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Submission by NatureNL to the

Newfoundland and Labrador Hydraulic Fracturing Review Panel

Prepared by Allan Stein on behalf of NatureNL, 2015-05-23.

The Natural History Society of Newfoundland dates back to 1910. In 2010 we changed our name to Nature Newfoundland and Labrador (NatureNL), but our mission remains unchanged: NatureNL promotes the enjoyment and protection of our wildlife, plants, natural areas, land and waters. We offer free monthly public lectures, hold outdoor activities to explore our natural world and work to protect and conserve our natural history heritage. For additional information search: *www.naturenl.ca* .

We are a conservative, not a radical environmental organization. We recognise that humans are part of the planet's ecosystem but while we must exploit it for our wellbeing, we must do so with sustainably and with minimal deleterious impacts. We fear hydraulic fracturing, or "fracking", does not meet those requirements. We are not alone in our concern.

Increasingly communities, states or provinces and countries are either banning or putting a "hold" on fracking proposals, for example, Quebec, Nova Scotia, New York, much of Europe and New England.... Even China with its enormous energy needs, far from pristine ecosystem and minimal environmental ethic is delaying or stopping projects and despite the facts that they appear to have the world's largest reserves of oil shale and at present use almost exclusively coal as a fossil fuel .

A recent release of the results of a survey of US adults, broken into two groups, the general population and members of the American Association for the Advancement of Science (AAAS) is of interest. A number of topics with a high science component were included and the difference in response of the two groups of adults noted. The "percentage of agreement" with some of the issues follow.

Topic/Issue	US Adults	AAAS scientists
Safe to eat genetically modified foods	37%	88%
Climate change is mostly due to human activity	50%	87%
Safe to eat foods grown with pesticides	28%	68%
Favor building nuclear reactors	45%	85%

Favor increasing bioengineered fuel	68%	78%
Favor childhood vaccinations	68%	86%
Favor increased use of fracking	31%	39%

Fracking is a clear outlier in that scientists and the lay population both offer little support.

Particular issues of concern to NatureNL form the bulk of the rest of this submission.

Greenhouse gases.

Carbon dioxide is the most discussed greenhouse gas but methane, the major component of natural gas is in fact a much more serious one, having approximately 86 times the impact in year one, decreasing to about 25 times in a 100 year horizon; methane has a shorter environmental half-life. In theory, used as fuel for thermal generation of electricity in place of coal, methane results in reduced CO2 emissions. True, in theory. Unfortunately, for example even for the major fracking fields in the Bakken formation of North Dakota, 40% of the co-generated nature gas is lost or flared as waste. It is not used. Of the losses, 45% is from drilling and production, 27% storage and transmission, 12% processing and 16% in distribution (CEN.ACS.org). From a steady state of about 0.7 ppm prior to 1800, the methane content in the atmosphere has risen to above 1.8 ppm, over two and a half times its historic level and continues to rise quite rapidly. Methane leakage is most pronounced during fracking and initiation of flow but decreases quite rapidly, as field pressure declines over time. The shorter lifetime of methane in the atmosphere, means that while through the first decade, the impact of leaked methane on global warming is greater than that of the CO2 that would be formed by its combustion, it falls to a few percent after a century.

In newly fractured wells the initially very high flow rates drop quickly to about 20% of first day rates and continue falling more slowly over time. If methane emission was spread over centuries, effects would be evened out and perhaps less catastrophic to our planet and its living ecosystem. An important factor in the leakage/waste of methane/natural gas is the rush to produce oil for a quick cash flow instead of delaying fracking and production until the infrastructure—pipelines, holding tanks, re-injection wells, etc. –are in place.

Recommendations:

1. **Infrastructure must be in place before fracking begins.**

2. **Legislation limiting greenhouse gas emissions in fossil fuel operations is required.**

Fracking Fluids.

Fluids are typically about 90% fresh water, 10% propping solids (typically silica sand added to prevent the fractures from closing when applied field pressure is reduced) and about 1% chemical additives which are generally proprietary mixtures of surfactants, acids (like HCl) and gelling agents (added to adjust the fluid's physical properties including viscosity to assist in suspending the proppant), and one or more biocides (to prevent bacterial growth which can clog newly opened pores).

A candidate oil field typically has one or several shallow aquifer of potable water, layers of permeable and impermeable rock and one or more deep, very saline aquifers which seal a gas and oil rich fine pored but quite impermeable rock, commonly oil shale.

It is this deep "oily" layer that is subjected to horizontal drilling and subsequent fracking using the fluid at very high pressure. Fine cracks propagate from the porous horizontal pipe, creating pores which are propped open by the added sand, allowing the oil and gas to flow as the pressure is released.

Most of what went down must come back up, the vast majority of it quickly once the applied pressure is released, millions of liters of injected fluid now mixed with the saline aquifer waters, hydrocarbons and materials extracted from rocks and waters. With gas and oil production saline aquifer water continues to flow, albeit at decreasing rates through the life of the well. That water contains residual fracking fluids, including the biocide, salts and species from the aquifers and rocks, including radioactive species—principally radon sources—and often moderate concentrations of bromide ions. Bromide, which often is quite abundant in the deep, saline aquifers, is problematic in potable water because chlorination treatment of the drinking water forms bromomethanes which are carcinogenic "halomethanes" formed by reaction with added chlorine. Well over a thousand chemical compounds have been detected in production water, most of unknown toxicity. If proprietary contents of fracking fluids are secret, determination of contaminants and quantities present is greatly complicated.

Production water must not be allowed to enter water supplies! Several states, including Pennsylvania, prohibit gas drillers from sending produced and waste waters to facilities which discharge into surface waters regardless of its pre-treatment.

Internationally, only relatively rarely is the production water processed and re-injected. The vast majority is simply de-oiled and then disposed via sewer systems, rivers or directly into the ocean. {Production water from our offshore is so treated ashore and disposed of as sewerage, a practice that should cease.}

Trial injection of production water and even fracking in North Dakota, Oklahoma, Texas, and Pennsylvania has caused moderate, earthquakes, as strong as 5.7. Disposal of the enormous volumes of production water by deep injection thus carries serious risks. According to the March 2015 National Geographic, in the state of Oklahoma since 2008 when deep injection and fracking began, the annual number of earth quakes has increased from about two to 584 (in 2014). The Reuse of recovered fracking fluids should be mandatory as this would reduce disposal volumes enormously.

Recommendations:

1. **Reinjection/reuse of fracking fluids, after processing, should be required.**
2. **Recovered or production fracking waters must be considered hazardous waste.**
3. **Production fluids, even when de-oiled must not be permitted in streams and lakes or drinking water sources.**
4. **Contents of the fracking fluid must not be "proprietary". Full disclosure must be mandatory.**

Ground water:

Ground water aquifers , that is potable water in relatively shallow aquifers, generally have limited capacity so should not be used as fracking water sources—they are the domestic water supplies in rural areas.

Contamination of potable water supplies is much more serious than their depletion. Depleted aquifers can refill over time but contaminated ones remain contaminated. Production water must not be allowed in surface or potable waters. Increasingly there are reports of contamination of drinking water with methane, larger hydrocarbons, sulfur compounds and fracking fluids which have entered the aquifer underground. Thus residents living near fracking sites in Texas, North Dakota, Wyoming, and Pennsylvania report their water supply is contaminated and "smells" and in some cases escaping natural gases from water taps can be ignited! The likely cause is failure of the impermeable layers between the fracking layer and the shallower, potable aquifer. The failure could be along an old fault, or through the rock layer itself. Or there could be failure of the cement seal of the stand pipe, that is loss of wellbore integrity, allowing high pressure fracking and production waters access to the aquifer. Any such contamination is irreversible.

Leakage due to faulty seals at the wellbore below the surface causes contamination of land and aquifers while leakage escaping to the atmosphere directly releases methane, a efficient greenhouse gas and can constitute a significant fire or explosion risk, and in the extreme, a well blow out. Unfortunately, gas leakage from wells is not rare; some EPA scientists claim several percent of newly completed wells have small leaks and perhaps as high as 30% leak over their lifetimes, typically for several decades. Fracking involves very high pressure and stress on rock strata and wellbore cement and would be expected to increase risks.

Recommendations:

1. **Before wells are drilled, large bonds adequate to cover rehabilitation and punitive costs should be deposited by drilling, fracking, and cementing/well sealing firms.**

Communal Infrastructure:

The vast volumes of fluids and the massive equipment that must be brought to and from fracking wells has the potential to seriously damage property, roads, bridges, water supplies and other communal infrastructure, little of which were designed for that weight and volume of traffic. The contamination of the land, surface and aquifer waters with fracking and production water, and the preparation of drill pads also degrades the communal property of our residents. Restoration of that communal property should be mandatory. Very large bonds should be required from the energy companies involved to ensure that restoration.

Recommendations:

1. **Restoration of communal and private property damaged during fracking and production activities must be mandated. That includes;**
    a. **Streets, roads and bridges and substructures and facilities like sewers, water mains,**
    b. **Electrical and other services.**
    c. **Water supplies and services**
    d. **Lands used or damaged in operations, like construction of drill pads, temporary holding ponds, etc.**

Fracking, a developing technology:

For a decade the fracking industry has relied upon brute force to accomplish their aims and desires. Alternative and modified technologies are now being tested or proposed. For example a Calgary-based energy services company, GasFrac, has developed jelled propane-based fracking fluid which would replace water-based fracking fluid. It is a “dry”, rather than a “wet” method. The propane is recovered and reused; the small amount that initially remains in the well is recovered in produced hydrocarbon. Only a small amount of deep aquifer water is produced and needs to be separated and reinjected or otherwise processed. The tens of millions of liters of water would no longer be necessary and the enormous waste stream of badly contaminated waste water would be reduced to a small fraction.

Jelled propane is but one possible game changer. As another example, Statoil has shown that using hot fracking fluids, up to 450C, dissolves and breaks up kerogen which otherwise blocks pores and impedes oil and gas flow through the fracked shale, markedly increasing field productivity. Other companies are working with bio-degradable polymers as fluid conditioners; they leave no residue to block the fracking pores and drastically reduce the environmental footprint over the wells lifetime.

USA patent filing is an indication of the dynamics. Until 2010, only about one USA patent application per year was filed on fracking strategies and additives. Since then patent application numbers have increased steeply, reaching 40 in 2014.

One must ask, why rush to exploit our possible resource with great risk of serious environmental contamination? At the very least, why not delay, prohibit development until the science and technology

are more advanced? It appears that it will be some years before oil prices reach a level where significant revenues are possible in any event.

Recommendations:

1. Issue a moratorium on fracking until it can be done with little environmental damage and risk.

Cost/ Economics:

The exploration and production drilling activity has been severely impacted by the oil price crash in the past year. Few rigs are active, workers are being laid off worldwide. Current oil prices are near or below the cost of fracking produced oil in the United States which likely has the most favourable cost structure.

Economically it clearly is not an auspicious time to commence drilling and fracking in this province. Subsidies will almost certainly be expected by the industry, royalties forgone and, hence no benefit or at the least only a token benefit for the people from their resource heritage.

Recommendations:

1. **A moratorium on fracking until the cost/benefit ratio is much more favourable is strongly recommended!**

References:

Numerous articles in the American Chemical Society's journal, "Chemical and Engineering News" were consulted. The principal ones follow. Others can be found by searching CEN.ACS.ORG .

"A New Way of Fracking", Stephen K. Ritter, C&EN, May 12, 2014, page 31ff.

"The Disclosure Debate", Jessica Morrison, C&EN, 2015, March 16, page 13ff.

"Figuring Out Fracking Wastewater", Celia Henry Arnaud, C&EN, 2015, March 16, page 8ff.

"The Public Versus Scientists", Andrea Widener, C&EN, February 2, 2015.

"China Backpedals on Shale Gas", Bree Feng, C&EN, 2015, January 19, page 22ff.

"Methane's Role in Climate Change", Jeff Johnson, C&EN, 2014, July 7, page 10ff.

"Greenhouse Emissions, Methane by the Numbers", Steve Ritter, C&EN, July 7, 2014, page 14-15.

The US publication, The National Geographic, has over the years published assessments of the fracking industry and its impacts and a number of informative U-Tube and Google presentations warrant review.

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