Brief Review of Threats to Canada's Groundwater from the Oil and Gas Industry's Methane Migration and Hydraulic Fracturing

A public interest project by Ernst Environmental Services

Photo - Colin Smith

As somebody who has reported for 20 years on this industry in [Alberta], I can tell you I've met hundreds of people in this province who have signed confidentiality agreements once their water was blown, once their livestock was killed, once a member of their family were injured, once they lost most of their grass or their trees as a result of fouling events, contamination events, air pollution, you name it. It is common practice in this province to buy people out, and then buy their silence ... so there is no record of how this industry quite often performs badly.

Andrew Nikiforuk presenting at a frac workshop in Cochrane, Alberta, September 10, 2011

TABLE 2 HUSKY OIL GAS MIGRATION REMEDIAL WORKOVERS

REMEDIAL WORKOVER TYPE	# WELLS	AVERAGE COST (K$)	SUCCESS* RATE (%)	COST PER SUCCESS* (K$)
Re-enter and case D&A wellbores	11	136	27	500
Re-enter and plug D&A wellbores	4	77	25	307
Cement squeezes on cased wellbores	6	74	50	148
Total	21	107	33	322

*Note: Success was defined as no detectable leakage shortly after the workover. Longer term success is unknown.

1993 Husky Oil's Gas Migration Research Effort – an Update

This project began a decade ago.

It was made possible by the many seeking help and blatant refusal by people of authority to assist or tell the truth. Without them, I may not have persisted, even living with dangerous contamination after EnCana* hydraulically fractured my community's drinking water aquifers, led at the time by EnCana CEO Gwyn Morgan, Vice President Gerard Protti (newly appointed by the provincial government to chair the Alberta Energy Regulator) and others.

I'm grateful to the journalists, scientists and participants who share their work publicly, so that communities and water might benefit.

Many thanks to those who gave their time editing, sharing information and sending links, reports and encouragement.

Obtaining data on groundwater contamination caused by the oil and gas industry in Canada is nearly impossible because of confidentiality agreements (non-disclosure or gag orders). These must be made illegal.

Full Disclosure: I have thirty years experience working in the oil and gas industry in the western provinces of Canada and own 70 acres of land in Alberta.

Earlier editions of this report were submitted to the New York Department of Environmental Conservation (January 11, 2012), the Québec Évaluation Environnementale Stratégique (ÉES) sur le Gaz de Schiste (January 15, 2012) and the Department of Enterprise, Trade & Investment, Belfast (June 13, 2013).

Updates will be ongoing as more contamination information becomes available.

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June 16, 2013.

(Endnote numbers are click-able; Alt & Back Arrow returns you to where you were in the text.)

*EnCana changed their name to Encana. Much of this paper was written before the change, thus both are used.

One issue on data gaps,…you know shale gas, my colleagues asked the federal government…what chemicals are being used on shale gas, and do they pose a risk to human health and the environment. We told parliament that right now the federal government doesn't have a very good idea of that.

But, what I thought was discouraging, is…in me posing that question, I was called an environmental extremist both by Tom Flanagan on a CBC show and the National Post and I think that was a reflection of some of the bullying – unfortunately – that some environmental groups experienced in asking basic questions about what is the state of Canada's environment. ...

I think what smarted with me about that phrase was, I've seen too many other community-based groups right across this country working on environmental protection to safeguard children, to…shield infants from toxins, from carcinogens … they've been called radicals.

I don't take this at all personally, but I've seen a pattern of bullying and that's what I find is extremely disturbing. ...

It also makes me appreciate how important it is for public participation, for engagement with civil society, for transparency in any environmental program, to build up trust and avoid name calling.

Scott Vaughan on his time as Canada's Environment Commissioner
Interview on *The Current*, March 18 2013, *CBC*

Contents

1. Groundwater is a critical resource for nearly 600,000 Albertans and 10-million Canadians. Yet good data on aquifers and groundwater quality remains sparse. In 2005 Dr. John Carey, Director General of the National Water Research Institute, told the Standing Senate Committee on Energy, the Environment and Natural Resources that "We would not manage our bank accounts without monitoring what was in them."[1] Alberta and Canada now manage their groundwater this way.

   Activities of the oil and gas industry greatly impact groundwater. The US Environmental Protection Agency (EPA) estimated in 1992 that 200,000 of 1.2 million (16.7%) abandoned oil and gas wells in the US were leaking and "have become conduits for noxious liquids that bubble up from deep below the earth's surface to kill crops and taint drinking water."[2]

   According to a 2002 workshop sponsored by the Canadian Council of Ministers of the Environment (CCME), drilling sumps, flare-pits, spills and ruptured pipelines as well as leaky abandoned oil and gas wells can all act as local sources of groundwater contamination. Given that little is known about the long-term integrity of concrete seals and steel casings in 600,000 abandoned hydrocarbon wells in Canada, the study added that the industry's future impact on groundwater could be immense. The CCME concluded that unconventional natural gas drilling such as coalbed methane (CBM) posed a real threat to groundwater quality and quantity, and that the nation needs "baseline hydrogeological investigations in coalbed methane….to be able to recognize and track groundwater contaminants."[3]

   > The shale gas boom combined with hydraulic fracking will cause wellbores to leak more often than run-of-the-mill conventional wells. The problem is going to get worse, not better.[4]
   >
   > Dr. Karlis Muehlenbachs

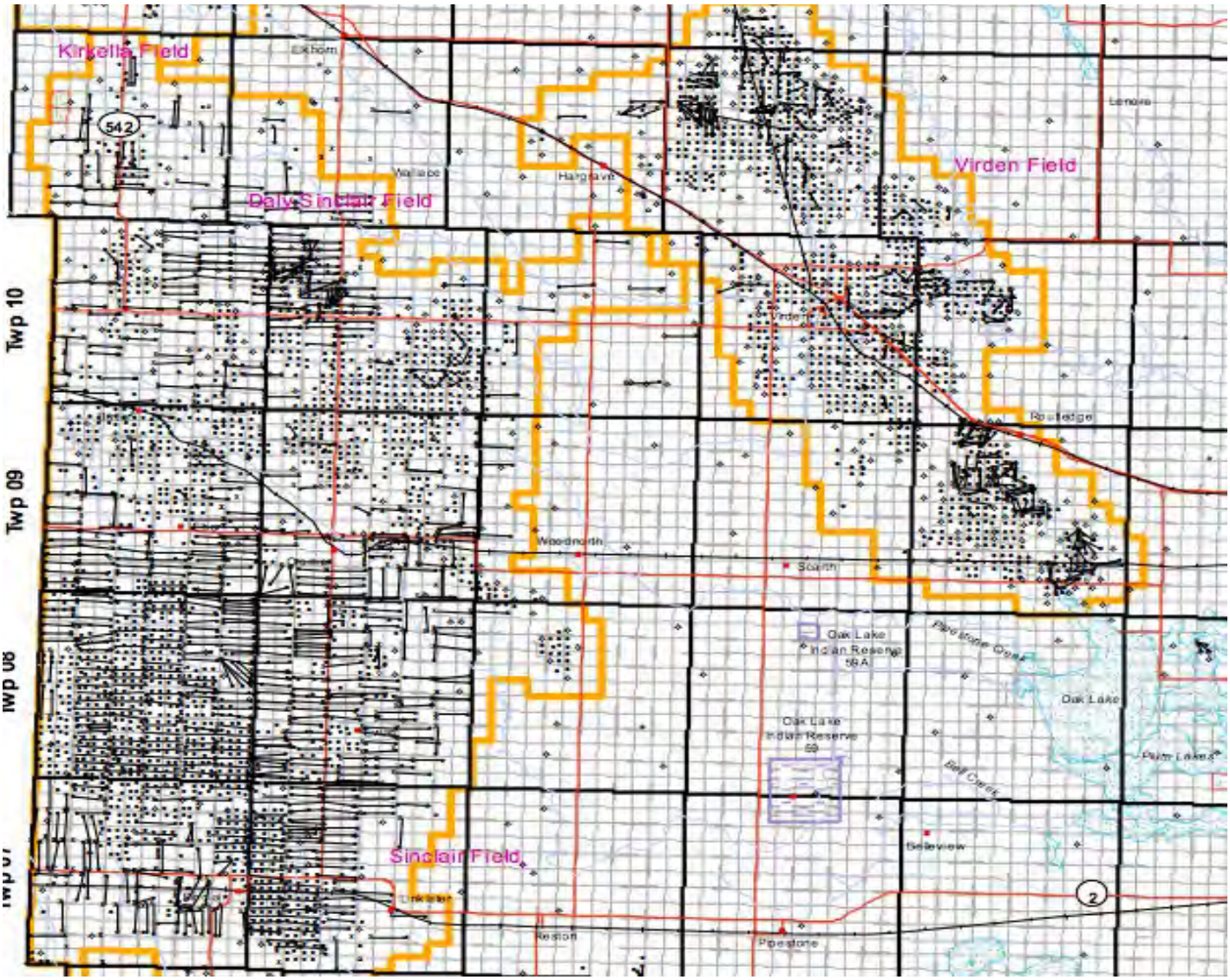
   Not until nine years later, in 2011, after an Alberta group demanded a moratorium on hydraulic fracturing in paid ads in local newspapers[5] [6] and held a frac workshop[7], did the Canadian government announce that it would initiate two reviews (not studies) of hydraulic fracturing, but only for shale gas (not tight or shale oil, or gas from CBM and tight sands); one review is by Environment Canada, the other by the Council of Canadian Academies.[8] The Council's 16 member panel and chair were selected in 2012.[9] Their report is being prepared for peer-review and the panel's final meeting is in June 2013.[10]

   In 2013, the Council of Canadians released results to an *Access to Information Act* request on the reviews showing that they rely on the Canadian Association of Petroleum Producers (CAPP), Canada's largest oil and gas industry lobby group, to understand chemicals used and "better understand industry plans" for using CAPP's voluntary, unenforceable operating practices.[11]

2. Government documents acquired under the *Access to Information Act* by researcher Ken Rubin revealed that "Canadians are currently facing serious groundwater quality and availability issues. … There is no visible federal water policy agenda nor a common agenda for the whole country." To date only three of eight key regional aquifers have been mapped and that only eleven of 30 key aquifers will be assessed for "volume, vulnerability and sustainability by 2010." At this current rate of progress it will take another 28 years to develop a basic National Inventory of groundwater resources.[12]

3. A 2007 review of Alberta groundwater programs by the Rosenberg International Forum on Water Policy declared Alberta's groundwater policies "inadequate" and reported a "lack of comprehensive monitoring systems." The report added that "exploitation of Alberta's energy resources is proceeding

at a pace much faster than had been anticipated" but that there had been no parallel acceleration in the protection of water resources. A monitoring network "is the last line of defense against contamination by industries that are essential to the economic future of the province."[13]



Each dot and line marks oil activity in and around Cromer, southwest Manitoba.[14]

There are too many big companies out here now, competing for monopoly. There was a deliberate dump last year right beside a well and uphill from a nearby creek. The company left it for the creek to clean up.

Carlyle Jorgensen, Cromer Manitoba Farmer[15]

4. In 1987, the US Environmental Protection Agency documented that hydraulic fracturing by industry had contaminated groundwater.[16] The New York Times' Ian Urbina reported that more cases were sealed by settlements and confidentiality agreements.[17] A 1989 peer-reviewed paper reported that "hydraulic fracturing stimulation" for light oil, in several wells in a low permeable sandstone reservoir in southwest Manitoba, propagated into the underlying water zone:

> Following the unsuccessful stimulation of several wells in the South Pierson field where hydraulic fractures propagated into the underlying water zone, a comprehensive re-evaluation and detailed design effort was implemented to minimize the potential for water production. ... Ideally, the hydraulic fracture created should extend laterally within the zone of interest, however, it is well known that substantial vertical fracture propagation may also occur, significantly impacting the success of the treatment. Complicating factors such as underlying water zones or overlying gas sections can be easily penetrated and subsequently reduce or eliminate any sought after oil production. ... Additional motivation for control of fracture height growth was to increase the effectiveness of the treatment by decreasing the extension into non-producing intervals and to reduce the over-all cost of the treatments.[18]

5. In 2010, the Canadian oil and gas industry advertised: "Fact: Fracturing has not been found to have caused damage to groundwater resources"[19] and EnCana advertised a year later: "In use for more than 60 years throughout the oil and gas industry, there are no documented cases of groundwater contamination related to the hydraulic fracturing process."[20]

6. In the USA, by the early 1990's numerous water contamination cases and lawsuits had sprung up in coalbed methane (CBM) development areas.[21] "In a two-year study, United States Geological Survey (US Geological Survey) scientists found methane gas in one-third of water wells inspected and concluded that oil and gas drilling is the main source of contamination of the shallow aquifers in the Animas River Valley.... Based in part on the [US Geological Survey] report, lawyers representing hundreds of area residents filed a class-action lawsuit Feb. 11 charging four oil companies - Amoco Production Company, Meridian Oil Inc., Southland Royalty Company, and Phillips Petroleum - with recklessness and deliberate disregard for the safety of local residents. The suit says the four oil companies ignored their tests, which showed that methane from their deep wells was polluting shallow aquifers, and asks for both actual and punitive damages."[22]

7. Industry and the Alberta government have reported leakage of gas and other contaminants into groundwater and atmosphere from old or abandoned oil and gas facilities for decades. In 2008, three wells drilled and abandoned in the 50's and 60's by Texaco, but the responsibility of Imperial Oil after the two companies merged, were found leaking within the town limits of Calmar, Alberta. (There are a total of 26 energy wells within the town limits.) One leaking well was found in a playground surrounded by homes, another was found because of bubbling gas in a puddle next to an elementary school. Four homes were demolished to allow a rig in to re-abandon and seal the wells, and the families relocated.[23] Another family is suing because the company is refusing to pay fair market value.[24]

   "The controversy has led to questions about other Alberta neighbourhoods. ....many residents in Leduc County are also living near gas well sites and aren't even aware of it. ... Another well site was found under the pavement of a cul-de-sac in Leduc County. ... An employee with the Town of Calmar says it is common practice to build parks and roads on top of well sites, but not homes."[25]

8. "Late in the afternoon of March 24, 1985, methane gas that had been accumulating ignited in an auxiliary room of the Ross Dress-For-Less Department Store...in...Los Angeles. The resulting explosion blew out the windows and partially collapsed the roof of the structure, reduced the store interior to a heap of twisted metal and resulted in injuries requiring hospital treatment of twenty-three people. Police closed off four blocks around an eerie scene of spouting gas flames that continued through the night. ... The Task Force then went on to present a scenario of shallow 'biogenic' methane

being displaced and pressurized by a rising water table....an imaginative explanation.... Troublesome legal issues were eliminated by this conclusion, **the implication being that the methane hazard could exist virtually anywhere, so no human agency was at fault for its workings.**"[26] [Emphasis added]

Years after a class action lawsuit was settled out of court with gag orders, further study revealed that corroded, leaking energy well bore casing and high pressure injections were at fault, not biogenic methane or swamp gas and a rising water table:

> Injection was at surface pressures of up to 770 [pounds per square inch] giving rise to a gradient of about 0.7 psi/ft within the subsurface near the point of injection. We conclude that this resulted in episodic fracturing of the Third Street fault. … Clearly the phenomenon of methane venting in the urban environment can be hazardous….[27]

The studies continue:

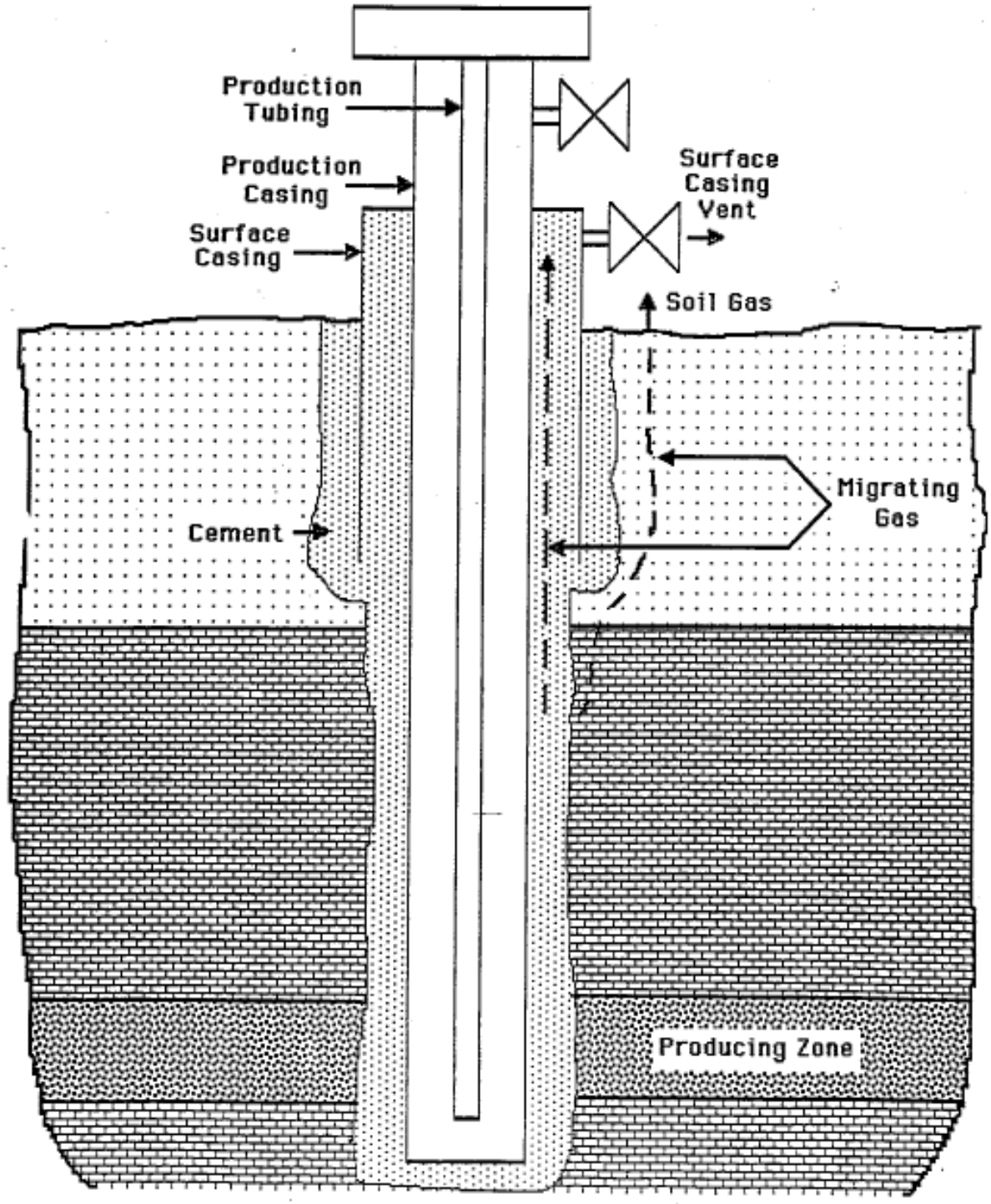
> Ignoring these issues could result in substantial legal liability upon oilfield operator and upon those responsible for the public safety. ... Virtually all well leaks can be traced to poor well completion and/or abandonment procedures (e.g., poor cementing practices). ... Tests showed that even when the most up-to date cement types and techniques are used, leakage can and will occur in a significant number of cases.... Numerous fields have accumulations of hydrogen sulfide that will eventually destroy the integrity of both the steel and cement relied upon to provide protection against gas migration.... The corrosive conditions of hydrogen sulfide are well known, and have defied engineering solutions.... The waterflooding for enhanced oilfield recovery can be a dangerous practice due to hydraulic fracturing which would create avenues for the migration of gas to the surface creating an explosive hazard.[28]

9. A Husky 1993 report[29] states: "Gas migration has received increasing attention in recent years….industry and regulators have become more cognizant [of] the problem, in terms of the numbers of wells affected, the potential cost to address the problems and the technical difficulty of completely stopping the leakage….the expected costs to eliminate gas migration are $300,000 per site overall." Husky reported that "roughly half the wells" in the area they studied were affected but "little consistent data was obtained with respect to the causes of the problem or what might be done about it…a technical solution which totally eliminates the problem may never be possible." Husky asked if part of the gas migration problem is caused by "natural sources" or biogenic swamp gas using industry wellbores as conduits. (Refer also to Figure 1 on Page 9.)

   The National Energy Board reports that unconventional drilling and hydraulic fracturing in Canada targets "biogenic" and thermogenic methane: "For example, the natural gas produced from the Second White Specks Shale of Alberta and Saskatchewan comes from shallow burial (it is shallow enough that gas is still being generated by bacteria), while the natural gas from the Devonian Horn River Basin and Triassic Montney shales was generated during deep burial. The Utica Shale of Quebec has both shallow and deep sections and there is potential for both biogenic and thermogenic natural gas, respectively."[30]

   In Saskatchewan, "shallow, biogenic tight-shale," is targeted "from 300 to 700 m. Biogenic gas is methane produced by bacteria feeding on the organic matter contained in the shale. ... The plus side of targeting shallow biogenic shale gas rather than the deeper shales that are often more prolific

FIGURE 1 GAS MIGRATION SCHEMATIC



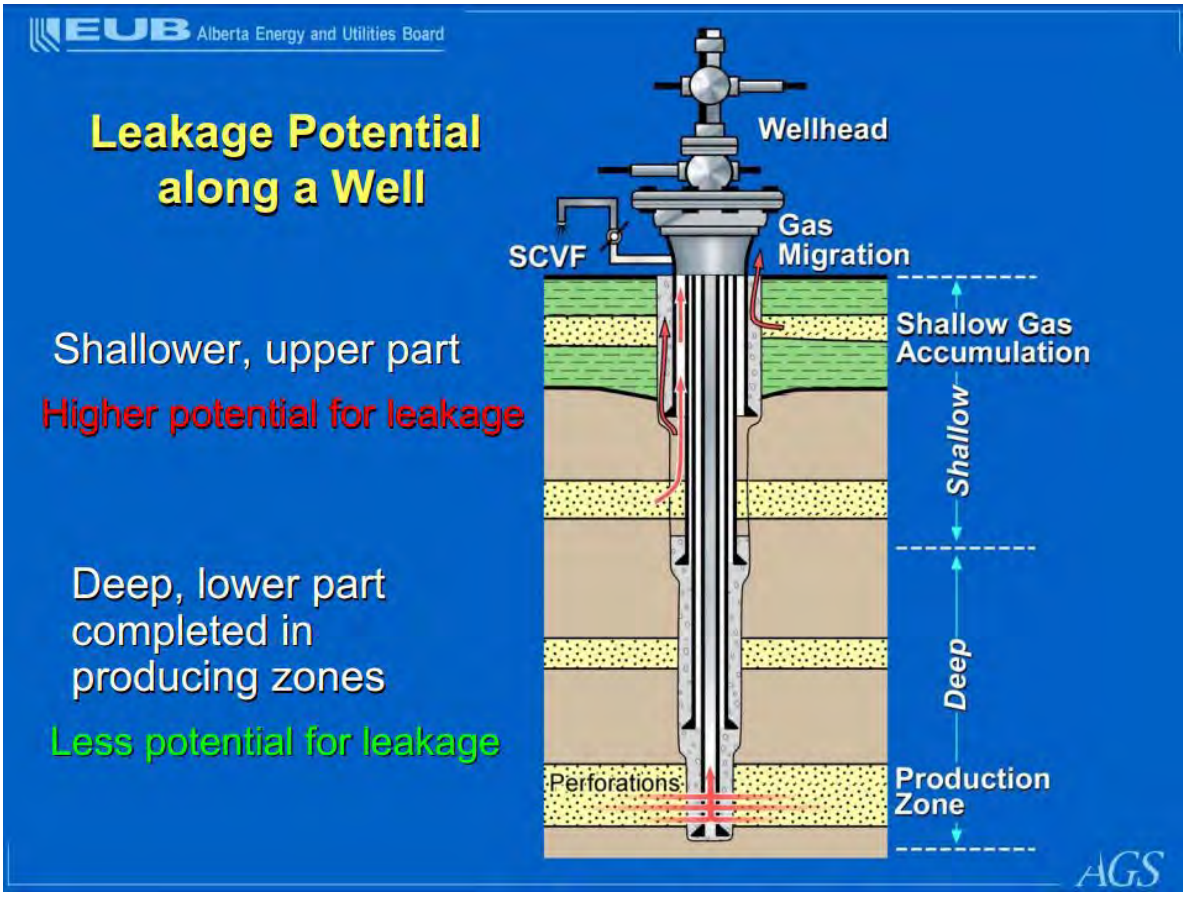
1993 Schematic from: Husky Oil's Gas Migration Research Effort – an Update

reservoirs, is the shallower resource has lower drilling costs. … But the shallow play also has its challenges...There are a pile of clays – and they are susceptible to water imbibition and swelling – that can cause serious reservoir problems."[31]

10. Dr. Karlis Muehlenbachs, geoscientist at the University of Alberta, developed the technique of sourcing industry-caused leaks, namely Surface Casing Vent Flow (SCVF) and Gas Migration (GM), using stable carbon isotopic analysis or isotopic fingerprinting of the gases.

    In 1999, the Alberta energy regulator, then the Alberta Energy and Utilities Board (EUB), now the Energy Resources Conservation Board (ERCB[32]), released Bulletin GB-99-06 recommending his technique: "Therefore, the [EUB] and Saskatchewan Energy and Mines (SEM) are prepared to accept the use and validity of this method on a site specific basis. Development and availability of high quality regional databases, containing interpreted analytical and geological information, are necessary prerequisites to defensible, extrapolated diagnoses for SCVF/GM problems. The need to involve qualified expertise is also necessary." [33]

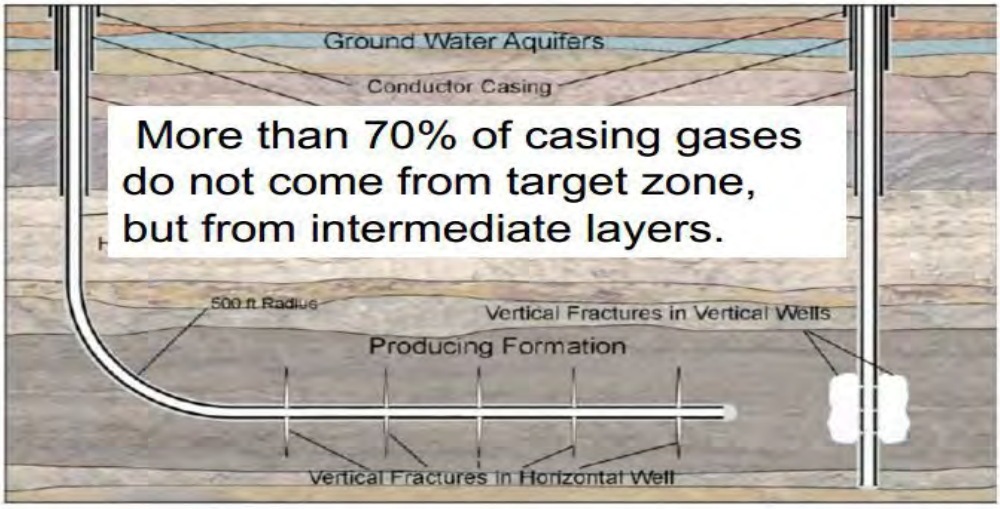
    In 2007, the EUB presented that the "shallower, upper part" of industry well bores (where much of the biogenic gas is) have "higher potential for leakage" than deep production zones:[34]



A study by GSI Environmental Inc. and Cabot Oil and Gas Corp. released in May 2013 on the methane migration problems in Susquehanna County, Pennsylvania, "suggests that gases present in local water wells are most consistent with Middle and Upper Devonian gases sampled in the annular spaces of local gas wells, as opposed to Marcellus production gases."[35]

In 2011, Dr. Muehlenbachs presented in Washington (slides included below) that more than 70% of casing gases come from intermediate layers of energy well bores, not the target zone:[36]

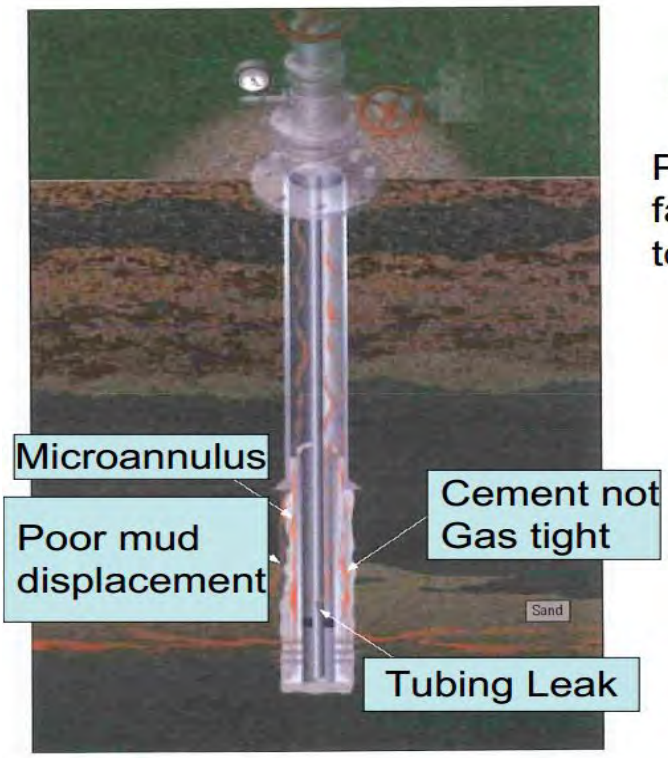
A series of casings are placed to intercept fugitive gas migrating along well bores



Schematic stratigraphy

But are casings effective in preventing gas migration to surface?

...



From Schlumberger, Oilfield review

Poor cementing and tubing failures lead to gas migrating to surface, causing:

- Sustained casing pressure
- Surface casing gas

Note: gas can leak from production tubing or from anywhere up the well bore leading to

- Soil contamination
- Aquifer contamination

Industry reports that the methane they are targeting in shallow shales, coals and tight sands is biogenic or "natural"; 7/7 of the industry coalbed methane (CBM) wells (completed between about 250 and 730 m below surface) in Alberta studied by the ERCB contained biogenic methane.[37]

11. The Canadian Association of Petroleum Producers (CAPP), founded and chaired for 16 years by Mr. Gerard J. Protti, a past EnCana executive, noted the problem of methane migration dramatically increased when drilling density increased.[38] This trend has also been reported in the United States.[39] Alberta researchers reported natural gas leakage along well bores of about 50% of oil wells in western Canada.[40] CAPP also reported that well bores were leaking gas and contaminating groundwater,[41] and high buildup pressures may force gas into underground water aquifers[42] years before the new "experimental" high pressure, densely drilled hydraulic fracturing began.

    The US Environmental Protection Agency (EPA) reviewed impacts to groundwater from hydraulic fracturing as it pertains to CBM production:

    > Fracturing fluids injected into the target coal zone flow into fractures under very high pressure. The hydraulic gradients driving fluid flow away from the well during injection are much greater than the hydraulic gradients pulling fluid flow back towards the production well during flowback and production pumping. Some portion of the coalbed methane fracturing fluids **could be forced along the hydraulically induced fracture to a point beyond the capture zone of the production well.** The size of the capture zone will be affected by the regional groundwater gradients, as well as by the drawdown caused by the well.
    >
    > **If fracturing fluids have been injected to a point outside of the well's capture zone, they will not be recovered through production pumping and, if mobile, may be available to migrate through an aquifer.**[43] [Emphasis added]

    A peer-reviewed paper published in *Marine and Petroleum Geology* - the lead author is the Director of *Durham Energy Institute* - studied vertical fracture propagation from a limited dataset:

    > The maximum reported height of an upward propagating hydraulic fracture from several thousand fracturing operations in the Marcellus, Barnett, Woodford, Eagleford and Niobrara shale (USA) is ~588 m. Of the 1170 natural hydraulic fracture pipes imaged with three-dimensional seismic data offshore of West Africa and mid-Norway it is ~1106 m. ...
    >
    > Constraining the probability of stimulating unusually tall hydraulic fractures in sedimentary rocks is extremely important as an evidence base for decisions on the safe vertical separation between the depth of stimulation and rock strata not intended for penetration. ...
    >
    > Despite the limitations of the datasets it is clear most of the natural hydraulic fractures reported here are 200 - 400 m in height and that very few natural fracture systems reported to date propagate beyond a height of 700 m. The tallest is 1106 m, which is comparable to the tallest injectites documented. ...
    >
    > Løseth et al. (2011) reported that pressure profiles from the injection well show a stepwise fracturing of the overburden and that fractures actually propagated for 900 m reaching the surface (the seabed).[44]

The ERCB's Stephan Bachu and independent consultant Teresa Watson (later appointed to the Board) presented in Paris, France that an increase in the number of water wells in heavily fractured oil and gas fields increases "the likelihood that gas, due to migration through shallow zones, can accumulate in buildings."[45] A few years later, France became the first country to make frac'ing illegal.[46]

12. In Quebec, as of January 2012, more than 50% of 31 new shale wells inspected (10 had been frac'd), are leaking natural gas; the regulator ordered the leaks repaired, the companies tried but failed.[47] Isotopic analysis by Dr. Muehlenbachs of water samples sent to him by Talisman indicated that groundwater in Quebec was already contaminated,[48] "from a geological point of view, the shale was sealed 300 million years ago, he says. "And then man intervened."[49] Talisman later reported in the media that the gas contaminated water was rainwater.[50] Dr. Muehlenbachs updated a presentation he gave in Washington with this new information.[51]

    In February 2012, an agricultural expert asking for health information about ingesting methane, sent Ernst a photo of white groundwater - possibly caused by a high concentration of methane - at a cattle producer's operation near shale wells in Quebec. It was suggested that the methane was naturally occurring.[52]

    In 2009, Canada's National Energy Board reported on the shales in Quebec:

    > Biogenic gas can be found in the Utica in shallow areas, while thermogenic methane can be found in medium-deep and structured shales.... The reservoir has an advantage over others in that it is folded and faulted, which increases the potential for the presence of natural fractures.... Only a handful of wells have been drilled in the Utica, most of them vertical.[53]

    A Quebec Ministry of the Environment 2012 inspection report obtained seven months later by the local group "Ensemble pour l'avenir durable du Grand Gaspé" via Freedom of Information admits that natural gas is leaking to surface near the Haldimand 1 Pétrolia oil well drilled in Gaspé. Leaks were detected 43m and 500m from the oil well, and in the field near two government research monitoring water wells. (Similarly, in New York State, documents obtained via Freedom of Information show that State inspectors found a new unfrac'd vertical shale gas well leaking in the Town of Owego and did not advise the public.[54])

    The Quebec regulator has not yet taken samples of the gas at surface or the groundwater for isotopic fingerprinting and has not warned the community of the leaks.[55] The regulator report suggests that the gas could be "biogenic".[56]

    A Pétrolia 2006 press release on Haldimand 1 states:

    > The well seems to have penetrated an over-pressurized zone of permeable rocks containing gas, salt water and oil.[57]

    The Pétrolia website currently claims:

    > Based on data gathered since 1986, Pétrolia and Québénergie believe traditional production is feasible on the Haldimand deposit. This means hydraulic fracturing will not be necessary.[58]

Company press releases on the website indicate that fluids have been injected, and media reports indicate that frac'ing is required.[59] Pétrolia used Section 25 of the Freedom of Information law to prevent citizens from accessing information on a methane leak detected at an exploratory oil well on Anticosti Island.[60]

In December 2012, the town of Gaspé, wanting to protect its drinking water supply and groundwater, adopted a bylaw prohibiting anyone from introducing underground "any substance that could alter the quality of the underground or surface water" used for human or animal consumption within 10 kilometres of a municipal surface water supply site and two kilometres from any town well.[61] Pétrolia's drill sites are about 5 kilometres from the town. In April 2013, Pétrolia "filed a motion for declaratory judgment with the Quebec Superior Court asking that a bylaw adopted by the town Dec. 19 be declared invalid."[62]

May 15, 2013, the Quebec government tabled legislation to impose a five year moratorium on exploration for shale gas in the St. Lawrence River valley.[63] The legislation allows frac'ing elsewhere, for example, on the Gaspésie Peninsula and Anticosti Island. It requires hydrogeological studies (paid for by the government), groundwater monitoring wells near energy wells and frac'ing must be deeper than 600m below ground surface if more than 50,000 litres (50 m3) of fluid is injected.[64] Significant citizen and community protest ensued, notably because the moratorium will not be province-wide (refer to the maps on Page 62) and the legislation only regulates water supply protection set-backs to 300m surface distance from frac'ing (but only for wells used by humans and for food processing, wells used for watering livestock will not be protected), disregarding the "Règlement dit de Saint-Bonaventure" bylaw voted in by 64 municipalities to protect their drinking water.[65]

The "Règlement dit de Saint-Bonaventure" bylaw set backs are:

- two kilometres for wells providing water for 20 people or less;
- six kilometres for municipal wells or wells providing water for more than 20 people;
- ten km for surface water withdrawal locations in a watercourse.[66]

A 2008 review of investigations in a heavily drilled coalbed methane (CBM) field in Colorado concluded: "There is a temporal trend of increasing methane in groundwater samples over the last seven years coincident with the increased number of gas wells installed in the study area."[67] In 2009, the Society of Petroleum Engineers published a peer reviewed paper that stated "in areas of high well density, well-to-well cross flow may occur in a single well leaking to surface through many nearby wellbores."[68]

Canada's National Energy Board reported that only 20% of fractured gas is recoverable;[69] "the circulating gas left behind will threaten the water Quebecers drink and could jeopardize agriculture."[70]

A 2012 peer-reviewed paper summarizes some common causes of gas migration:

> At the time of drilling the well, many fractures are formed owing to the percussion activity of the drill bit. In addition, cementing operations pressurize the wellbore further with the potential of creating additional fractures. During the cement squeezing operations, the wellbore may be even further hydraulically fractured. These vertical fractures may extend for tens of feet from the wellbore depending upon the characteristics of the formation and the injection pressures used for placement of the cement. The cement will fill some of the larger fractures surrounding

> the casing, but the cement particles cannot enter the smaller fractures away from the wellbore. The end result is that a fracture system is created parallel to the wellbore forming a potential path for the migration of gas.
>
> Acidizing, a common practice in revitalizing oilwells, causes acid to enter the pore channels and fractures of the reservoir, usually under high pressure, fracturing and etching (widening) of pre-existing fractures. Over time, the ring of cement around the well casing is damaged by deformation (caused by tectonic and seismic movements and subsidence owing to oilfield operations) and by chemical decomposition. Formation fluids usually corrode both the cement and casing, generating additional paths for future migration of gas and fluids by breaking down the intended cement seal. The breakdown of the cement can open paths for the flow of gas and liquid behind the casing. Corrosion also results in casing leaks (holes). ...
>
> Any holes in the casing and the surrounding cement sheath in the annular space between the casing and the wellbore, within the calculated "zone of escape," will result in gas leaking out of the wellbore and then toward the surface.[71]

A paper by Dr. Barb Tilley and Dr. Muehlenbachs in a recent *Proceedings from International Network of Environmental Forensics Conference* analyzed industry and government data on leaking energy wells causing gas contaminated water wells in numerous communities in Alberta, including Rosebud:

> The various levels of well casings designed to protect against gas migration are illustrated. However, the numerous surface casing vent flow gases that we have analyzed indicate that the release of hydrocarbon gases to the shallow environment occurs regardless. Gas production is from multiple coal seams that are fractured and the gases from several coal horizons are generally commingled. The carbon isotopic composition of gases from water wells (seven from Rosebud itself, 17 from presumed pristine water wells) are compared to oil field gases (production gases from 3 different depth intervals, shallow [coalbed methane (CBM)] wells, and surface casing vent flows (SCV) within a 40 km radius of the hamlet of Rosebud....
>
> The wide range in δ13C values of SCV gas indicates that there is a history of problem gas flow from a wide range of depths in this area. Comparison of the δ13C values of methane and ethane for gas from the problem water wells in Rosebud with the calculated mixing curves of Figure 10 shows that gases of waters from all seven wells have mixed with either CBM or the deeper production gases.[72]

A 2013 peer-reviewed study found correlation between coalbed methane (CBM) wells and radon concentrations in the atmosphere and that radon "may be useful in monitoring enhanced soil gas fluxes to the atmosphere due to changes in the geological structure associated with wells and hydraulic fracturing in [CBM] fields."[73] Radon concentrations were found to be "approximately three times higher in areas with high densities of [CBM] wells than those areas with low densities."[74] An ongoing Southern Cross University study reported three times the level of methane in the CBM field of Tara than outside it and suspects that "depressurisation (fracking, groundwater pumping) of the coal seams during gas extraction changes the soil structure (i.e., cracks, fissures) that enhance the release of greenhouse gases such as methane and carbon dioxide."[75]

A 2013 report by EPA again ranks the oil and gas industry as top contributor of methane pollution in the US,[76] and a 2013 peer-reviewed study "identified that 8 percent of the methane emissions in the

L.A. basin is due to leaks from the oil and gas industry, which corresponds to a 17 percent leak rate for the Los Angeles–area oil and gas operations."[77]

Isotopic fingerprinting of several aquifer gas samples collected over a decade ago for Imperial Oil in the Cold Lake area "indicate a contribution of hydrocarbons from deeper geologic strata that reflect known releases of production fluids from leaks in well casing."[78]

In 2006, a water sampling company noted that natural gas leaks from surface casing vents in western Canada had "the potential to contaminate ground-water, kill vegetation and become a safety concern."[79] A 2002 field study by Trican Well Service and Husky Energy reported that the percentage of leaking wells ranged from 12% in the Tangleflag area in eastern Alberta to as high as 80% in the Abbey gas field in southern Alberta.[80]

In 2004, the ERCB reported that the number of leaking gas wells in the Wabanum Lake area increased from none in 1990 to more than 140 in 2004.[81]

Schlumberger Well Cementing Services reports gas migration problems at 25% in Alberta's heavy oil fields.[82] The ERCB reported in 1999 that there were "3810 wells with active surface casing vent flow and 814 with gas migration problems in Alberta,"[83] but no longer makes this data public.

A peer reviewed paper[84] published by the Society of Petroleum Engineers, co-authored by the ERCB, states that the regulator "records well leakage at the surface as surface-casing-vent flow (SCVF) through wellbore annuli and gas migration (GM) outside the casing, as reported by industry" and maintains information on "casing failures" but that details are "not publicly available." The paper reports that "SCVF is commonly encountered in the oil and gas industry….high buildup pressures may potentially force gas into underground water aquifers" and that soil GM occurs when deep or shallow gas migrates up outside the wellbore "through poorly cemented surface casing." The paper concludes that **factors affecting wellbore leakage "can be generalized and applied to other basins and/or jurisdictions."** [Emphasis added]

The ERCB's 2011 Field Surveillance Report notes that wellbore leakage and methane migration are routine matters of "high risk noncompliance" voluntarily disclosed to the regulator.[85]

> Yes, the industry's own researchers found that a substantial percentage of wells leak initially, an even higher percentage of wells leak eventually, and now more wells are leaking than in the past; the process is getting worse, not better.
>
> Fractured Future[86]

13. Nearly two decades ago Husky Oil advised that extensive gas leakage from oil and gas wells in eastern Alberta was largely due to "inadequate cementing."[87] A 2001 Australian study that investigated the causes of cement failure in industry wells concluded poor cement work poses a central risk to aquifers.[88] The causes of cement failure include high cement permeability, shrinkage and carbonation, as well as formation damage. A 2010 government study of the Tara rural residential estate area in Queensland reported 44% of coal seam gas or coalbed methane (CBM) wells leaking.[89]

    Cement pulsation researchers reported that 15% of primary cement jobs fail, costing the oil and gas industry about half a billion dollars annually, with about one-third of the failures "attributable to gas migration or formation water flow during placement and transition of the cement to set."[90] The

industry publication *GasTIPS* reported: "A chronic problem for the oil and gas industry is failure to achieve reservoir isolation as a result of poor primary cement jobs, particularly in gas wells....remedial squeeze treatment is expensive and treating pressures may breakdown the formation" and that there are areas in Alberta and Saskatchewan that have historically had gas migration problems, "on average 57% of gas wells develop gas migration after the primary cement job."[91]

14. Alberta industry data shows that "wellbore deviation is a major factor affecting overall well-bore leakage" and that in the test area about 60% of deviated wells were found leaking, about 50% more than the area average, cement slumping and casing centralization were suggested reasons why. The data also shows a strong correlation between the percentage of wells leaking and oil price.[92]

    The ERCB reported that shallow hydraulic fracturing is "high risk"[93] and in their original Directive 027 that shallow fracturing harmed oilfield wells (by communication events) and information provided by industry "shows there may not always be a complete understanding of fracture propagation at shallow depths and that programs are not always subject to rigorous engineering design."[94] Examples of shallow frac communication events were filed with the ERCB.[95]

    In 2010, the British Columbia Oil and Gas Commission released a Safety Advisory because of deep fracture communication incidents, 18 in British Columbia, one in western Alberta. The Advisory states:

    > A large kick was recently taken on a well being horizontally drilled for unconventional gas production in the Montney formation. The kick was caused by a fracturing operation being conducted on an adjacent horizontal well. Fracture sand was circulated from the drilling wellbore, which was 670m from the wellbore undergoing the fracturing operation.... Fracture fluids introduced into producing wells results in suspended production, substantial remediation costs and pose a potential safety hazard. Incidents have occurred in horizontal wells with separation distances between well bores ranging from 50m to 715m.
    >
    > **Fracture propagation via large scale hydraulic fracturing operations has proven difficult to predict. Existing planes of weakness in target formations may result in fracture lengths that exceed initial design expectations.**[96] [Emphasis added]

    One of the Safety Advisory recommendations is that "operators cooperate through notifications and monitoring of all drilling and completion operations where fracturing takes place within 1000m of well bores existing or currently being drilled." This safety recommendation is not adopted by either the Alberta or British Columbia regulator for shallow or deep fracture operations near farms, homes, water wells, municipal water supply towers, fire halls, police stations, churches, non oil and gas businesses, communities, hospitals, parks, schools, *etc*. and requests for such to companies and regulators by concerned citizens, communities or municipalities have been ignored or denied.

    In November 2011, the British Columbia Oil and Gas Commission admitted to Propublica that 25 frac communication events had been voluntarily reported since 2009. "Companies are not required to report such events."[97] In March 2011, at an EPA frac workshop, Denbury Resources presented and concluded: "Even with the tools available to perform fracture diagnostics operators are still faced with challenges that are difficult to predict. **As well density increases it becomes increasingly probable that wells will communicate either through previously created fractures or through adjacent wellbores and then into previously created fractures.**"[98] [Emphasis added]

In January 2012, after the Innisfail frac blow-out ("pressure that built up in one escaped to the other bore-hole" and "fracking fluid leaked to the surface"[99]), the ERCB released a list of deep, horizontal frac communication events in Alberta (excluding shallow and/or vertical events) but did not post this information on their website:

> Since 2008, almost 2,000 wells have been drilled in Alberta that utilized horizontal, multi-stage, hydraulic fracturing to enhance oil and gas recovery. Of these, more than 640 were gas wells and almost 1,300 were oil wells. The ERCB has confirmed five instances of hydraulic fracturing impacting nearby energy wells.

One frac communicated 1,600 metres (one mile) surface distance between wells, another, 470 metres subsurface distance between wells.[100] Disclosure in Alberta is voluntary. In January 2012, the regulator released Bulletin 2012-02 warning industry:

> The ERCB fully expects licensees to maintain well control at all times so as not to impact the environment, public safety, and efficient recovery of the resource and to prevent adverse effects to offset energy wellbores. The ERCB reminds industry that it is obligated to plan safe and effective hydraulic fracturing operations and report any unintentional communication between energy wellbores. Licensees are reminded that in maintaining well control, they are required to prevent adverse effects to offset wellbores through appropriate planning. [101]

The ERCB had already warned industry this in 2006 when it was the EUB:[102]

> The EUB expects licensees to conduct all drilling and completion operations at any depth with technical due diligence and in compliance with EUB requirements. The EUB also believes it is prudent for industry to carefully design and monitor fracturing operations…. Additionally, all fracture treatments must…not reach any other wellbore, including both oilfield wells and water wells, at any point during the process of fracturing.[103]

The ERCB admitted that 21 deep frac communication events had occurred in 2012 alone:

> Curran says that since the ERCB began monitoring interwellbore communication this year, there have been 21 incidents, but they rarely cause damage. … Curran says geologists understand the technology and its potential consequences quite well, and that the ERCB is not struggling to align rule-changes with a poorly developed science. "Hydraulic fracturing as a technology is very well understood, and it's been applied here extensively in Alberta over our history…. There's been over 171,000 wells that have been hydraulically fractured in Alberta since the practice began in the 1950s," he says.[104]

In 2006, the international *2nd Well Bore Integrity Network Meeting*'s first key conclusion started with:

> **There is clearly a problem with well bore integrity in existing oil and gas production wells, worldwide.**[105] [Emphasis added]

The British Columbia energy regulator recently reported 272 earthquakes directly caused by hydraulic fracturing over a three year period. One caused such extensive damage to the well bore it could not be completed.[106] In the UK in 2011, two earthquakes, both "located close to the point of injection," were also caused by hydraulic fracturing.[107] The cumulative impacts and risks to well bore integrity from

earthquakes caused by fracturing and associated activities, chemical interactions and repeat multi-zone perforations and high pressure hydraulic fracturing events have not been studied in Canada, or anywhere in the world.

15. A 2011 European Union study on possible impacts of hydraulic fracturing concluded that it is "high risk" if not done right with "possible high risk for environmental damages and hazards to human health even when applied properly..."[108]

    The ERCB Associate General Counsel responded to a citizen's Access to Information request on "each and every blow-out, frac-out, communication event, and or loss of control or pressure during completion, perforating, acidizing, hydraulic fracturing and or stimulating of energy wells" by threatening to apply to Alberta's Information and Privacy Commissioner for authorization to disregard the access request "on the basis that it is unclear, frivolous and vexatious" unless the request was narrowed or clarified.

    > **Responding to such a request would require a massive undertaking on the part of the ERCB: potentially in the order of millions of pages of records.**[109] [Emphasis added]

    A Pennsylvania newspaper filed a Right to Know request to the Department of Environmental Protection (DEP) for records on water contamination caused by the oil and gas industry. The DEP refused to release the records for a variety of reasons, including claiming that the records are not tracked.[110] This was challenged by the paper and the DEP was ordered to release the records under Right to Know Law. The DEP appealed the order to the Commonwealth Court, claiming the paper's request was too broad and burdensome. The Court ruled against the DEP and the paper obtained and summarized the records:[111] "oil and gas drilling had damaged 161 water supplies between 2008 and 2012, ground-breaking information that the DEP should be able to provide to the public as a matter of course."[112]

    Ernst tried for four years via Freedom of Information to obtain public records on methane contaminated water wells in Alberta, winning a 2012 order[113] to receive the records, only to be refused by Alberta Environment because of the lawsuit.[114]

    > They'll frack each well up to 20 times. Each time the pressure will shudder and bang the pipes in the wellbore. The cement is hard and the steel is soft. If you do it all the time you are going to break bonds and cause leaks. It's a real major issue.[115]
>
> Dr. Karlis Muehlenbachs

16. A report released in 2012 by the Energy Institute at the University of Texas called for more science on hydraulic fracturing and reported that a "lack of baseline studies in areas of shale gas development makes it difficult to evaluate the long-term, cumulative effects and risks associated with hydraulic fracturing."[116]

    "Leaks in part of the well bore could mean gas getting into water wells nearby. But the same thing happens in conventional gas production. …We haven't found **any** community where inspection practices, pre-development conditions, monitoring of development and post-development assessment has been done according to best practices."[117] [Emphasis added]

The Energy Institute report clearly covered gas migration into groundwater caused by drilling and specifically hydraulic fracturing:

> Unplanned releases of natural gas in the subsurface during drilling may result in a blowout of the well or migration of gas below the surface to nearby houses, where the gas may accumulate in concentrations high enough to cause an explosion. … Many blowouts happen as a result of the failure of the integrity of the casing or the cementing of the casing such that high-pressure fluids escape up well bore and flow into subsurface formations. ... Blowouts are apparently the most common of all well control problems, **and they appear to be under-reported.** ...
>
> Subsurface blowouts may pose both safety hazards and environmental risks. The potential environmental consequences of a blowout depend mostly on three factors: 1) the timing of the blowout relative to well activities (which determines the nature of the released fluid such as natural gas or pressurized fracturing fluid); 2) occurrence of the escape of containments through the surface casing or deep in a well; and 3) the risk receptors, such as freshwater aquifers or water wells, that are impacted. …
>
> Blowouts due to high gas pressure or mechanical failures happen in both conventional and shale gas development. **Shale gas wells have the incremental risk of potential failures caused by the high pressures of fracturing fluid during hydraulic fracturing operations.** Underground blowouts occur in both wells that had been or about to be hydraulically fractured. ...
>
> An example of the environmental consequences of an underground blowout…has been reported in Louisiana, in which pressure changes in the Wilcox aquifer caused a number of water wells around the blowout [well] to start spouting water. … In another incident in Ohio… high-pressure natural gas was encountered and moved up the well bore and invaded shallow rock formations. Within a few days gas bubbling was observed in water wells and surface water, and the floor of a basement in a house was uplifted several inches. Over 50 families were evacuated from the area. ...
>
> In one well-known case in Ohio, a house exploded soon after a nearby hydraulically fractured well was drilled. After much investigation by the regulatory agency and a private geological engineering consulting firm, followed by study of the case by a distinguished review committee, it was concluded that methane may have migrated to the house along shallow horizontal fractures or bedding planes. ... Other cases of methane explosions in homes and wellhouses have been investigated in Colorado, Pennsylvania, and Texas. In some of these cases, the explosions were found caused by gas migration from hydraulically fractured wells.[118]

The press release accompanying the Energy Institute's report was intentionally misleading:

"New Study Shows No Evidence of Groundwater Contamination from Hydraulic Fracturing"[119] setting off similar headlines in the media across the globe.

In April, 2013, a documentary reported coalbed methane fields leaking in Australia and government fast tracking approvals for massive projects without assessing the risks. Methane contaminated water wells and is bubbling in rivers. This from the transcript:

> *ABC News*: Professor Pells has studied AGL's report, which found there was no evidence of natural connectivity - or movement - between shallow and deep groundwater systems. …
>
> Professor Phillip Pells (indicating a graph on the screen): "The groundwater system has now substantially depressurized. We took their conceptual model exactly how they presented it - with their geometry, with their parameters...and we ran the model. And it simply shows that they are connected. And I'm just disappointed that a conclusion was reached which clearly isn't supported by their own model."[120]

If you were looking for a way to poison the drinking water supply…you couldn't find a more chillingly effective and thorough method of doing so than with hydraulic fracturing.[121]

Dr. Paul Hetzler

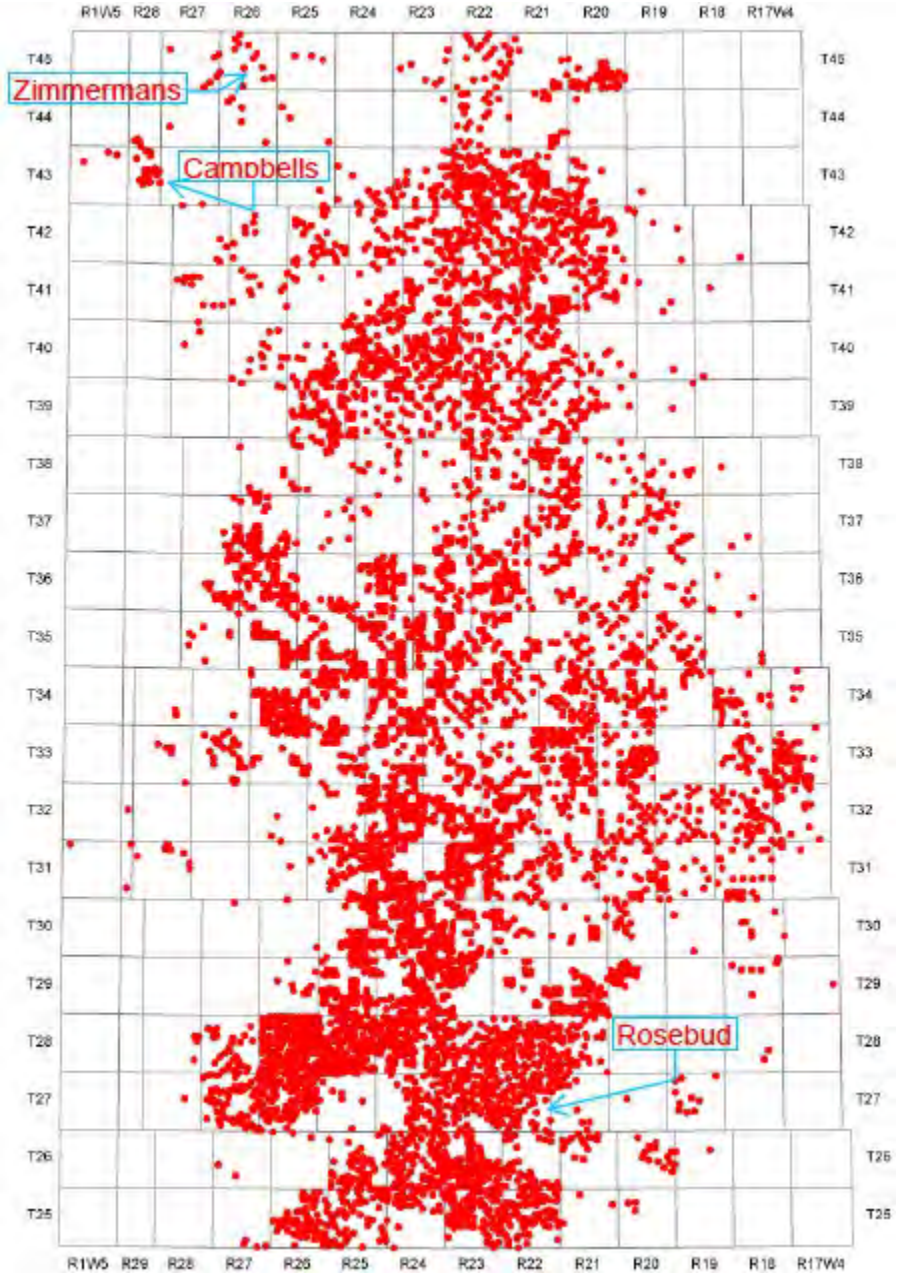
17. Maurice Dusseault, a prominent Canadian oil and gas industry researcher and gas migration expert, reported that leaking methane gas from thousands of resource wells posed "massive environmental problems" because the escaping methane "changes the water, and generates aquifer problems."[122] Dusseault explained in an Alberta report on heavy oil that, "all unplugged wells will leak eventually, and even many wells that have been properly abandoned" would also leak gas up to the surface outside of the well casing posing a hazard to groundwater and the atmosphere.[123]

    In 2006, the ERCB reported that 362,265 total resource wells have been drilled in Alberta of which 116, 550 are abandoned.[124]

    In a 2000 report entitled *Why Oilwells Leak: Cement Behaviour and Long-Term Consequences*, Dusseault and colleagues warned:

    > The consequences of cement shrinkage are non-trivial: in North America, there are literally tens of thousands of abandoned, inactive, or active oil and gas wells, including gas storage wells, that currently leak gas to surface. …
    >
    > Some of the gas enters shallow aquifers, where traces of sulfurous compounds can render the water nonpotable, **or where the methane itself can generate unpleasant effects such as gas locking of household wells, or gas entering household systems to come out when taps are turned on.**
    >
    > Methane from leaking wells is widely known in aquifers in Peace River and Lloydminster areas (Alberta), where there are anecdotes of the gas in kitchen tap water being ignited. Because of the nature of the mechanism, the problem is unlikely to attenuate, **and the concentration of the gases in the shallow aquifers will increase with time.** …
    >
    > **Unfortunately, even if no gas appears at the surface, it is no guarantee that the well is not leaking. In fact, the common occurrence of household water sources being charged with deep-sourced gas is clear evidence that there are many cases of leakage where the gas simply enters the water aquifer, and may never bubble around the casing**.[125] [Emphasis added]

Alberta regulators permitted the drilling of nearly 8,000 coalbed methane (CBM) wells without standardized baseline hydrogeological investigations from about 2001 to May 2006. Many gas-bearing coal seams are connected to drinking water aquifers.



Alberta Horseshoe Canyon coalbed methane wells, 2006 (each square = Township x Range = 6 x 6 miles).[126]
Conventional and other unconventional wells are not included on this map, nor are all CBM wells.
(The blue points to some of the contamination cases discussed in this brief.)

There were 15,850 coalbed methane (CBM) wells in Alberta by 2009 and 20,000 by February 2013. In 2011, the ERCB reported that when "CBM development began, some Albertans expressed concerns that we would experience similar impacts to those occurring in some U.S. jurisdictions. We soon learned that our geology and world-class regulations helped us avoid these problems."[127]

In 1996, the Canadian Association of Petroleum Producers (CAPP) reported that 17 of about 24,000 (0.07%) historic water well records reviewed by Alberta Environmental Protection (name changed to Alberta Environment[128]) indicated gas present before oil and gas development.[129] In 2001, four out of 2,300 (0.17%) historic water well records within about 50 square kilometres of Rosebud, Alberta noted gas present before experimental hydraulic fracturing began in 2001.[130] EnCana advertisements[131] in 2006 state that Alberta Environment had 906 entries in its Ground Center Database indicating gas present. This is 0.18% of about 500,000 total groundwater wells in the province[132] and 3.8% of about 24,000 in coals.

The ERCB conducted a CBM water chemistry study in Alberta and reported that about 90% of water wells in coal they tested had no detectable methane or ethane present,[133] while the ethane fingerprints in CBM wells (fractured between about 250 and 730 metres below surface) matched the ethane fingerprints found in gases in contaminated water wells at Rosebud.[134]

From 1999 through 2011, the US Geological Survey (in cooperation with the New York State regulator since 2009), sampled groundwater for dissolved gases, including methane "meant to document the natural occurrence of methane in the State[']s aquifers." Eighty-three percent of the 239 water wells sampled had less than 1 mg/l methane; 47% had none detected. Seventeen percent had more than 1 mg/l, of which five had more than 28 mg/l, the highest at 45 mg/l.[135] The report did not include the locations of the more than 75,000 oil and gas wells drilled in the state since the 1820's[136] (only 14,000 remain active),[137] or the rates of methane leakage from the energy wells, especially those abandoned and poorly plugged.

A 2004 New York State Oil, Gas and Mineral Resources report states:

> Most of the wells date before New York established a regulatory program. Many were never properly plugged or were plugged using older techniques that may not last. Abandoned wells can leak oil, gas and/or brine; **underground leaks may go undiscovered for years. These substances can contaminate ground and surface water, kill vegetation and cause safety and health problems.**
>
> Historically, abandoned wells have been discovered in residential yards, playgrounds, parking lots, wooded areas, **inside buildings and underwater in wetlands, creeks and ponds.** Every year DEC staff discover additional abandoned wells while conducting scheduled inspections **or investigating complaints. Many abandoned well issues take several years to resolve as [the Department of Environmental Conservation (DEC)] pursues legal action against the responsible parties.**[138] [Emphasis added]

Regional groundwater assessments by Hydrogeological Consultants Ltd. (HCL),[139] in conjunction with Agriculture and Agri-Food Canada and the Prairie Farm Rehabilitation Administration, were completed for 45 Alberta counties and municipal districts[140] before and/or during unconventional oil and gas development. The assessments included identifying aquifers and quality and quantity of the water in those aquifers; **they did not report dangerous or explosive levels of methane as a naturally occurring phenomena.** Regulators began publicly stating that all water wells in coal are naturally contaminated with explosive levels of methane after media reported flammable, explosive well water in Alberta.[141] The historic records publicly available at the time on Alberta Environment's water well database for the reported contamination cases - including Ernst's - state *Gas Present: No*.[142]

CAPP Chairman and EnCana Vice President, Gerard Protti, was interviewed about the Ernst case in 2006:

> Asked about Jessica Ernst's burning water..."That's actually fairly common." It's a natural phenomenon in an area where there's so much natural gas, he says, adding that such water is safe to drink.[143]

In about 2010, the historic records on Alberta Environment's water well database that state *Gas Present: No*, were replaced with altered records where the information for *Gas Present:* is now blank.[144]

Dr. Anthony Ingraffea,[145] fracturing processes researcher and professor at Cornell University since 1977, summarized natural methane concentrations in groundwater and the problem of blaming nature for industry's gas migration:

> Along with these fairly direct evaluations of the migration of methane and other substances, industry sources have asserted that private water wells are often contaminated by "naturally occurring" methane. This is often presented in an apparently analytical but confusing way, suggesting that the appearance of methane in drinking water wells is sort of "common" and thus unlikely related to any gas well drilling. ...
>
> The New York DEC's data...make crystal clear that for a 2010 sample of water wells (n=46) in the "Delaware, Genesee, and St. Lawrence River Basins," presumably not near gas wells, just 2% of the wells had a dangerous level over 10 mg/L. One well had a level of 22 mg/L; the remaining wells then had an average level of 0.31 mg/L. This low percentage of "normal" risk has been confirmed repeatedly in studies in PA,...,in the Southern Tier of NY (1450 water wells, [US Geological Survey], 2010), in Alberta, Canada (360,000 wells, Griffiths, 2007) and by both independent investigations and by testing by gas drillers (e.g., Boyer, et al., 2011).
>
> **None of these findings suggest, in any way, that dangerous levels of methane are at all common in rural private water wells. Thus, a fairly strong implication is that, if and when methane does occur at high levels in water wells near gas drilling, it is likely due to some aspects of gas drilling, fracing and/or production operations themselves**. This is consistent with both the Osborn, et al. (2011) study and the EPA Pavilion (2011) preliminary report.[146] [Emphasis added]

18. The development of coalbed methane (CBM) and other unconventional deposits of natural gas and oil requires extensive hydraulic fracturing. Hydraulic fracturing consists of injecting diesel fuel, water, foams, silica, nitrogen and undisclosed mixes of chemicals into coal and other formations to force the tight gas or oil to release. Some fracturing chemicals that pose a threat to human health include benzene,[147] phenanthrenes and florenes,[148] naphthalene,[149] 1-methylnaphthalene, 2-methylnaphthalene, aromatics, ethylene glycol and methanol.

    According to the US Environmental Protection Agency (EPA) about 40 percent of every fracturing treatment remains in the ground where it poses a threat to groundwater; **CBM requires five to ten times more fracturing than conventional natural gas wells**.[150]

    The ERCB Hydraulic Fracturing Directive released on May 21, 2013 has a section titled: "Special Provisions for Coalbed Methane Fracturing."[151]

Our CBM zones are not fracked....
What we do is provide nitrogen down there in a stimulation fashion.
We just take the nitrogen from the air you breathe stimulate the coals with it.[152]

Stacy Knull, EnCana Vice-President to Investors in 2010

The Canadian Society of Unconventional Gas reported in 2007 that "[u]nconventional gas, by definition, is difficult-to-produce gas that requires some sort of artificial stimulation to flow at commercial rates. Because of this, there has been much research and field experimentation on fracturing technologies that will work on the thinner, often complex unconventional gas zones of western Canada. In the Horseshoe Canyon, producers quickly discovered a high-pressure nitrogen fracture could make gas flow at commercial rates."[153] Trident Exploration presented in 2009 that their CBM in Alberta is "unable to produce on perforation alone" so each seam is fractured with high rate nitrogen.[154]

In 2004, Encana fractured directly into the drinking water aquifers at Rosebud: "The top perforation was stimulated with 3,000 m3 [3,000,000 litres] of nitrogen (at standard temperature and pressure) at a rate of 500 m3/min [500,000 litres/min] for six minutes. The top set of perforations in this CBM well (125.5 to 126.4 mKb) was in the Weaver coal zone, the same as many of the local water wells...."[155] There were six perforations into the fresh water aquifer and 18 more below them. Water wells in the community started to go bad and EnCana retained Hydrogeological Consultants Ltd. (HCL) to investigate. HCL is the same company that did the regional groundwater assessments for 45 Alberta counties and municipal districts, including Wheatland County in 2003 (Refer also to Page 23). Testing of the gas from the aquifer in 2004 showed high concentrations of methane and nitrogen. Nitrogen was as high as 30% in the gas in the first water well that went bad.[156] A publicly available gas analysis on the Encana CBM well that frac'd the aquifer shows it contained 29.65% nitrogen even after it was flowed for months.[157] HCL admitted in their report that "there is an elevated concentration of nitrogen in the gas from the aquifer" but dismissed it by:

1) Ignoring Encana's data from the gas well with 29.65% nitrogen, and instead using data from gas wells up to 27 kilometres away that had 4.1, 3.9 and 2.9% nitrogen and concluding: "the concentration of nitrogen in gas in the groundwater pumped from the...water wells is elevated above the concentration of nitrogen in gas from gas wells in the area;"
2) Using expectations instead of the data: "there is no reason to expect any significant nitrogen remained...;" and
3) Stating "the concentration of nitrogen in the gas from the...water wells is similar to the nitrogen concentration of a gas sample from a domestic water well...southwest of Calmar" (a town near Edmonton, about 300 kilometres away; refer also to #7).[158]

The Alberta Research Council dismissed the high nitrogen levels in the Signer and Lauridsen wells at Rosebud by also ignoring Encana's data from the gas well with 29.65% nitrogen and claiming:

1) the water wells might be breathing wells;
2) there might be an "aquifer connection to the atmosphere at some distant point;" and
3) "[n]itrogen concentrations in energy wells are less than 15%."

Regulator tests in 2007 on the Ernst well showed 881,000 ppmv methane, 26.70 ppmv ethane and 137,000 ppmv nitrogen in free gas collected, and 24.3 mg/l methane, 0.021 mg/l ethane and 12.3 mg/l nitrogen dissolved in the water. Canadian Drinking Water Guidelines are 10 mg/l total nitrogen.[159]

Total nitrogen in fresh groundwater contaminated by frac'ing in 2011 near Grand Prairie, Alberta, dropped to one-fifth the initial concentration after about a year and continues to be monitored by the regulators.[160] The contaminated citizen water wells at Rosebud are not being monitored for anything.

The Alberta Research Council did not review the high nitrogen in the Ernst water, not even to dismiss it. The research council did however use a high nitrogen level in a gas sample from an EnCana gas well at Rosebud, to claim air contamination and thereby dismiss the isotopic fingerprinting analysis that matched ethane signatures in EnCana's gas to gas in the contaminated water wells. Instead of requesting new gas samples from EnCana, the research council used gas samples from gas wells frac'd much deeper and located over 100 miles away to claim no match, and refuse to release this data,[161] even after Freedom of Information requests and subsequent inquiry.[162]

Documents obtained by Freedom of Information show that the Alberta Research Council calculated the gas production from the Ernst water well to be 0.94 litres/minute. This information was not revealed in their reports. The research council dismissed the gas in the water wells at Rosebud by claiming it was biogenic but couldn't explain where it came from. The research council included in their reports the historic records for the now contaminated water wells that state *Gas Present: No*, but did not discuss them. Instead, on the Ernst case, the council wrote: "Historically, methane has been observed in water wells in the Rosebud area"[163] and on the Signer and Lauridsen cases: "Historically, methane has been observed in water wells in the Rosebud and Redland areas."[164]

The ERCB and Alberta Environment accepted HCL's and the Alberta Research Council's omissions, errors and arguments, and the contamination cases were closed. The claimants requested peer-review and correction of the errors and omissions.[165] They received no response. Drs. Barbara Tilley and Karlis Muehlenbachs, geochemists at the University of Alberta questioned Dr. Blyth's dismissal of the contamination cases:

> In summary, given the unqualified nature of the D35 well database, the disregard of diagnostic ethane isotope ratios and the lack of coal gas isotope data, we find the overall conclusion of Dr. Blyth's report "An independent review of coalbed methane related water well complaints filed with Alberta Environment" January 16, 2008, to be premature.[166]

In 2005, the energy regulator (before the name was changed from the EUB to the ERCB) warned that shallow fracturing operations had impacted oilfield wells.

> The EUB has recently met with most major coalbed methane operators and service companies to discuss their fracturing practices, including program design. These discussions have indicated that design of fracture stimulations at shallow depths requires improved engineering design and a greater emphasis on protection of groundwater.[167]

The ERCB did not advise the public or landowners that companies were fracturing thousands of gas wells where Alberta's fresh water is or above the Base of Groundwater Protection.

There are an increasing number of stakeholders that have been raising questions and concerns about the development of [coalbed methane (CBM)]. …
There also seems to be a misconception held by some people that..."experimental" means that it poses a higher risk to the public.

Canadian Association of Petroleum Producers (CAPP), 2003[168]

Encana fracturing Rosebud's drinking water aquifers was reported to the regulators in 2005[169] (perhaps earlier). Since 2001, the ERCB permitted hundreds of gas wells to be frac'd above the Base of Groundwater Protection, but did not prohibit the injection of toxic fracturing chemicals where the fresh water is until 2006.[170] [171]

In 2008, Congress moved to protect drinking water in the United States from hydraulic fracturing[172] and in 2010 the Committee on Energy and Commerce investigated eleven companies, including EnCana, regarding their hydraulic fracturing practices and all allegations of groundwater contamination.[173] Ernst asked Encana for a copy of the company's submission to Congress and received this reply: "The information requested by Congress does not relate.... Since Encana does not intend to inject petroleum distillates or diesel...Encana has no information to provide in this regard."[174]

A 2011 ERCB public relations package clearly states that companies "must" disclose frac chemicals injected:

> The ERCB requires that any hydraulic fracture fluids used above the base of groundwater protection...be nontoxic **and that the operator reveal the contents of the fluids to the ERCB upon request.** The ERCB also requires that the type and volume of all additives used in fracture fluids be recorded in the daily record of drilling operations for **any** well. **This information must be submitted to the ERCB**.[175] [Emphasis added]

Why has the regulator allowed companies to risk Alberta's groundwater without proper safeguards as recommended by the Canadian Council of Environmental Ministers in 2002? Why has [coalbed methane (CBM)] activity been allowed to escalate at the expense of public health and safety?

What are the fracing chemicals?

The Groundwater Debate, 2006[176]

Freedom of Information request responses[177] show that companies have not disclosed to Alberta regulators or affected families the chemicals injected in shallow or deep wells. A 2012 letter from ERCB General Counsel to Ernst in response to her request for the chemicals injected by Encana states:

> **The ERCB does not currently require licensees to provide detailed disclosure of the chemical composition of fracturing fluids.** [Emphasis added][178]

19. EnCana, one of North America's largest coalbed methane drillers, publicly admitted that the same fracturing practices and gelled fluids used in the United States, which included diesel, have been applied in Alberta. A 2005 study by the company, tested recovered fracturing fluids and drilling waste mixed with water from 20 shallow gas wells on the Suffield Range in southeastern Alberta.[179] The study, which detected metals such as chromium, arsenic, barium, mercury, and BTEX (benzene, toluene, ethyl benzene and xylenes), recommended that "Frac fluid companies should investigate the use of alternative additives that may be even more environmentally friendly (i.e. lower toxicity)."

Public Lands Division of Alberta Sustainable Resource Development officially reported in 2003 that companies (including Encana) inappropriately dumped waste in the Suffield National Wildlife Area and Canadian Military Base, including directly into wetlands and through water courses, putting groundwater at risk:

> The survey of [Landspraying while drilling (LWD)] sites within CFB Suffield highlighted concerns with the poor distribution of LWD residual solids; associated smothering impacts to grassland vegetation where there were skins and mudpacks of LWD materials; mechanical impacts like rutting; and siting problems such as application on sand dunes, **watercourses, wetlands and steep slopes.** … It is not unusual to find mud packs in excess of one inch thick being dropped at the start of a load. ... Problem land sprays have been left with inadequate clean up. … The file review and field observations revealed that on a high percentage of sites, LWD is not being conducted according to the guidelines and **is having a negative impact** on native range.[180] [Emphasis added]

The regulator was aware of the violations. Darren Barter, ERCB public relations spokesman, dismissed them claiming no "serious breaches" occurred. "If they are not following our regulations, we should be involved in it."[181] Canadian military base commander at Suffield, Daniel Drew, wrote that activities on the base "illustrate an apparent lack of respect for the landowner and the lands themselves," referring to an environmental assessment report by the military that found oil and gas companies discarded and abandoned "hazardous material drums and lubricant pails, assorted pipe, plastic tubing, oil rags and frac sand" at well sites.[182] "These incidents appear to run counter to industry guidelines and standard practices, and illustrate an apparent lack of respect for the landowner and the lands themselves. ... The base is not prepared to tolerate these types of destructive and negligent operating practices."[183]

At Rosebud, EnCana dumps drilling waste on agricultural lands, often in thick mud packs and sometimes dumping on them more than once.[184]

Encana drilling waste dumped at Rosebud, November 18, 2012

Drilling fluids are transported, stored and handled in tanks. Typically, drilling fluid waste will be transported off-site for re-use and treatment/disposal…. Some additives may be caustic, toxic, or acidic.

Canadian Association of Petroleum Producers (CAPP) Best Practices, 2006[185]

Drilling muds and petroleum industry wastes are sometimes disposed of in pits and covered. Industry and regulators describe it as a benign "spraying" or "farming" when it is dumped on land and companies offer a pittance or claim it is free fertilizer to attract farmers and ranchers to take the waste.

Possible toxics in the wastes are not disclosed to landowners or communities, can harm human health[186] and contaminate groundwater.[187] Groundwater flow systems can transport pollutants several kilometres.[188] The managing director of Wunderlich Securities announced at WasteExpo2013 that drilling companies in America and Canada are spending between $20 billion and $30 billion on waste disposal. A reporter covering the Expo wrote: "A year and a half ago, Alberta, Canada, eliminated 'land farming' of oil-field wastes, a practice where the wastes are sprayed over open land and allowed to break down naturally."[189] Drilling waste disposal is a serious, widespread problem:

> About 1.2 barrels of solid waste are created with each foot drilled, according to the American Petroleum Institute. Simply to reach the approximate 8,000-foot depth of a Barnett Shale gas well, drilling creates more than 9,600 barrels, or 403,200 gallons, of solid waste. That does not take into account any horizontal drilling performed after reaching that depth. For the 14,000 Barnett Shale wells drilled so far, the waste would cover the entire city of Fort Worth in more than an inch of drill cuttings, slurry, heavy metals and other toxic compounds. ….millions of gallons of toxic waste are spread on the land, sometimes overflowing into waterways, sometimes becoming airborne and blowing across the prairie.[190]

An article about shallow gas drilling in Saskatchewan touts drilling waste as free fertilizer:

> They also collect drilling fluids in vacuum trucks. The drilling fluid consists of calcium nitrate (fertilizer) which is spread onto the farmer's land after completion. This creates a double benefit for the farmer. He has lease revenue and fertilized land when it is all said and done.[191]

In 2011, after high-risk enforcement action by the ERCB against Baytex Energy for landspraying a farmer's field with crude oil, the company's CEO was reported claiming that spraying drilling waste is good for the land and crop generation. "All it really is, is taking in sand and some shale's and stuff from the hole we drill out before you get to the target zone and spraying it on the field."[192]

"Mortgages routinely contain clauses prohibiting hazardous activity/substances on the property, the storage of hazardous waste, and activities that may devalue the property. ... The interests of the banking industry, consumers, and oil and gas exploration companies appear to be at odds. At the core, the issue is who should bear the risks...."[193]

Researchers in the US studied the additives used in drilling:

> For many years, drillers have insisted that they do not use toxic chemicals to drill for gas, only guar gum, mud, and sand. While much attention is being given to chemicals used during fracking, our findings indicate that drilling chemicals can be equally, if not more dangerous.[194]

Alberta Environment found BTEX in the Hamlet of Rosebud water supply, arsenic and hexavalent chromium in a monitoring water well in the community, and evidence of petroleum distillates in the hamlet and citizen water wells after intense unconventional gas developments. The chromium in the Ernst water well increased by a factor of 45 after EnCana fractured the aquifer[195] that supplies that well. The Alberta Research Council neglected to explain this increase in their report on the Ernst case. The regulator did not test for arsenic or mercury in the contaminated citizen wells at Rosebud.[196]

20. Lost circulation or the seepage of cement and other fluids into the ground is a constant problem with coalbed methane (CBM) and other unconventional oil and gas drilling.[197] EnCana experienced 10% lost circulation in one CBM field[198] and EnCana drilling and fracturing records for shallow CBM wells near the contaminated Campbell water well at Ponoka, Alberta indicate "severe" lost circulation events.[199]

    Lost circulation poses a variety of risks to groundwater including contamination by products used to stop the seepage. Although EnCana and other companies claim they only use fibre to seal the leaks, many of the products are toxic. Industry, for example, often refers to Soltex (sodium asphalt sulphonate) as a "cellulose based" product, but the compound can include high amounts of antimony, arsenic, barium, chromium, lead and mercury.[200]

    Oilweek Magazine[201] lists almost a hundred products used for lost circulation including oil soluble resin polymer system, high lignin cellulosic, acid soluble blend, graphite plugging agent, and oil wet cellulose fiber. Ferro-chrome lignosulfonate (thinner and deflocculant), is a drilling mud additive listed as being used in Alberta[202] and has been reported to negatively affect fish eggs and fry.[203]

    Since 2003, more than fifteen Alberta landowners reported contamination of their water wells after intense unconventional gas drilling and fracturing. Alberta Environment reluctantly and partially sampled some of these wells. Analysis by the Alberta Research Council[204] and other labs detected indicators of industrial contamination, including BTEX (benzene, toluene, ethyl benzene, xylenes), barium, strontium, hexavalent chromium, tert-butyl alcohol, phthalates, H2S, and heavy hydrocarbons indicative of contamination by petroleum distillates such as kerosene and naphthalene.

    Methodical studies by the University of Alberta on gases in the contaminated water also indicated industrial contamination.[205]

    The ERCB's mandate is to become involved in fresh groundwater cases that have indication of petroleum industry contamination. In the majority of cases, the ERCB involvement has been limited to claiming in the media and public town hall meetings that the contamination is natural, and most recently, that the regulator owes "no duty of care" to Albertans or groundwater.[206] [207]

    The Energy Institute recently reported that fracturing fluid additives frequently include the known carcinogen benzene and probable carcinogen naphthalene, and high volumes of 2-butoxy-ethanol (of serious concern because it destroys red blood cells and is "dangerous to the spleen, liver, and bone marrow"). The report noted that 2-butoxy-ethanol is "being replaced in hydraulic fracturing with a new product having low toxicity and with properties requiring use of a much lower volume of product and summarized fracturing fluid additives: "Estimates of the actual chemicals utilized range as high as 2500 service company products containing 750 chemical compounds."[208]

In 2006, Alberta Environment finally released a Standard for Baseline Water Well Testing for coalbed methane (CBM). It is not standardized or baseline: "Surprisingly, many presumed pristine water wells contain effervescing methane...with traces of ethane...indicating that some of the water wells have already been contaminated."[209] (Refer also to the 2006 CBM well map on Page 22.) The Standard is further limited by only being applicable to shallow CBM wells, not sands, shales or deep CBM, and does not mandate testing for dissolved methane or red flag indicators of petroleum industry contamination, such as arsenic, mercury, chromium, barium, strontium, BTEX. Water wells are to be tested if they are within 600 or 800 metres of CBM wells to be frac'd above the Base of Groundwater Protection.[210]

On May 21, 2013, the ERCB released Directive 083, "Hydraulic Fracturing – Subsurface Integrity,"[211] the day after the regulator's "millions of pages of records" response to a Freedom of Information request on frac-related incidents was made available to the public.[212]

The Directive provides the "option for single-barrier" design and ability to apply for less. The ERCB defines "Single-barrier system" as a "well system designed for hydraulic fracturing operations comprised of a primary barrier system only."

> From a design perspective, we've heard that engineering steelcase systems, which are fully cemented externally, provide multiple barriers to the migration of fluids from well bores to groundwater aquifers.
>
> Richard Dunn, (Vice-President, Regulatory and Government Relations, Encana Corporation) Testimony on "best practices" in 2010 to Parliamentary Committee[213]

The Directive **does not mandate baseline water well or spring testing** for vertical or horizontal shales or sands frac'd above or below the Base of Groundwater Protection, or CBM below it.[214]

In 2012, a spring's flow was reduced by a third after frac'ing and the water was later contaminated after a second frac operation nearby. The rancher asked for testing before and after the frac'ing but the company refused. "They said their geologist said there was no risk from the fracking and that they didn't see a reason to test."[215] The rancher sent a 32-page complaint letter to the regulator over the lack of testing. "Nothing has happened with the ERCB." [216]

The Canadian Association of Petroleum Producers (CAPP) 2012 "Hydraulic Fracturing Operating Practice" suggests developing programs to provide voluntary baseline testing for water wells and springs within 250 metres, "**or as specified by regulation**, of a wellhead before drilling shale gas, tight gas or tight oil." [Emphasis added]. The Practice does not include testing dissolved methane.[217]

An Engineering and Materials Testing firm in Alberta recommends that dissolved methane, barium and strontium are added tests to the government standard because they are indicators of methane gas migration into water wells.[218] EnCana refuses to provide these, even if landowners offer to pay the additional costs for sampling and analysis.[219] [220]

The ERCB reported that shallow and deep shales will be fractured in Alberta, that fracturing is a known risk to groundwater but will not mandate appropriate baseline testing.[221] In Alberta, mandatory partial chemical disclosure was introduced on fracfocus.ca after public outcry, but only from 2013 on and trade secrets are permitted.[222] In British Columbia, partial frac chemical disclosure via fracfocus.ca began the previous year.[223]

21. A 2008 analysis of 457 chemicals used by oil and gas industry for drilling and fracturing in five western states found that 92 percent had adverse health effects and that more than one quarter were water-soluble.[224] Researchers compiled a list of 944 products containing 632 chemicals used during natural gas operations and reported: "These results indicate that many chemicals used during the fracturing and drilling stages of gas operations may have long-term health effects that are not immediately expressed….The discussion highlights the difficulty of developing effective water quality monitoring programs."[225]

22. The oil and gas industry has been drilling the Stoney Creek community in New Brunswick for about 100 years, and fracturing there since about 1940 when a well was frac'd with nitroglycerin.[226]

"Fracturing Stoney Creek Field well with nitroglycerin, circa 1940"

Lab tests of drinking water in the Stoney Creek community find it unsafe: "This report contradicts the claims made by the government of New Brunswick that there have been no incidents connected to the oil and gas industry in recent decades..." "Senior laboratory technicians reported that they, quote, 'lit the water on fire', and found the water sample, provided to them by Mr. Charles Doucet, found it to be super saturated with methane." ... "Water contaminated with thermogenic natural gas, with diesel oil, and with barium — substances that are not normally found in this area." Hundreds of homes are thought to be affected. "This is a well-known problem in the area. [W]hy the government has never bother[ed] to investigate is something that eludes me, I really don't understand."[227]

The Government of New Brunswick, as with most jurisdictions on the continent, downplays industry's cumulative gas migration problems: "Many of the flaming tap footage seen on TV and in films have been attributed to biogenic methane. Other cases have been attributed to natural gas contamination via faulty casing and/or inadequately constructed/grouted gas wells. Methane has been found to occur naturally in groundwater in parts of NB. During recent baseline sampling in the Elgin area, 13 of 303 [4.3%] wells tested positive for methane. Baseline (pre-drilling) sampling will therefore be important to distinguish between naturally occurring gas and any possible future impacts from the industry. A baseline sampling protocol has been developed to identify methane in domestic wells in areas surrounding natural gas operations before Natural Gas activities [commence]."[228]

An Alberta engineering and materials testing firm notes "that monitoring relatively shallow domestic water wells will not provide advance warning of developing water quality impacts."[229]

23. In Nova Scotia, Colchester County recently decided to allow 4.5 million litres of frac'ing wastewater, stored in open pits for years, to be discharged into the municipal sewer system and on into the Chiganois River and Bay of Fundy. Frac waste had previously been discharged this way until it was determined that the waste was radioactive. The county's decision was appealed by 30 individual appeals:

> Council of Canadians: "We are alarmed that Colchester County is aware that naturally occurring radioactive materials (NORM) and the four chemicals in the BTEX group (Benzene, Toluene, Ethyl-Benzene and Xylene) are present in the fracking wastewater and still approves AIS' plan."[230]
>
> Ecology Action Centre: "AIS has given assurances to council of extensive testing of all hydraulic fracturing fluids before the company accepts them for treatment...But the evidence indicates that there was little or no testing of fluids that AIS brought from New Brunswick. Results of testing performed on the fluids in the Triangle Petroleum Kennetcook waste ponds have been secured and made publicly available through Freedom of Information. These analyses were made available to AIS, but are only for a very limited number of chemical compounds. AIS also received from Triangle the manifests for all the chemical compounds used in the hydraulic fracturing- but the amounts used are not given, and cannot be calculated."[231]

Public hearings were held May 6 and 7, 2013. Statements were given by the company, the Director of Public Works, Nova Scotia Department of Environment, and 15 appellants and intervenors, and presentations were given by 17 members of the public who had not filed a formal appeal. The Sewer Use Appeals Committee on behalf of Colchester County unanimously decided to overturn the decision and will not allow the discharge of the frac waste into the sewer systems. The provincial government had given partial approval and the company argued the water will meet federal guidelines. The Committee members decided there are too many unknowns with "no independent verification of which chemicals are going down the drain" and that the "river and the Bay of Fundy are too important to permit such discharge on an experimental basis."

"In the end the Committee feels **it is not the role of the Municipality to allow the Bay of Fundy to be a petri dish for fracking wastewater.** Rather, it is the Municipality's role to ensure the environment is protected now and in the future, and **in that role, it must exercise caution to act only when the information is complete.**" [232][Emphasis added]

> And what comes back out is much, much worse than anything you put in there, so the real concern is, what do you do with the water that comes back out? Because that's where the potential for major environmental impact occurs.
>
> Radisav Vidic, civil and environmental engineer, University of Pittsburgh, on frac waste water[233]

24. In 2009, a study published in *The Journal of Hydrology* concluded that coalbed methane (CBM) development has lowered and will continue to lower aquifers in the southern portion of the Powder River Basin in Montana and that the drawdown is significant and extends for miles.[234]

The Alberta Research Council reported that static water levels in Rosebud wells dropped significantly (in one case more than 3.5 metres) after a CBM producer fractured the area's drinking water aquifers, diverted fresh water from CBM and experimented with hundreds of secret shallow completions. The research council suggested that drought or water use by residents caused the declines.[235] Alberta Environment reported that CBM may cause "water level decline and yield reduction in water wells" and "methane gas release, gas migration into shallow aquifers, basements, explosions etc."[236]

25. A 2008 report by the Alberta Research Council noted that Alberta Environment still does not have "a specific and documented response process" for investigating groundwater contamination and that "data gathering and evaluation decisions are made somewhat subjectively." In addition, "specific responsibilities of Alberta Environment towards the companies and water well owners are not clearly delineated and appear to vary between complaints."[237]

26. In 2006, the Texas Railroad Commission recorded 351 cases of groundwater contamination due to oil and gas activity.[238] In 2007, New Mexico recorded 705 incidents of groundwater contamination due to oil and gas development since 1990.[239] Pennsylvania environmental regulators "determined that oil and gas development damaged the water supplies for at least 161 Pennsylvania homes, farms, churches and businesses between 2008 and the fall of 2012."[240]

27. In 1996, a serious and sudden gas migration incident while drilling was reported:

> Dale Fox Drilling Gas Well on Bixby Hill Rd, Freedom. Natural gas escaped thru fault in shale, affected properties apprx 1 & ½ miles SW on Weaver Rd. Town of Yorkshire. Gas bubbling in Ron Lewis's pond. Bubbling in ditch west side of Weaver Rd. 12 Families evacuated. Gas in Lewis's basement (built on shale). Farmer's well in barn 11708 Weaver Rd (Steve Woldszyn) vented to outside. Gas coming up throu ground in Lewis's yard.[241]

Four Plaintiffs took the case to the Supreme Court of the State of New York, and won their case. In court documents, the defendant Dale Fox admitted what happened:

> On November 19th, we drilled into the reef. As we did, at approximately 2600 feet of depth, the reef began to produce gas and came up the drilling pipe and sprayed out the discharge pipe. The direction of the wind at the time caused the mist and gas to be blown back on us and the rig. Because of the fire hazard, we immediately cased drilling operations and engaged the BOP. We began pumping brine into the well, along with a defoamer, but the pressure [from] the formation spit the brine back up as foam. Foam lacks weight and density to kill a well, so we could not pump it back in. We used all three hundred gallons of brine by 8:00PM, and shut down operations. We ordered heavier fluid to pump into the well (called Gel or Mud).
>
> Unfortunately that could not be delivered until the next day…. On November 20, Mud was delivered, mixed and pumped into the well. We successfully killed the well. In all my years of drilling and oil and gas work, I have never encountered or heard about pressure like that from a formation.[242]

28. A comprehensive investigation in Kansas demonstrated that leaking industry gas had migrated almost seven miles.[243] The migrating gas caused explosions in 2001 in Hutchinson that destroyed two businesses and damaged many others. Two people died from injuries in a subsequent explosion three miles away the next day caused by the migrating gas.[244]

29. Alberta's Department of Energy defines fracturing as: "the opening up of fractures in the formation to make gas flow more freely."[245] Fracturing can also result in the migration of methane "toward the land surface through natural fractures in the rock and through old drill holes that were poorly plugged when abandoned. Wells that once were good water wells now become water and gas wells. In some cases good water wells become better gas wells than water wells."[246]

30. The Alberta Research Council reported that natural methane release in Alberta is rare because reservoirs are "tight" [247] and that nitrogen used in coalbed methane (CBM) recovery "increases diffusion rate of hydrocarbon gases from coal matrix into natural fractures."[248]

    Hydraulic fracturing has been associated with gas migration into groundwater as well as groundwater drawdown or contamination throughout the continent. A study of 203 water wells in an area of high CBM density by the US Geological Survey found that "manmade migration pathways probably" accounted for the contamination of shallow water wells by methane.[249] A 2006 US Geological Survey study discovered extensive methane contamination of local drinking water wells in areas of intense coal mining.[250]

31. Alberta Environment,[251] Alberta Agriculture,[252] Canada's oil and gas lobby group (CAPP)[253] and the Canadian Society for Unconventional Gas[254] warned that natural gas in water wells can be dangerous to property and people. Water wells in Alberta contaminated with migrant gases have blown up.[255]

    The Bruce Jack water well at Spirit River was contaminated with dangerous levels of methane and ethane after nearby drilling and hydraulic fracturing. Mr. Jack tried for three years to get appropriate regulator response, investigation and resolution.[256]

    On May 9, 2006, Bruce Jack and two industry gas-in-water testers, were seriously injured and hospitalized when the contaminated water well exploded, [257] even though the oil company involved had contracted the professional installation of equipment to separate and vent the gas to make the water "safe", as is recommended by Alberta Environment.[258]

    The Jack water well contamination and explosion was featured in a documentary by Grant Gelinas for *CBC News*[259] and argued in the Legislative Assembly of Alberta:[260]

> The Speaker: Good afternoon. Let us pray.
>
> We confidently ask for strength and encouragement in our service to others. We ask for wisdom to guide us in making good laws and good decisions for the present and the future of Alberta. Amen. ...
>
> Dr. Swann: Thank you, Mr. Speaker. Rural Albertans have lost trust in the ability of this Environment minister to protect groundwater and their safety. Growing rural concerns about increasing gas migration into water have been dismissed as fearmongering by this minister.
>
> One week ago in Spirit River a private well exploded, burning and hospitalizing three men. Alberta Environment has been investigating and receiving complaints about this well for over three years. ... Mr. Speaker, after two years of complaints from people like the Zimmermans, Ernsts, Lauridsens, and others, how can we believe this department is protecting their health and doing a proper investigation of the complaints?

The Jack's water well the day before it exploded.[261] Note the gas forcing water out of the well even though the oil company had retained the professional installation of equipment to remove the gas and vent it through the roof.[262]

Isotopic fingerprinting by Dr. Karlis Muehlenbachs of the gases in area energy wells and the Jack well water determined the source. The case is in legal proceedings against Penn West and the contracting firm that installed the gas venting equipment.

Bruce Jack natural gas contaminated water well, photo taken day of the explosion, May 9, 2006

Bruce Jack in hospital, May 9, 2006.

Bruce Jack was hospitalized for a month. There are no Canadian Drinking Water Guideline Limits for methane and ethane (or propane, butane, pentane, *etc*.).[263]

After EnCana repeatedly fractured the Rosebud drinking water aquifers, the community water tower blew up in an explosion, sending a worker to hospital with serious injuries:

> "investigators say an accumulation of gases appears to have caused the explosion that destroyed the Rosebud water tower…the operator was unable to detect the gases by smell and did not use a detection device...." [264]

The new reservoir cost the community about $700,000.[265]

Holy mackerel, this is an expensive proposition

Samuel Potter, Colorado Oil and Gas Conservation Commission

(The agency in charge of cleaning up after a Bondad gas explosion will ask the Legislature for $800,000 in emergency funding to plug an abandoned well and deal with a worsening methane seep. ... The price tag could climb an additional $750,000 if the commission decides it needs to buy out area property owners to ensure public safety. A trailer home exploded...the investigation showed that methane gas leaking from underground reservoirs was to blame.[266])

Homes and businesses in the U.S. have exploded from industry's migrating methane,[267] including the Fairfax *Dress for Less* explosion that injured 23 people and caused extensive damages.[268] [269]

> "One of the gravest dangers posed by urban oil-well drilling and production is the potential for explosive methane gas to migrate to the surface from several thousand feet underground. Unless the present-day practices are changed, under-ground migration of methane from oil and gas reservoirs will continue to pose a significant explosion threat."[270]

A 2011 Client Advisory "for Oil and Gas Lease Operators" warns that the shift to "unconventional drilling and heavy multi-stage fracking has created new insurance issues for the industry" because of an increase in blowouts:

- during the completion/fracking stage.
- involving communication between multiple wells.
- caused by casing/cementing failure.
- caused by surface events.
- involving producing wells.
- involving plugged and abandoned wells.[271]

In 2011, 43 families in Bainbridge, Ohio, settled a class action lawsuit - including the Paynes whose house on English Drive was lifted off its foundation in an explosion caused by migrating gas released during hydraulic fracturing.

Ohio Valley Energy and the other companies involved paid out the families and Nationwide Insurance, which covered the Payne's home.[272]

The following year, Nationwide Mutual Insurance Co. became the first major insurance company to prohibit frac'ing risk related coverage:

> After months of research and discussion, we have determined that the exposures presented by

> hydraulic fracturing are too great to ignore. Risks involved with hydraulic fracturing are now prohibited for General Liability, Commercial Auto, Motor Truck Cargo, Auto Physical Damage and Public Auto (insurance) coverage.
>
> "Prohibited risks" apply to landowners who lease their land for fracturing operations and contractors serving frac operations....[273]

In 2012, the Ontario Assessment Review Board reduced a contaminated property's value for taxation to zero. "The methane problem, it ruled, is more than a mere nuisance, posing a real hazard. Such hazard had a devastating effect on the current value of the house, making it unsellable. ... This case shows how seriously environmental contamination can affect the value of a property."[274] Biogenic shale gas is targeted in Ontario:

> Calgary-based Mooncor Oil & Gas Corp. wants to develop a resource in Ontario that has been largely overlooked by its rivals: shale gas. … [Terry Carter, petroleum resources geologist with Ontario's Ministry of Natural Resources] said the Marcellus zone doesn't offer much in Ontario. "Almost all of it is beneath Lake Erie," he said. "Kettle Point and Blue Mountain would appear to have better potential." Both have what Carter described as biogenic gas, created when bacteria in fresh water come in contact with organic-rich bedrock. The bacteria eat the organic material and produce methane. "The natural gas is being produced in real time, just like in a landfill site"[275]

Biogenic shale gas is also targetted in Manitoba: "Geochemistry results support that this is an unconventional biogenic shallow gas play."[276]

32. A new study[277] in shale gas development areas with no records of historic conventional wells in north-central Arkansas reported that dissolved methane was detected in 63% of 51 drinking water wells sampled. Concentrations of methane in six water wells (12%) exceeded 0.5 mg/l, of which the highest was 28.5 mg/l. One of the researchers was reported saying: "Only a fraction of the groundwater samples we collected contained dissolved methane...."[278] The researchers conclude in their paper that the methane is primarily biogenic of "local, shallow origin" and "unrelated to shale-gas extraction in the vast majority of samples," and that the lack of methane contamination is possibly because of "better wellbore integrity" and/or "a lack of conventional oil and gas development" prior to the shale gas extraction. "Our findings in Arkansas are important, but we are still only beginning to evaluate and understand the environmental risks of shale gas development. Much more research is needed."

The Osborne *et al* peer reviewed study in Northeastern Pennsylvania found that in active gas-extraction areas (one or more gas wells within 1 km), average dissolved methane concentrations in drinking water wells increased with proximity to the nearest gas well and was 19.2 mg/l; samples in neighboring non-extraction sites (no gas wells within 1 km) averaged only 1.1 mg/l.[279]

In contrast, dissolved methane concentrations in contaminated water wells (each with at least three gas wells within one km) under investigation at Rosebud, Alberta averaged 43.0 mg/l after a company repeatedly fractured into the aquifers that supply those wells.[280] Subsequent review on sampling methodology indicated that groundwater gas concentrations at Rosebud were being underestimated by a factor of three.[281] Sampling by Alberta Environment in 2006[282] and All Points Energy Ltd. in 2011,[283] on a farm water well about four miles southeast of Rosebud where Encana did not fracture the aquifers, found dissolved methane at 0.006 mg/l and less than the detection limit of 0.005 mg/l, respectively.

Leaking energy wells and gas storage-fields have created dangerous concentrations of dissolved methane in household water wells as high as 92 mg/l. "In January 2001, State oil and gas inspectors noted bubbles of natural gas in well water during a complaint investigation near Tioga Junction, Tioga County, north-central Pa.... By 2004, the gas occurrence in ground water and accumulation in homes was a safety concern.... Although it is common for ground water in the region to contain salt brine and hydrogen sulfide, **natural gas in ground water was rarely noted by earlier investigators.** Historic assessments of ground-water resources only mentioned natural gas in water-supply wells converted from gas wells." [Emphasis added].[284]

The maximum concentration found in water wells and springs in oil and gas development fields in Saskatchewan was 94.5 mg/l.[285]

Pre-drilling values of methane in groundwater in Garfield County, Colorado, established natural background was less than 1 ppm, except in cases of biogenic methane that is confined to pond and stream bottoms.[286] In CAPP's gas migration study, most of the water supply wells had less than 0.05 mg/l of methane, with the two highest just over 1 mg/l. A monitoring water well near a leaking hydrocarbon well in the study had 19.1 mg/l (the highest concentration in the study), **with the level of methane generally increasing towards the top of the aquifer indicating "that lateral gas phase migration may be occurring along the top of the aquifers."**[287] [Emphasis added] Methane data, including fugitive thermogenic gas originated from coals, collected from the Hanford site in Washington provides "an excellent case study of the shallow groundwater system deflecting hydrocarbon gas vertically and laterally. As shown...methane enters the shallow groundwater system...and is then transported several kilometers southeasterly towards the Columbia River, along the groundwater flowpath."[288]

Measurements of baseline methane in non-polluted, non-oilfield, potable waters from Cretaceous, Jurassic and Triassic carbonate and sandstone aquifers in England revealed concentrations of up to 0.05 mg/l with a mean value of less than 0.01 mg/l.

> The presence of methane...in groundwater is usually only noticed when it rises to high concentrations.... Concentrations in excess of 1.5 mg/l were only found in non-potable waters with the highest found up to 16 mg/l in Namurian shales. **The only potable waters (two) with extremely high levels of methane (100 mg/l) were in a developed oil field.**[289]
>
> The Bath Spa water has a methane concentration of 53µg/L (Edmunds et al. 2002), which is low. The source of this was considered to be biogenic. **It is important to know the background levels prior to any exploration.** Hydraulic fractures have been shown to propagate 588m vertically from horizontal wells in the US (Davies et al. 2012) **and it would seem prudent to expect a similar horizontal spread from any vertical well.**[290] [Emphasis added]

33. A 2008 regulator report summarized the contamination of Bainbridge, Ohio water wells with methane leaking from a recently fractured energy well with faulty casing. The fugitive methane caused an explosion seriously damaging one home and required the evacuation of 19 others. The company immediately assumed responsibility, provided temporary housing and "disconnected 26 water wells, purged gas from domestic plumbing/heater systems, installed vents on six water wells, plugged abandoned in-house water wells, plumbed 26 houses to temporary water supplies, provided 49 in-house methane monitoring systems for homeowner installation, and began to provide bottled drinking water to 48 residences upon request."[291] The highest concentration of dissolved methane found in 79

ground water samples at Bainbridge, Ohio was 1.04 mg/l.[292] The highest found by regulator sampling at Rosebud, Alberta was 66.3 mg/l (this excludes methane in the free gas).[293]

If it is present, the presumption is that it's naturally occurring….

Mr. David Pryce, Canadian Association of Petroleum Producers (CAPP), Testimony to Parliamentary Committee on testing for methane in water wells[294]

34. CAPP warned in their 1996 gas migration report that if there is more than 1 mg/l of dissolved methane in water, "there may be a risk of an explosion, if the water supplies pass through poorly ventilated air spaces" and reported dramatically increased levels of methane found in groundwater near leaking hydrocarbon wells.[295] The US Geological Survey studying groundwater in western Colorado reported that methane concentrations greater than or equal to 1 mg/l are considered "high."[296]

I don't see the day when these technologies can be used in a safe way

Québec's Natural Resources Minister and former Hydro-Québec engineer, Ms. Martine Ouellet[297]

Data collected by the US Geological Survey in Chafin's survey of 203 water supply wells and two springs in the Animas River Valley of Colorado and New Mexico was summarized in CAPP's 1996 report:

> Gas has been produced from various formations in this area for decades. Recent expansion of the development of a coal-bed gas field in this area has led to public concern about "the possibility of increasing concentrations of natural gas in domestic water supplies". The survey indicated that the methane concentrations were below the reporting limit of 0.0005 mg/litre in 66% of the cases. Twelve percent of the sites had methane concentrations of 1 mg/litre or more. The mean concentration was 1.3 mg/l, and the maximum was 39 mg/litre….Presence of methane was often associated with presence of H2S.[298]

Water samples from the Amos/Walker well in Garfield County, Colorado, where EnCana received a notice of violation and a large fine from the state regulator for impacting the water, showed methane concentrations ranging from 0.1 to 13 mg/l.[299] The Amos case reportedly settled with a confidentiality agreement and payout.

EnCana had received notice of violation and a record fine from the same regulator for contaminating the Bracken well water and West Divide Creek with methane and benzene the year previous, also in Garfield County.[300] In 2013, the US Geological Survey released an overview of groundwater quality data in the Piceance Basin, western Colorado:

> Methane concentrations greater than or equal to 1 mg/L were considered high.... **Most samples that contained detectable methane concentrations were from Garfield County** (fig. 23). Methane concentrations in the study area ranged from less than the detection limit (commonly 0.0008 mg/L) to 36.7 mg/L, and 75 values (8.5 percent) were greater than 1 mg/L (high methane). **Most methane detections and methane concentrations greater than 1 mg/L were found in Garfield County in the Mamm Creek–Divide Creek area** (fig. 23). A sample from a domestic well in Garfield County had the highest methane concentration.... [301] [Emphasis added]

A 2009 regulator report summarized 64 gas migration cases in 22 counties in Pennsylvania dating from the 1990's to 2009 caused by the oil and gas industry; five cases were caused by hydraulic fracturing that contaminated numerous wells and two springs used as domestic water supply.[302] The 64 cases resulted in 11 explosions, five fatalities, three injuries, a road closure, and numerous evacuations with residents in one community displaced for two months.

The problem is more common than regulators like to admit.[303]

The fugitive methane in the Dimock Pennsylvania case migrated nine square miles affecting 14 water supplies.[304] At the end of 2011, the US Environmental Protection Agency (EPA) reopened the contamination investigation at Dimock because litigants released sealed water data collected by Cabot Oil and Gas that indicate fracturing might be responsible.[305] In March 2012, data collected by the EPA at Dimock reportedly showed in four of six summaries that "methane levels exceeded the 7 mg/l actionable threshold necessary for mitigation under Pennsylvania law. … One of the test results showed methane levels at seven times that limit."[306]

The Pennsylvania Department of Environmental Protection (DEP) fined Chesapeake Energy $900,000 for methane migration "up faulting wells" in Bradford County, Pennsylvania, contaminating 16 families' drinking water in 2010.[307] The DEP found methane concentrations ranging from 2.16 to 55.8 mg/l.[308] "DEP Secretary Michael Krancer said the contamination fine is the largest single penalty the agency has ever levied against a driller….As part of the consent order issued by the department, Chesapeake will have to remediate the contaminated water supplies, take steps to fix the faulty gas wells and report any water supply complaints to the DEP."[309]

In 2012, the Pennsylvania regulator released a notice of violation[310] to Cabot Oil and Gas for contaminating three private water wells in Lenox Twp, Susquehanna County, with methane that seeped from a flawed natural gas well; the notice of violation states that the dissolved methane in one water supply jumped from 0.29 mg/l in a 2010 pre-drilling sample to 49.2 mg/l and 57.6 mg/l after drilling. "It bubbled up in a private pond, a beaver pond and the Susquehanna River from as many as six sets of faulty wells in five towns."[311] Cabot installed methane detection alarms in three homes and vented the three affected water wells to keep the methane from accumulating and creating an explosion risk.[312]

The EPA issued an emergency order to Range Resources to take immediate action to protect landowners with explosive levels of methane in their water, "homeowners who lived near drilling operations of Range Resources in Parker County, Texas, reported problems with their tap water, complaining that it was bubbling and even flammable."[313] Heavier hydrocarbons were also found in the water. Levels of dissolved methane in the 25 affected water wells, including two municipal wells, ranged from 0.62 to under 28 mg/l. "Range experts say their analysis found the methane in the water wells is actually coming from the more shallow formation."[314]

In western Louisiana, hundreds of families were evacuated from their homes after an Exco Resources natural gas well blowout contaminated a drinking water aquifer with methane. Forty families were initially evacuated; after regulator officials detected contaminants in the surrounding Wilcox aquifer, an additional 105 families were evacuated.[315] A federal class action lawsuit was filed in 2011 by David L. Andre, and other residents of Caddo Parish, claiming that the Carrizo-Wilcox aquifer system was polluted by hydraulic fracturing.[316] "South Caddo Parish was the site of another high profile drilling

accident...when 16 cattle were found dead at a Chesapeake Energy well site after reportedly coming into contact with drilling fluids used in hydraulic fracturing."[317]

35. The US EPA connected natural gas and toxic chemicals found in water wells at Pavillion, Wyoming to Encana's hydraulic fracturing and waste pits.[318] The EPA reported: "Hydraulic fracturing in gas production wells occurred as shallow as 372 meters below ground surface with associated surface casing as shallow as 110 metres below ground surface."[319] In comparison, within about six miles around Rosebud, Alberta (before April 2006, when the government mandated testing of water wells prior to fracturing coals above the Base of Groundwater Protection, *i.e.* where the fresh water is), EnCana:

    - perforated at 100.5 metres below ground surface;[320]
    - fractured at 121.5 metres below ground surface;[321]
    - fractured about 195 gas wells above the Base of Groundwater Protection[322] of which:
        - 62 were fractured at less than 200 metres below ground surface;
        - 11 were fractured at less than 175 metres below ground surface; and 80 had less than 65 metres of surface casing (less than the depth of many area water wells).

> The way I read the EPA report, the surface casings were too short and that the cementing was inadequate and then they fracked at very shallow depths. It's almost negligence.[323]
>
> Dr. Karlis Muehlenbachs

The highest concentration of methane found by the EPA in citizen water wells at Pavillion, was 0.81 mg/l,[324] the highest found, excluding the free gas, by the regulator in citizen water wells at Rosebud was 66.3 mg/l.[325] Doug Hock, a spokesman for EnCana Corp., was reported saying that the methane contamination at Pavillion was at: "extremely low" levels, indicating that it was naturally occurring and if "this was related to oil and gas production wells, we would be seeing much higher levels of methane."[326]

At Pavillion, methane "identified in 7 drinking water wells was found to be of thermogenic origin, meaning it originated within the natural gas reservoir. One drinking water well showed methane resulting from microbial activity, known as biogenic methane."[327] Two monitoring water wells were installed at Pavillion: "Well MW01 was completed to a depth of 785 feet (ft) below land surface (bls) and well MW02 was completed to a depth of 980 ft bls." Methane concentrations in the monitoring wells ranged from 20 to 30.5 mg/l.[328]

In 2007, the Alberta Research Council and Alberta Environment oversaw the drilling of two monitoring water wells near homes with toddlers in the Hamlet of Rosebud. One was about 140 m deep and produced no water, only methane and ethane,[329] so much so, the gases forced the water well lid open. The regulator and research council left the well venting the gases to atmosphere without warning flagging or notifying the fire department. Citizens called 911. The research council report on the monitoring wells states "methane was present" even though EnCana workers detected methane and ethane at this well during the 911 incident.[330] A compression cap with locking mechanism to restrict access was later fitted to the well, and a barrier of safety flagging erected. The research council report ends with this recommendation: "The Rosebud Well #1 will need to be licensed by the [ERCB]. This process has been initiated by [Alberta Environment]." The report does not provide data on how

much methane and ethane was venting from the "gas" water monitoring well, or how much dissolved and free gas was in the water monitoring well.[331]

Alberta Environment water monitoring well near a public road in the Hamlet of Rosebud (before compression cap and lock show below), April 2007. The lid was forced open by the venting gas.

Alberta Environment's water monitoring well in the Hamlet of Rosebud, compression lid and locked to mitigate the danger because this well produces gas instead of water. Alberta's water regulator had to apply to the energy regulator for gas well licensing. A developer plans to build 17 homes at this location.

that flooded water on to the industrial property.

"Councils job is to take care of the landowners. The developer's job is to appease surrounding landowners," said Deputy Reeve, Division 7 Councillor, Ben Armstrong.

"We have to figure out a way to finish the completion of storm water problems," said Reeve, Division 6 Councillor Glenn Koester.

"It is an extremely hard process to get money from the bank," said representative for the developer Pat Maloney asking for a third reading.

"The issue is to manage the pumping of the two ponds," said Asst. Manager of Transportation and Infrastructure, Mike Ziehr.

"It's the developers job to maintain storm water problem."

Councillors unanimously voted to defer this issue until a later date and until they get a Traffic Impact Assessment.

Development in Rosebud

Developers are planning to build 17 residential sites, one storage site and one parking site in the Rosebud area.

Maloney displayed to Council the ideas through a PowerPoint presentation, which is called the Rosebud River Ridge Area Concept Plan.

"There is one small part of land where there is a pond and it seems that this is a environmental property. The pond will be enough drainage for all the 17 properties," said Maloney.

In the presentation Maloney spoke of how there will be an increase in parking. This parking will be designated for residents, student and movie goers.

She also stated that there is a shortage of housing in the Rosebud area.

Water will be upgraded to make sure it clean and safe.

There are hopes to upgrade the sanitary systems and not replace it.

The roads will need to widen. Owners have requested roads for walking access to the park and river.

If there are landowners in the area of their plan they will give land to these owners and not cash in lieu.

The developers are currently working with one landowner to appease the problem of the plan to build so close to their property.

Some of the properties will be built on a slope and Division 1 Councillor Alice Booth had concerns over this.

Maloney stated and had documents showing that tests were done to ensure that it is safe to build properties on the slope.

Using technology to mitigate absences

Councillors discussed the possibility of having meetings through internet technology if they are unable to attend a meeting.

This was the first discussion and they discussed what kind of equipment would be needed.

"This should not be abused if we decide to accept it in the future," said Division 1 Councillor Alice Booth.

"We should also have look into broadcasting our meetings online," said CA Alan Parkin.

The Councillors made unanimous decision to lo

Celebrating

Rev. Pamela Scott-Strathmore United Churc

Pass the Salt

Ever have that feeli

The Strathmore Standard reported on April 17, 2013, that Rosebud's water will be "upgraded" to make sure it is "clean and safe" for the new subdivision, but did not detail how.[332]

From April 1, 2006 to January 2011, EnCana fractured new or re-fractured about 300 gas wells above the Base of Groundwater Protection in the impacted area, of which about 110 were during the Alberta government's community-wide investigation of Rosebud's contaminated groundwater.[333] Encana continues to frac above the Base of Groundwater Protection at Rosebud [334] whereas New Brunswick prohibits oil or gas exploration or production within formations containing fresh groundwater.[335] Quebec legislation tabled in May 2013, appears to allow frac'ing into formations containing fresh groundwater if less than 50,000 litres (50 m3) of frac fluid is injected.[336]

Encana frac'ing above the Base of Groundwater Protection at Rosebud, Alberta, December 15, 2012.

The Canadian oil and gas industry advertised in 2010 that "in all cases groundwater and the hydraulically fractured zone are isolated to prevent potential cross-flow of fluids between the natural gas-producing intervals and groundwater aquifers."[337]

> If the [coalbed methane] wells are completed in the same aquifer as local water wells, the operator should closely monitor groundwater and natural gas rates in both [coalbed methane] wells and water wells. Changes in the water wells can then be detected and appropriate responses taken.
>
> A 2006 Canadian Association of Petroleum Producers (CAPP) Best Practice when Gerard Protti was CAPP Chair[338]

> The ERCB has regulatory requirements in place that are designed to prevent any hydraulic fracturing fluid from mixing or entering groundwater or surface water regardless of whether or not it contains toxic chemicals.
>
> Alberta Energy Resources Conservation Board (ERCB) Public Promotional Brochure[339]

36. The Zimmerman water wells at Wetaskiwin, Alberta, suddenly and dramatically changed after nearby hydraulic fracturing in 2005 by MGV (Mike Gatens Ventures, name later changed to Quicksilver Resources Inc.).

The water, investigated by Alberta Environment and reviewed by the Alberta Research Council, has 49.7 mg/l methane, ethane, and heavier hydrocarbons (C6-C50).[340] Unable to explain where the methane originated from, the research council dismissed the contamination case as natural, as it did the Rosebud cases:

> The groundwater flow velocity in a 1 mm fracture would stop a bubble of 2.9 mm or less from rising. Therefore from this assessment if an induced connection existed between the CBM well and the Zimmerman water wells, methane bubbles would not tend to rise in a fracture because they would be held back by the downward groundwater flow driven by the gradient observed at the site.[341]

The research council also used this bubble theory to dismiss the Rosebud contamination cases.[342]

Canada's oil and gas lobby group (CAPP) reported that for gas migration to occur, the buoyant gas phase must have a sufficient pressure to overcome the confining pressure of groundwater and capillary forces in the pores along the migration pathway.[343] Researchers in the US reported in a peer-reviewed paper that a "bubble of gas can float upwards in a fracture even in a downward moving stream of water that has a velocity <0.22 cm/s."[344]

Notes on the Zimmerman case obtained in 2008 by Ernst under Freedom of Information requests to the Alberta Research Council state: "isotope data triggered [ERCB] involvement. ... [Alberta Environment] asked [MGV] to haul water...." The ERCB becomes involved in Alberta Environment investigations when data indicates contamination of fresh water by the oil and gas industry.

The year 2000 historic records for the Zimmerman well water filed by Alberta Environment on the public water well database state: *Gas Present: No.*[345] The research council included these records in their report on the Zimmerman case, but did not mention them. The Zimmerman historic records were

removed from the regulator's database in about 2010 and replaced with altered records with the *Gas Present:* left blank.[346]

> This will be the toughest to get through. Drought is over in a year, BSE it will take us a few years, but this could last a life time. ... We may have to move. And I've been told that by the [ERCB]. We may have to move.
>
> Dale Zimmerman on *CBC News* Edmonton, 2006[347]

Alberta Environment closed the Zimmerman case: "The Alberta Research Council report concludes that coalbed methane and other energy development projects have not impacted your water well. ... Given the presence of gas in your wells, Alberta Environment recommends that you take measures to properly vent your water wells and distribution system."[348] The Zimmerman case is proceeding legally.[349]

37. The Campbell ranch well water at Ponoka is contaminated with methane, ethane, propane, butane, pentane, and hydrogen sulphide.[350] The Alberta Research Council reported these gases also leaking to surface via soils on the lease of an energy well with cementing problems near the Campbell's contaminated water well.[351] Alberta Environment reluctantly investigated after writing the Campbell's was the "only affected water in Alberta"[352] and retained the research council to review[353] the investigation:

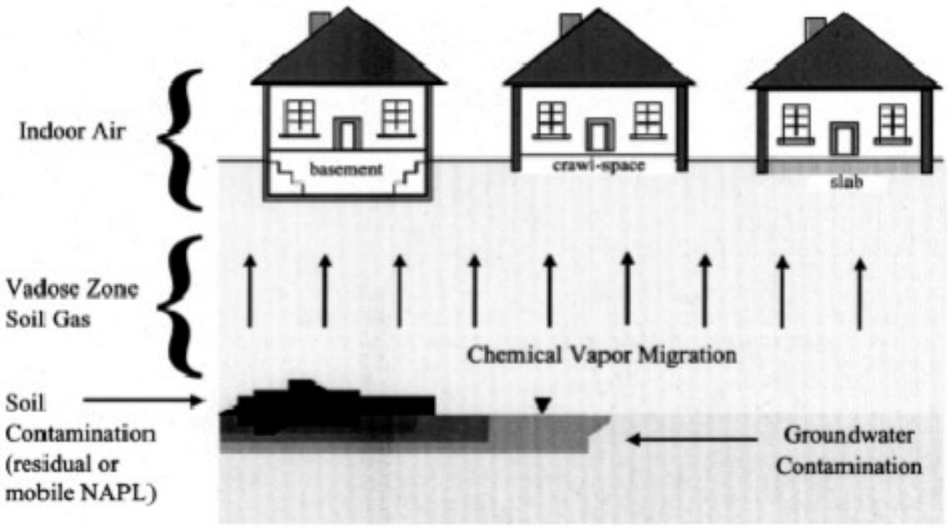
> The report concludes that the methane gas present in your water well is predominantly biogenic, indicating it was formed at shallow depth. The report also identifies a small component of deeper gas present in your well. Further work is required to determine whether this deeper source is a leaking resource well or a natural geological feature, such as a fault.[354]

> Comparisons between soil-gas-methane concentrations measured adjacent to 352 gas-well casings and 192 groundwater sites used as background measurements indicate that gas-well annuli are more important than natural fractures for upward migration of gas. ... Manmade migration pathways probably introduce most near-surface gas to the study area.
>
> Daniel T. Chafin, US Geological Survey, 1994[355]

Alberta Environment advised the Campbells their investigation was complete and that: "Given the presence of gas in your wells, Alberta Environment recommends that you take measures to properly vent your water wells and distribution system."[356]

After the Campbells and other affected Albertans objected,[357] the fresh water regulator clarified:

> As indicated to you in the letter sent to you on January 16, 2008, Alberta Environment has confidence in the results presented by Dr. Blyth of the Alberta Research Council regarding your water well complaint. Alberta Environment is supporting the Energy Resources Conservation Board (ERCB) in further investigating the source of the deeper gas in your water well. ... Alberta Environment strongly encourages well owners to retain a qualified water well contractor to properly vent their water distribution system as a safe means of mitigating the presence of gas in water well supplies. ... Hydrogen sulphide (H2S) is a common natural occurrence in water well systems, often due to the presence of bacteria.[358]



2002 "Generalized schematic of the pathway for subsurface vapor intrusion into indoor air" by the US Environmental Protection Agency (NAPL = non-aqueous phase liquids).[359] In 2013, the agency updated this diagram.[360]

The 1980 historic water well records for the Campbell's ranch previously publicly filed on Alberta Environment's water well database state: *Gas Present: No.* These records were included in the Alberta Research Council report on the Campbell's case,[361] but not mentioned, and were also pulled from the regulator database in about 2010 and replaced with altered records where the information for *Gas Present:* is now blank.[362]

In 2005, at least two coalbed methane (CBM) wells were drilled by Encana with severe loss of circulation at 120m (within water bearing zones) near the Campbell's water well; these CBM wells were frac'd repeatedly, as shallow as 338m.[363] Encana publicly claims the company stimulates *(i.e.* fracs) CBM with nitrogen.[364] Another CBM well nearby was perf'd in 2005 at 330-700m with expert calculations obtained under Freedom of Information indicating "the gas has to only migrate 40m to the water aquifer...."[365] Tests by Alberta Environment in 2007 on the Campbell water showed it had 24.7 mg/l dissolved nitrogen.[366] The high nitrogen was listed but not discussed in the research council report on the Campbell case. The regulators did not test any of the CBM wells, only tested 9 of the 50 energy wells within about a mile radius of the Campbell's well, and continue to allow more.

The ERCB is monitoring[367] [368] the Campbell well water contamination which the regulators are not doing at Wetaskiwin, Spirit River or Rosebud where lawsuits are ongoing. The regulator admits the contamination is from a deep formation but advise the Campbells it is their responsibility to make the water safe; nothing is being done to help the family.[369] Fourteen official reports - totaling more than 1,000 pages over a nine year period - have been completed on the case so far.[370] In the Legislature in 2006, the government promised all affected families, "safe alternate water," "now and into the future," regardless of whether the gas was from "natural flow" or not,[371] but failed to supply any to the Campbells.

Well, I would say that I would agree with the statement to the extent that it's not the role of Alberta Environment to advocate on behalf of the environment.

Rob Renner, Minister of Environment, 2007[372]

The Campbells' contaminated well water being gas tested in a flow-through cell for the ERCB, April 3, 2013
The black in the cell is the Campbell's water; it took 20 minutes to clear. The well is plastic lined
and had not been used for about a year. (Flow-through cells are about 15% efficient.[373])

38. The Campbells and other families including the Zimmermans, Signers, Lauridsens and Ernst, repeatedly request(ed) comprehensive testing and accountable resolution. Alberta guidelines require coalbed methane (CBM) developers to "resolve any allegations of impact on any existing water supply" and provide "water supply to the well owner for his current water needs."[374] Instead of adhering to this, regulators and some companies in Alberta try to discredit, insult and intimidate citizens with contaminated well water by claiming they refuse to cooperate.

    An official inquiry into the Alberta Research Council refusing to release the complete records used to review the water contamination cases, revealed detailed notes taken during a May 3, 2006 "CBM Review Meeting with Alberta Environment." (The first regulator tests on the Ernst well were on March 3, 2006; critical data from this testing remains withheld.) The notes state:

    > - never was a complaint, aren't allowed to do any investigation, and badmouthing on the side
    > - still feel bad for Jessica because she clearly has bad water. ... Ernst is...not co-operative[375]

    Encana, despite fulfilling Ernst's request in 2003 to test her water,[376] publicly claims on their website that Ernst refuses to cooperate[377]:

    > Since becoming aware of Ms. Ernst's concerns, Encana has offered to test her water well on a number of occasions. To date, Encana has been unable to obtain Ms. Ernst's cooperation in order to perform the offered testing on her property.[378]

    On April 30, 2013, a month after the Campbells consented to water testing for the thirteenth time, Alberta's Energy Minister accused them of refusing to cooperate:

    > The sampling of your well for 2013 has not yet been scheduled as the ERCB is currently waiting for your consent. ... I strongly encourage your continued cooperation with the ERCB and its contractor, Alberta Innovates - Technology Futures so that the specific source can be identified.[379]

39. In July 2004, an EnCana "supervisor error" while pressure testing "to 21 Mpa" on the frac'd CBM well that impacted Rosebud's drinking water aquifers "cracked the remedial cement. Cement will no longer pressure test to 7 Mpa."[380] In 2006, the Alberta government knew from their investigation at Rosebud that isotopic fingerprinting of gases from water wells indicated a match to gases from EnCana's wells[381] and provided alternate, safe water deliveries for two years to two adversely affected families. (Encana provided deliveries to a third family and stopped when the government stopped.) The regulator refused to disclose data to complainants claiming "confidentiality" but disclosed data to EnCana (discovered years later via Freedom of Information).

    The government and regulators accused citizens of refusing to cooperate, while refusing to provide a comprehensive investigation with appropriate safety and sampling protocols, and continued to allow EnCana to frac more wells near where the company fractured the aquifers.

    > You don't care if it comes from fracking or a bad cement job, you suffer the consequences all the same, and lose your well water[382]
    >
    > Dr. Karlis Muehlenbachs

In 2007, within a month of finally promising a comprehensive investigation into the community-wide contamination, the government reneged and a year later broke their promise of safe alternate water deliveries "now and into the future."[383] Alberta Environment recommended the same inappropriate, unsafe mitigation provided to the Jacks: hiring a professional to separate and vent the dangerous gases,[384] but instead of the company providing it, Rosebud landowners were to obtain gas separation systems themselves. This was necessary because by then the government and regulators knew from the Jack case that such systems fail and to protect industry, they need the liability to rest on the water well owners.

Citizens breathe, bathe in, ingest and live with dangerous, contaminated water or haul alternate water. When the health problems of some Rosebud residents were reported to the authorities, the flu was blamed.

At the 2013 WATERtech annual conference in Alberta, SLR International Corporation presented on treating methane contaminated drinking water wells in a shale gas exploration area in Pennsylvania:

> Treating Methane is More Than Treating Methane
>
> - Methane treatment by aeration is relatively easy and reliable.
> - Chemophobia, PR, and litigation issues all had to be addressed.
>
> ...
>
> - Methane removal is typically greater than 95%, and often above 98%.
> - These high removal rates result in methane concentrations in the treated water that are typically less than one-fifth of the [Pennsylvania regulator] treatment standard of 4 mg/l.
>
> ...
>
> - Public preconceptions and misunderstandings can be as difficult to deal with as the water.[385]

A serious failure with the aeration system, as evident with the gas separation system installed for the Jacks (Refer to #31.), is that treating the water after it is pumped from the well does not mitigate the danger in the well itself or the aquifer(s) supplying it.

40. Some of the same toxic contaminants found in sampling by the EPA at Pavillion were found by Alberta Environment in groundwater at Rosebud and were dismissed, ignored or reported incorrectly by the Alberta Research Council. The wholly owned government agency was notified of the errors and omissions, but did not correct them as is required to maintain laboratory accreditation in Canada. The contaminants include: diesel range organics, benzene, toluene, ethylbenzene, xylenes, phthalates, and *tert*-butyl alcohol which is used in hydraulic fracturing and not expected to occur naturally in groundwater; *tert*-butyl alcohol (TBA) is a known breakdown product of methyl tert-butyl ether (MTBE, a fuel additive), also used in hydraulic fracturing and not expected to occur naturally in fresh groundwater.[386]

41. On September 22, 2011, GasFrac (for Crew Energy Inc./Caltex Energy Inc.) accidentally perforated and fractured above the Base of Groundwater Protection near Grande Prairie contaminating fresh groundwater. Alberta Environment and the ERCB initiated an investigation while continuing, for over a year, to tell the public that there had never been a case of hydraulic fracturing contaminating groundwater in Alberta.[387] On December 22, 2012, the ERCB released its investigation report

admitting that hydraulic fracturing had contaminated fresh water with toxic chemicals, including benzene, ethylbenzene, toluene and xylenes, and "isopropanolamine, being the selected indicating chemical for the presence of the fracturing fluids." Petroleum hydrocarbon fractions F2 through F4 concentrations decreased during the year of monitoring, with fraction F1 showing an anomalous increase.

> Hydraulic fracturing operations were subsequently conducted using gelled propane as a carrier fluid, pumping 20.07 tonnes of sand and 130 cubic metres (m3) of gelled propane. When it was realized that hydraulic fracturing had occurred through the shallow perforations, flow-back operations of the fractured interval were conducted. A two-well groundwater monitoring program was initiated and is ongoing to evaluate the impact of the incident upon groundwater. ... At approximately 137 m, the depth where the perforations were found, the coiled tubing jumped on the reel while stripping in. This was interpreted to be a coil wrap problem on the coiled tubing reel. The possibility that the perforating gun had fired at this depth was not recognized at the time. ... The GasFrac supervisor's recognition of the low shut-in pressure and the declining stimulation pressure did not apparently trigger a question at the time as to whether or not there was a problem with this particular fracturing stage or that there may have been any out-of-zone communication.[388]

The accident, documented in detail in ERCB's 19-page report, violated the favoured gas industry assurance that fracking will never occur above base groundwater depths. Oil and gas industry lobby group Canadian Association of Petroleum Producers (CAPP) insists on its public relations website morefactslessfriction.ca[389] that fracking production pipes are "bound by rock and several hundred meters below the deepest fresh water aquifers." [Natural Resources Canada] writes that "hydraulic fracturing is permitted only well below the deepest freshwater aquifers."[390]

Reporting by Carol Linnitt[391]

The ERCB did not levy a fine or punishment; the chemicals injected into the fresh groundwater at Grande Prairie remain secret. "What we've seen is some jurisdictions where there've been problems, there have been regulatory gaps," ERCB's Bob Curran insists. It is "because of that some of these accidents have occurred. And in Alberta those regulations are already in place to prevent that from occurring."[392] "About 40 cubic metres [40,000 litres] of the propane gel injected underground remains there, so no drilling is allowed in a 200-metre radius of the well site. ... A sandstone layer separates the two water sources so the risk to drinking water was deemed 'insignificant,' says Alberta Environment."[393]

"There's been over 171,000 wells that have been hydraulically fractured in Alberta since the practice began in the 1950s," [ERCB's Bob Curran] says. Curran says it's this understanding of the technology, Alberta's geology, and a long-standing "stringent" regulatory system that have prevented negative incidents in Alberta that are making headlines in other parts of the continent.[394]

Reporting by Suzi Thompson[395]

In comparison, in 2004, EnCana repeatedly perforated and fractured directly into Rosebud's drinking water aquifers without notifying the community. The regulators did not enforce the regulations in place to protect Albertans and groundwater, or the *Water Act* and *Alberta's Environmental Protection and Enhancement Act.* EnCana, the regulators, Alberta Health and government covered it up[396] and the

regulators continue to allow EnCana to intentionally perforate and fracture above the Base of Groundwater Protection at Rosebud.

42. The ERCB released a report on the Innisfail communication event that occurred during horizontal frac'ing of a deep well that blew frac fluids and oil up a suspended well, which pooled in a farmer's field and was observed dripping off trees along the bank of the Red Deer River. Hydraulic fracturing was blamed, but again no fines or punishments were levied. The chemicals the workers found themselves standing in while cleaning up the blowout remain secret.[397]

43. The Alberta Research Council - before the name was changed to Alberta Innovates-Technologies Futures and EnCana's VP Gerard Protti was appointed to the Board - stated on its website:[398] "We deliver innovative science and technology solutions, meeting the priorities of industry…."

    Alberta's "World Class" regulators do not report or map cases of groundwater contamination caused by the petroleum industry. For years, they've insisted to the public, adversely affected water well owners and concerned landowners that it "never" happens, and blame nature, bacteria, swamp gas and or poor water well construction and maintenance.

> In Alberta, it's almost a religious belief that gas leaks can't contaminate groundwater.
>
> Dr. Karlis Muehlenbachs[399]

44. In February 2012, Cal Hill, executive manager of the Regulatory Development Branch of the ERCB, explained in a press conference on hydraulic fracturing that methane is buoyant and looks for a way up to the surface. "There is an expectation you are going to find some signal in groundwater. How did it get there and how did the oil and gas activity exacerbate that problem. That's a complicated problem that we'd welcome more answers to."[400] He remained non-committal when asked if the ERCB would implement recommendations proposed by isotopic gas fingerprinting expert Dr. Karlis Muehlenbachs.[401]

    The recommendations, "not onerous," include: baseline isotopic fingerprinting of methane, ethane and propane for:

    Pre-development water wells
    Production gases
    Detailed gas isotope stratigraphy (mudgas isotope log)
    Gases from:
        conductor, surface and intermediate casings; legacy wells if present; and
        natural seeps, springs and soil."[402]

45. February 8, 2013, a final report by Canada's Environment Commissioner, Mr. Scott Vaughan, was tabled in Parliament.

    The report includes a bracing chapter on hydraulic fracturing, critical highlights include:

> On average, fracturing a shale gas well requires 11 million litres of water. The chemicals make up between 0.5 percent and 2 percent of the fluid, or between 55,000 and 220,000 litres of chemicals per well. …

Under the Canadian Environmental Protection Act, 1999 (CEPA 1999), Health Canada and Environment Canada share the mandate for assessing whether substances used in Canada are toxic to human health or the environment. According to CEPA 1999, a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that

> (a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity,
> (b) constitute or may constitute a danger to the environment on which life depends, or
> (c) constitute or may constitute a danger in Canada to human life or health.

CEPA 1999 requires Environment Canada and Health Canada to develop control measures for substances determined to be toxic or capable of becoming toxic.

Environment Canada also maintains the National Pollutant Release Inventory, which, as stated earlier, is a legislated, publicly accessible inventory of pollutant releases, disposals, and transfers for recycling. In addition, under the Pest Control Products Act, Health Canada has the mandate to prevent unacceptable risks to people and the environment from the use of pest control products, such as biocides and antimicrobials. These chemicals are also used in fracturing fluid. ...

We asked Environment Canada for an update on the status of its review of the National Pollutant Release Inventory (NPRI) that the Department said was under way in October 2011. According to Environment Canada, the NPRI is a "major starting point for identifying and monitoring sources of pollution in Canada and in developing indicators for the quality of our air, land, and water. NPRI information also helps to determine if regulatory or other action is necessary to ensure pollution reductions, and if so, the form that action should take."

The Minister of the Environment has discretion regarding industry reporting requirements.

Environment Canada told us that oil and gas exploration and drilling activities are exempt from reporting to the NPRI. According to Environment Canada, in order to consider whether changes to NPRI reporting requirements are warranted, **the Department needs to know specifically what substances are used for hydraulic fracturing** as well as their volumes and concentrations.

Environment Canada and Health Canada told us that while a partial list of substances that are likely to be used in hydraulic fracturing has been developed, **a complete list of substances used in Canada is not known.**

Environment Canada informed us that it has initiated internal discussions on the NPRI review, but that official stakeholder engagement and consultations have not been initiated. Both Environment Canada and Health Canada told us that they consider hydraulic fracturing to be an emerging global issue that they are beginning to investigate. Environment Canada told us that it expects to complete the review and determine whether changes are warranted by March 2014.

We asked Environment Canada and Health Canada what they have done to identify and assess the risks posed by hydraulic fracturing substances. They told us that, under the Canadian

Environmental Protection Act, 1999 (CEPA 1999), they are able to consider new information and, if appropriate, assess and manage identified risks to protect human health and the environment.

The departments informed us that they are following a three-step approach for responding to emerging issues, such as hydraulic fracturing:

> identifying the substances being used,
> assessing risks to the environment or human health, and
> establishing control measures to manage the risks posed by substances determined to be toxic or capable of becoming toxic.

Environment Canada and Health Canada indicated that they are currently gathering information to develop a path forward for hydraulic fracturing substances, **which may or may not include proceeding with risk assessments and risk management.**

The departments told us that they are **considering** a **voluntary** survey of companies engaged in hydraulic fracturing to gather information on the substances and how they are being used. ...

The departments have developed a partial list of more than 800 substances known to be used or suspected to be used for hydraulic fracturing in the United States and parts of Canada. Officials told us that although the departments have not carried out risk assessments on the use of these substances for hydraulic fracturing, 33 of the substances on the list had previously been assessed as toxic in other applications (for example, benzene in gasoline). ...

However, **the departments have not yet decided whether to carry out risk assessments of the substances when used for hydraulic fracturing**.

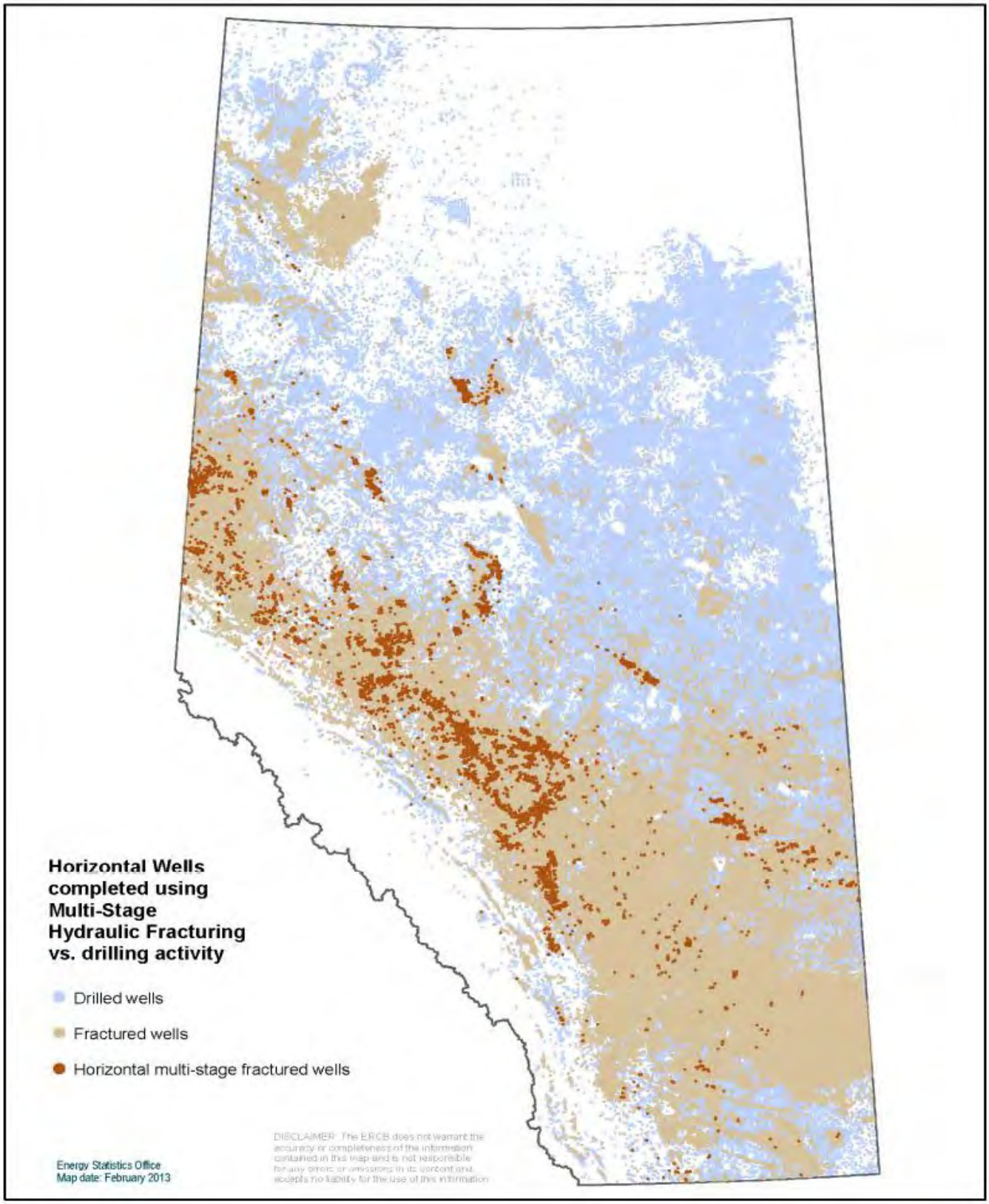
The departments informed us that a risk assessment typically requires a minimum of 18 months per substance, assuming that sufficient data is available and the necessary methodologies exist.

Under CEPA 1999, Environment Canada and Health Canada are required to develop control measures for substances determined to be toxic or capable of becoming toxic.

Control measures, such as regulations and pollution prevention plans, are intended to reduce the risks associated with the use and release of toxic substances.

Environment Canada informed us that it takes about three years to establish control measures. … **Environment Canada and Health Canada told us that they are still working toward gaining a better understanding of the substances contained in hydraulic fracturing fluid and the risks associated with the hydraulic fracturing process.** [Emphasis added][403]

46. Alberta allowed about 171,000 oil and gas wells[404] to be hydraulically fractured without this critical information and continues to do so (Refer below to the February 2013 Map by Energy Statistics Office). Only on May 22, 2013, did the energy regulator finally release a frac Directive. (It does not mandate baseline water well testing or completion of community health risk assessments.)[405]



Map presented by the ERCB March 14, 2013 at "The Fracking Truth" Expert Panel in Calgary.[406]

47. April 1, 2013, the Alberta government appointed past EnCana (and Cenovus) senior executive Mr. Gerard J. Protti to Chair the new Alberta Energy Regulator for a five year term.[407]
Heading the Energy Regulator, Mr. Protti will control the ERCB, Alberta Sustainable Resource Development, Alberta Environment, Alberta's fresh water and fresh water well records.

> Isn't appointing Gerard Protti to regulate the energy industry in Alberta, like appointing the Wolf to protect the Three Pigs? He can't, even if he'd like to. He's a 'wolf' with an appetite for large amounts of oil and gas revenue.
>
> Joan Young, April 5, 2013[408]

In 2012, the government passed legislation to make the new Energy Regulator (and anyone working there, or subcontracting to the Energy Regulator) immune from lawsuits, including for omissions such as failing to protect Albertans and water from industry's massive, "expensive" gas migration problem. In 2011-2012, the ERCB was 67.76% funded by industry,[409] today, "the [Energy Regulator] is entirely funded by industry."[410]

> We have nothing to hide
>
> Canadian Association of Petroleum Producers (CAPP) president Dave Collyer[411]

48. Mr. Protti's appointment to monitor impacts to environment and water from the energy industry is rife with conflict of interest. He:

- served as Founding President and Chairman of CAPP since its inception in October 1992[412] to September 15, 2008,[413] when the President of Shell Canada was appointed to take over;
- served as EnCana senior executive 1995 to 2009;
- is Executive Advisor to Cenovus Energy (split from EnCana in 2009[414]), 2010 to current;[415]
- was appointed by Order in Council to the Board of the Alberta Research Council (after the name was changed to Alberta Innovates - Technology Futures), 2010 to December 2013;
- was appointed by Order in Council on July 26, 2011 to Vice-chair of the Board of Directors of Alberta Innovates – Technology Futures;[416]
- was a Board member of Darian Resources Ltd.;[417]
- is a Director of Petromanas Energy Inc.;[418]
- is on the Board of Directors of Sub-One Technology,[419] strategic partner with Flint InnerArmour and Quinn's Oilfield Supply;
- is Chairman of Flint Transfield Services Inc.[420]
- is a Vice Chair of Energy Policy Institute of Canada (EPIC);[421] and
- was still a registered lobbyist for EPIC when he was appointed.[422]

Mr. Protti's keynote speech at the 2005 Public Policy Forum's Second Annual Western Conference revealed that EnCana had "begun to set up innovative development strategies," including:

> - Targeting royalties
> - Regulatory streamlining....[423]

The Energy Policy Institute of Canada writes deregulation policy and lobbies government to implement regulatory reform:

Governments should make it clear that a go/no-go decision on projects requires an early determination of whether a "show-stopper" environmental effect is likely.

Detailed monitoring and studies should only be required at the permitting stage.[424]

That's actually fairly common.[425]

EnCana vice president of corporate relations, Mr. Gerard Protti
in a 2006 interview about Jessica Ernst's flammable water

If the [coalbed methane (CBM)] wells are completed in the same aquifer as local water wells, the operator should closely monitor groundwater and natural gas rates in both CBM wells and water wells. Changes in the water wells can then be detected and appropriate responses taken.

A 2006 Canadian Association of Petroleum Producers (CAPP) Best Practice[426]
when Gerard Protti was CAPP Chairman

Ernst water, after EnCana fractured the aquifer that supplies the Ernst well at Rosebud.

Al Strauss has noted that most of the bigger complaints come from people who moved in but didn't put in the well, that think water comes from taps (like city people). ... (Encana has also been drilling people new wells & giving them $)

Notes from coalbed methane review meeting with Alberta Environment, May 3, 2006[427]

Al Strauss is a retired Alberta Environment water well tester. His 2006 results on the Ernst well remain withheld.

Bruce Jack Water Well Explosion
Spirit River, Alberta, May 9, 2006

CBC News: "[Bruce Jack] called Alberta Environment. After all, he thought, it's the department's job to protect Alberta's fresh water. ... He didn't get the response he was looking for."

Bruce Jack: "I was told, it's really a grey area. ...If it's oilfield related, it's the EUB....if it's not oilfield related, it's [Alberta Environment], so until it's proven...nobody's responsible."

CBC News: "Bruce Jack called the Energy Utilities Board, the EUB."

EUB [now ERCB, soon to be Alberta Energy Regulator (AER)]: "We respond to 100% of complaints."

CBC News: "Except this complaint, EUB decided was outside its jurisdiction."

EUB: "Alberta environment is responsible for water wells in Alberta."

CBC News: "True, says Alberta Environment, but..."

Alberta Environment [soon to be AER]: "The EUB regulates oil and gas in this province. We work with the EUB staff as partners in these investigations."

CBC News: "And the EUB has lots of faith in the oil industry's track record when it comes to their gas wells leaking into people's water wells. EUB records show, it virtually never happens."

Dr. Karlis Muehlenbachs: "That's simply false, that's simply false."

CBC News: "The truth is, this scientist says, is that the EUB hasn't looked very hard. It's not that there isn't gas in well water; there's lots of it. But oil companies are almost always exonerated. The EUB has always said it is not the companies polluting underground aquifers. The gas is blamed on natural causes: biofouling, so called swamp gas."

Dr. Karlis Muehlenbachs: "Microbial gas, swamp gas, is very possibly generated and therefore that's the likely excuse. But, I don't think anyone has actually gone to the trouble of poking around in a biofouled well and seeing if the little bubbles are coming out of the biofouling or if they're coming out of the aquifer. ..."
...
EUB: "Industry knows the rules, understands the rules and are following the rules. ...
...
Stephanie Cowles, Bruce Jack's neighbour: "Is it the EUB's responsibility? Or is it Alberta Environment's responsibility? They play ring around the rosie about people's water wells."

Bruce Jack: "They're supposed to be our regulators, but it doesn't seem they're doing it. I don't have a bunch of faith in either one of them right now."

Transcribed from: *Bruce Jack Well Water Explosion documentary*[428]

Our success will be defined nationally and internationally by third parties

Alberta Energy Minister Ken Hughes, 2013[429]

I'd like to engage a group of independent experts
who will give us comments on how we are meeting our objectives ...
I don't think I have had as exciting an opportunity like this, in my career....

Alberta Energy Regulator Chair, Gerard Protti, 2013[430]

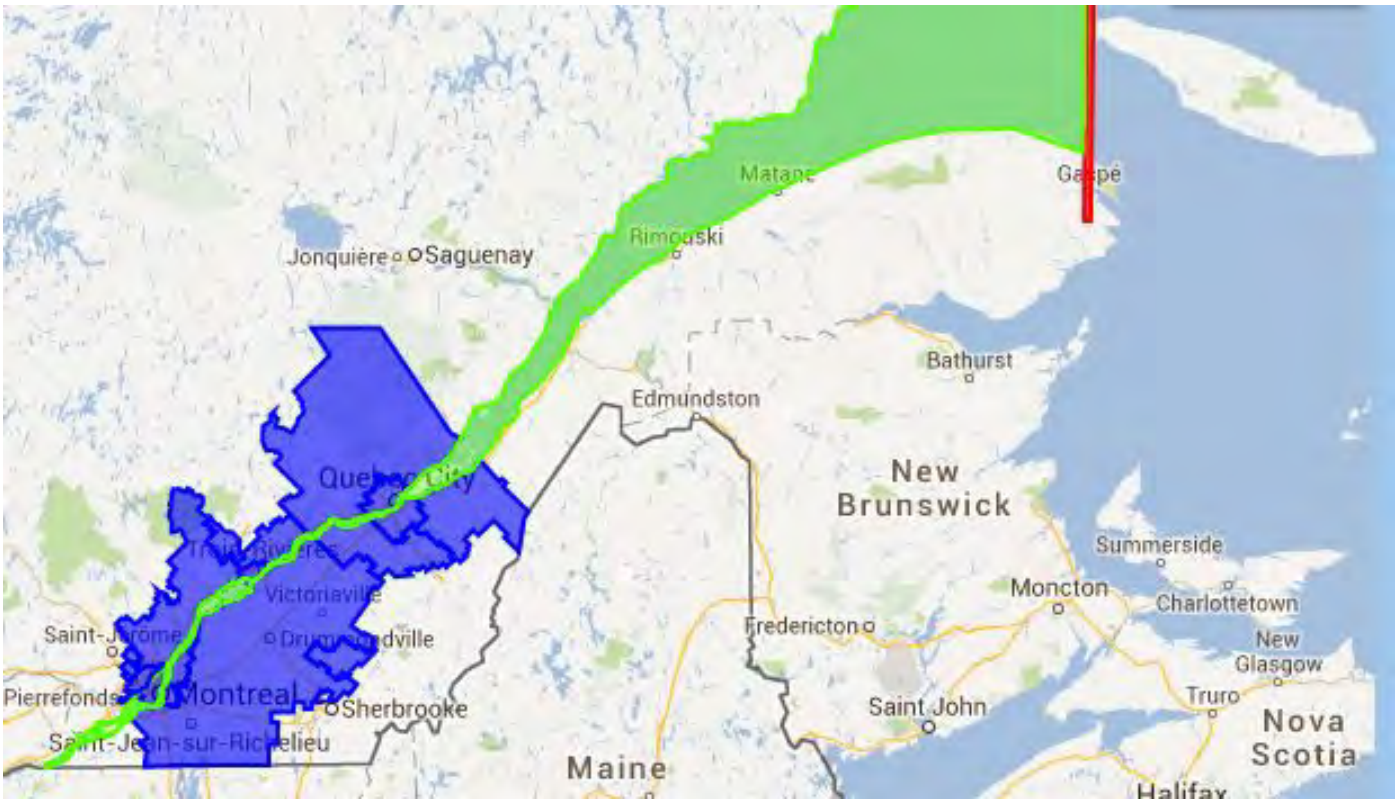
People often talk about the mysterious chemicals involved in hydraulic fracturing, but what about the possibility of fracked wells leaking natural gas, methane, and other problem substances into the environment? Our guest says, quite a few fractured wells in British Columbia leak from day one. Now here's an interview he gave at a website called tyee.ca, he says that generally...soon as the leaks enter groundwater, the industry goes into denial. ... Well, joining us from Edmonton is Karlis Muehlenbachs. He's a geochemist, and professor at the University of Alberta.

Business News Network, January 13, 2013[431]

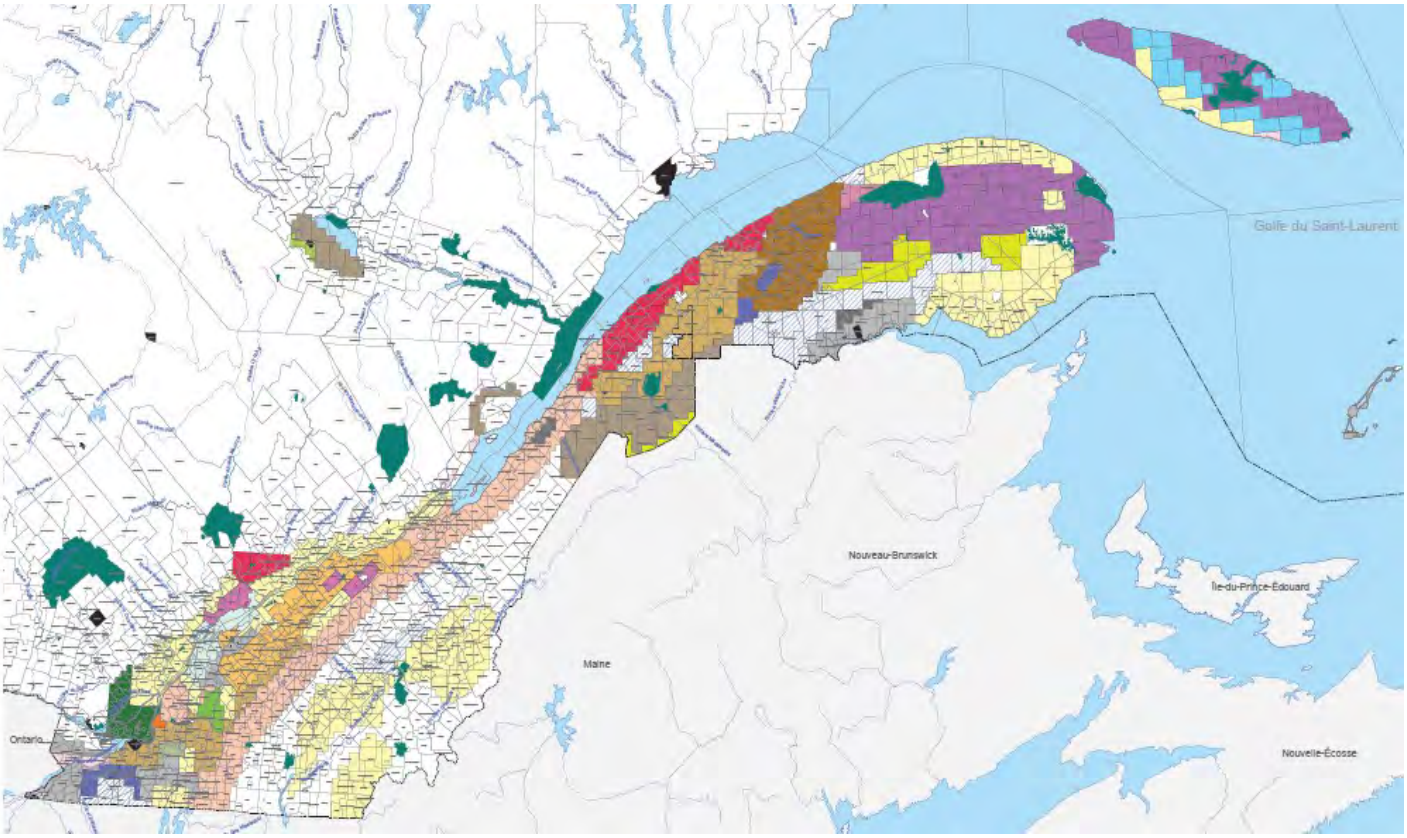
No one pays any attention to me.
The Alberta regulators are only interested in optimizing production.[432]

Dr. Karlis Muehlenbachs
Independent, world-renowned, gas fingerprinting expert

Table 1: Dissolved Methane Concentrations in Water Wells Discussed in this Brief		
	Near Oil and Gas?	**Highest Concentration Detected**
Pavillion, Wyoming	Yes	0.81 mg/l (citizen wells)
Bradford County, Ohio	Yes	1.04 mg/l (caused home explosion)
Alberta/Saskatchewan Canadian Association of Petroleum Producers Study (CAPP)	Yes	19.1 mg/l near known leaking hydrocarbon well. (1 mg/l = risk of explosion if water passes poorly ventilated space)
Arkansas	Yes	28.5 mg/l
Colorado USGS	Yes	36.7 mg/l (1 mg/l considered "high")
Colorado/New Mexico Chafin/USGS	Yes	39 mg/l 66% < 0.0005 mg/l (reporting limit)
New York USGS/DEP	Yes	45 mg/l
Dimock, Pennsylvania	Yes	49 mg/l 9 square miles contaminated
Wetaskiwin, Alberta	Yes	49.7 mg/l
Bradford County, Pennsylvania	Yes	55.8 mg/l After 2.16 mg/l Pre-drill
Lenox County, Pennsylvania	Yes	57.6 After 0.29 Pre-drill
Osborne *et al* Pennsylvania	Yes 1 or more gas wells within 1 km No gas wells within 1 km	Highest = 64 mg/l Average = 19.2 mg/l Average = 1.1 mg/l
Rosebud, Alberta	Yes, aquifers frac'd 3 or more gas wells within 1 km S of Rosebud, aquifers not frac'd	Highest = 66.3 mg/l Average = 43 mg/l <0.005 mg/l
Tioga County, Pennsylvania	Yes, Leaking gas storage	92 mg/l 50 square miles contaminated
Saskatchewan	Yes	94.5 mg/l
United Kingdom	Yes	100 mg/l



Quebec Frac moratoria: blue, shale gas only (Bill 37, tabled May 15, 2013); green (Law 18, passed June 13, 2011). If passed, the new moratorium is to last five years or until Quebec adopts a hydrocarbon law.[433]



Areas permitted to oil and gas companies.[434] Dark green are parks and protected areas. Maps from Regroupement interrégional sur le gaz de schiste de la vallée du Saint-Laurent.

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Links change frequently and documents are often removed from public access, especially since the Government of Canada became the "Harper Government"

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For the moment the fracking technology should not be used for commercial production of shale gas, in view of serious gaps in our knowledge about its environmental impacts.

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…there is a lot of data that different companies and different entities have
that have been collected since the hydraulic fracturing started,
but these data are proprietary....
I really would implore on everybody involved to share the data....

Podcast interview with Radisav D. Vidic, Associate Professor, University of Pittsburgh

ERCB Energy Resources Conservation Board

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Via Email

February 19, 2013

Stewart Shields
84 Hathaway Lane
Lacombe, AB. T4L 1T4
Email : lagran@shaw.ca

Dear Mr. Shields:

RE: *FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY ACT*
REQUEST FOR ACCESS TO RECORDS

I have reviewed your response to my letter dated January 10, 2013, asking you to clarify your access request. Despite your numerous references in your response to hydraulic fracturing, you confirmed in response to my "Question 1" that you are indeed looking for all information relating to **". . . each and every blow-out, frac-out, communication event, and or loss of control or pressure during completion, perforating, acidizing, hydraulic fracturing and or stimulating of energy wells . . .".** The rest of your email message did not serve to clarify your request; in fact the closing portion of your response provides argument more than clarification.

Mr. Shields, it is still unclear to us exactly what information you are requesting. I have provided the description that is in bolded type above to ERCB personnel who would be responding to your request and they are left with the impression that every completion event for which the ERCB has records could potentially be responsive to your request and would have to be reviewed. I have asked them to estimate the magnitude of the task that would be required to compile all the documents in the ERCB's custody or control that may contain responsive information. They have advised me that responding to such a request would require a massive undertaking on the part of the ERCB: potentially in the order of millions of pages of records.

As a result, pending any further clarification or narrowing of your request in response to this letter, the ERCB intends to apply to Alberta's Information and Privacy Commissioner for authorization to disregard your access request on the basis that it is unclear, frivolous and vexatious. Please indicate by response if you can clarify or narrow your request further. Please provide a copy of your response to the ERCB's FOIP Coordinator, Reta McPhail, at Reta.McPahil@ercb.ca.

Yours truly,

Gary Perkins
Associate General Counsel