying the relationship between hydraulic fracturing and drinking water, the conditions that may be associated with contamination of drinking water resources, and the identification of factors that may lead to human exposure and risk.
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711-08.pdf

Research in the US has found systematic evidence for methane contamination of drinking water associated with shale-gas extraction. Methane in drinking water is a concern for human health and is an indicator of the potential for contamination with other compounds. http://www.nicholas.duke.edu/cgc/pnas2011.pdf

Gas can migrate from coal seams to aquifers where a pathway exists. It can migrate some distance though natural or man-made geological pathways. Investigation is complicated by the fact that tracing a definitive source of contamination can be difficult, as groundwater supplies and gas deposits are often separated by considerable distances. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2866701/pdf/ehp-118-a199.pdf

Assoc Prof Heiger-Bernays of Boston University School of Public Health has been quoted as saying: "*We normally think of methane toxicity in terms of inhalation, and by that route, we know it can displace oxygen, which creates an asphyxiation hazard... we know virtually nothing about how methane might affect people who ingest it.*" By interacting with chlorine in water, methane might produce chlorinated hydrocarbons that are known to be toxic by ingestion.
http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.119-a348

Residents of Pavillion, Wyoming USA, live in an unconventional gas field and for years complained of health problems. An investigation by the US EPA has found that ground water which is a source of their drinking water contains compounds likely to be associated with gas production practices, including hydraulic fracturing. Chemicals detected include methane, other petroleum hydrocarbons and other chemical compounds. Residents of the town have been advised to use alternate sources of water for drinking and cooking, and have adequate ventilation when showering.
http://yosemite.epa.gov/opa/admpress.nsf/20ed1dfa1751192c8525735900400c30/ef35bd26a80d6ce3852579600065c94e!OpenDocument

Accumulation of contaminants in aquifers can have long-term impacts. Studies on the transport and fate of volatile organic compounds have found they can persist in aquifers for more than 50 years and can travel long distances, exceeding 10 km.
http://www.sciencedirect.com/science/article/pii/S0045653508002233

The Australian Senate report noted "there is a risk that residues of chemicals used in fraccing may contaminate groundwater and aquifers used for human or stock consumption or irrigation. There are examples where water has been contaminated. It is acknowledged that in one case in Australia, fraccing resulted in damage to the Walloon Coal measures, causing leakage between that and the Springbok aquifer."
http://www.aph.gov.au/Parliamentary_Business/Committees/Senate_Committees?url=rrat_ctte/completed_inquiries/2010-13/mdb/interim_report/report.pdf

A farmer's submission to the Senate Inquiry describes the problem eloquently:"It is critical that any chemicals used in drilling and CSG well stimulation activities do not migrate to the bores of groundwater users. It is critical also that natural occurring chemicals and compounds in coal seams and strata formations are not mobilised to water aquifers tapped by water bores. Many homes use bore water, the livestock we eventually eat as steak, chicken, lamb and pork from supermarkets more often than not drinks it, and the plants we grow for grain and vegetables soak up bore water through their roots and foliage systems under irrigation." (Anne Bridle Submission 328)

http://www.aph.gov.au/Parliamentary_Business/Committees/Senate_Committees?url=rrat_ctte/completed_inquiries/2010-13/mdb/interim_report/e01.htm

Reduced water availability

The CSG industry uses enormous quantities of water. Current projections indicate the Australian CSG industry could extract in the order of 7,500 gigalitres of water from groundwater systems over the next 25 years. The National Water Commission is concerned that "CSG development represents a substantial risk to sustainable water management given the combination of material uncertainty about water impacts, the significance of potential impacts, and the long time period over which they may emerge and continue to have effect."

Vast quantities of water are required for fracking, and only a reported 60% or possibly less of the volume of fluid injected may be recovered (this is difficult to estimate as records are not required). CSG companies are not under the same constraints to conserve water as are other users, such as farmers.

The Australian Senate report into this issue noted: "The main cause for concern is with the potential impact of the extraction of large volumes of water on the pressure within adjacent aquifers, the stability of the intervening strata, the levels of water and directions of flow, and the possibility of contamination of higher quality water, all of which may have a long term impact on sources of groundwater used for agriculture, rural communities and the environment."
http://www.aph.gov.au/Parliamentary_Business/Committees/Senate_Committees?url=rrat_ctte/completed_inquiries/2010-13/mdb/interim_report/report.pdf

Production and disposal of contaminated waste water

Increasingly large volumes of produced CSG water will need to be treated to remove salt and other contaminants, but removal methods are not 100% effective. For example chemicals such as benzene, and a number of chemicals used or mobilised during in fracking may be poorly removed through reverse osmosis membranes.
http://www.nwc.gov.au/__data/assets/pdf_file/0003/10974/Waterlines_Quantative_Chemical_Exposure.pdf

The Australian senate report notes "The chemical make–up of the water varies but all of it will have significant levels of dissolved salt plus a range of other chemicals – heavy metals such as arsenic, mercury and lead, naturally occurring BTEX chemicals and uranium. The water may also contain residues of chemicals used in the drilling and hydraulic fracturing processes". Obviously many of these chemicals are potentially dangerous to human health, livestock and soils".
http://www.aph.gov.au/Parliamentary_Business/Committees/Senate_Committees?url=rrat_ctte/completed_inquiries/2010-13/mdb/interim_report/report.pdf

There are already examples of where produced CSG water has been legally discharged into waterways with contaminants of concern to the environment. Discharge of treated coal seam gas water into the Condamine River south of Chinchilla has allowed discharge of 22 chemicals in excess of ANZECC freshwater environmental guidelines, including

boron, silver, chlorine, copper, cadmium cyanide and zinc, which at the limits approved are toxic to aquatic organisms. http://www.abc.net.au/news/specials/coal-seam-gas-by-the-numbers/

Waste water with additives returned to the surface pose problems with treatment, disposal and storage. This water can contain volatile organic compounds, high concentrations of ions and radioactive substances. Substances that can be mobilised from rock formations may include arsenic, cadmium, chromium, lead, selenium, thorium, radium and uranium. CSG water brought to the surface is often highly saline and not suitable for agricultural or domestic purposes.
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711-08.pdf

Waste water has to be stored in tanks or pits at the well site, where spillage can occur and then has to be recycled for future use in fracking, injected into underground storage wells, discharged into nearby surface water or transported to wastewater treatment facilities. The 2011 Tyndall Centre (University of East Anglia, UK) report notes that *"flowback fluid is likely to be of greater concern than that of the fracturing fluid itself, and is likely to be considered as hazardous waste in the UK."*
http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf

The CSG industry is one that produces huge amounts of waste salt. Modelling suggests the industry could produce 31 million tonnes of waste salt over the next 30 years. The industry has not yet come up with a solution for disposal of all this waste salt and it is likely that much of it will end up in landfill - in a country that is already battling salinity problems.

(b) Air

Air pollution may pose a serious threat to health. Toxicity of the pollutant, concentration, duration and frequency of exposure and vulnerability of the recipient will determine the health impacts of air pollution. Strenuous outdoor activity will expose a subject to many times the dose than sedentary indoor activity. Young children who play outside and those who work outdoors may be more exposed to air contaminants. Weather systems will greatly affect how much contaminated air is trapped close to the surface and therefore around homes. This can affect exposures by 10 to 20 times.

The following overview of air pollutants draws heavily from the unconventional gas literature emerging from the United States, where shale gas dominates over coal seam gas. We acknowledge that shale gas reserves are much deeper than coal seam gas reserves and that they require high volume hydraulic fracturing. Although the geology in NSW coal seams is somewhat different, the pollutants potentially released in the process are very similar. In terms of health impacts, all types of unconventional gas extraction pose the same types of risks to human health. It is our opinion that these studies are therefore relevant and should be cautionary.

Volatile organic compounds (VOCs) and poly-aromatic hydrocarbons (PAH) including the carcinogen benzene are released during unconventional gas operations, from venting, holding tanks, holding ponds, compressors and other infrastructure. VOCs and fugitive emissions of methane mix with nitrous oxides from diesel fueled machinery emissions

creating ground-level ozone, exposure to which is a known risk factor for respiratory disease. In some rural areas ozone and smog are as bad as in urban areas. Rural areas in Wyoming and Utah with intense gas operations have measured ozone levels higher than the worst day of smog in Los Angeles.

A study of air quality in a Colorado gas field used US EPA guidelines to calculate health consequences for those living in proximity to gas wells.

McKenzie LM et al. Human health risk assessment of air emissions from development of unconventional natural gas resources *Sci Total Environ 2012;424 : 79-87*
http://www.ncbi.nlm.nih.gov/pubmed/22444058

Results showed residents living <1/2 mile from wells are at greater risk for health effects than are residents living >1/2 mile from wells. The non-cancer risk for residents <1/2 mile from wells was driven primarily by exposure to airborne trimethylbenzenes, xylenes, and aliphatic hydrocarbons. Increased cumulative cancer risk was also increased for those living nearby wells, mostly as a result of increased exposure to airborne benzene. Exposure to harmful air pollution was greatest at the time of well completion (fracking, flowback). Headaches, throat and eye irritation reported by residents during well completion activities are consistent with known health effects of many of the hydrocarbons evaluated in this analysis.

In another study, air sampling was done 1.1km away from a gas well pad before during and after drilling and hydraulic fracturing 16 wells over the course of a year.

Colborn T et al. An Exploratory Study of Air Quality near Natural Gas Operations *Human and Ecological Risk Assessment DOI:10.1080/10807039.2012.749447*
http://www.endocrinedisruption.com/files/HERA12-137NGAirQualityManuscriptforwebwithfigures.pdf

This well pad used a best practice closed loop drilling system where all fluids were piped straight to closed tanks on site. Methane, non-methane hydrocarbons (NMHC) and polycyclic aromatic hydrocarbons were detected. Some PAHs were at concentrations greater than those at which prenatally exposed children in urban studies had lower developmental and IQ scores. The authors conclude:

> *"In order to determine how to reduce human exposure for both those who work on the well pads and those living nearby, systematic air quality monitoring of natural gas operations must become a regular part of permitting requirements. It is apparent from what is presented in this paper that the NMHCs need far more attention not only because of their potential immediate and long term chronic health effects, but also for their secondary indirect health and environmental impacts as precursors to ozone."*

The US Environmental Protection Authority has already acknowledged the seriousness of air pollution from unconventional gas operations and has introduced new standards for the industry that will be phased in by 2015. These will include so called 'green completion' of wells.

> *"Natural gas is lauded as a cleaner-burning fuel than either coal or oil, but getting the fuel out of the ground can be a dirty process, especially given the widespread adoption of the technology known as hydraulic fracturing ('fracking'). Concerns about toxic air emissions from previously unregulated fracking sites led to the U.S.*

Environmental Protection Agency (EPA) announcement on 18 April 2012 of new and updated air pollution regulations for these facilities and certain other elements of oil and natural gas production and transmission. Compliance with the new regulations is expected to result in major reductions in emissions of methane and volatile organic compounds (VOCs), particularly from new fracked natural gas wells."

Weinhold B. The Future of Fracking: New Rules Target Air Emissions for Cleaner Natural Gas Production *Environmental Health Perspectives 2012;120(7):A272-A279*
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3404676/

In the US state of Utah one region has commenced a multi-year air quality study including levels wintertime ozone and concentrations of particulate matter (PM_{10} and $PM_{2.5}$). Already the study has found elevated levels of ozone near gas activity, and that oil and gas operations were responsible for 98-99% of volatile organic compound (VOC) emissions and 57-61% of nitrogen oxide (NOx) emissions.

Utah Department of Environmental Quality (DEQ), "Uintah Basin: Air Quality and Energy Development,"
http://www.deq.utah.gov/locations/uintahbasin/index.htm

Dr David Brown, a Public Health toxicologist, describes the four exposure pathways of water, air, soil and food for chemicals in the unconventional gas industry to reach humans: http://www.youtube.com/watch?v=AhkswtBom4s
He identifies the main pollutants of interest in Marcellus shale gas development as follows.

- Fine particulates (diesel exhaust)
- PAH (BTEX)
- VOC's
- Carbon monoxide
- Silica dust
- Barium, arsenic
- Fluoride salts
- Methylene chloride
- Acetaldehyde/formaldehyde
- Radium

Many of these can be transmitted through air.

Fine particulates are a major air pollutant from drilling sites and compressors. Contained in the diesel exhaust of the many trucks, tankers and heavy machinery used in drilling and hydraulic fracturing, they are known to increase attacks of asthma or COPD, and to increase the risk of cardiovascular events. In air, fine particles become hydrated and then adsorb industrial chemicals, irritants and VOCs (anything water-soluble). This synergistic effect provides a route for these chemicals down deep into the lungs and bloodstream, increasing their effect. Fine particulates can also combine with ozone to increase human health impacts as measured by emergency department presentations.

Peng RD et al. Emergency admissions for cardiovascular and respiratory diseases and the chemical composition of fine particle air pollution *Environ Health Perspect 2009 117:957-63*

There may be many chemicals used in the process for hydraulic fracturing operations and drilling which have the ability to become volatile. Colburn et al analysed hundreds of chemicals used in the unconventional gas industry and found that 37% of those that could be identified were volatile.

Colburn T et al Natural Gas from a Human Health Perspective *Human and Ecological Risk Assessment: An International Journal 2011, 17:5, 1039-1056*

Arsenic has two valence states, one of which is very toxic. It can become volatile as the gas arsine. A case of arsenic poisoning of a child has been documented and the probable route of exposure was due to misting of produced water. A child living in a house less than 1 mile from a well pad became unwell with fatigue, severe abdominal pain, sore throat and backache. 6 months later the child was hospitalised with delirium and tests revealed arsenic poisoning. The family stopped drinking the water from their well, despite later testing which indicated it was safe to drink, and the child gradually recovered. If there had not been reports of numerous animal deaths in the neighbourhood since the gas drilling had started the child's doctor would not have ordered the right tests.

Bamberger M, Oswald R. Impacts of Gas Drilling on Human and Animal Health *New Solutions 2012;22:51-77*

The families of this house and another 1 mile away were monitored and urine tests revealed high levels of phenol, a metabolite of benzene. Levels consistent with chronic exposure to 500 to 4000 ppb (0.5 to 4 ppm) in air of benzene. They were experiencing symptoms such as headaches, extreme fatigue, nosebleeds, rashes, loss of smell and hearing. They were advised to move out, and those that did got better while those that stayed got worse.

Silica dust is highly controlled in industry due to its capacity to cause the occupational lung disease silicosis. When silica dust is inhaled it goes to deep lung, releases lysosome, causing scarring which is progressive. Sand (silica) is used as a proppant in hydraulic fracturing operations. Silica has been found in air and along streets in Pennsylvania. People find it in their dishwashers.

Radium is released from Marcellus shale during unconventional gas extraction and has been undergoing radioactive decay for since the Devonian period 500 million years ago. Radium is highly radioactive and is a known carcinogen but the toxicology of radium this old has not been studied. It is water-soluble and can become an aerosol.
The solvent methylene chloride is commonly used as a paint stripper and is highly volatile.

> The acute (short-term) effects of methylene chloride inhalation in humans consist mainly of nervous system effects including decreased visual, auditory, and motor functions, but these effects are reversible once exposure ceases. The effects of chronic (long-term) exposure to methylene chloride suggest that the central nervous system (CNS) is a potential target in humans and animals. Human data are inconclusive regarding methylene chloride and cancer. Animal studies have shown increases in liver and lung cancer and benign mammary gland tumors following the inhalation of methylene chloride.
> US EPA 2000
> http://www.epa.gov/ttnatw01/hlthef/methylen.html

In one study of air quality around an active well pad in Colorado methylene chloride was the second most frequent compound found in air around well pads after methane. As it is not a known chemical from shale or used in drilling and fracking, the authors were perplexed as to its origin. Local residents and gas workers said it was used for cleaning on the well pad, removing a sludge that can build up on equipment. Methylene chloride

is a CNS depressant and when warmed decomposes to phosgene gas, used in World War I as a chemical weapon. When metabolised in the body it is converted to carbon monoxide.

Colborn T et al. An Exploratory Study of Air Quality near Natural Gas Operations *Human and Ecological Risk Assessment DOI:10.1080/10807039.2012.749447*
http://www.endocrinedisruption.com/files/HERA12-137NGAirQualityManuscriptforwebwithfigures.pdf

Carbon monoxide is released by incomplete combustion of natural gas, and is a component of vehicle and machinery emissions. It irreversibly binds haemoglobin molecules on red blood cells displacing oxygen. Carboxy-haemoglobin may accumulate over episodic exposures and cause neurological effects, which may be irreversible. Even low levels of exposure over long periods may cause headaches and dizziness. Higher levels cause nausea and confusion, convulsions and death. Gas workers and nearby residents may be at risk.

The potential risk to health of air pollution from unconventional gas operations must also take in to account the many unknown effects from multiple chemical interactions. At present the scientific literature documenting air contaminants is in its infancy. Not enough has been done to understand the impacts. And yet symptoms are being reported. The exact causes of those symptoms have not been established. Just as in Australia, baseline testing of air quality has been absent or inadequate, and ongoing monitoring virtually non-existent.

Very limited air sampling has occurred in even the most established CSG field in Australia, in one case despite several years of health complaints from residents. One finding of elevated levels of benzene at night was found in the Tara gas field in southwest Queensland. The NEPM for average annual exposure to benzene is 10.3 micrograms per cubic metre. The level 25 micrograms per cubic metre, was more equivalent to that expected in a dense urban environment. However, due to the very limited sampling interpretation is difficult.

Coal Seam Gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data March 2013, Queensland Department of Health.
http://www.health.qld.gov.au/publications/csg/

Methane emissions

Fugitive emissions of methane gas contribute to local air pollution problems as described above. Although not a direct threat to health unless oxygen is insufficient, methane is a potent greenhouse gas. It is 70-100 times more potent than C02 over a 20 year time frame and 20-30 times more potent over a 100 year time frame.

The potential for fugitive emissions, and the role of gas as an energy source in accelerating climate change, is of great concern, as climate change is a threat to sustainable health.

The next one to two decades are crucial in the fight to keep global warming to a 'safe' 2 degrees increase in temperature. Unconventional gas is frequently promoted as the ideal transition fuel, lower in carbon emissions than coal when combusted for electricity generation. However various reports have concluded that only 2-4% of the methane

needs to be lost in fugitive emissions for the greenhouse gas advantage to be lost. The whole lifecycle of unconventional gas production (especially if you also liquefy it for export overseas) is carbon intensive. A report estimates that electricity generation from exported Australian coal seam gas has a lifecycle carbon footprint equivalent to a new black coal power station. Paul Hardisty explains "if methane leakage approaches 4% of gas production… the GHG intensity of CSG-LNG generation is on a par with sub-critical coal-fired generation"

Paul Hardisty et al. Life Cycle Greenhouse Gas Emissions from Electricity Generation: A Comparative Analysis of Australian Energy Sources *Energies 2012, 5, 872-897*

Tom Wigley, US National Center for Atmospheric Research, writes, "Unless leakage rates for new methane can be kept below 2%, substituting gas for coal is not an effective means for reducing the magnitude of future climate change."

Coal to gas: the influence of methane leakage *Climate Change (2011) 108:601-608*

In the Tara/Chinchilla CSG field in Queensland, preliminary independent air monitoring for methane by Southern Cross University found methane concentrations over 3 times as high as the highest level found outside the gas field. The highest methane level outside the gas field was 2.1ppm, and within was 6.89ppm. Analysis demonstrated the fingerprint of CSG. These results imply widespread methane leakage, not just localised leakage from one well or piece of gas infrastructure. Information on gases other than methane and carbon dioxide is not available, but the leakage of methane indicates the potential for additional airborne chemical exposures with the potential to harm health. http://www.scu.edu.au/coastal-biogeochemistry/index.php/70/

In Colorado, researchers found that twice as much methane was being leaked into the atmosphere from oil and gas activity as was originally estimated.

G. Petron et al., "Hydrocarbon Emissions Characterization in the Colorado Front Range: A Pilot Study," *Journal of Geophysical Research* 117 (D4) (2012), http://dx.doi.org/10.1029%2F2011JD016360

Australian investigators found enrichment of radon gas and carbon dioxide in a CSG field in Queensland. They monitored continuously for 24 hours at sites both inside and outside the gas field. Levels of both radon and CO2 were more elevated at night. Average levels of CO2 were 390 outside the gas field and 467 within it. There was a 3-fold increase in maximum radon within the field compared to outside it. The authors conclude that emissions from the gas field may be coming from both point sources (leaking infrastructure) and altered diffusion through the soils. This has implications for estimating the fugitive emissions of methane from the gas field as well. It is clear from this work that any air monitoring is best done continuously around the clock, preferably in real time.

Tait D R et al. Enrichment of Radon and Carbon Dioxide in the Open Atmosphere of an Australian Coal Seam Gas Field *Environmental Science & Technology 2013, 47, 3099−3104*
http://pubs.acs.org/doi/pdf/10.1021/es304538q

In a discussion paper published by the federal government CSG fugitive emissions were estimated as follows:

> *In 2010-11, fugitive emissions from the Australian natural gas sector, which includes CSG as well as conventional gas, were estimated to be 10.5 million*

tonnes of CO2-e, or around 1.9% of Australia's National Greenhouse Gas Accounts.

Coal Seam Gas: Enhanced Estimation and Reporting of Fugitive Greenhouse Gas Emissions under the National Greenhouse and Energy Reporting (Measurement) Determination *Technical Discussion Paper, April 2013*

The paper proposes a voluntary introduction of direct measurements of fugitive emissions at well completion and well 'workovers', including emissions during venting and hydraulic fracturing. Submissions are being sought from industry and a proposal for mandatory direct measurements to be in place in 2 years. In addition the federal department will also commence a project with CSIRO to measure the emissions of existing CSG fields in Queensland and NSW.
http://news.smh.com.au/breaking-news-national/csg-miners-prodded-on-emissions-data-20130416-2hxw9.html

(c) Soil and Food

The CSG industry threatens Australia's ability to feed itself and an increasingly hungry world by damaging the ecology of soils and the health and productivity of agricultural land. A Federal Government report from its Science, Engineering and Innovation Council indicates that Australia could become a net importer of food, as the country's population continues to grow and climate change cuts agricultural production. Importing food can be more expensive and will raise the cost of living. Supply chains can be susceptible to disruption by military conflict and natural disasters. Food miles and the carbon footprint of the food we eat will increase.

CSG infrastructure involves a well every half to one kilometre and a network of roads, gas and water pipelines with their surrounding easements. This infrastructure alone breaks up productive land and makes it hard to farm. Large-scale irrigation is impossible. In addition the loss of productive land from gas infrastructure is considerable. The Nature Conservancy, USA, estimates that 8.8 acres of land are required per shale gas well, including roads and ponds. The land area required doubles if collecting and distributing pipelines are included in the calculation.

Soil is fundamental to human survival. It is vital that impacts from CSG on agricultural soils are considered. Australian soils are mostly low in carbon and nutrients. Rainfall in many areas is scarce and will become more variable still with climate change. We note with concern that the New South Wales government has only belatedly excluded CSG development from "Critical Industry Clusters identified under the Strategic Regional Land Use Plans - horse breeders and wine producers". This announcement does not include protection from existing licenses, nor does it specifically mention the vital food growing areas of NSW.

Barry O'Farrell, Premier of NSW, Media Release, 19th February 2013. Tough New Rules for Coal Seam Gas Activity.
http://www.premier.nsw.gov.au/sites/default/files/TOUGH%20NEW%20RULES%20FOR%20COAL%20SEAM%20GAS%20ACTIVITY.pdf

The Liverpool Plains south of Gunnedah is under license by Santos for CSG development. The local community is almost unanimously opposed to CSG and the local council has imposed a moratorium. Farmers have so far successfully blockaded the CSG industry.

http://ccag.org.au/csg/tide-turns-half-a-million-hectares-on-the-liverpool-plains-protected-from-csg/

The soil of the Liverpool Plains is a black or grey vertisol, well structured, high in nutrients and with excellent water holding capacity and the ability to hold salt below the level of the roots. The region is highly productive for crops, as the patchwork appearance from air attests. Land values there are five times the surrounding areas. Wheat, canola and sorghum yields are up to 4 times those of other growing areas. This has not been taken in to account when approving CSG mining in the area. Loss of productive land from infrastructure, contamination and reduction of water supplies, soil contamination from surface spill incidents, all threaten agricultural productivity and potentially food quality.

The scientific literature is informative of impacts on agricultural production. Unconventional gas extraction (shale) is associated with a measureable decrease in numbers of dairy cows and milk production in Pennsylvania according to research published this month.

> *Data based on U.S. Department of Agriculture statistics show a greater decrease in milk production (in thousands of pounds) and number of milk cows in counties with the most drilling activity compared to neighboring counties with fewer than 100 wells drilled…. Counties with the most wells drilled during 2007 through 2011 uniformly had declines in total milk production ranging from –16.8 percent in Tioga county to –28.9 percent in Washington county.*

Finkel M L et al. Marcellus Shale Drilling's Impact on the Dairy Industry in Pennsylvania: a descriptive report *New Solutions, Vol. 23(1) 189-201, 2013*

(3) Impacts on psycho-social wellbeing and mental health

Water and air pollution, water shortages, permanent degradation of productive agricultural land and loss of livelihood and landscape, all have mental health consequences for communities living in a gas field. The CSG process can divide previously close-knit rural communities, increasing tension and disharmony. Noise from development of infrastructure, increased traffic and CSG operations can also impact upon mental health.

Unconventional gas development can threaten other industries such as tourism and affect property prices. "Boom-town effects" may occur with negative social effects from rapid mining development including changes in demographics, increases in crime, drug and alcohol use, domestic violence, the outstripping of public services and infrastructure, lack of quality affordable housing, increased cost of living, increased community dissatisfaction.

There is very little peer-reviewed literature directly examining the link between coal seam gas mining, loss of psychosocial wellbeing and mental health disorders. The lack of data does not in any way indicate that no risks or impacts exist. This is especially true for mental health, since the absence of study likely reflects both under-recognition of the

importance of non-physical aspects of health, as well as challenges in measuring a loss of wellbeing. The 'causal pathways analysis' approach for defining mental health risks is one way of understanding the problem. This will involve the identification of aspects of coal seam gas mining that have and can pose known mental health risks.

Berry, H.L., Bowen, K., Kjellstrom, T. 2010. Climate change and mental health: a causal pathways framework. International Journal of Public Health 55, 123-132.

Loss of mental health is a leading cause of disability and contributor to Australia's burden of disease (AIHW 2012; Vos et al., 2012). It is also a driver of health expenditure through direct service use and a major contributor to losses in workplace productivity.

AIHW 2012. Australia's health 2012. Australia's health no. 13. Cat. no. AUS 156. Canberra: AIHW.
http://www.aihw.gov.au/publication-detail/?id=10737422172

Maintaining a healthy population relies heavily on the protection and promotion of healthy environments where people can live, raise families, work and achieve their potential. Prominent among public health concerns are the protection the capacity for people to meet their basic needs for good health; these include accessible supplies of clean and sufficient water, nutritious food (high nutrient/low energy density), clean air and adequate shelter. Also fundamental are places and opportunities to participate in physical activity, to build strong and supportive relationships.

McMichael, A.J. 2012. 1. Australia's health: integrator and criterion of environmental and social conditions. Negotiating our future: living scenarios for Australia to 2050. Volume 2. Background Papers, pp 1-25.
http://www.science.org.au/policy/australia-2050/volume2/Australia-2050-volume-2_web-version.pdf

The Australian Institute of Health and Welfare (2012) explains how mental health can be lost and illness develop as a result of environmental distress:
"A diverse range of social, environmental, biological and psychological factors can impact on an individual's mental health. In turn, people can develop symptoms and behaviours that are distressing to themselves or others, and interfere with their social functioning and capacity to negotiate daily life. These symptoms and behaviours may require treatment or rehabilitation, even hospitalisation.
http://www.aihw.gov.au/mental-health-faqs/

Hossain et al. (2013) recently published a comprehensive list of issues raised in workshops held in 12 communities recently affected by coal and coal seam gas mining in Southwest Queensland. This paper provides a useful understanding of people's own perceptions of how their lives had been negatively impacted in terms of their health and access to services, socially and financially. Different concerns were raised in different communities suggesting variation in experience. Most alarming among a list of impacts perceived by residents of some communities was a sense of disempowerment, isolation and pessimism.

Hossain D, Gorman D, Chapelle B, Mann W, Saal R & Penton G. (2013) Impact of the mining industry on the mental health of landholders and rural communities in southwest Queensland. Australasian Psychiatry. 2013 Feb;21(1):32-7.
http://apy.sagepub.com/content/21/1/32

A very important area of understanding of mental health vulnerability comes from Glenn Albrecht (2005) who described and named the concept of 'solastalgia' after examining the impact of open cut coalmines in the Hunter Valley. Albrecht defined 'solastalgia' as

"the pain experienced when there is recognition that the place where one resides and that one loves is under immediate assault . . . a form of homesickness one gets when one is still at 'home.'

Connor, L., Albrecht, G., Higginbotham, N., Freeman, S., Smith, W. Environmental Change and Human Health in Upper Hunter Communities of New South Wales, Australia. November 2004, EcoHealth, Vol. 1, Suppl. 2, pp. 47-58. http://link.springer.com/article/10.1007%2Fs10393-004-0053-2

Albrecht GA (2005) Solastalgia: a new concept in human health and identity. PAN: Philosophy Activism Nature 3:41–55
Higginbotham, N., Connor, L., Albrecht, G., Freeman, S., Agho, K. (2007). Validation of an Environmental Distress Scale. EcoHealth, Vol 3, 245-254.

There is little doubt that the nature and spread of coal seam gas mining over extensive areas with permanent well pads, interconnecting roads, noise, heavy traffic, changed communities, etc. poses substantial risks of solastalgia to communities, combined with significant community, social, financial and health impacts.

An excerpt from a recent submission to the NSW Parliamentary Enquiry on Coal Seam Gas by retired psychiatrist, Dr. Steve Robinson describes an insiders' experience with his own community in the Hunter Valley when the CSG exploration began. When considering the impacts of CSG on community health, this direct assault on the sense of place, peace and control among residents cannot be ignored.

"Exploration is when the psychological stresses are first noticed in the community. Exploration maps are placed in the local newspaper but they are difficult to decipher and individual landholders are not notified. This uncertainty starts to generate community anxiety. Some individual landholders are approached and offers are made mostly for access but with agreements that include confidentiality clauses. Individuals don't know if they are being treated fairly.

The community starts to divide between the few who see it as an opportunity for an additional income and the larger number who hear the risks and see little in the way of benefits. The local council has a sharp pro-mining versus anti- mining divide leading to a spill of one mayor. The letters page in the local newspaper has amply echoed this divide for the past 5 years.

Seismic surveys come and go with some damage to paddocks, heavy vehicle traffic ruining country roads, and noise. Drilling occurs with the same complications. The town takes on a different look with mining vehicles being prominent and drilling teams from interstate coming and going. The visual impact is slowly increasing.

A few properties are purchased for good prices, other houses close-by cannot be sold and their value drops. Lifetime plans are put on hold or cancelled. Property development in the area declines as a result of the general uncertainty. Rental property is more expensive. The tourism industry is threatened and wealthy prospective city retirees look to other beautiful areas not impacted by mining. The gas company employs very few locals.

Exploration wells are fracked to optimize the flow and the wells are flared for months. There is no explanation of the risks and precautions taken in these fracking and flaring operations. There is no publicity given to any air or water testing. There have been at

least two separate unpredicted explosions locally due to gas migration known to the community from just a dozen exploration wells and even more dramatic events elsewhere from gas mining. This results in understandable anxiety about safety risks. In Gloucester this first phase has taken 5 years so far and production has yet to commence."

http://www.parliament.nsw.gov.au/Prod/parlment/committee.nsf/0/ba6e0623d71d072aca25790d000ac77c/$FILE/Submission%200098.pdf

http://www.abc.net.au/news/2011-11-01/concerns-coal-seam-gas-will-increase-mental-health-disorders/3611930

In describing the mental health impacts felt among communities being subjected to the above experience, Dr. Robinson highlighted the additional distress lead to recurrences of mental illnesses among the most vulnerable in the population, including depression, anxiety and paranoia. He also highlighted some new cases of depression among those who had not been previously affected, particularly associated with "stresses that continue for a very long time, involving a powerful opponent and having no apparent solution promote feelings of helplessness and hopelessness". In addition, Dr. Robinson observed occurrences of "angry outbursts, single episodes of antisocial behaviour and interpersonal disharmony" and highlighted the tremendous sense of injustice felt by the residents.

The largest coal seam gas mining operation so far operating in Australia is located in Tara and other communities in Central Queensland. A Four Corners program produced in 2010 documented experiences from local community members that match well with the description provided by Dr Robinson in New South Wales. Recounting their experience with the coal seam gas industry, affected farmers described feelings of betrayal, confusion, sadness, anger, loss and helplessness as the industry had allegedly not disclosed the extent of development being planned. Reports of clusters of symptoms amongst Tara residents have been occurring for several years without rigorous investigation of possible toxic exposures. A recently released report by McCarron (2013) found that 58% of 113 Tara community residents felt that their health had been affected by CSG. Many reported that they were affected by headaches, severe fatigue, difficulty in concentrating, sleeping and depression/anxiety since the coal seam gas mining had commenced.

McCarron, G. 2013. Symptomatology of a gas field. Independent health survey of Tara rural residential estates and environs. 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

Many other studies demonstrate impacts of mining on communities.

Sharma, S., Rees, S. 2007. Consideration of the determinants of women's mental health in remote Australian mining towns. Australian Journal of Rural Health 15. 1-7. http://onlinelibrary.wiley.com/doi/10.1111/j.1440-1584.2007.00842.x/full

Hajkowicz, S. A., Heyenga, S., & Moffat, K. 2011. The relationship between mining and socio-economic well being in Australia's regions. Resources Policy, 36(1), 30-38. http://www.sciencedirect.com/science/article/pii/S0301420710000486

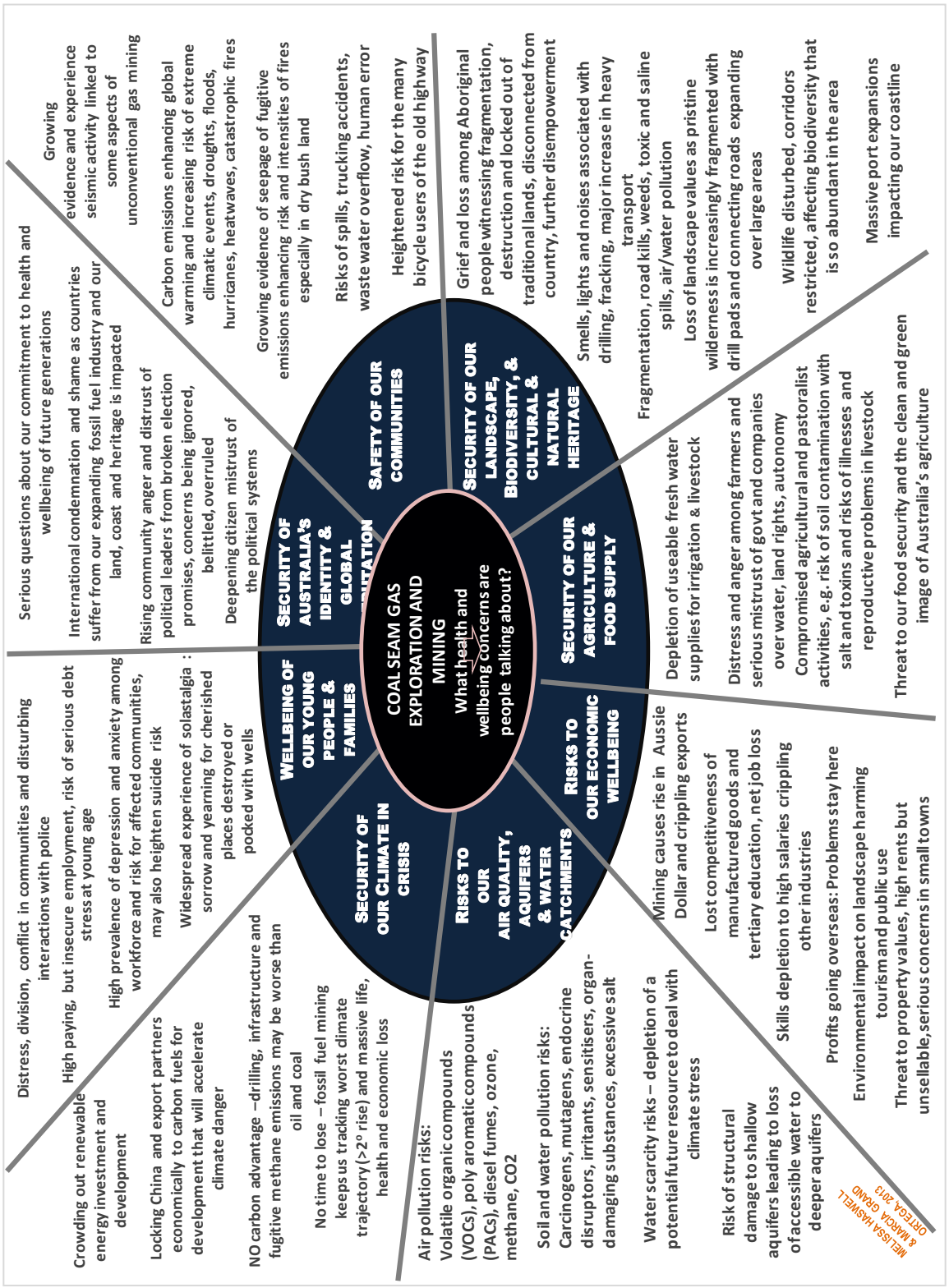
Negative social impacts on the communities in Queensland's Bowen Basin have been documented where mines were operating. These included sharp increases and limited availability of accommodation, high turnover and decreasing school enrolments,

perceptions of negative visual and crime impacts as well as reduced social cohesion and identity of the community, unhealthy lifestyles among the mining workforce and increased traffic density.. Another study highlighted a growing social justice issue felt strongly by communities in Queensland where major mining developments involving increasingly non-resident workforces.

Lockie, S, Rolfe, J and Ivanova, G. Mining developments and social impacts on communities: Bowen Basin case studies. Rural Society, v.19, no.3, Oct 2009: 211-228.
http://www.bowenbasin.cqu.edu.au/Petkova%20et%20al.%20Rural%20Society%2009.pdf

Carrington, K. & Pereira, M. (2011) Assessin g the social impacts of the resources boom on rural communities. Rural society, 21 (1), 2-20.
http://rsj.e-contentmanagement.com/archives/vol/21/issue/1/article/4413/assessing-the-social-impacts-of-the-resources

As an aid to understanding these complexities, we provide a diagram of some of the many concerns that communities have raised regarding coal seam gas mining.



(4) Cumulative impacts

Health Impact Reports

While more and more information is emerging from the peer-reviewed literature about impacts of unconventional gas mining, no long-term epidemiological studies of human health have yet been completed. There are currently significant data and research gaps that limit the ability to thoroughly assess risks to public health from this industry. A number of reasons for this are: the rapid development of the industry, lack of publicly accessible toxicity information on chemicals used and wastes produced, lack of exposure data and information on cumulative effects, lack of baseline health studies and pre and post environmental monitoring, lack of comprehensive health impact assessments etc.

A health risk assessment has been (very belatedly) commenced for AGL's Camden Gas Project in south western Sydney. The project has been operating for 10 years, with no previous requirement to consider health.

There have however been many anecdotal and case reports of health impacts. Most notably in Australia, residents of the estates near Tara on the Western Downs of Queensland have been complaining of symptoms, which they attribute to the coal seam gas field in which they live, since 2008. CSG development had commenced in 2006.

These symptoms are very similar in nature to those reported in gas fields overseas:

Steinzor N et al. Investigating Links Between Shale Gas Development and Health Impacts through a community survey Project in Pennsylvania *NEW SOLUTIONS, Vol. 23(1) 55-83, 2013*
http://www.earthworksaction.org/files/publications/Health-Report-Full-FINAL-sm.pdf

In March the Queensland government released a report of their investigation of the symptoms. http://www.health.qld.gov.au/publications/csg/

This included very limited direct assessment of symptomatic individuals, and limited environmental testing of water and air, some of which was commissioned by the gas industry. The Darling Downs Public Health Unit (DDPHU) comments:

> *"This investigation by itself is unable to determine whether any of the health effects reported by the community are linked to exposure to Coal Seam Gas activities."*

The DDPHU acknowledges significant limitations to their investigation:

> *"To better assess whether these reported symptoms could be related to exposure to CSG activities, comprehensive information on air, water and soil contaminants, as well as an evaluation of the level of noise currently experienced needs to be obtained."*
>
> *"In summary, the most that can be drawn from the DDPHU report is that it provides some limited clinical evidence that might associate an unknown proportion of some of the residents' symptoms to transient exposures to airborne contaminants arising from CSG activities".*

One of the biggest problems with investigating health complaints such as this cluster of health complaints in Queensland is that no comprehensive environmental monitoring of air and water has been completed at baseline, nor since the industry commenced. DEA has been recommending comprehensive independent baseline and ongoing monitoring of air and water in coal seam gas development since it first submitted on CSG to the Federal Senate Inquiry in 2011. The other most pressing issue is the ongoing lack of disclosure of the chemicals used in the industry. Without knowing what has been used one cannot know what to test for.

Seismic risks

In several parts of the world, increased earthquake activity has been reported in relation to fracking. An increase in earthquakes has been found in parts of the USA that traditionally have not seen many, including Arkansas, Texas, Ohio, and Colorado—all states where fracking activity has increased substantially in the past decade. A recent study published in "Geology" reported that the number of earthquakes per year recorded in the US midcontinent increased 11-fold in the four year period 2008-2011, compared to the three decades1976–2007. It related a 2011 earthquake in Oklahoma to wastewater reinjection and noted that "significantly, this case indicates that decades-long lags between the commencement of fluid injection and the onset of induced earthquakes are possible".
http://geology.gsapubs.org/content/early/2013/03/26/G34045.1.abstract
http://earthquakes.bgs.ac.uk/research/earthquake_hazard_shale_gas.html

Cumulative impacts

Risks to health from accelerating climate change have not been covered in this document, but are of concern with the expansion of the CSG industry and the unquantified nature of fugitive emissions. A certain proportion of CSG wells fail and leak greenhouse gases shortly after establishment, and over time many more are at risk of failing – long after industry is no longer taking responsibility for depleted wells.

Threats to water from unconventional gas operations and degradation of catchment ecology will be increasingly serious in a warming climate. Increasingly people will be turning to the ground water, as rainfall fails. Water authorities will be increasingly tempted to further stress aquifers to meet the water needs of a significantly increased population, even with enhancements such as recycling water and reduced water wastage.

Grigg, NJ, Walker, B.H, Capon, A., Foran, B., Parker, R., Steward, J., Stirzaker, R., Young, W. 2012. System-resilience perspectives on sustainability and equity in Australia. In Part 1 Scenarios, Negotiating our future: living scenarios for Australia in 2050. Raupach, M.R., McMichael, T., Finnigan, J.J., Manderson, L., Walker, B.H., eds. Australian Academy of Science. http://science.org.au/policy/australia-2050/volume1/Australia-2050-Vol-1-for-web.pdf

Grigg, NJ, Walker, B.H, 2012. Towards a resilience assessment for Australia. In Part 2 Background Papers, Negotiating our future: living scenarios for Australia in 2050. Raupach, M.R., McMichael, T., Finnigan, J.J., Manderson, L., Walker, B.H., eds. Australian Academy of Science. http://www.science.org.au/policy/australia-2050/volume2/Australia-2050-volume-2_web-version.pdf

Dewatering for gas and coal production, drilling through aquifers and hydrofracturing coal seams below, disturbing vegetation and ecological systems that protect the catchment quality, allowing hundreds of truck movements, raising dust and contaminants, pose health and wellbeing risks today that will be amplified tomorrow. Given the irreversibility and lack of demonstration of rehabilitation to original conditions means that their permanent footprint will be felt into the decades beyond.

The risks of CSG impacts on air pollution will very likely rise over time. Ozone production associated with CSG will increase in warmer temperatures. Excursions over safe levels of ozone already occur with concerning frequency Sydney and the Illawarra and are projected to increase with climate change. This is likely to increase the number of cardiovascular and respiratory diseases and deaths linked to ozone pollution.

Steffen, W, Hughes, L. n.d.The critical decade: Illawarra/NSW South coast impacts.. Commonwealth of Australia, Department of Climate Change and Energy Efficiency. http://climatecommission.gov.au/report/illawarransw-south-coast-climate-change-impacts/

NSW Environmental Protection Authority, 2012. Chapter 2. Atmosphere. NSW State of the Environment 2012, NSW EPA, Sydney. http://www.environment.nsw.gov.au/soe/soe2012/chapter2/

Experience in the United States is increasingly adding weight to the evidence that exposures and impacts will and do occur. As noted in our sections on air pollution, greenhouse gas emissions and water security, there are many hazardous characteristics of CSG mining that create concern:

- the significant number of drilling events involved in the proposed developments;
- the enormous volumes of water and gas being extracted, treated and/or transported;
- the toxicity and multiplicity of chemicals from multiple sources (fracking chemicals, produced water, diesel engines in trucks and heavy machinery, volatile gases emanating from the coal seam, etc); and
- the resulting number of inevitable accidents and incidents
- the direct and compounding overlap between the coal seam gas mining and climate change resulting in environmental systems stressed beyond previous limits
- the consistency in social and emotional distress among affected communities of widespread, unwanted encroachment on their lands and residences
- the consistent lack of baseline measurements and monitoring mechanisms to properly implement early warning systems and risk management to minimise impacts on the environment and residents' health and wellbeing

The report of the Chief Medical Officer of New Brunswick on unconventional gas developments in that province, made a range of recommendations that are relevant to unconventional gas development in the state of NSW:

- develop and implement a protocol for monitoring the health status of persons living, working, attending school or playing in proximity to the industry

- put in place monitoring networks for ambient air and water quality, as well as drinking water quality in the local areas expected to have an industry presence, *in advance of industry development and continuing throughout the lifetime of development, production and post-production*

- require full and timely disclosure of all chemical compounds (rather than products or compound classes) which must include their identities, concentrations and quantities

- develop and implement reasonable, safe setback distances approved by Public Health that consider human health and which are based on exposure risk assessments in addition to established precedents

- develop and implement standards approved by Public Health to limit health impacts from noise, vibration and continuous illumination

- enhance the mechanisms that are in place to promote and protect the health of workers in the industry and others who may be at the work sites

- develop a plan for anticipating and mitigating the "Boomtown Effect"

- undertake a Strategic Health Impact Assessment to estimate the long-term cumulative health and social benefits and costs

- designate areas excluded from development, including drinking watersheds, sensitive natural areas, specified agricultural lands, and other areas of special significance

- implement a process that will allow planning and regulatory decisions to consider vulnerable and disadvantaged populations that are at greater risk to environmental contaminants

- encourage, promote and financially support research, such as long-term longitudinal health studies and research on potential health effects, social impacts, and other aspects

- commit to periodically reviewing and reporting to the public on environmental and health monitoring data

- establish sufficient capacity and resources to enable relevant Government departments to oversee the development of this industry including conducting project reviews and approvals, inspections, monitoring, enforcement and management of environmental, health or social consequences

Conclusion

- Doctors for the Environment Australia regards the development of coal seam gas mining in NSW and Australia as a significant threat to public health.

- The current level of assessment, monitoring and regulation of CSG exploration and mining activities in Australia is inadequate to protect the health of current and future generations of Australians.

- There is the potential for public health to be affected by CSG operations directly, and indirectly via

    - contamination of water, air, soil and food
    - from mental health impacts on communities who have had environmental changes imposed upon them

- Human health relies on having clean safe drinking water and unpolluted air. Coal seam mining operations should not be allowed to endanger these basic health needs of Australians. Any development of this industry requires adequate scientific studies and the application of precautionary principle.

- The long-term impacts of unconventional gas mining risks significant damage to the ecological systems upon which human life depends.

- Coal seam gas (CSG), like all fossil fuels contributes to greenhouse gas emissions and therefore climate change. As such it contributes to the globally increasing burden of ill-health due to climate change.

Recommendations

- Full and timely mandatory disclosure of the composition and quantities of all chemical compounds used in CSG operations (including their identities, concentrations and quantities). Make this information publicly accessible along with information on potential health effects.

- Assess all fracking chemicals for safety through the national chemicals regulator, NICNAS.

- Establish monitoring networks for ambient air and water quality, as well as drinking water quality, in the areas under exploration or production, in advance of industry development and continuing throughout the lifetime of development, production and post-production. Results should be independently audited and publicly accessible.

- Monitor and report on volumes and contaminants of waste water produced, and disposal methods with information publicly accessible.

- Independent full life cycle comparative analyses of the carbon emissions from the CSG industry.

- Legal protection for landholders against involuntary intrusion on their land by CSG operations including the right of veto.

- Require Health Impact Assessment for all unconventional gas project assessments under nationally developed guidelines - including long-term cumulative health and social benefits and costs.

- Develop and implement a protocol for health surveillance of persons living, working, or attending school in proximity to CSG development. Regularly report on surveillance outcomes.

- Develop and implement safe setback distances from CSG development that consider human health and which are based on scientific health risk assessments.

- Research, assess and report on the specific occupational health issues of workers in the unconventional gas industry.

- Promote and financially support research, such as long-term longitudinal health studies and research on potential health effects, social impacts, and other aspects relating to unconventional gas development.

- Establish sufficient capacity and resources to enable relevant government departments to oversee the safe development of this industry including conducting project reviews and approvals, inspections, monitoring, enforcement and prevention and management of environmental, health or social consequences.