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To the NY Department of Environmental Conservation

Sent via http://www.dec.ny.gov/energy/76838.html

Frac'ing Inhumanity

I hiked in New York State most weekends in the fall as I was growing up in Quebec. I love New York. You have much to protect from the new brute force highly risky and toxic hydraulic fracturing. Please stop believing industry's lies, promises and assurances. Please stand up to the corruption seething around the world, especially in our politicians and captured energy regulators and do the right thing – say no.

I am a scientist with 30 years experience working in Western Canada in the oil and gas industry. I am suing EnCana, the Alberta Government and energy regulator for unlawful activities (www.ernstversusencana.ca). Albertans are told we have the best in the world regulations and regulators. My statement of claim tells a compelling tale of drinking water contamination cover-up and how even the best regulations and laws do not protect families, communities, water, lands and homes from hydraulic fracturing. I consider it part of this submission; it is available to the public on the case website at the above link.

I had an incredible supply of fabulous water. I miss it everyday. The new frac'ing is a global issue, a scary Hellish one. I live it; I've been a frac guinea pig for a decade.

The historic record (1986, attached after my submission) on my water well in a regulator commissioned report states: *Gas Present: No.* Prior to the arrival of experimental, brute force hydraulic fracturing (2001) in my community, only 4 of 2,300 historic water well records noted the presence of a gas that could be methane within about 50 square kilometers around my water well. After EnCana fractured my community's fresh water aquifers, there was so much gas coming out of my well, it was forcing water taps open making them whistle like a train. Bathing caused incredibly painful caustic burns to my skin. As water wells went bad community wide, we got the same promises fractured communities get everywhere. For example: "We only fracture deep below your drinking water supply, deep below the impermeable layer to prevent gas from migrating into your water." They reminded us that Albertans are blessed with "World Class, Best in the World" regulators and regulations, while quietly deregulating and taking our rights away to accommodate the inevitable frac impacts.

My water is too dangerous to be connected to my home; the isotopic signature of the ethane in my water indicates the contamination comes from EnCana's gas wells. In 2006 in the Legislature, the Alberta government promised affected families a bandage - safe alternate water "now and into the future." They broke that promise and ripped the water away. I drive more than an hour to haul safe water for myself.

I learned that when you're frac'd, there's no after care. What happened in my community is reportedly happening everywhere they frac, regardless of company or country.

Affected citizens are abandoned.

Americans are fortunate to have the Environmental Protection Agency (EPA) and federal health officials (Agency for Toxic Substances and Disease Registry) that warned Pavillion citizens to stop drinking the water. EnCana frac'd hundreds of metres more shallow around my community than the EPA reports the company did at Pavillion. EnCana was also stingy here with surface casing. Alberta's regulator found much more methane in my water than the EPA found at Pavillion, and some of the same man-made toxics. Is that a frac coincidence?

And like at Pavillion, and in so many contaminated communities in the USA, the company still has not disclosed all the chemicals they injected, and our regulators and governments refuse to make them. Hexavalent chromium was found in a regulator monitoring water well; the regulator didn't share this with my community, it was gleaned it through my Freedom of Information request. In another regulator monitoring water well, they found no water, only methane and ethane - so much so that the gas was forcing the lid open – like the gas did to my water taps. Did they warn anyone? No. They commissioned reports that ignored all the damning data and the historic records, and used unsubstantiated claims of gas in other water wells to blame nature.

I see no help from the Canadian Association of Petroleum Producers, American Petroleum Institute, Groundwater Protection Council or FracFocus and its newly released Canadian cousin. I do not believe that multinationals keep chemical secret for proprietary reasons. I believe they keep them secret because companies know their drilling and frac'ing - waterless or not – is irreversibly contaminating groundwater, and they do not want anyone to be able to prove it.

Recently, EnCana drilled more gas wells around my home and under my land. I thought of farmers around the world as I watched EnCana dump their toxic waste on my neighbor's agricultural land and pump undisclosed chemicals labeled flammable down their gas well to be fractured above the Base of Groundwater Protection near my home.

Even the *best* laws and regulations will not protect New York's water and people from this arrogant, bullying, deceptive, uncooperative, "bad neighbour" industry. Shamefully, the revised draft *Supplemental Generic Environmental Impact Statement (dSGEIS)* on high-volume horizontal drilling and hydraulic fracturing is nowhere near O.K., never mind the best. I get "Best in the World." Look at what Poland gets. What does New York get? Who will de-flame and purify your water, and detain your corrupt state and corporate officials?

I've learned that frac'ing is hideous, but what follows reveals true inhumanity and greed. Please find my comments with supporting documents attached. Thank you.

Sincerely,

Jessica Ernst, B.Sc., M.Sc.

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. According to a 2002 workshop sponsored by the Canadian Council of Ministers of the Environment, 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 paper 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."[2] Not until nine years later on September 21 2011, did the Canadian government announce that it would initiate two reviews to determine whether hydraulic fracturing is harming the environment.[3] These are not investigations or studies.

2. Recent government documents acquired under the *Access to Information Act* by Ottawa 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.[4]

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."[5]

4. In 1987, the EPA documented that hydraulic fracturing by industry had contaminated groundwater.[6] The New York Times' Ian Urbina reported that many more cases were sealed by settlements and confidentiality agreements.[7] In 2010, the Canadian oil and gas industry advertised: "Fact: Fracturing has not been found to have caused damage to groundwater resources"[8] and EnCana advertised: "In use for more than 60 years throughout the oil and gas industry, there are no

[1] Standing Committee on Energy, the Environment and Natural Resources, November, 2005
[2] Crowe *et a*l, Canadian Council of Ministers of the Environment, 2003
[3] Fakete and Penty, 2011
[4] Natural Resources Canada, January 2006
[5] Rosenberg International Forum on Water Policy, February 2007
[6] EPA, 1987
[7] Urbina, 2011
[8] Canadian Natural Gas, 2010

documented cases of groundwater contamination related to the hydraulic fracturing process."[9] Some companies and regulators continue to mislead the public, others have replaced the word "documented" with "proven" in their chant.

5. In the USA, by the early 1990's numerous water contamination cases and lawsuits had sprung up in CBM development areas.[10] "In a two-year study, United States Geological Survey (USGS 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 USGS 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."[11]

6. 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.[12] Another family is suing because the company is refusing to pay fair market value.[13]

7. A Husky 1993 report 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. The Alberta Energy Resources Conservation Board (ERCB) presented that the "shallower, upper part" of industry well bores (where the biogenic gas is) have "higher potential for leakage" than deep production zones.[14] Dr. Karlis Muehlenbachs presented in November 2011 in Washington that 70% of casing gases come from intermediate layers of well bores, not the target zone, and questioned how effective casings are at preventing migrating gas from reaching the surface.[15]

[9] EnCana, 2011
[10] Wright, 1993; Chafin, 1994; LEAF, 1995
[11] Wright, 1993
[12] Ibrahim, 2011
[13] Williams, 2011
[14] Bachu and Watson, 2007
[15] Muehlenbachs, 2011

8. The Canadian Association of Petroleum Producers (CAPP) noted the problem of methane migration dramatically increased when drilling density increased.[16] This trend has also been reported in the United States.[17] Alberta researchers reported natural gas leakage along well bores of about 50% of oil wells in western Canada.[18] CAPP reported that well bores were leaking gas and contaminating groundwater long before the new high pressure and densely drilled hydraulic fracturing began.[19]

9. The University of Alberta's Dr. Karlis Muehlenbachs 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's energy regulator, now the Energy Resources Conservation Board (ERCB), released Bulletin GB-99-06[20] recommending his technique: "Therefore, the Alberta Energy and Utilities Board (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."

10. In Quebec, more than 50% of 31 new fractured shale wells that were inspected are leaking natural gas; the regulator ordered the leaks repaired, the companies tried but failed to stop the leaks.[21] Isotopic analysis by Dr. Muehlenbachs indicates that groundwater in Quebec is already contaminated,[22] "from a geological point of view, the shale was sealed 300 million years ago." he says. "And then man intervened."[23] A 2008 review of investigations in a heavily drilled 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."[24] 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." In 2009, Canada's National Energy Board reported that only 20% of fractured gas is recoverable[25], "the circulating gas left behind will threaten the water Quebecers drink and could jeopardize agriculture".[26]

    In 2011, a peer reviewed study reported 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/litre; samples in neighboring non-extraction sites (no gas wells within 1 km) averaged only 1.1 mg/litre[27]. 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/litre after a company repeatedly fractured into

[16] Canadian Association of Petroleum Producers, 1996
[17] Albrecht, 2008
[18] Arkadakskiy et al, 2005
[19] Canadian Association of Petroleum Producers, 1996
[20] EUB, 1999
[21] CBC News, 2011
[22] Muehlenbachs, 2011
[23] Côté, 2011
[24] Thyne, G., 2008
[25] NEB, 2009
[26] Dougherty, 2010
[27] Osborne et al, 2011

the aquifers that supply those wells.[28] Subsequent review on sampling methodology indicated that groundwater gas concentrations were being underestimated by a factor of three.[29]

Isotopic fingerprinting of several aquifer gas samples collected 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".[30] 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."[31]

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[32]. 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.[33]

Schumblerger Well Cementing Services reports gas migration problems at 25% in Alberta's heavy oil fields.[34] Although the ERCB reported that there were "3810 wells with active surface casing vent flow and 814 with gas migration problems in Alberta,"[35] since 1999 it no longer makes this data public.

A peer reviewed paper[36] published in 2009 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 concluded that the factors affecting wellbore leakage "can be generalized and applied to other basins and/or jurisdictions."

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[37]

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."[38] A 2001 Australian study that investigated the causes of cement failure in industry wells concluded poor cement work poses a

[28] Alberta Environment, 2006
[29] Ryan, December 2008
[30] Szatkowski, B., Whittaker, S., Johnston, B., Sikstrom, C., and K. Muehlenbachs, 2001
[31] Maxxam Analytical Labs, Issue No sol-o11e
[32] Dusterhoff et al, 2002
[33] Bachu and Celia, 2005
[34] Debruijn, 2008
[35] ERCB (EUB) Statistical Series 57, 98/99
[36] Watson and Bachu, March 2009
[37] CBC News, 2011
[38] Schmitz *et al*, 1993

central risk to aquifers.[39] The causes of cement failure include high cement permeability, shrinkage and carbonation, as well as formation damage.

Cement pulsation researchers reported a study that showed 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."[40] 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."[41]

Alberta industry data shows that "wellbore deviation is a major factor affecting overall well-bore leakage" and that in one test area, deviated wells leaked about 50% more than the area average, cement slumping and casing centralization were suggested reasons why.[42] The data also shows a strong correlation between the percentage of wells leaking and oil price.

January 2006, the ERCB reported 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,"[43] a few examples were filed.[44]

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 post 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."[45]

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 protection is not recommended by either the Alberta or British Columbia regulator for shallow or deep fracture operations near farms, houses, water wells, municipal water supply towers, fire halls, non oil and gas businesses, communities, hospitals, parks, schools, *etc*. When concerned citizens or municipalities ask for this simple and reasonable protection, companies and regulators deflect, lie and or bully the requests away.

[39] Mavroudis, 2001
[40] Newman *et al*, 2001
[41] Stein et al, 2003
[42] Watson and Bachu, March 2009
[43] EUB (now ERCB), 2006
[44] EUB, date unknown
[45] BC OGC, 2010

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."[46]

11. Maurice Dusseault, a prominent Canadian oil patch 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."[47] 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.[48] In 2006, the ERCB reported that 362,265 total resource wells have been drilled in Alberta of which 116, 550 are abandoned.[49]

    Since 2001 Alberta permitted the drilling of nearly 8,000 coal bed methane wells without standardized baseline hydrogeological investigations. Many gas-bearing coal seams are directly connected to drinking water aquifers. In 2011, the ERCB reported that by "the end of 2010, there were more than 15,300 CBM wells….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."[50]

12. CAPP reported that only 17 of about 24,000 historic water well records reviewed by Alberta Environmental Protection (changed under Premier Klein to Alberta Environment[51]; changed under Premier Redford to Alberta Environment and Water) for their gas migration study indicated gas present before oil and gas development.[52] Only four out of 2,300 historic water well records within about 50 square kilometers of Rosebud, Alberta noted gas present before experimental hydraulic fracturing for CBM began in 2001[53]. The ERCB conducted an extensive CBM water chemistry study and reported in 2006 that about 90% of water wells in coal they tested had no detectable methane or ethane present.[54]

    Regional groundwater assessments by Hydogeological Consultants Ltd. (HCL)[55] in conjunction with Agriculture and Agri-Food Canada and the Prairie Farm Rehabilitation Administration were completed for 45 Counties and Municipal Districts[56] in Alberta during the initial years of shallow hydraulic fracturing. These regional assessments included identifying aquifers and quality and quantity of the water in those aquifers. They do not state that methane is naturally present in all water wells in coal in Alberta. After the media reported dangerous levels of methane in numerous water wells in Alberta after CBM developments, and the contaminated Bruce Jack water well exploded at Spirit River in 2006[57] seriously injuring and hospitalizing three men including two

[46] IEA Greenhouse Gas R & D Programme (IEA GHG), September 2006
[47] Dusseault, 2002
[48] Dusseault, 2003
[49] Bachu and Watson, 2007
[50] ERCB package, 2011
[51] For the sake of this brief, the regulator is termed Alberta Environment
[52] CAPP, 1996
[53] Ernst v EnCana *et al*, 2011
[54] ERCB, 2006
[55] http://www.hcl.ca
[56] HCL, various years
[57] Alberta Hansard, May 17, 2006

industry water well testers, Alberta regulators began telling the public that all water wells in coal are naturally contaminated with methane. [58]

13. The development of CBM and other unconventional deposits of natural gas in Alberta and the United States requires extensive hydraulic fracturing. Hydraulic fracturing consists of injecting diesel fuel, water, foams, silica, nitrogen and undisclosed mixes of chemicals into a coal formation to force the tightly adsorbed methane to release. Some fracturing chemicals that pose a threat to human health include benzene[59], phenanthrenes and florenes[60], naphthalene[61], 1-methylnapthalene, 2-methylnapthalene, 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 10 times more fracturing than conventional natural gas wells.[62] In 2008, Congress moved to protect drinking water in the United States from hydraulic fracturing[63] and in 2010 the Committee on Energy and Commerce investigated numerous companies, including EnCana, regarding their hydraulic fracturing practices and all allegations of groundwater contamination.[64] Although CBM fracturing into drinking water supplies in Alberta occurred in 2004[65], perhaps earlier, regulators did not forbid the use of toxic fracturing chemicals above the base of groundwater protection until 2006.[66]

14. EnCana, one of North America's largest CBM drillers, publicly admitted that the same fracturing practices and gelled fluids used in the United States, which included using 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.[67] The study, which detected metals such as chromium, arsenic, barium and 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)." EnCana dumped and continues to dump their waste on agricultural lands in Alberta, including around Rosebud. Alberta Environment found BTEX in the Hamlet of Rosebud municipal water supply, arsenic and hexavalent chromium in a monitoring water well in the Hamlet and red flag indicators of petroleum distillates in the hamlet water and citizen water wells after heavy CBM drilling and waste dumping. The chromium in the Ernst water well increased by a factor of 45 after EnCana fractured the aquifer that supplies that well. The regulator did not test for arsenic or mercury in the contaminated citizen wells at Rosebud.[68]

15. Lost circulation or the seepage of cement and other fluids into the ground is a constant problem with CBM and other unconventional gas drilling.[69] EnCana experienced 10% lost circulation in one CBM field[70] and EnCana drilling and fracturing records for CBM wells near the contaminated Campbell water well at Ponoka, Alberta indicate "severe" lost circulation events.[71] Lost circulation

[58] Alberta public meetings assuring groundwater protection, 2006 and onward
[59] Detected in sampling by Alberta Environment in the Signer drinking water, November 2, 2006
[60] Detected in sampling by Alberta Environment in the Hamlet of Rosebud drinking water, spring 2006
[61] Detected in sampling by Alberta Environment in the Ernst drinking water, March 3, 2006
[62] Environmental Protection Agency, June 2004
[63] HR 7231 IH, 110th Congress 2nd Session, September 29, 2008
[64] Congress of the United States, 2010
[65] Hydrogeological Consultants Ltd., January 2005
[66] Alberta Environment, May 2006
[67] EnCana, 2005
[68] Alberta Environment, 2006 & 2007; EnCana tests on the Ernst water well, 2003
[69] Oilfield Review, Winter 2003/2004
[70] ERCB (EUB) Decision 2006-102, October 2006
[71] EnCana CBM data, 2005

poses a variety of risks to groundwater including contamination by products used to stop the seepage. Although EnCana and other companies claim that 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.[72] *Oilweek Magazine*[73] 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[74] and has been reported to negatively affect fish eggs and fry.[75] Drilling muds and petroleum industry wastes are sometimes disposed of in pits or by land dumping (termed "spraying" or "farming" to make it more palatable to farmers and ranchers paid to take the waste). The toxics in the wastes are not disclosed to landowners or communities, and can be toxic to human health[76] and contaminate groundwater.[77] Groundwater flow systems can transport pollutants several kilometers.[78]

16. 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 was water-soluble.[79] In a 2011 peer reviewed paper, 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."[80]

17. Since 2003, more than fifteen Alberta landowners reported contamination of their water wells after intense CBM drilling. Alberta Environment reluctantly and partially sampled some of these wells. Analysis by the Alberta Research Council (ARC[81]) and other labs detected industrial contamination (some examples: benzene, toluene, ethyl benzene, xylenes, H2S and heavy hydrocarbons indicative of contamination by the petroleum distillates kerosene and naphthalene). Methodical studies by the University of Alberta on the gases in the water also indicated industrial contamination.[82] Although Alberta Environment finally released a Standard for Baseline Water Well Testing for CBM in 2006, it is not standardized, only applicable to very shallow CBM wells and does not mandate testing dissolved methane or red flag indicators of petroleum industry contamination. When landowners request dissolved methane testing by EnCana, offering to pay for the hundred dollar test, EnCana refuses.[83] The ERCB reported that shallow and deep shales will be fractured in Alberta, and is considering chemical disclosure, but not baseline water well testing.[84]

[72] Wills, 2000
[73] Oilweek Magazine, 2006 & 2008
[74] Oilweek Magazine, 2006 & 2008; Petroleum Services Association of Canada, 2005
[75] Wills, 2000
[76] Sumi, 2004; Colborn *et al*, 2011
[77] Sumi, 2004
[78] Weyer, 2006; Zhang *et al*, 2003
[79] The Endocrine Disruption Exchange, 2008
[80] Colborn *et al*, 2011
[81] now Alberta Innovates Technology Futures
[82] Kusnetz, 2011; Nikiforuk, 2011
[83] Desmogblog, 2011; 2006; letters to EnCana by Ernst, various years
[84] ERCB, 2011

18. In 2009, a study published in *The Journal of Hydrology* concluded that 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.[85] In 2007, the ARC reported that static water levels in Rosebud complainant water wells dropped significantly (in one case more than 3.5 metres) after a CBM producer repeatedly fractured the area's drinking water aquifers and experimented with hundreds of secret shallow completions in the area.[86] In 2006, 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."[87]

19. A 2008 report by the ARC 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."[88]

    In 2006, the Texas Railroad Commission recorded 351 cases of groundwater contamination due to oil and gas activity.[89] In 2007, New Mexico recorded 705 incidents of groundwater contamination due to oil and gas development since 1990.[90]

    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."[91] Four Plaintiffs took the case to the Supreme Court of the State of New York, and won their case. In the 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."[92]

    A comprehensive investigation in Kansas demonstrated that leaking industry gas had migrated more than six miles.[93] The migrating gas caused explosions in 2001 in Hutchinson that destroyed

[85] Myers, 2009
[86] Blyth, 2007, Ernst, Lauridsen and Signer Water Wells Complaint Reviews
[87] de la Cruz, 2006
[88] Blyth, January 2008
[89] Texas Groundwater Protection Committee, July, 2007
[90] New Mexico Energy, Minerals and Natural Resources Department, http://www.emnrd.state.nm.us/ocd/
[91] Toxics Targeting, 2009 FOIP Results
[92] Toxics Targeting, 2009
[93] Coleman, 2004

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.[94]

20. Alberta's Department of Energy defines fracturing as: "the opening up of fractures in the formation to make gas flow more freely."[95] 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."[96]

21. In 2003, the ARC reported that natural methane release in Alberta is rare because reservoirs are "tight" and that nitrogen used in CBM recovery "increases diffusion rate of hydrocarbon gases from coal matrix into natural fractures."[97] Hydraulic fracturing has been associated with gas migration into groundwater as well as groundwater drawdown or contamination throughout the continent. A 1994 Colorado study of 203 water wells in a area of high CBM density by the USGS found that "manmade migration pathways probably" accounted for the contamination of shallow water wells by methane.[98] A 2006 USGS study discovered extensive methane contamination of local drinking wells in areas of intense coal mining.[99]

22. Alberta Environment[100], CAPP[101] and the Canadian Society for Unconventional Gas[102] 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;[103] in one case three men were seriously injured and hospitalized.[104] Homes in the U.S. have exploded from migrant resource well gases[105]. Leaking gas wells have created dangerous concentrations of dissolved methane in household water wells as high as 92 mg/litre in Tioga County in north central Pennsylvania.[106] In the '70's, the maximum concentration found in water wells and springs in oil and gas development fields in Saskatchewan was 94.5 mg/litre.[107]

    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."[108]

[94] Hutchinson Response Project, March 2001
[95] Alberta Department of Energy
[96] Bredehoeft, 2003
[97] Gunter, 2003
[98] Chafin, 1994
[99] U.S. Geological Survey, January 2006
[100] Alberta Environment letters to complainants, January 16 2008
[101] Canadian Association of Petroleum Producers *et al*, 1995.
[102] Canadian Society for Unconventional Gas, http://www.csug.ca/facts.html
[103] Reports by complainants to Alberta Environment.
[104] Alberta Hansard, May 17, 2006: Private water well explosion at Spirit River, Alberta; Hanel, 2005
[105] Pennsylvania Geological Survey, http://www.dcnr.state.pa.us/topogeo/hazards/otherhaz.aspx; Hanel, 2005
[106] U.S. Geological Survey Scientific Investigations Report 2007-5085
[107] Dyck and Dunn, 1986
[108] Ohio DNR, 2008

The highest concentration of dissolved methane found in 79 ground water samples at Bainbridge, Ohio was 1.04 mg/litre. [109] The highest found in Rosebud, Alberta after the community fresh water supply was hydraulically fractured by a CBM developer was 66.3 mg/litre. CAPP, Canada's oil and gas lobby group, warned in their 1996 gas migration report that if there is more than 1 mg/litre 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 that dramatically increased levels of methane were found in groundwater near leaking hydrocarbon wells, with the highest at 19.1 mg/litre.[110] In their 1996 report, CAPP summarized the data collected by the USGS in their CBM gas migration study:

> Chafin et al. (1993) and Chafin (1994) documented a 1990-91 survey of 203 water supply wells and 2 springs in the Animas River Valley of Colorado and New Mexico. 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."[111]

Water samples from the Amos/Walker well in Colorado, where EnCana received a notice of violation and a large fine from the regulator for impacting the water, showed methane concentrations ranging from 0.1 to 13 mg/litre.[112] 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 in Colorado for contaminating water and a creek with methane and benzene the year previous.[113])

In 2010, 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."[114] 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/litre. "Range experts say their analysis found the methane in the water wells is actually coming from the more shallow formation"; the EPA said that Range has not supplied all the technical information required in its order."[115]

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.[116] 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 fugitive methane in

[109] Ohio DNR, 2008
[110] CAPP, 1995 & 1996
[111] CAPP, 1996
[112] COGCC, 2005
[113] COGCC, 2004
[114] EPA, 2011
[115] Hawes, 2011
[116] Pennsylvania Department of Environmental Protection, 2009.

the Dimock case migrated nine square miles affecting 14 water supplies.[117] At the end of 2011, the 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.[118]

The DEP fined Chesapeake Energy $900,000 for methane migration "up faulting wells" in Bradford County, contaminating 16 families' drinking water in 2010.[119] The DEP found methane concentrations ranging from 2.16 to 55.8 mg/litre.[120] "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."[121]

In 2012, the Pennsylvania state regulator released a notice of violation[122] 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/litre in a 2010 pre-drilling sample to 49.2 mg/litre and 57.6 mg/litre 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."[123] 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.[124]

In a 2011 draft report, the EPA connected natural gas and toxic chemicals found in water wells at Pavillion, Wyoming to hydraulic fracturing and waste pits by EnCana.[125] The EPA reported: "Hydraulic fracturing in gas production wells occurred as shallow as 372 meters below ground surface." In comparison, at Rosebud, Alberta, EnCana fractured as shallow as 121.5 metres below ground surface[126], with perforations as shallow as 100.5 metres.[127] About 62 gas wells were fractured less than 200 m below ground surface within about six miles of Rosebud.

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[128]

Dr. Karlis Muehlenbachs

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."[129] EnCana's well data shows this not to be the case.

[117] Pennsylvania Department of Environmental Protection, 2010.
[118] Legere, May 18, 2011
[119] Legere, December 31, 2011
[120] PRNewswire, 2011
[121] Legere, December 31, 2011
[122] DEP, 2011
[123] Legere, May 18, 2011
[124] Legere, 2012
[125] EPA, 2011
[126] EnCana CBM data, 2004
[127] EnCana CBM data, 2001
[128] Quote reported by Nikiforuk in The Tyee, 2011
[129] Canadian Natural Gas, 2010

Methane concentrations in Rosebud water wells are much higher than the EPA found in Pavillion, Wyoming or Parker County, Texas or that the USGS found in Colorado and New Mexico.[130] In 2005, the Rosebud water tower exploded "investigators say an accumulation of gases appears to have caused the explosion that destroyed the Rosebud water tower and sent a Wheatland County employee to hospital….the operator was unable to detect the gases by smell and did not use a detection device….Alberta Environment and Occupational Health and Safety are working with the county to ensure standards are met and continue investigation into the mishap." [131]

In 2006, the Alberta government promised in the Legislature that all affected families would receive safe alternate water "now and into the future" [132] and knew that isotopic fingerprinting of gases from Rosebud water indicated match to EnCana's gas wells in the community.[133] The government refused to disclose this damning data to complainants claiming "confidentiality", but immediately disclosed data to EnCana (this and the damning data was found out years later via Freedom of Information Requests). The government then proceeded for over a year to refuse complainants sampling and safety protocols and a comprehensive investigation while allowing EnCana to drill and fracture numerous more shallow wells and commingle existing and new wells in the area where the company fractured the community's fresh water aquifers. In 2007, within a month of promising a comprehensive investigation the government reneged and a year later broke their promise of safe water. Citizens breathe, bathe in and ingest and live with dangerous, contaminated water or haul their own.

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[134]

Dr. Karlis Muehlenbachs

Some of the contaminants found in sampling by the EPA at Pavillion where found in sampling by Alberta Environment in groundwater at Rosebud, Alberta and dismissed, ignored or reported incorrectly by the ARC. These include: diesel range organics, benzene, toluene, ethylbenzene, xylenes, and *tert*-butyl alcohol - a known breakdown product of methyl tert-butyl ether (a fuel additive) that is not expected to occur naturally in ground water. Freedom of Information request responses[135] show that companies have not disclosed to Alberta regulators or affected families the chemicals experimented with and injected in communities with water contamination even though the ERCB reports that it "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."[136]

The "World Class" regulators do not report or map cases of groundwater contamination caused by the petroleum industry in Alberta. They continue to publicly claim it hasn't happened.

It's stupid! Don't do it. [137]
Dr. Tony Ingraffea

[130] Chafin, 1994
[131] Strathmore Standard, 2005
[132] Alberta Environment letters to complainants, 2008
[133] Kusnetz, 2011
[134] Quote reported by Nikiforuk in The Tyee, 2011
[135] Ernst FOIP to Alberta Environment in 2007; to the Alberta Research Council in 2008 – still in Inquiry because of withheld and censored public records.
[136] ERCB, 2011
[137] Ingraffea on shale gas well placement in Penobsquis, 2011

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High Country News -- April 19, 1993 (Vol. 25 No. 7)

Fouled water leads to court

DURANGO, Colo. - After years of futile public hearings, letter-writing and media campaigns, residents of La Plata County in southwestern Colorado have turned to lawsuits and civil disobedience to protect themselves from the impacts of an oil and gas boom.

Since 1980, the year Congress approved lucrative tax credits for coalbed methane gas production, U.S. energy firms have drilled over 1,000 wells into coal seams south of Durango looking for pockets of trapped methane gas.

The wells are scattered throughout the Animas and San Juan river basins across a checkerboard of public and private land. While the wells have generated profits for oil companies, they have also brought pumpjacks, pipelines, compressor stations, and gravel transport roads to the residents of mostly rural La Plata County - sometimes right to their backyards (HCN, 12/4/89).

But what continues to unite residents there and in neighboring New Mexico counties are accounts of foul-tasting well water, flaming pitchers of lemonade and exploding kitchen pipes. For years, residents on both sides of the border have asked the Bureau of Land Management, the Forest Service and the Colorado Oil and Gas Commission for tougher regulations, arguing that gas production is polluting their wells and drinking water. So far the agencies have refused to slow the boom.

Recently, the growing coalition of residents and environmentalists found an ally in a U.S. Geological Survey draft report released earlier this year. In a two-year study, USGS 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.

Western Colorado Congress president Jerry Swingle says the report shows that "the industry isn't anywhere near as competent in preventing that kind of contamination as they have led everyone -including regulators - to believe."

Based in part on the USGS 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. A victory

could result in strict new controls on oil and gas drilling, well maintenance and groundwater monitoring.

"You're not looking at a bunch of hippies who live out in the wilderness or Earth First!ers who have come in to file this lawsuit," says Chris Shuey, a water resources specialist who acted as a technical consultant for the residents. "These are people who have lived there for generations and some of them work or have worked in industries associated with the oil and gas industry. I think they felt litigation was the last avenue available to them."

However, both the oil companies and the BLM, which regulates oil and gas drilling on public lands, say they think the methane migrates into upper aquifers naturally through cracks and fissures underground.

They say the USGS report is a product of bad science and bias. "We are somewhat disturbed," the BLM responded in written comments, "that several apparent contradictions are present and many conclusions are drawn based on what could arguably be characterized as inconclusive data."

"We are also concerned that, to a certain degree, the tone of the document seems to lack objectivity," said the agency's district manager, Sally Wisely, in a letter.

The USGS, which was hired in a 1989 compromise among the various parties to the dispute as a neutral investigator, stands by its research. "I find (the BLM's comments) really peculiar," says USGS district director David Lystrom. "We're both Department of Interior agencies. What axe are they grinding?" Lystrom says his agency stands by its report, and will issue a final document within a year.

Local residents and environmental groups say the BLM's reaction reflects a long-standing refusal to trust evidence linking rising numbers of methane-contaminated private wells with the gas boom.

Residents have also battled with the U.S. Forest Service, most recently over the agency's decision to allow Amoco to drill 15 wells on environmentally sensitive lands in the HD Mountains on the eastern edge of La Plata County.

Last September, the Forest Service closed the drilling area to the public after Western Colorado Congress and the San Juan Citizens Alliance blockaded and shut down Amoco's drill rigs. After a second protest, which drew 80 people, the Forest Service charged eight people with criminal trespass.

In a January trial, two women, including a San Juan Alliance organizer, were found guilty and fined $250. However, Judge Edward Schlatter said he was troubled by the verdict. Protesters had intended the rally to be peaceful and legal at all times and, he believed, did not know they were across the closure line.

"The Forest Service acted as a publicly financed security force for Amoco," says Western Colorado Congress' Swingle. "The decision to prosecute was motivated not by justice, but was intended as punishment, intimidation and a clear message to all citizens that dissidents will not be tolerated."

For more information, contact the BLM/Forest Service offices at 701 Camino Del Rio, Durango, CO 81301 (303/247-4082); or the Western Colorado Congress and San Juan Citizens Alliance at 820 E. 7th St., Suite B, Durango CO 81302 (303/259-3583).

- Ken Wright
Ken Wright, a former HCN intern, covers environmental issues for The Daily Times in Farmington, New Mexico.

http://www.hcn.org/issues/69/2203

Canadian Association
of Petroleum Producers

CAPP

Migration of Methane into Groundwater

from leaking production wells near Lloydminster

March 1995

CAPP Pub. #1995-0001

Canadian Association
of Petroleum Producers

CAPP

Migration of Methane into Groundwater from Leaking Production Wells near Lloydminster

Report for Phase 2 (1995)

March 1996
CAPP Pub. #1996-0003

1.0 INTRODUCTION

In 1995 the Saskatchewan Research Council continued an investigation of gas migration in groundwater in the Lloydminster area. This report documents the 1995 research program, which followed the initial (1994) program (Van Stempvoort and Jaworski, 1995; Schmitz, 1995).

The research project has the following objectives:

- to investigate the occurrence of methane in groundwater near leaking production wells in the Lloydminster study area,

- to determine whether the methane is derived from the leaking well or occurs naturally in the aquifer,

- to determine the concentration gradients and approximate flux rates of methane from leaking wells to shallow aquifers, and

- to predict the migration rate of methane in aquifers under various scenarios of time and physicochemical conditions (e.g., aquifer properties).

This project is funded by the Canadian Association of Petroleum Producers (CAPP), the Lloydminster Area Operators Gas Migration Team (LAOGMT), the Panel for Energy Research and Development (PERD) and the Saskatchewan Research Council (SRC). In 1995, the steering committee for this program included Ron Schmitz (Husky Oil, CAPP), Garry Lorenz (LAOGMT), Les Bernier (Saskatchewan Energy and Mines), David Blume (Provost Area Surface Rights), Tom Cook (Alberta Energy Utilities Board), Garry Ericson (Saskatchewan Energy and Mines), Margaret Klebek (Alberta Environmental Protection), Kennedy Kohlman (Koch Exploration), Brian Moneta (Elan Energy), Don Roberts (Alberta Energy Utilities Board), Scott Robinson (Saskatchewan Environment and Resources Management), Harold Seitz (Wascana Energy), Kurt Uhrich (Amoco) and Gary Webster (CAPP).

The 1995 program included five components as indicated in the following sections:

- expansion of monitoring at the Lindbergh site,
- selection of five new sites; installation of monitoring wells at two of these sites,
- investigation of dissolved methane and other hydrochemical species,
- development of modelling for simulation of methane migration in groundwater,
- survey of methane in 23 water supply wells in the Lloydminster area.

7.1 Historical Data on Presence of Gas in Supply Wells

Alberta Environmental Protection (AEP) has provided a summary of their records of water wells in the study area that indicated that "gas" was present. Of ~24,000 water well records, presence of gas was reported for 58 wells (Table 13). These records do not provide chemical analyses of the gas.

Fifteen of the AEP records of gas in wells were observations made during the Federal water well survey of 1935-36. Gas was reported for two other wells prior to oil and gas exploration and development in the area: in 1949 and 1953 (Table 13). Generally, the early AEP records (1935-53) indicated presence of gas in wells completed at depths > 40 m BGS. Although the gas was not identified, these records suggest that methane was present in some aquifers in the study area prior to oil and gas exploration.

Of the 41 later AEP records that report presence of gas (1960-95), most were observations made by drillers' at the time the wells were installed. These wells tended to be relatively deep (mean completion depth of 123 m BGS, range of 51 to 238 m BGS) compared to the average well in the region (< 50 m BGS based on AEP records).

A study by the Prairie Farm Rehabilitation Administration (1993) indicated occurrence of dissolved methane in eight monitoring wells completed in Judith (Belly) River Fm aquifers in the Special areas in Alberta. Methane was the dominant dissolved gas observed, but absolute concentrations were not determined. The source of the methane (intrinsic vs. oil & gas activities) was unknown. This area investigated by the PFRA overlaps with and includes the southernmost portion of the Lloydminster study area.

Currently there is no provincial database that provides historical information on the presence of gas in water wells for the Saskatchewan portion of the study area. Unlike the AEP records, the equivalent water well database provided by the Saskatchewan Water Corporation contains no information on the occurrence of gases in wells.

Table 13. Water wells in study area in which gas was noted to be present (Alberta Environmental Protection waterwell database).

Q or LSD	Sec	T	R W4	Well Owner	Depth (m)	Year Reported
Reported between 1935 and 1953						
NE	32	41	2	Feero	117.3	1935
SW	4	42	2	McMann	114.3	1935
NW	6	42	7	S. McLaughlin	19.8	1935
SW	3	43	4	S.V. Snyder	3.0	1935
SW	11	44	3	A. Cooper	97.5	1935
12	3	48	12	F. Ploc	45.4	1935
8	35	49	1		6.1	1935
14	36	49	1		38.7	1935
1	3	50	1	Blackwell	50.6	1935
15	23	50	1	K. Parr	34.1	1935
SE	34	50	2		28.3	1935
15	34	52	4	Hodgson	47.2	1935
4	36	52	4	R. Seville	102.4	1935
SE	4	53	4	G. Brett	71.9	1935
NE	16	45	11	G.F. Albrecht	115.8	1936
SW	14	50	2	Plater	63.4	1949
4	7	45	12	Seman Engin.	54.9	1953
Reported between 1960 and 1995						
NE	29	36	5	Provo Gas Prod.	237.7	1960
NE	31	37	9	G. Hewitt	42.7	1960
NW	28	41	13	D. Bownes	73.2	1979
	34	37	8	S. Twa	160.0	1988
NW	23	37	13	R. Holloway	142.0	1964*
SW	15	50	2	W. Ulan	87.8	1964*
SE	24	36	12	H. Plenhert	132.6	1965*
SW	22	37	13	H. Wideman	189.0	1965*
14	20	46	2	J. W. Gordon	106.7	1966*
NW	30	43	9	Mon-Max Services	67.1	1967*
SW	4	39	13	D. Coppack	106.7	1968*
NE	32	36	12	S. Mereski	82.3	1969*
9	25	42	10	Hardisty Storage	125.3	1969*
SE	14	36	12	A. McRae	118.9	1970*
NW	4	57	3	North School (Frog L. IR)	56.4	1970*
SE	19	43	2	R. Morrison	71.9	1971*
NE	3	40	5	H. Tennant	167.6	1972*
11	25	50	5	Water Res.	51.8	1972*
	19	36	11	D.&E. Dennis	173.7	1973*
NE	8	48	11	J. Veenstra	106.7	1973*
SE	36	36	12	A. Bye	137.2	1974*
NW	20	40	8	L. Crone	192.0	1974*
SW	9	39	8	R. Gilbertson	152.4	1975*
SE	18	51	2	General Crude Oil	91.4	1975*
SE	6	36	3	R. Worobo	184.1	1976*
NW	8	36	6	K. Gilmer	160.3	1976*
NE	22	36	12	C. Plehnert	137.2	1976*
SE	28	37	8	J. Ekrol	177.4	1977*
SW	36	41	9	B. Cullen	169.5	1977*
SW	16	38	13	A. Engel	117.7	1978*
NW	11	59	9	A. Severin	68.3	1978*
NW	25	36	2	J. Scheck	142.0	1979*
10	28	60	3	World Wide Energy	109.7	1982*
SW	6	41	12	P. Spady	125.6	1986*
NW	26	50	2	L. Gnyra	109.7	1989*
NW	2	53	12	E. Horon	103.6	1989*
NE	19	53	7	Jacula Farms	85.3	1990*
4	21	38	1	Pan Cdn.	218.8	1992*
8	33	42	11	C. Davidson	65.5	1994*
NE	17	42	13	B. Kuefler	76.2	1994*
SW	33	52	2	M. Hames	97.5	1995*

*reported by driller at time of well installation

ERNST WATER WELL COMPLAINT REVIEW

Prepared by:
Alexander Blyth, P.Geol., Ph.D.

Alberta Research Council Inc.
Permit to Practice P03619

Prepared for:

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December 31, 2007

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1 INTRODUCTION

The Alberta Research Council (ARC) was contracted by Alberta Environment (AENV) to conduct a review of the technical and scientific data on the subject of a complaint placed by landowner Ms. Jessica Ernst, located SE-13-027-22 W4M, near Rosebud, Alberta. The complaint was about Coal Bed Methane (CBM) activities undertaken by EnCana Corporation and her concerns about the presence of methane gas in her water well and an associated or simultaneous decrease in water quality. Historically, methane has been observed in water wells in the Rosebud area. This is an expected occurrence because most water wells in the area are completed in coal. The complainant suggests that CBM activities in the area have increased the amount of methane in her well. ARC undertook this review to assess whether the evidence suggests that energy resource extraction operations have impacted the water quality on the landowner's property through the migration of methane from the CBM well to the water wells. ARC agreed to work under contract to Alberta Environment (AENV) to independently assess the situation and provide conclusions identifying whether or not the AENV investigation suggests groundwater has been impacted by CBM or conventional oil/gas extraction activities in the area.

This report summarizes ARC's independent conclusions based on scientific and technical data surrounding the investigation of the complaint. The review is based primarily on the collected information in AENV's water well complaint file. Available scientific and technical data include groundwater quality data, water well construction characteristics, oil and gas extraction and production activities, and local groundwater gas characteristics. In addition, ARC endeavoured to compile, review and assess supplementary information not included within the complaint file. This supplementary information includes results of an evaluation of CBM Baseline water well testing data in the general area (provided by AENV and Komex), digital elevation maps and a geological cross section of the area constructed by ARC.

2 REGIONAL GEOLOGIC AND HYDROGEOLOGIC SETTING

2.1 Stratigraphy

The study area is found within the Alberta Basin. A complete review of the geology of the basin is provided in Mossop and Shetsen (1994). A brief overview is given below. The Alberta basin originated in the late Proterozoic by rifting of the North American craton Early sedimentary deposition was dominated by carbonates, evaporates and shale. Uplift of the Rocky Mountains in the early Cretaceous deposited fluvial sandstone and shale into the developing foreland basin. Sea level rises and falls during the middle to late Cretaceous resulted in deposition of marine shale and coal-bearing fluvial sandstone. Peat accumulation provided the source material for the major coal-bearing strata including the Manville, Belly River and Edmonton (including the Horseshoe Canyon Formation) groups. The latter two formations are where the EnCana CBM wells are completed. A period of compression and uplift in the Tertiary led to the deposition of fluvial sandstone, siltstone and shale. Peat accumulation provided the source material for the coals in the Cretaceous/Tertiary Scollard Formation and the Tertiary Paskapoo

APPENDIX B
WATER WELL DRILLING REPORTS

Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0123548
Map Verified:	Map
Date Report Received:	1986/05/14
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: FECKLEY, F.L.	Well Location Identifier:	
P.O. Box Number: 723	Mailing Address: ROSEBUD	Postal Code: T0J 2T0
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
SE	13	027	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: FT
How Obtain: Not Obtain

3. Drilling Information

Type of Work: Chemistry
Reclaimed Well
Date Reclaimed: Materials Used:
Method of Drilling: Drilled
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No

Proposed well use: Domestic
Anticipated Water Requirements/day 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description

5. Well Completion

Date Started(yyyy/mm/dd): Date Completed(yyyy/mm/dd):

Well Depth: 190 FT Borehole Diameter: 0 Inches

Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT

Perforations
from: 0 FT to: 0 FT
from: 0 FT to: 0 FT
from: 0 FT to: 0 FT

Perforations Size:
0 Inches x 0 Inches
0 Inches x 0 Inches
0 Inches x 0 Inches

Perforated by:

Seal:
from: 0 FT to: 0 FT
Seal:
from: 0 FT to: 0 FT
Seal:
from: 0 FT to: 0 FT

Screen Type:
from: 0 FT to: 0 FT
Screen ID: 0 Inches
Slot Size: 0 Inches

Screen Type:
from: 0 FT to: 0 FT
Screen ID: 0 Inches
Slot Size: 0 Inches

Screen Installation Method:

Fittings
Top: Bottom:

Pack:
Grain Size: Amount:

Geophysical Log Taken:
Retained on Files:

Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held: 1 Documents Held: 1

Pitless Adapter Type:
Drop Pipe Type:
Length: Diameter:

Comments:

6. Well Yield

Test Date (yyyy/mm/dd): Start Time:

Test Method:

Non pumping static level: FT

Rate of water removal: Gallons/Min

Depth of pump intake: FT

Water level at end of pumping: FT

Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery

Total Drawdown: FT

If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min

Recommended pump intake: FT

Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Report 1

Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0123549
Map Verified:	Map
Date Report Received:	1987/10/27
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: M&M DRILLING CO. LTD.		Drilling Company Approval No.: 118890
Mailing Address: BOX 1, SITE 22, RR 2	City or Town: STRATHMORE AB CA	Postal Code: T1P 1K5
WellOwner's Name: WHEATLAND, COUNTY OF	Well Location Identifier:	
P.O. Box Number: 90	Mailing Address: STRATHMORE	Postal Code: T0J 3H0
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
SE	13	027	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: FT
How Obtain: Not Obtain

3. Drilling Information

Type of Work: New Well-Abandoned
Reclaimed Well
Date Reclaimed: 1987/09/29
Materials Used: Unknown
Method of Drilling: Rotary
Flowing Well: No
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Municipal
Anticipated Water Requirements/day 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description
25	Brown Clay
32	Gray Clay
47	Gray Sandy Clay
58	Sand
89	Sandy Clay
93	Shale
95	Water Bearing Sandstone
97	Coal
105	Sandy Shale
107	Sandstone
115	Shale
127	Sandstone
137	Shale
165	Shale & Sandstone Ledges
175	Shale
177	Water Bearing Coal
185	Sandstone
200	Shale
207	Sandy Shale
210	Shale
212	Coal
232	Shale
235	Sandy Shale
251	Brown Shale
254	Sandstone
258	Shale
259	Water Bearing Coal
267	Shale
272	Sandy Shale & Sandstone Ledges
300	Shale

5. Well Completion

Date Started(yyyy/mm/dd): 1987/09/28	Date Completed(yyyy/mm/dd): 1987/09/29
Well Depth: 300 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT

Perforations
from: 0 FT to: 0 FT
from: 0 FT to: 0 FT
from: 0 FT to: 0 FT
Perforations Size:
0 Inches x 0 Inches
0 Inches x 0 Inches
0 Inches x 0 Inches

Perforated by:

Seal:
from: 0 FT to: 0 FT
Seal:
from: 0 FT to: 0 FT
Seal:
from: 0 FT to: 0 FT

Screen Type:
from: 0 FT to: 0 FT
Screen ID: 0 Inches
Slot Size: 0 Inches

Screen Type:
from: 0 FT to: 0 FT
Screen ID: 0 Inches
Slot Size: 0 Inches

Screen Installation Method:

Fittings
Top:
Bottom:

Pack:
Grain Size:
Amount:

Geophysical Log Taken:
Retained on Files:

Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held: 0
Documents Held: 2

Pitless Adapter Type:
Drop Pipe Type:
Length:
Diameter:

Comments:
DRILLER REPORTS NOT ENOUGH WATER

6. Well Yield

Test Date (yyyy/mm/dd):
Start Time:
Test Method:
Non pumping static level: FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery

Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min
Recommended pump intake: FT
Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.: VA5444
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Report 1

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0123545
Map Verified:	Map
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: LIN MURRAY DRILLING		Drilling Company Approval No.:
Mailing Address:	City or Town:	Postal Code:
WellOwner's Name: PATTERSON, JOE	Well Location Identifier:	
P.O. Box Number: 718	Mailing Address: ROSEBUD	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
SE (SW?)	11	027	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 2625 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed: Materials Used:
Method of Drilling: Rotary
Flowing Well: No
Gas Present: No
Rate: Gallons
Oil Present: No

Proposed well use: Domestic & Stock
Anticipated Water Requirements/day
0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description
30	Sandy Topsoil
32	Hard Ledges
100	Yellow Clay
160	Gray Clay
200	Gray Shale

5. Well Completion

Date Started(yyyy/mm/dd): 1977/12/12	Date Completed(yyyy/mm/dd): 1977/12/14
Well Depth: 200 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type: Steel
Size OD: 0 Inches	Size OD: 5.5 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0.156 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 200 FT
Perforations from: 120 FT to: 200 FT from: 0 FT to: 0 FT from: 0 FT to: 0 FT	Perforations Size: 0.125 Inches x 2 Inches 0 Inches x 0 Inches 0 Inches x 0 Inches
Perforated by: Torch	
Seal: Packer & Cement from: 50 FT	to: 100 FT
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	Bottom:
Pack: Grain Size:	Amount:
Geophysical Log Taken: Retained on Files:	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 1	Documents Held: 2
Pitless Adapter Type: Drop Pipe Type: Length: FT	Diameter: Inches
Comments:	

6. Well Yield

Test Date (yyyy/mm/dd): 1977/12/14	Start Time: 11:00 AM
Test Method: Bailer	
Non pumping static level:	30 FT
Rate of water removal:	2 Gallons/Min
Depth of pump intake:	0 FT
Water level at end of pumping:	FT
Distance from top of casing to ground level:	Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery
Total Drawdown: 0 FT

If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: 4 Gallons/Min

Recommended pump intake: 0 FT

Type Pump Installed
Pump Type:
Pump Model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0299882
Map Verified:	Not Verified
Date Report Received:	2002/05/06
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: GERRITSEN DRILLING		Drilling Company Approval No.: 118135
Mailing Address: BOX 187	City or Town: ROCKYFORD ALBERTA CANADA	Postal Code: T0J 2R0
WellOwner's Name: SIGNER, DEBBIE	Well Location Identifier:	
P.O. Box Number:	Mailing Address: 916 EAST CHESTERMERE DR,	Postal Code: T1X 1A8
City: CHESTERMERE	Province: AB	Country: CA

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
SE	10	027	22	4

Location in Quarter
0 FT from S Boundary
0 FT from W Boundary

Lot Block Plan

Well Elev: FT
How Obtain: Not Obtain

3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed:
Materials Used: Unknown

Proposed well use: Domestic
Anticipated Water Requirements/day 300 Gallons

Method of Drilling: Rotary

Flowing Well: No
Gas Present: No
Rate: Gallons
Oil Present: No

4. Formation Log

Depth from ground level (feet)	Lithology Description
17	Tan Till
21	Brown Fine Grained Gravel
42	Blue Till & Clay
123	Blue Till & Rocks
126	Blue Clay
177	Blue Shale
181	Coal
184	Dark Gray Shale

5. Well Completion

Date Started(yyyy/mm/dd): 2002/02/05	Date Completed(yyyy/mm/dd): 2002/02/07
Well Depth: 184 FT	Borehole Diameter: 0 Inches
Casing Type: Plastic	Liner Type: Plastic
Size OD: 6 Inches	Size OD: 4.5 Inches
Wall Thickness: 0.38 Inches	Wall Thickness: 0.237 Inches
Bottom at: 135 FT	Top: 124 FT Bottom: 184 FT

Perforations
from: 174 FT to: 184 FT — Perforations Size: 0.187 Inches x 3 Inches
from: 0 FT to: 0 FT — 0 Inches x 0 Inches
from: 0 FT to: 0 FT — 0 Inches x 0 Inches

Perforated by: Saw

Seal: Driven & Bentonite
from: 0 FT to: 135 FT
Seal: Unknown
from: 0 FT to: 0 FT
Seal: Benseal
from: 0 FT to: 0 FT

Screen Type: Unknown — Screen ID: 0 Inches
from: 0 FT to: 0 FT — Slot Size: 0 Inches

Screen Type: Unknown — Screen ID: 0 Inches
from: 0 FT to: 0 FT — Slot Size: 0 Inches

Screen Installation Method: Unknown

Fittings
Top: Unknown — Bottom: Unknown

Pack: Unknown
Grain Size: — Amount: Unknown

Geophysical Log Taken:
Retained on Files:

Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held: 0 — Documents Held: 3

Pitless Adapter Type:
Drop Pipe Type:
Length: FT — Diameter: Inches

Comments:
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 27".

6. Well Yield

Test Date (yyyy/mm/dd): 2002/02/07
Start Time: 11:00 AM
Test Method: Pump

Non pumping static level: 20.407 FT
Rate of water removal: 1.66 Gallons/Min
Depth of pump intake: 184.7 FT
Water level at end of pumping: 80.9 FT
Distance from top of casing to ground level: 27 Inches

Depth To water level (feet) / Elapsed Time

Drawdown	Minutes:Sec	Recovery
20.407	0:00	74.245
22.835	2:00	71.785
24.344	4:00	69.783
24.475	6:00	67.88
22.31	8:00	66.109
25.459	10:00	64.436
34.186	12:00	62.861
37.664	14:00	61.352
40.322	16:00	59.974
42.716	18:00	58.629
45.013	20:00	57.382
47.146	22:00	56.201
49.114	24:00	55.085
50.984	26:00	54.035
52.723	28:00	53.051
54.429	30:00	52.1
55.971	32:00	51.214
57.448	34:00	50.361
58.727	36:00	49.541
59.941	38:00	48.786
61.056	40:00	48.064
62.238	42:00	47.375
63.32	44:00	46.719
64.239	46:00	46.096
65.289	48:00	45.505

Total Drawdown: 60.696 FT

If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: 1.58 Gallons/Min
Recommended pump intake: 183.7 FT

Type Pump Installed
Pump Type:
Pump Model:
H.P.:
Any further pumptest information? No

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.: 1

This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.

Signature Yr Mo Day

EUB Alberta Energy and Utilities Board

Factors Affecting or Indicating Potential Wellbore Leakage

Dr. Stefan Bachu

Alberta Energy and Utilities Board
Stefan.Bachu@gov.ab.ca

Theresa Watson

T.L. Watson and Associates Inc.
Theresa.Watson@TLWatson.com

EUB Alberta Energy and Utilities Board

Alberta Geological Survey
AGS

T.L. WATSON & ASSOCIATES INC.

AGS

EUB Alberta Energy and Utilities Board

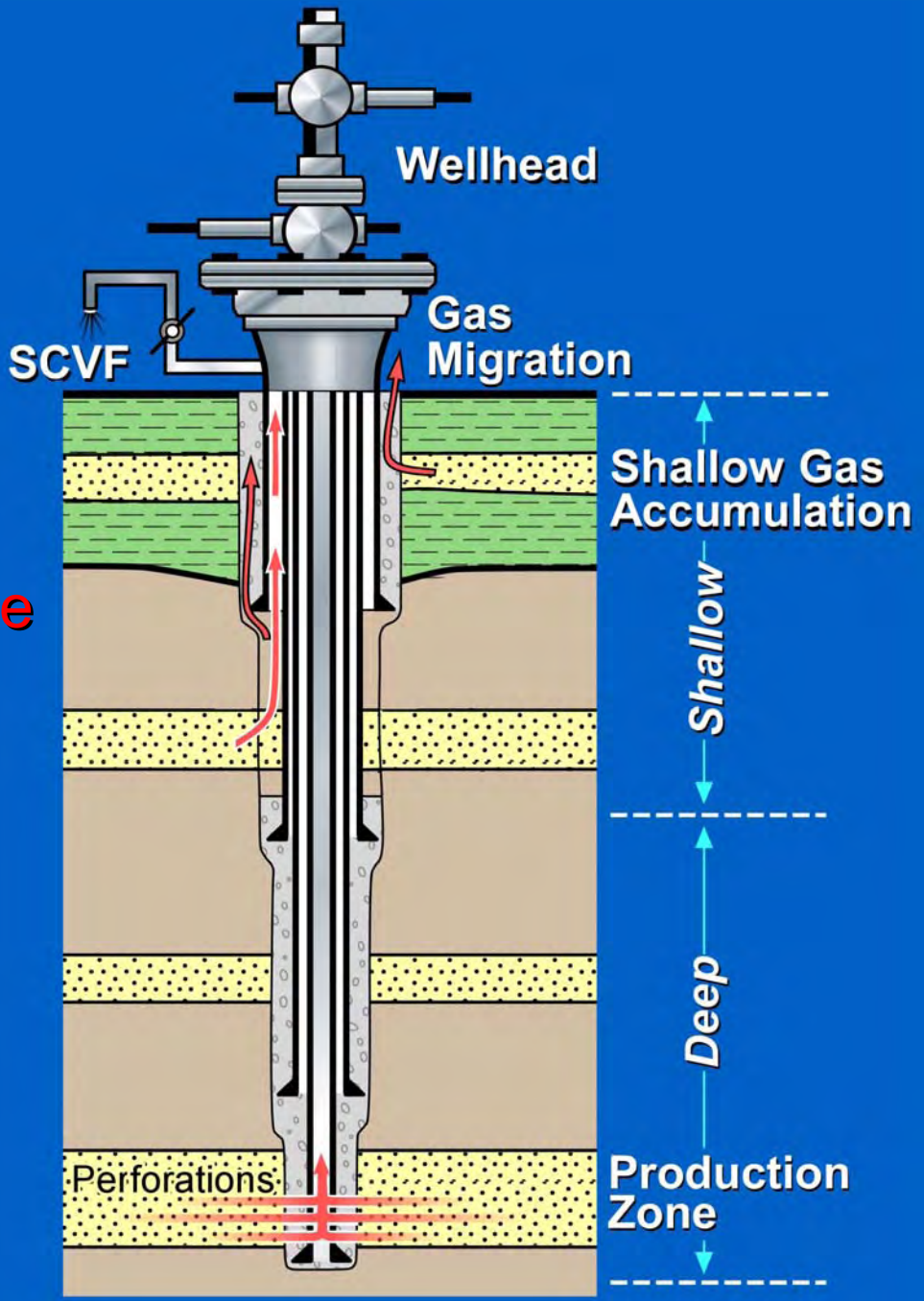
Leakage Potential along a Well

Shallower, upper part

Higher potential for leakage

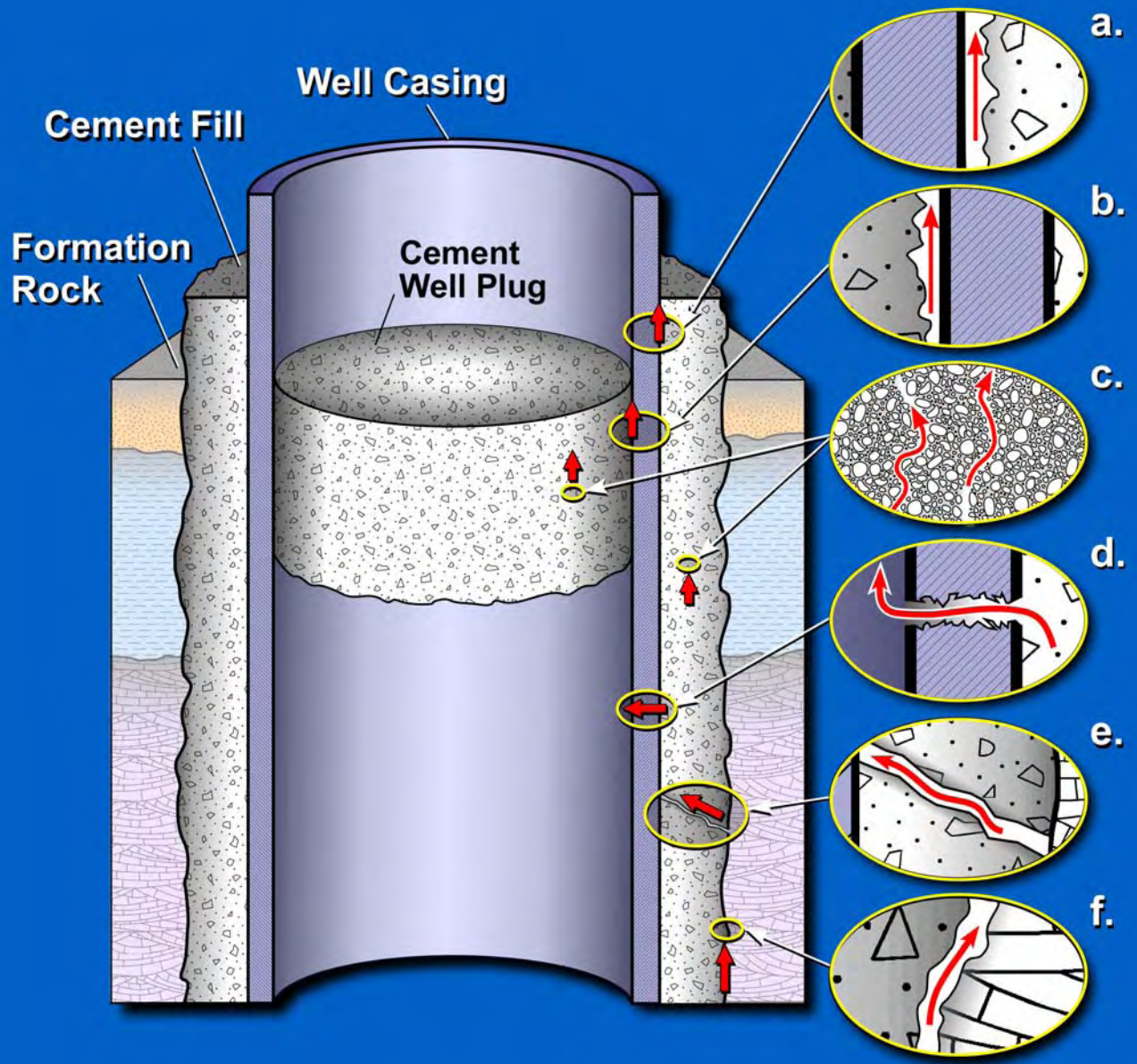
Deep, lower part completed in producing zones

Less potential for leakage



AGS

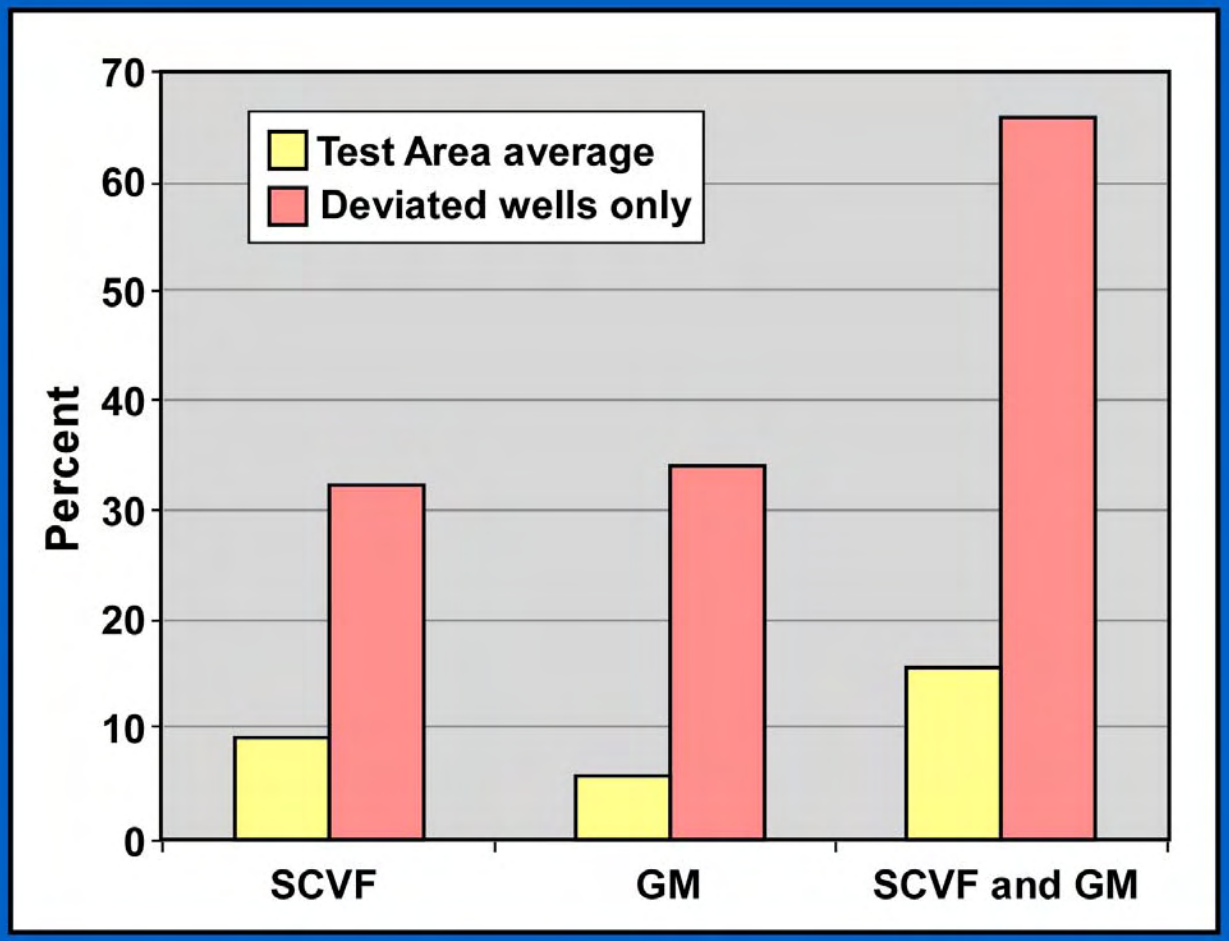
Potential Gas Migration Paths along a Well



Factors of Major Impact

- Geographic area (Test Area)
- Well deviation
- Well type:
  - drilled and abandoned (SCVF/GM incidence rate of 0.5%)
  - cased and abandoned (SCVF/GM incidence rate of 14%), for 98% of the total
- Abandonment method (bridge plugs, welded caps)
- Economic activity, regulatory changes and SCVF/GM testing
- Uncemented casing/hole annulus!

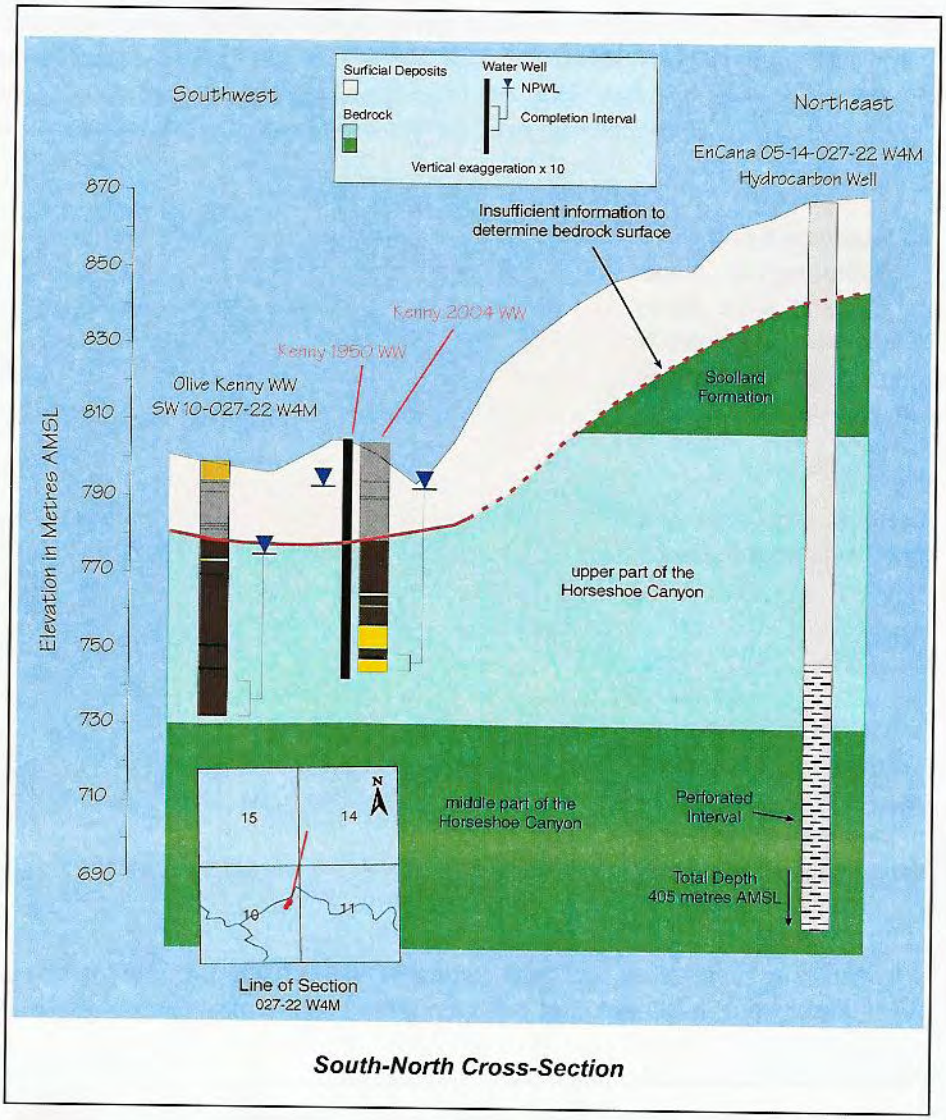
Occurrence of SCVF/GM in the Test Area, Alberta



6. INTERPRETATION

6.1. Aquifers

The SK 1950 WW and the SK 2004 WW are completed in the same hydraulic unit within the upper part of the Horseshoe Canyon Formation. The elevations of the water levels in both water wells are similar; there is no significant difference in the chemical quality of the groundwater from the two water wells and pumping from the SK 1950 WW causes measured drawdown in the water level in the SK 2004 WW. The vertical relationship between the elevation of the completion depths and the non-pumping water levels in the SK 1950 WW and the SK 2004 WW is shown in the adjacent cross-section.



South-North Cross-Section

Also shown on the cross-section is the EnCana 05-14 Gas Well and the perforation interval of the gas well when stimulated on 02 Mar 04. The cross-section shows the top of the perforated interval at an elevation of 747.45 metres AMSL, which coincides closely with the top of the completion interval of the SK 2004 WW.

The stimulation of the EnCana 05-14 Gas Well used nitrogen gas and the estimated pressure outside the perforations is nine megaPascals. Based on an aquifer model, the pressure change measured at the SK 1950 and SK 2004 water wells as a result of the stimulation would be in the order of 0.2 kiloPascals. As a result of flowing the 05-14 Gas Well for 76 days after stimulation, very little if any nitrogen gas would be expected to remain in the coal zone in the 125.5- to 126.5-metres below KB interval.

6.2. Sean Kenny 2004 Water Well

The interpretation of the turbidity data indicates that there are two sources of sediment in the groundwater from the SK 2004 WW. The first source is the groundwater running down the outside of the liner; the second source is the sandstone layers below the coal zone. When the water well is not being pumped, there is a gradual flow of groundwater down the annulus.

Owner: **Encana Corporation**
[unknown], AB

Contractor: **[unknown contractor]**
Well Name: **PCP ET AL 102 REDLAND 6-4-27-22**

METRIC REPORT

Easting (m): **136250** ** 84/83
Northing (m): **5680226** **
Elevation (m): **849.0** ***
Google Earth

06-04-027-22 W4M

M38268.500012

Work Type: **Gas Well**
Drilling Method: **Drilled**
Proposed Use: **Industrial**
Completion Type: **Casing/Perforated Liner**

Date Started: **June 21, 2001**
Date Completed: **June 25, 2001**

Elog Taken: **No**
Gamma Taken: **No**
Stick Up (m): **0.0**
Flowing: **No**

General Details

Depth Completed (m): **138.5**
Depth Drilled (m): **457.0**
Completion Interval (m): **100.5 — 138.5** *

Completion Details

Surface Casing: **[unknown] — 177.8 mm (O.D.) x 2.00 mm (thick) x 78.00 m (bottom)**
Liner: **[unknown] — 114.3 mm (O.D.) x 2.00 mm (thick)**

Intervals

(Liner Bottom at: 456.0 m

Completion Interval: *Slotted*: **100.5** to **101.5 m** - **2** - Method: **Other**
Completion Interval: *Slotted*: **109.0** to **111.0 m** - **2** - Method: **Other**
Completion Interval: *Slotted*: **114.8** to **115.8 m** - **2** - Method: **Other**
Completion Interval: *Slotted*: **119.8** to **120.8 m** - **2** - Method: **Other**
Completion Interval: *Slotted*: **126.2** to **128.2 m** - **2** - Method: **Other**
Completion Interval: *Slotted*: **135.5** to **138.5 m** - **2** - Method: **Other**

Lithology Details

Elevation (AMSL)	Depth (BGL)	Lithology Descriptions (1)
392.0	457.0	[unknown]

Chemistry Summary Details (mg/L, except as noted)

(most recent first)

General Comments / Observations

HCL well added to be included in a x-sec for 04-510. perforations are representative of coal layers. perforations performed with nitrogen gas. Objective of perforations was to obtain coal bed methane gas production.

Oil Present: **No**
Gas Present: **No**

Aquifer Tests

Alias IDs

* **TGWC** calculated or determined value.
** 84 - Surveyed (other) — 10TM NAD83
*** 83 - Surveyed (other) — {Ground ; AMSL}

ERCB WELL DRILLING OCCURRENCE DATA			
WELL NAME:	PCP ET AL 102 REDLAND 6-4-27-22	**FIELD:**	REDLAND
POOL:		**OIL SANDS AREA:**	
OIL SANDS DEPOSIT:		**DOWNHOLE OFFSETS:**	N 752 E 470.2
ACTUAL DOWNHOLE LATITUDE:	51.277517	**LONGITUDE:**	113.045462
THEORETICAL DOWNHOLE LATITUDE:	0	**LONGITUDE:**	0
GROUND ELEVATION:	849	**KB ELEVATION:**	853
CF ELEVATION:	0	**WELL TOTAL DEPTH:**	461
TRUE VERTICAL DEPTH:	0	**PB DEPTH:**	0
SPUD DATE:	JUNE 21, 2001	**FINAL DRILL DATE:**	JUNE 25, 2001
RIG RELEASE DATE:	JUNE 26, 2001	**ON PRODUCTION DATE:**	
DRILLING CONTRACTOR:		**RIG NUMBER:**	4

ERCB WELL TOPS & MARKERS DATA

GEO REVISED DATE	TYPE	FORMATION	DEPTH	QUALITY	DESCRIPTION
	LOG	BEARPAW FM	365.7	GOOD PICK FROM LOGS	TOP OF UNIT
	LOG	BELLY RIVER GRP	399.8	GOOD PICK FROM LOGS	TOP OF UNIT

ERCB WELL LOG DATA

LOG RUN NUMBER	LOG RUN DATE	LOG TYPE	TOP INTERVAL	BASE INTERVAL	DESCRIPTION
1	Jun 26 2001	MICRO LOG	82.6	455.8	
1	Jun 26 2001	COMP NEUTRON LITHO DENSITY	82.6	455.8	
1	Jun 26 2001	DUAL INDUCTION LOG	82.6	458.8	

There is no DST data for this well.

There is no Tour - Occurrence data for this well.

There is no Tour - Direction Drilling data for this well.

ERCB WELL TOUR - CASING DATA

DATE	CASING	SIZE	SHOE SET DEPTH	LINER TOP DEPTH	DENSITY	STEEL PROCESS	YIELD STRENGTH	COLLAR TYPE	MXD STRING
Jun 21 2001	INTERMEDIATE	177.8	82	0	25.3		40		
Jun 26 2001	PRODUCTION	114.3	460	0	14.1	J	55		

ERCB WELL TOUR - CEMENTING DATA

STAGE NO	UNIT	AMOUNT	TYPE	RECEMENT
0	TONNEST	2.6	CLASS A NEAT	0
0	TONNEST	6	LIGHT WEIGHT	0

There is no Tour - Cores Cut data for this well.

ERCB WELL TOUR - PERFORATION / TREATMENT DATA

DATE	TYPE	INTERVAL TOP	INTERVAL BASE	SHOTS
Aug 2 2001	JET PERFORATION	416.8	417.8	13
Aug 2 2001	JET PERFORATION	413.3	414.3	13
Aug 2 2001	JET PERFORATION	410.3	411.3	13
Aug 2 2001	JET PERFORATION	403.4	404.4	13
Aug 2 2001	JET PERFORATION	399.9	400.9	13
Aug 2 2001	JET PERFORATION	359	363	13
Aug 2 2001	JET PERFORATION	342.4	343.4	13
Aug 2 2001	JET PERFORATION	334	336	13
Aug 2 2001	JET PERFORATION	326.5	328.5	13
Aug 2 2001	JET PERFORATION	273	276	13
Aug 2 2001	JET PERFORATION	271	273	13
Aug 2 2001	JET PERFORATION	265.7	267.7	13
Aug 2 2001	JET PERFORATION	242	245	13
Aug 2 2001	JET PERFORATION	238.8	239.8	13
Aug 2 2001	JET PERFORATION	234	235	13
Aug 2 2001	JET PERFORATION	227.3	228.3	13

Aug 2 2001	JET PERFORATION	221.8	224.8	13
Aug 2 2001	JET PERFORATION	213.6	214.6	13
Aug 2 2001	JET PERFORATION	168.3	169.3	13
Aug 2 2001	JET PERFORATION	145.5	146.5	13
Aug 2 2001	JET PERFORATION	139.5	142.5	13
Aug 2 2001	JET PERFORATION	130.2	132.2	13
Aug 2 2001	JET PERFORATION	123.8	124.8	13
Aug 2 2001	JET PERFORATION	118.8	119.8	13
Aug 2 2001	JET PERFORATION	113	115	13
Aug 2 2001	JET PERFORATION	104.5	105.5	13
Sep 30 2001	FRACTURED	213.6	417.8	0
Sep 22 2004	CEMENT SQUEEZE	104.5	417.8	0

There is no Tour - Initial Production data for this well.

ERCB WELL TOUR - PLUG BACK / ABANDONMENT DATA

DATE	RUN TYPE	INTERVAL TOP	INTERVAL BASE	CEMENT UNIT	CEMENT AMOUNT	TOP FOUND DEPTH	SURF ABAND DATE
Sep 22 2004	ABANDON A ZONE	104.5	417.8	TONNEST	4.6	104.5	

ERCB WELL STATUS HISTORY DATA

DATE	STATUS
Jun 13 2001	
Jun 26 2001	DRL&C
Sep 22 2004	ABZONE
Oct 8 2004	ABD

There is no Completion data for this well.

There is no Production Control data for this well.

Owner: ***EnCana Corporation***
[unknown], AB

Contractor: ***[unknown saskatchewan contractor]***
Well Name: ***ECA ECOG HUSSAR 5-14-27-22***

METRIC REPORT

Easting (m): ***139,003*** ** 84/83
Northing (m): ***5,683,326*** **
Elevation (m): ***868.5*** ***
Google Earth

05-14-027-22 W4M

M38268.500313

Work Type: ***Gas Well***
Drilling Method: ***Drilled***
Proposed Use: ***Industrial***
Completion Type: ***Casing/Perforated Liner***

Date Started: ***Oct 13, 2003***
Date Completed: ***Oct 13, 2003***

Elog Taken: ***No***
Gamma Taken: ***No***

Flowing: ***No***

General Details

Depth Completed (m): ***219.0***
Depth Drilled (m): ***463.0***

Completion Interval (m): ***121.5 — 219.0 ****

Completion Details

Surface Casing: ***[unknown] — 177.8 mm (O.D.) x 2.00 mm (thick) x 81.00 m (bottom)***
Liner: ***[unknown] — 114.3 mm (O.D.) x 2.00 mm (thick)***

Intervals

(Liner Bottom at: 463.0 m

-- Completion Interval(s) --

Slotted: ***121.5*** to ***122.5 m*** - ***2*** - Method: ***Other***
Slotted: ***127.7*** to ***130.0 m*** - ***2*** - Method: ***Other***
Slotted: ***137.4*** to ***138.4 m*** - ***2*** - Method: ***Other***
Slotted: ***173.1*** to ***174.1 m*** - ***2*** - Method: ***Other***
Slotted: ***182.1*** to ***183.1 m*** - ***2*** - Method: ***Other***
Slotted: ***216.1*** to ***219.0 m*** - ***2*** - Method: ***Other***

Lithology Details

Elevation (AMSL)	Depth (BGL)	Lithology Descriptions (1)
405.5	463.0	[unknown]

Chemistry Summary Details (mg/L)

(most recent first)

General Comments / Observations

HC well added to be included in a x-sec for 04-510. Perforations are representative of coal layers. Perforations performed with nitrogen gas. Objective of perforations was to obtain coal bed methane gas production.

Oil Present: ***No***
Gas Present: ***No***
Observations (water): Colour: ; Odor: ; Quality:

Aquifer Tests

Alias IDs

** **TGWC** calculated or determined value.*
*** 84 - Surveyed (other) — 10TM NAD83*
**** 83 - Surveyed (other) — {Ground ; AMSL}*

PRINT REPORT CLOSE REPORT

WELL ID: 00 / 05-14-027-22 W4 / 0

ERCB COMPANY INFORMATION
CURRENT TO November 30, 2009

COMPANY NAME:	ENCANA CORPORATION		
ADDRESS:	Box 2850, 150 - 9 Avenue SW Calgary, AB T2P 2S5		
PHONE #:	403-645-2000	**BUSINESS ASSOCIATE CODE:**	0026

ERCB WELL PRODUCTION DATA
CURRENT TO OCTOBER 6, 2009

AVERAGE DAILY PRODUCTION RATE

WATER

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2004	0	0	0	0	0	0	0	96	0	0	0	0

ERCB WELL LICENSING DATA

UNIQUE WELL ID:	0274221405000	**WELL LICENCE NUMBER:**	0293679
REGULATION SECTION:	Section 2.020	**WELL LICENCE DATE:**	SEPTEMBER 24, 2003
SURFACE LOCATION:	05-14-027-22 W4	**SURFACE OFFSETS:**	N 570 E 40
ACTUAL SURFACE LATITUDE:	51.304912	**LONGITUDE:**	113.004771
THEORETICAL SURFACE LATITUDE:	0	**LONGITUDE:**	0
LICENCEE:	ENCANA CORPORATION		
ERCB AREA OFFICE:	MIDNAPORE	**TERMINATING FORMATION:**	BELLY RIVER GRP
LAHEE CLASSIFICATION:	DEVELOPMENT	**CONFIDENTIAL STATUS:**	NON CONFIDENTIAL
SURFACE OWNER:	FREEHOLD	**MINERAL RIGHTS OWNER:**	FREEHOLD
AGREEMENT NUMBER:		**AGREEMENT TYPE:**	
AGREEMENT EXPIRY DATE:		**DRILL COST AREA:**	
SCHEME APPROVAL NUMBER:		**SCHEME EXPIRY DATE:**	
INCENTIVE CERTIFICATE NUMBER:	00000	**INCENTIVE CERTIFICATE DATE:**	
SURFACE ABANDONED TYPE:	PLATE	**SURFACE ABANDONED DATE:**	AUGUST 31, 2009

ERCB WELL DRILLING OCCURRENCE DATA

WELL NAME:	ECA ECOG HUSSAR 5-14-27-22	**FIELD:**	HUSSAR
POOL:	BR UND	**OIL SANDS AREA:**	
OIL SANDS DEPOSIT:		**DOWNHOLE OFFSETS:**	N 570 E 40
ACTUAL DOWNHOLE LATITUDE:	51.304912	**LONGITUDE:**	113.004771
THEORETICAL DOWNHOLE LATITUDE:	0	**LONGITUDE:**	0
GROUND ELEVATION:	868.5	**KB ELEVATION:**	872.5
CF ELEVATION:	0	**WELL TOTAL DEPTH:**	467
TRUE VERTICAL DEPTH:	0	**PB DEPTH:**	0
SPUD DATE:	OCTOBER 13, 2003	**FINAL DRILL DATE:**	OCTOBER 13, 2003
RIG RELEASE DATE:	OCTOBER 13, 2003	**ON PRODUCTION DATE:**	
DRILLING CONTRACTOR:		**RIG NUMBER:**	34

ERCB WELL TOPS & MARKERS DATA

GEO REVISED DATE	TYPE	FORMATION	DEPTH	QUALITY	DESCRIPTION
	LOG	BELLY RIVER GRP	415.4	GOOD PICK FROM LOGS	TOP OF UNIT

ERCB WELL LOG DATA

LOG RUN NUMBER	LOG RUN DATE	LOG TYPE	TOP INTERVAL	BASE INTERVAL	DESCRIPTION
1	Jun 27 2004	GAMMA RAY CEMENT BOND	5	120	
1	Jun 29 2004	COLLAR LOG	105	180	
1	Nov 7 2003	COMP NEUTRON SONIC	50	450	

There is no DST data for this well.

There is no Tour - Occurrence data for this well.

There is no Tour - Direction Drilling data for this well.

ERCB WELL TOUR - CASING DATA

DATE	CASING	SIZE	SHOE SET DEPTH	LINER TOP DEPTH	DENSITY	STEEL PROCESS	YIELD STRENGTH	COLLAR TYPE	MXD STRING
Oct 10 2003	SURFACE	177.8	85	0	25.3	H	40		
Oct 13 2003	PRODUCTION	114.3	467	0	14.1	J	55		

ERCB WELL TOUR - CEMENTING DATA				
STAGE NO	**UNIT**	**AMOUNT**	**TYPE**	**RECEMENT**
0	TONNEST	4	CLASS G NEAT	0
0	TONNEST	6	CLASS G NEAT	0

There is no Tour - Cores Cut data for this well.

ERCB WELL TOUR - PERFORATION / TREATMENT DATA				
DATE	**TYPE**	**INTERVAL TOP**	**INTERVAL BASE**	**SHOTS**
Feb 15 2004	JET PERFORATION	418.9	419.9	13
Feb 15 2004	JET PERFORATION	415.5	416.5	13
Feb 15 2004	JET PERFORATION	374.3	375.3	13
Feb 15 2004	JET PERFORATION	371.7	372.7	13
Feb 15 2004	JET PERFORATION	358.4	359.4	13
Feb 15 2004	JET PERFORATION	354.5	355.5	13
Feb 15 2004	JET PERFORATION	347.8	348.8	13
Feb 15 2004	JET PERFORATION	342.6	343.6	13
Feb 15 2004	JET PERFORATION	284.9	286.9	13
Feb 15 2004	JET PERFORATION	283.5	284.5	13
Feb 15 2004	JET PERFORATION	259.3	260.3	13
Feb 15 2004	JET PERFORATION	248	250	13
Feb 15 2004	JET PERFORATION	244.9	245.9	13
Feb 15 2004	JET PERFORATION	238.6	239.6	13
Feb 15 2004	JET PERFORATION	234.6	235.6	13
Feb 15 2004	JET PERFORATION	228.7	230.7	13
Feb 15 2004	JET PERFORATION	222	223	13
Feb 15 2004	JET PERFORATION	220.1	221.1	13
Feb 15 2004	JET PERFORATION	186.1	187.1	13
Feb 15 2004	JET PERFORATION	177.1	178.1	13
Feb 15 2004	JET PERFORATION	141.4	142.4	13
Feb 15 2004	JET PERFORATION	133	134	13
Feb 15 2004	JET PERFORATION	131.7	132.7	13
Feb 15 2004	JET PERFORATION	125.5	126.5	13
Mar 2 2004	FRACTURED	131.7	419.9	0
Jul 12 2004	CEMENT SQUEEZE	141.4	142.4	0

Jul 12 2004	CEMENT SQUEEZE	133	134	0
Jul 12 2004	CEMENT SQUEEZE	131.7	132.7	0
Jul 12 2004	CEMENT SQUEEZE	125.5	126.5	0
Oct 10 2004	CEMENT PLUG	17	425	0

There is no Tour - Initial Production data for this well.

ERCB WELL TOUR - PLUG BACK / ABANDONMENT DATA

DATE	RUN TYPE	INTERVAL TOP	INTERVAL BASE	CEMENT UNIT	CEMENT AMOUNT	TOP FOUND DEPTH	SURF ABAND DATE
Oct 10 2004	ABANDON A ZONE	17	425	METRESM	408	17	

ERCB WELL STATUS HISTORY DATA

DATE	STATUS
Sep 24 2003	
Oct 13 2003	DRL&C
Jun 3 2004	GAS TEST
Oct 10 2004	GAS ABZONE
Aug 31 2009	GAS ABD

ERCB WELL COMPLETION DATA

INITIAL INTERVAL TOP	INITIAL INTERVAL BOTTOM
177.1	419.9

ERCB WELL PRODUCTION CONTROL DATA

WELL NAME:	ECA ECOG HUSSAR 5-14-27-22
FIELD NAME:	HUSSAR
POOL NAME:	BR UND
RECOVERY MECHANISM:	Natural Depletion
WELL STATUS FLUID:	Gas
WELL STATUS MODE:	Abandoned

PRINT REPORT CLOSE REPORT

WELL ID: 00 / 03-23-043-28 W4 / 0

EUB COMPANY INFORMATION
CURRENT TO June 29, 2007

COMPANY NAME:	ENCANA CORPORATION		
ADDRESS:	Box 2850, 150 - 9 Avenue SW Calgary, AB T2P 2S5		
PHONE #:	403-645-2000	**BUSINESS ASSOCIATE CODE:**	0026

EUB WELL PRODUCTION DATA
CURRENT TO MAY 25, 2007

AVERAGE DAILY PRODUCTION RATE

CONDENSATE

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2005	0	0	0	0	0	0	0	0	0	0.017	0	0

GAS

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2005	0	0	0	0	0	0	0	0	2.75	1.775	2.337	2.397
2006	2.273	2.121	1.763	1.057	2.268	1.282	1.945	1.654	1.647	1.453	1.207	0.473
2007	0.46	0.429	0.435	0.533	0	0	0	0	0	0	0	0

WATER

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2005	0	0	0	0	0	0	0	0	0.025	0.126	0.05	0.026
2006	0.039	0	0.013	0.017	0.021	0.017	0	0.007	0	0	0	0
2007	0	0	0.132	0	0	0	0	0	0	0	0	0

EUB WELL LICENSING DATA

UNIQUE WELL ID:	0434282303000	**WELL LICENCE NUMBER:**	0325145
REGULATION SECTION:	Section 2.020	**WELL LICENCE DATE:**	JANUARY 26, 2005
SURFACE LOCATION:	04-23-043-28 W4	**SURFACE OFFSETS:**	N 314.9 E 62.5
ACTUAL SURFACE LATITUDE:	52.715384	**LONGITUDE:**	113.969106
THEORETICAL SURFACE LATITUDE:	0	**LONGITUDE:**	0
LICENCEE:	ENCANA CORPORATION		
EUB AREA OFFICE:	RED DEER	**TERMINATING FORMATION:**	HORSESHOE CANYON FM
LAHEE CLASSIFICATION:	DEVELOPMENT	**CONFIDENTIAL STATUS:**	NON CONFIDENTIAL
SURFACE OWNER:	FREEHOLD	**MINERAL RIGHTS OWNER:**	FREEHOLD
AGREEMENT NUMBER:		**AGREEMENT TYPE:**	
AGREEMENT EXPIRY DATE:		**DRILL COST AREA:**	
SCHEME APPROVAL NUMBER:		**SCHEME EXPIRY DATE:**	

INCENTIVE CERTIFICATE NUMBER:	00000	**INCENTIVE CERTIFICATE DATE:**	
SURFACE ABANDONED TYPE:		**SURFACE ABANDONED DATE:**	

EUB WELL DRILLING OCCURRENCE DATA

WELL NAME:	ECA 3C FBANK 3-23-43-28	**FIELD:**	FERRYBANK
POOL:	HRSSH CAN UND	**OIL SANDS AREA:**	
OIL SANDS DEPOSIT:		**DOWNHOLE OFFSETS:**	N 292.3 E 429.4
ACTUAL DOWNHOLE LATITUDE:	52.715173	**LONGITUDE:**	113.963672
THEORETICAL DOWNHOLE LATITUDE:	0	**LONGITUDE:**	0
GROUND ELEVATION:	922.7	**KB ELEVATION:**	927
CF ELEVATION:	0	**WELL TOTAL DEPTH:**	813
TRUE VERTICAL DEPTH:	723.5	**PB DEPTH:**	0
SPUD DATE:	FEBRUARY 21, 2005	**FINAL DRILL DATE:**	JULY 5, 2005
RIG RELEASE DATE:	JULY 6, 2005	**ON PRODUCTION DATE:**	SEPTEMBER 23, 2005
DRILLING CONTRACTOR:	PRECISION DRILLING CORPORATION	**RIG NUMBER:**	292

There is no Tops & Markers data for this well.

EUB WELL LOG DATA

LOG RUN NUMBER	LOG RUN DATE	LOG TYPE	TOP INTERVAL	BASE INTERVAL	DESCRIPTION
1	Jul 17 2005	COMP NEUTRON SONIC	50	790	
2	Jul 17 2005	COMP NEUTRON SONIC	50	790	TVD

There is no DST data for this well.

EUB WELL TOUR - OCCURRENCE DATA

TYPE	OPERATOR PROG	DATE	DEPTH	MUD DENSITY	VISCTY	CNTRL DATE	CNTRL DEPTH	FNL MUD DENSITY	FNL VISCTY	WATER SEVERTY	WATER FLOW RATE	CIRCLN SEVERTY	LOST CIRCLN VOLUME
LOST CIRCULATION	DRILLING	Jul 5 2005	125	1050	999	Jul 5 2005	713	1050	999		0	SEVERE	146

EUB WELL TOUR - DIRECTION DRILLING DATA

START DATE	DEPTH	REASON
Feb 21 2005	0.1	DEVIATION TO HIT A POOL

EUB WELL TOUR - CASING DATA

DATE	CASING	SIZE	SHOE SET DEPTH	LINER TOP DEPTH	DENSITY	STEEL PROCESS	YIELD STRENGTH	COLLAR TYPE	MXD STRING
Feb 21 2005	SURFACE	177.8	85.3	0	25.3	H	40		
Jul 6 2005	PRODUCTION	114.3	813	0	14.1	J	55		

EUB WELL TOUR - CEMENTING DATA

STAGE NO	UNIT	AMOUNT	TYPE	RECEMENT
0	TONNEST	2.6	CLASS G NEAT	0
0	TONNEST	10	LIGHT WEIGHT	0

There is no Tour - Cores Cut data for this well.

EUB WELL TOUR - PERFORATION / TREATMENT DATA

DATE	TYPE	INTERVAL TOP	INTERVAL BASE	SHOTS
Jul 29 2005	JET PERFORATION	774.1	775.1	13
Jul 29 2005	JET PERFORATION	767.9	768.9	13
Jul 29 2005	JET PERFORATION	762.9	763.9	13
Jul 29 2005	JET PERFORATION	761.5	762.5	13
Jul 29 2005	JET PERFORATION	753	755	13
Jul 29 2005	JET PERFORATION	741.9	742.9	13
Jul 29 2005	JET PERFORATION	727.1	728.1	13
Jul 29 2005	JET PERFORATION	714.6	716.6	13
Jul 30 2005	JET PERFORATION	711.9	712.9	13
Jul 30 2005	JET PERFORATION	702.5	703.5	13
Jul 30 2005	JET PERFORATION	699.1	700.1	13
Jul 30 2005	JET PERFORATION	665.8	666.8	13
Jul 30 2005	JET PERFORATION	635.3	636.3	13
Jul 30 2005	JET PERFORATION	630.7	631.7	13
Jul 30 2005	JET PERFORATION	627.6	628.6	13
Jul 30 2005	JET PERFORATION	623.3	626.3	13
Jul 30 2005	JET PERFORATION	620.6	621.6	13
Jul 30 2005	JET PERFORATION	574.9	575.9	13
Jul 30 2005	JET PERFORATION	556.3	557.3	13
Jul 30 2005	JET PERFORATION	554.1	555.1	13
Jul 30 2005	JET PERFORATION	508.3	509.3	13
Jul 30 2005	JET PERFORATION	382.2	386.2	13
Jul 30 2005	JET PERFORATION	372.9	373.9	13
Jul 30 2005	JET PERFORATION	367.1	369.1	13
Aug 28 2005	FRACTURED	367.1	742.9	0
Nov 25 2006	JET PERFORATION	485	487	13
Dec 5 2006	FRACTURED	485	487	0

There is no Tour - Initial Production data for this well.

There is no Tour - Plug Back / Abandonment data for this well.

EUB WELL STATUS HISTORY DATA

DATE	STATUS
Jan 26 2005	
Jul 5 2005	DRL&C
Sep 20 2005	TEST
Sep 23 2005	FLOW

EUB WELL COMPLETION DATA

INITIAL INTERVAL TOP	INITIAL INTERVAL BOTTOM
367.1	775.1

PRINT REPORT CLOSE REPORT

WELL ID: 02 / 02-23-043-28 W4 / 0

EUB COMPANY INFORMATION
CURRENT TO June 29, 2007

COMPANY NAME:	ENCANA CORPORATION		
ADDRESS:	Box 2850, 150 - 9 Avenue SW Calgary, AB T2P 2S5		
PHONE #:	403-645-2000	**BUSINESS ASSOCIATE CODE:**	0026

EUB WELL PRODUCTION DATA
CURRENT TO MAY 25, 2007

AVERAGE DAILY PRODUCTION RATE

GAS

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2005	0	0	0	0	0	0	0	0	1.202	1.263	1.27	0.995
2006	1.113	1.12	1.017	0.838	1.104	0.956	0.896	1.003	0.993	0.879	0.728	0.77
2007	0.807	0.75	0.767	0.94	0	0	0	0	0	0	0	0

WATER

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2005	0	0	0	0	0	0	0	0	0.009	0.091	0.027	0.01
2006	0.019	0	0.006	0.014	0.011	0.013	0	0.003	0	0	0	0
2007	0	0	0	0.074	0	0	0	0	0	0	0	0

EUB WELL LICENSING DATA

UNIQUE WELL ID:	0434282302020	**WELL LICENCE NUMBER:**	0324098
REGULATION SECTION:	Section 2.020	**WELL LICENCE DATE:**	JANUARY 12, 2005
SURFACE LOCATION:	02-23-043-28 W4	**SURFACE OFFSETS:**	N 259 W 518.9
ACTUAL SURFACE LATITUDE:	52.71486	**LONGITUDE:**	113.953848
THEORETICAL SURFACE LATITUDE:	0	**LONGITUDE:**	0
LICENCEE:	ENCANA CORPORATION		
EUB AREA OFFICE:	RED DEER	**TERMINATING FORMATION:**	HORSESHOE CANYON FM
LAHEE CLASSIFICATION:	DEVELOPMENT	**CONFIDENTIAL STATUS:**	NON CONFIDENTIAL
SURFACE OWNER:	FREEHOLD	**MINERAL RIGHTS OWNER:**	FREEHOLD
AGREEMENT NUMBER:		**AGREEMENT TYPE:**	
AGREEMENT EXPIRY DATE:		**DRILL COST AREA:**	
SCHEME APPROVAL NUMBER:		**SCHEME EXPIRY DATE:**	
INCENTIVE CERTIFICATE NUMBER:	00000	**INCENTIVE CERTIFICATE DATE:**	
SURFACE ABANDONED TYPE:		**SURFACE ABANDONED DATE:**	

EUB WELL DRILLING OCCURRENCE DATA			
WELL NAME:	ECA ECOG 2D2 FBANK 2-23-43-28	**FIELD:**	FERRYBANK
POOL:	HRSSH CAN UND	**OIL SANDS AREA:**	
OIL SANDS DEPOSIT:		**DOWNHOLE OFFSETS:**	N 259 W 518.9
ACTUAL DOWNHOLE LATITUDE:	52.71486	**LONGITUDE:**	113.953848
THEORETICAL DOWNHOLE LATITUDE:	0	**LONGITUDE:**	0
GROUND ELEVATION:	943.6	**KB ELEVATION:**	947.4
CF ELEVATION:	0	**WELL TOTAL DEPTH:**	767
TRUE VERTICAL DEPTH:	0	**PB DEPTH:**	0
SPUD DATE:	FEBRUARY 22, 2005	**FINAL DRILL DATE:**	MAY 31, 2005
RIG RELEASE DATE:	JUNE 1, 2005	**ON PRODUCTION DATE:**	SEPTEMBER 2, 2005
DRILLING CONTRACTOR:	PRECISION DRILLING CORPORATION	**RIG NUMBER:**	139

There is no Tops & Markers data for this well.

EUB WELL LOG DATA

LOG RUN NUMBER	LOG RUN DATE	LOG TYPE	TOP INTERVAL	BASE INTERVAL	DESCRIPTION
1	Jun 1 2005	DUAL INDUCTION LATEROLOG	77.8	765.8	
1	Jun 1 2005	COMP NEUTRON SONIC	77.8	765.8	
1	Jun 1 2005	BHC SONIC	77.8	765.8	
1	Jun 1 2005	COMP NEUTRON LITHO DENSITY	77.8	765.8	
1	Jun 21 2005	GAMMA RAY CORR	80	753.8	

There is no DST data for this well.

EUB WELL TOUR - OCCURRENCE DATA

TYPE	OPERATOR PROG	DATE	DEPTH	MUD DENSITY	VISCTY	CNTRL DATE	CNTRL DEPTH	FNL MUD DENSITY	FNL VISCTY	WATER SEVERTY	WATER FLOW RATE	CIRCLN SEVERTY	LOST CIRCLN VOLUME
LOST CIRCULATION	DRILLING	May 31 2005	120	1030	999	May 31 2005	159	1070	999		0	SEVERE	75

There is no Tour - Direction Drilling data for this well.

EUB WELL TOUR - CASING DATA

DATE	CASING	SIZE	SHOE SET DEPTH	LINER TOP DEPTH	DENSITY	STEEL PROCESS	YIELD STRENGTH	COLLAR TYPE	MXD STRING
Feb 22 2005	SURFACE	177.8	78	0	25.3	H	40		
Jun 1 2005	PRODUCTION	114.3	767	0	14.1	J	55		

EUB WELL TOUR - CEMENTING DATA

STAGE NO	UNIT	AMOUNT	TYPE	RECEMENT
0	TONNEST	3	CLASS G NEAT	0
0	TONNEST	9	CLASS G NEAT	0

There is no Tour - Cores Cut data for this well.

EUB WELL TOUR - PERFORATION / TREATMENT DATA

DATE	TYPE	INTERVAL TOP	INTERVAL BASE	SHOTS
Jun 21 2005	JET PERFORATION	701.6	702.6	13
Jun 21 2005	JET PERFORATION	696.9	697.9	13
Jun 21 2005	JET PERFORATION	688.3	689.3	13
Jun 21 2005	JET PERFORATION	687	688	13
Jun 21 2005	JET PERFORATION	676.9	677.9	13
Jun 21 2005	JET PERFORATION	650.6	652.6	13
Jun 21 2005	JET PERFORATION	647.9	648.9	13
Jun 21 2005	JET PERFORATION	641.6	642.6	13
Jun 21 2005	JET PERFORATION	608	609	13
Jun 21 2005	JET PERFORATION	591.5	592.5	13
Jun 21 2005	JET PERFORATION	582.8	583.8	13
Jun 21 2005	JET PERFORATION	578.4	579.4	13
Jun 21 2005	JET PERFORATION	524.3	525.3	13
Jun 21 2005	JET PERFORATION	508.8	509.8	13
Jun 21 2005	JET PERFORATION	504.5	505.5	13
Jun 21 2005	JET PERFORATION	499.3	500.3	13
Jun 21 2005	JET PERFORATION	479.2	480.2	13
Jun 21 2005	JET PERFORATION	469.8	470.8	13
Jun 21 2005	JET PERFORATION	452	453	13
Jun 21 2005	JET PERFORATION	438.9	439.9	13
Jun 21 2005	JET PERFORATION	358.9	361.9	13
Jun 21 2005	JET PERFORATION	337.9	338.9	13
Jul 22 2005	FRACTURED	337.9	702.6	0

There is no Tour - Initial Production data for this well.

There is no Tour - Plug Back / Abandonment data for this well.

PRINT REPORT | CLOSE REPORT

WELL ID: 02 / 06-04-027-22 W4 / 0

ERCB COMPANY INFORMATION
CURRENT TO December 31, 2009

COMPANY NAME:	ENCANA CORPORATION		
ADDRESS:	Box 2850, 150 - 9 Avenue SW Calgary, AB T2P 2S5		
PHONE #:	3---2000	**BUSINESS ASSOCIATE CODE:**	0026

There is no Production data for this well.

ERCB WELL LICENSING DATA

UNIQUE WELL ID:	0274220406020	**WELL LICENCE NUMBER:**	0256259
REGULATION SECTION:	Section 2.020	**WELL LICENCE DATE:**	JUNE 13, 2001
SURFACE LOCATION:	06-04-027-22 W4	**SURFACE OFFSETS:**	N 752 E 470.2
ACTUAL SURFACE LATITUDE:	51.277517	**LONGITUDE:**	113.045462
THEORETICAL SURFACE LATITUDE:	0	**LONGITUDE:**	0
LICENCEE:	ENCANA CORPORATION		
ERCB AREA OFFICE:	MIDNAPORE	**TERMINATING FORMATION:**	BELLY RIVER GRP
LAHEE CLASSIFICATION:	NEW POOL WILDCAT	**CONFIDENTIAL STATUS:**	NON CONFIDENTIAL
SURFACE OWNER:	FREEHOLD	**MINERAL RIGHTS OWNER:**	FREEHOLD
AGREEMENT NUMBER:		**AGREEMENT TYPE:**	
AGREEMENT EXPIRY DATE:		**DRILL COST AREA:**	
SCHEME APPROVAL NUMBER:		**SCHEME EXPIRY DATE:**	
INCENTIVE CERTIFICATE NUMBER:	00000	**INCENTIVE CERTIFICATE DATE:**	
SURFACE ABANDONED TYPE:	PLATE	**SURFACE ABANDONED DATE:**	OCTOBER 8, 2004

EUB WELL STATUS HISTORY DATA	
DATE	**STATUS**
Jan 12 2005	
May 31 2005	DRL&C
Sep 2 2005	FLOW

EUB WELL COMPLETION DATA	
INITIAL INTERVAL TOP	**INITIAL INTERVAL BOTTOM**
337.9	702.6

EUB Alberta Energy and Utilities Board

640 - 5 Avenue SW Calgary, Alberta Canada T2P 3G4 Tel 403 297-8311 Fax 403 297-7336 www.eub.gov.ab.ca

Directive 027

January 31, 2006

Shallow Fracturing Operations—Interim Controls, Restricted Operations, and Technical Review

The Alberta Energy and Utilities Board (EUB/Board) has approved this directive on January 31, 2006.

<original signed by>

M. N. McCrank, Q.C., P.Eng.
Chairman

The recent trend in Alberta to develop shallow gas reservoirs less than 200 metres (m) deep using high fracture volumes, pump rates, and pressures has caused the Alberta Energy and Utilities Board (EUB) to consider the need for a review of the technical design requirements and regulatory options regarding fracturing. Information provided by industry to date shows that 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. As well, a Multistakeholder Advisory Committee on coalbed methane (CBM) identified in its preliminary report that oilfield and water well drilling and completions practices may not be adequate and should be reviewed. Consequently, the EUB is instituting the following requirements.

Interim Controls

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 shallower than 200 m to ensure protection of water wells and shallow aquifers.

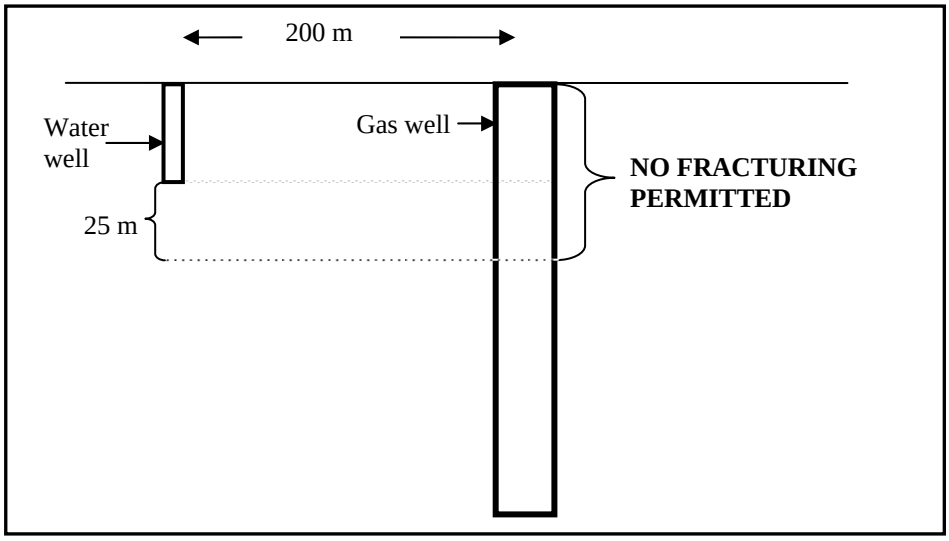
Effective immediately, licensees must not conduct fracturing operations at depths less than 200 m unless they have fully assessed all potential impacts prior to initiating a fracturing program. Licensees must be prepared to provide the EUB with an assessment demonstrating that a complete review was conducted and all potential impacts were mitigated in the designed fracture program. The EUB requires such an assessment to include, as a minimum,

- the fracture program design, including proposed pumping rates, volumes, pressures, and fluids,
- a determination of the maximum propagation expected for all fracture treatments to be conducted,
- identification and depth of offset oilfield and water wells within 200 m of the proposed shallow fracturing operations,
- verification of cement integrity through available public data of all oilfield wells within a 200 m radius of the well to be fractured, and
- landholder notification of water wells within 200 m.

The EUB will conduct random or select audits of fracturing operations at depths less than 200 m. The above-noted fracture assessments and any other supporting information must be made available for these audits within five working days of a request by the EUB.

Restricted Operations

Also effective immediately, licensees are prohibited from conducting fracturing within a 200 m radius of water wells whose depth is within 25 m of proposed well fracturing depth (see diagram below). The EUB believes this restriction provides a conservative safety margin based on existing fracturing propagation data available to the EUB.



Additionally, all fracture treatments must

- use only non-toxic fracture fluids above the base of groundwater protection,
- be designed so that no zone containing non-saline water is contaminated, and
- not reach any other wellbore, including both oilfield wells and water wells, at any point during the process of fracturing.

The above interim controls and restrictions apply to both new wells and recompletion of existing wellbores.

Compliance Assurance

Failure to conduct an assessment prior to conducting a shallow fracturing operation will result in High Risk enforcement action. As well, any fracture treatment within the restricted area of 200 m of a water well will also result in High Risk enforcement action. Failure to supply the assessment information to the EUB within 5 working days of a request will result in Low Risk enforcement action. Persistent noncompliance will result in escalating consequences.

Technical Review Committee

The EUB believes that although existing oilfield drilling and completion requirements are adequate for deeper formations, fracturing of shallow formations warrants further review because it is a relatively new practice. The EUB, in consultation with Alberta Environment, will establish a new multistakeholder technical review committee to evaluate current industry fracturing practices and assess the need for appropriate regulatory controls or industry recommended practices (IRPs), with a targeted completion date in late 2006.

Questions regarding this directive should be directed to the EUB Well Operations Section: telephone (403) 297-5290, fax (403) 297-2691, or e-mail eub.welloperations@gov.ab.ca.