submission to the Review on CSG activities
Effie Ablett to: csg.review@chiefscientist.nsw.gov.au 20/04/2013 04:26 PM
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Submission to the NSW Chief Scientist & Engineer's review of coal seam gas activities in NSW.

Undetected Chemical Carcinogens released by CSG mining:
A new major health risk for NSW.

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Submission to the NSW Chief Scientist & Engineer's review of coal seam gas activities in NSW.

Undetected Chemical Carcinogens released by CSG mining: A new major health risk for NSW.

By Effie M Ablett BSc (Hons) Phd *

Summary.

Coal consists of a complex mixture of organic chemicals, many having structures likely to cause mutations in DNA and the potential to cause cancer in humans. Fracking chemicals include known human carcinogens eg. benzene, and potentially more potent carcinogens as impurities. A few of these chemicals have been studied and listed as possible carcinogens, but most, including those likely to be the most potent carcinogens, remain untested and therefore are largely not taken into account in assessing potential health risks. *For the first time, Coal Seam Gas (CSG) mining will allow large amounts of these chemicals to be solubilised from coal seams and leached out into ground water, as well as fracking chemicals to be released into the atmosphere and ground water. This poses a new major health risk for NSW, with a possible increase in cancer cases on par with or greater than asbestos.*

Present legislated “safe” or maximum contamination levels are close to the level of detection for the few known carcinogens listed. More potent carcinogens such as those likely to be found in coal, are likely to initiate cancer at concentrations that are orders of magnitude below their detectable levels in drinking water. So testing ground or drinking water may be of little use in determining cancer risk.

Testing of produce water is one possible way of detecting carcinogens released from coal by

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the mining process. Testing air close to the well may detect fracking chemicals. However most Volatile Organic Compound (VOC) tests do not detect the chemicals of interest, with the exception of benzene, as typically only the top 5 or 10 VOC's are assayed. The more complex carcinogens, Poly Aromatic Hydrocarbons (PAH), may only be detected in the top 20 to 100 VOC's. Assays are often reported as negative, which is misleading as the chemicals of interest were not included in the assay results, and the chemical may still be present.

During the CSG mining process the fracking chemicals used can change and the coal seam can vary in composition. Testing needs to be carried out frequently and there is no guarantee that a variable chemical was not missed with the sampling regime.

Over 100 people living near CSG wells at Tara, Qld, have reported symptoms such as skin rashes, dizziness, nausea and nosebleeds, consistent with exposure to fracking chemicals, and elevated levels of benzene have been measured adjacent to CSG wells in the area. The health effects reported in USA CSG mining areas are now occurring in Australia. Once a well is drilled, carcinogenic chemicals can leak out for years afterwards, and for wells in the catchment of urban water supplies this poses a huge long-term risk to public health. Chlorination of drinking water can produce chloro-derivatives of compounds that are even more potent carcinogens, adding to this health risk.

As many of the carcinogenic hydrocarbons and PAHs are persistent, we need to legislate, and implement the recommendations below, to minimise the release of chemical carcinogens into the atmosphere and groundwater. Air and water-borne carcinogens are increasing at alarming rates. By acting now, we can reduce the escalation of chemically induced cancer in future generations.

Introduction.

This submission deals with the potent chemical carcinogens, mainly hydrocarbons, that are liberated from CSG mining, and their effect on the health of people exposed to them. The main focus is on aromatic hydrocarbons, particularly PAHs and their derivatives, which are the most potent mutagens and thus the most likely of the chemicals released to increase cancer incidence. How they can best be monitored and cancer risks reduced is discussed in the light of what little information is available on them.

Chemical Carcinogens, Mutagens and Cancer.

The process of development of human tumors is complex,[1] but the underlying cause of the process is mutation of DNA. "Most evidence points to a multistep process of sequential alterations in several, often many, oncogenes, tumor-suppressor genes, or microRNA genes in cancer cells."[2]

Carcinogens are classified according to their mode of action as genotoxic or nongenotoxic carcinogens. Genotoxic carcinogens initiate carcinogenesis by direct interaction with DNA, resulting in DNA damage or chromosomal aberrations that can be detected by genotoxicity tests eg. Ames Test[3]. Nongenotoxic carcinogens are agents that, at least initially, directly interact with DNA. These indirect modifications to DNA structure, amount, or function may result in altered gene expression or signal transduction[4].

A large range of chemical mutagens have been found to cause cancer in animal models.[5] Poly Aromatic Hydrocarbons (PAH) and their derivatives are among the most potent carcinogens, having structures that resemble the base pair in DNA and readily intercalating and/or covalently bonding to DNA causing mutation.[6,7] The effect of carcinogens in mixtures is complex and synergistic effects often occur.[8] Care must be taken in assessing risks from carcinogens from complex mixtures such as environmental samples.

Possible CSG Carcinogens

Coal consists of a complex mixture of organic chemicals, many having structures likely to cause mutations in DNA and the potential to cause cancer in humans. PAHs solubilised from coal samples ranged from 1.21 to 28.6 mg/kg, and this did not include compounds 4 rings or larger.[9] Amounts of US EPA specified PAHs extracted from coals in this study range from 0.28 to 6.38 mg/kg. Less than ¼ have been listed as possible carcinogens, the rest remain unstudied, and therefore are not classified by agencies like the International Agency for Research on Cancer(IARC), the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) or the National toxicology Program of the U.S.Department of Health and Human Services (NTP) as carcinogens or possible carcinogens. As they are not classified, the majority of carcinogens in coal and fracking chemicals are not taken into account in assessing potential health risks.

Coal tar is a complex mixture made when coal is carbonised to make coke or gasified to make coal gas. It contains many of the PAH's from coal and is listed by IARC as a Group 1 mixture, carcinogenic to humans, based on sufficient evidence of human and animal carcinogenicity.[10]

Fracking chemicals include known human carcinogens eg. benzene, and potentially more potent carcinogens as impurities.[11]

Few of these chemicals, mainly PAH's[12], that can be solublised from coal or occur as impurities in fracking chemicals have been studied and listed as possible carcinogens. Most, including those likely to be the most potent carcinogens, remain untested and therefore are largely not taken into account.

Liberation of Carcinogens by CSG Mining.

CSG mining solublises large quantities of chemicals from coal (production water can range between 0.1 megalitres per day (ML/d) and 0.8 ML/d.48), and uses large amounts of drilling and fracking chemicals typically 18.500 kg.[11] "Geogenic contaminants mobilised from the coal seams during fracking may add to the mixture of chemicals with the potential to affect both ground and surface water quality.[12]" Orem *et al*[13] identified a wide range of phenols, biphenyls, heterocyclic
compounds, aromatic amines and aliphatic compounds, typical of those found in coal, in produced water from Wyoming CSG wells. Total PAH's were measured at levels of 23µg/l. Individual PAH's ranged from 0.01 to 18 µg/l.

Under natural conditions, fossil fuels contribute a relatively small volume of PAHs to the environment. Because most coal and oil deposits are trapped deep beneath layers of rock, there is little chance to emit PAHs to the surface environment. For the first time, Coal Seam Gas (CSG) mining will allow large amounts of these chemicals to be solublised from coal seams and leached out into ground water, and fracking chemicals to be released into our atmosphere. This poses a new major health risk for NSW, with a possible increase in cancer cases on par with or greater than asbestos.

"Safe" levels of Carcinogens.

The dose response curve for the Ames test using varying concentrations of chemical is almost always linear [14] indicating that there is no threshold concentration for mutagenesis. This suggests that, as with radiation, there may be no "safe" threshold for chemical mutagens or carcinogens [15,16] and they need to be considered differently to other chemical toxins where a high threshold amount is needed, for example, to adversely affect the function of a whole organ. Chemical carcinogens on the other hand typically initiate cancer by one molecule causing a DNA mutation in one cell.

Present legislated "safe" or maximum contamination levels are close to the level of detection for the few known carcinogens listed. For example US EPA Maximum Contamination Level (MCL) for benzene is 5ng/l benzene. [17] More potent carcinogens such as PAHs found in coal, are likely to cause cancer at concentrations that are orders of magnitude below their detectable levels in drinking water; typical water testing limits of quantification (LOQ) values for PAHs range from μg/l [18] to 10 ng/l. So testing ground or drinking water may be of little use in determining cancer risk.

Assays for CSG Carcinogens.

Testing of produce water is one possible way of detecting carcinogens released from coal by the mining process, as they will be present at higher concentrations when first released from wells. Orem et al [13] found individual PAHs rangeing from 0.01 to 18 μg/l, in produced water from Wyoming CSG wells, allowing measurement of levels above the LOQ range.

Few reports have so far been published on produce water as most assay results are kept confidential. Produce water assay results are needed to assess carcinogen release from individual wells, and these should be made public. Policies should preclude non-disclosure agreements from covering these results.[19]

Testing air close to the well may detect measurable levels of fracking chemicals.[20] However most VOC tests do not detect the chemicals of interest, with the exception of benzene, as typically only the top 5 or 10 VOC's are assayed. The more complex carcinogens, (PAH), may only be detected in the top 20 to 100 VOC's. Assays are often reported as negative, which is misleading as the chemicals of interest were not included in the assay results, and the chemical may still be present.

Frequency of testing.

During the CSG mining process the composition of the drilling and fracking chemicals used can be altered, and the coal seam will vary in composition. Testing needs to be carried out frequently during drilling so that a variable chemical was not missed with the sampling regime. Steinzor, Subra and Sumi[19] state that “Factors such as the stage of drilling, weather conditions, wind speeds, topography, geology, and whether facilities are on operation may have an impact of the testing results” for air-borne chemicals.

The Long-term Cancer Risk.

Over 100 people living near CSG wells at Tara, Qld, have reported symptoms such as skin rashes, dizziness, nausea and nosebleeds, consistent with exposure to fracking chemicals,[21] and elevated levels of benzene have been measured adjacent to CSG wells in the area. McKenzie *et al*[20] have estimated nearly double the cancer risk from chemical exposure for Colorado residents living ≤ 1/2 mile form CSG wells compared to those living > ½ mile away, based on measurement of air-borne carcinogens.

The health effects reported in USA CSG mining areas are now occurring in Australia. Santos and Maher[22] have measured some of the highest levels of methane in the atmosphere in CSG mining areas in Queensland. This was consistent with fugitive gas emissions. Whenever wells leak, other chemicals (including carcinogens) will be leaking along with methane, so this data raises the possibility that Australia could have relatively high CSG emissions and high air-borne carcinogen levels from CSG mining. Once a well is drilled, carcinogenic chemicals can leak out for years afterwards, and for wells in the catchment of urban water supplies this poses a huge long-term risk to public health. Chlorination of drinking water can produce chloro-derivatives of PAHs that are even more potent carcinogens,[23] adding to this health risk.

Conclusion.

The Australian Institute of Health and Welfare Report[24] on cancer incidence in Australia found that between 1991 and 2009, the number of new cancer cases diagnosed in Australia each year almost doubled; from 66,393 to 114,137. This is likely to be only partly accounted for by increase in population and increased diagnosis; environmental factors are likely to play a major role. Vineis and Xun,[25] describe "The emerging epidemic of environmental cancers in developing countries." Grant[26] has identified air pollutants in particular PAH's as "the likely source of air pollution that affects cancer risk on a large scale, through production of black carbon aerosols with adsorbed polycyclic aromatic hydrocarbons". These types of studies, the recent data on Australian cancer incidence, and the worldwide rise in air- and water-borne chemical carcinogens[29] should be ringing alarm bells throughout the public health sector about chemical carcinogens.

As many of the carcinogenic hydrocarbons and PAHs likely to be released by CSG mining are persistent, we need to legislate, and implement the recommendations below, to minimise the release of chemical carcinogens into the atmosphere and groundwater. We need to act now to reduce air and water-borne carcinogens, in order to slow the escalation of chemically induced cancer in future generations.

Recommendations.

1. CSG mining should not be allowed in any catchment areas for urban water supplies.

2. Chemical carcinogens need to be monitored by comprehensive assays of organics, including a range of PAHs, in produced water from all CSG wells. The tests need to be carried out frequently during drilling to measure any carcinogens that vary along the coal seam.

3. Measurement of chemical carcinogens in urban water supplies and groundwater may

be irrelevant as carcinogens are likely to be diluted to below the limit of detection, and may still initiate cancer at these levels.

4. Chemical carcinogens need to be monitored by comprehensive assays of organics, including a range of PAHs, in air adjacent to all CSG wells. The tests need to be carried out frequently to measure any carcinogens that might vary with different mining operations.

5. The results of produced water and air assays needs to be made public. Policies should preclude non-disclosure agreements from covering these results.

6. Australian drinking water and air standards “Safe“ levels for chemical carcinogens need to be revised and extended to a comprehensive range of chemicals likely to be liberated by CSG mining activities. Simultaneous exposure to multiple chemicals needs to be taken into account.

7. The health of residents in the immediate area of CSG mining activities needs to be monitored, especially symptoms which could be due to chemical exposure.

8. Individuals with symptoms consistant with chemical exposure need to have follow up monitoring to detect cancer development in the early stages.

9. The cost of potential long-term health care for mining induced illness (including cancer treatment, monitoring of carcinogen release and the health of local residents) needs to be considered for any new CSG mining proposal.

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