Submission from Environmental Health Association of Nova Scotia (EHANS) to the Nova Scotia Review of Hydraulic Fracturing on Human Health Risks and Impacts, April 2014

The Environmental Health Association of Nova Scotia (EHANS) is pleased to have the opportunity to make a submission to the Nova Scotia review of hydraulic fracturing. We are particularly pleased that the Nova Scotia government, in expanding the scope of this review to include health, recognizes that understanding potential health impacts is a critical part of fully evaluating hydraulic fracturing and the high volume hydraulic fracturing (HVHF) industry.

Introduction:
Emerging evidence, but no definitive answers

Three years ago, when EHANS made a submission proposing that the scope of the in-house review of hydraulic fracturing include heath, we documented a wide range of health concerns that were emerging, and argued that the review needed to consider those issues. At that time, there was little peer-reviewed evidence of health risks, but information showed a pattern of newly developed health problems in states and provinces where shale gas development was taking place.

The emerging information, though "unproven," gave a reasonable basis for concern that health risks could be serious and widespread, and that there was reason to proceed with caution in allowing HVHF.

In the past three years, human health has become widely recognized as a major issue to be addressed in assessing the impacts of unconventional natural gas development (UGD) including high volume hydraulic fracturing. New peer reviewed articles have measured and evaluated air emissions in gas production areas, potential routes of exposure from water and air and potential health impacts associated with contaminants released through unconventional gas operations. These studies provide ever-increasing evidence of potential for a wide range of risks to health, and health impacts for people living in UGD areas. Our concerns remain, and have been strengthened by the evidence of the past three years. Other health organizations in the US and Canada share these concerns.

Focal points of EHANS submission
Because there now exist a number of excellent summaries of the health issues relating to hydraulic fracturing for unconventional gas, EHANS' focus in this submission will not be to summarize all the evidence.

Summaries of the evidence and gaps in evidence relating to hydraulic fracturing and public health may be found in articles by Adgate et al (Environmental Science and Technology, 2014), Finkel and Hayes (Public Health, 2013), the position paper of the American Public Health Association (2012), and the report issued by Dr. Eilish Cleary, Chief Medical Officer of Health for New Brunswick (2012) among others.

Our approach in this submission is rather to:

- Direct the review's attention to particular science-based resources that we believe provide excellent overview summaries of potential health risks and impacts, as well as studies of specific risks arising from hydraulic fracturing and unconventional natural gas development (UGD).
- Sum up key points of consensus in the literature.
- Highlight key issues and approaches that we believe this review should take into account in reviewing and making recommendations on high volume hydraulic fracturing in order to address protection of public health as well as worker health and safety.

Part 1: Consensus in the literature
Overall, from a health perspective, there are six major points that emerge through the literature.

1. **Understanding potential health risks requires a full impacts approach to reviewing hydraulic fracturing.**

There is often disagreement on what is meant by evaluating hydraulic fracturing. Some argue that the evaluation of hydraulic fracturing should be restricted to the actual brief event and its immediate spin-offs, e.g. production of wastewater. From a health perspective, there is consensus that understanding the impacts of hydraulic fracturing requires assessing the full impacts of unconventional gas and oil development arising from hydraulic fracturing. For example, The American Public Health Association (APHA) notes:

> Many disagreements about the impacts of HVHF [high volume hydraulic fracturing] are due to differences in how HVHF is defined. If the definition of HVHF is restricted to the technological process of hydraulic fracturing of wells, this evidence of and potential for harm is limited. However, looking at the broader impacts of natural gas development made possible

by HVHF (aggregate impacts on air, water, and communities), a wider spectrum of health problems are relevant.[1]

The Draft Scoping document for the Maryland Health Impact Assessment (HIA) also defines hydraulic fracturing broadly. The document refers repeatedly to the "HVHF industry" and notes: The Impact Assessment will include water and air quality, noise, public safety, social determinants of health, mixed and cumulative exposures, vulnerable populations, and data on baseline environmental exposures, population health, and data gaps."

The document further states, "some factors such as high volume truck traffic are so integral to the HVHF process as to be arguably primary rather than secondary impacts."

The Maryland HIA concludes, "the assessment will focus on those exposures and conditions that either would not occur in the absence of, or would be increased as a result of the HVHF industry." [2]

2. **The literature establishes that toxic substances are used and generated by the HVHF industry in large quantities, that routes of exposure to these toxins exist via air and water, and that large numbers of people may be affected. There may be potential exposure via soil and food.**

"For communities near development and production sites the major stressors are air pollutants, ground and surface water contamination, truck traffic and noise pollution, accidents and malfunctions, and psychosocial stress associated with community change," write Adgate et al.[3] "The primary routes of exposure to chemicals and other harmful substances used and generated by oil and gas facilities are inhalation, ingestion, and dermal absorption—of substances in air, drinking water, or surface water—which can lead to a range of symptoms," notes Steinzor. [4]

Independent studies in areas where UGD development is taking place in proximity to homes, farms and workplaces have begun to document contaminants in air and water at levels known to have human health impacts.

McKenzie[5] documents increased cancer and non-cancer risks among people living within ½ mile of an active well in Colorado. Steinzor[6] documents widespread reported symptoms in Pennsylvania communities, and measured levels of contaminants in both air and water. A community health survey in Dish, Texas found that 94% of residents reported health symptoms that did not exist before UG facilities located in their community. Independent air quality analysis in Dish by Wolf Eagle Environmental confirmed the presence of multiple known toxins, including multiple human carcinogens, at levels in excess of short and long term ESL's and noted that no other source of these chemicals existed besides the gas compressor stations. [7]

Researchers found greater hormone-disrupting properties in ground and surface water located near hydraulic fracturing drilling sites in Colorado than in areas without drilling.[8] According to lead researcher Susan Nagel, this "could raise the risk of reproductive, metabolic, neurological and other diseases, especially in children who are exposed to endocrine-disrupting chemicals." MacKenzie found that women who live near natural gas wells in rural Colorado are more likely to have babies with neural tube and congenital heart defects.[9] Colorado is now investigating a recent spike in fetal abnormalities in Garfield County. [10]

Correlations between chemicals measured in air and water in UG production areas, their known health effects, and reported symptoms have been documented in several studies. For example, Steinzor notes "health symptoms reported by the individuals living in a home where testing occurred matched the known health effects of chemicals detected in that home at an overall rate of 68 percent. … [T]he percent of individuals reporting symptoms that have been associated with chemicals detected in air testing at households participating in this study showed some consistency across counties with regard to the most significant categories of problems reported, as shown in Table 6 – indicating that patterns in both chemicals detected and symptoms exist despite different geographic locations." [11] Wolf Eagle's air emission report for Dish, Texas found similar correlations.

There is recognition that pollutants linked to UGD can travel for many miles, creating both local and regional air quality impacts.

High levels of ozone, which has severe impacts on respiratory health, have been measured in Colorado, Utah, Wyoming and Texas, including in rural areas with little industrial activity. A 2013 Colorado study[12] by NOAA scientists documented that half the ozone forming pollutants in the area studied came from oil and natural gas drilling operations. The researchers used a "chemical signature" to differentiate emissions from oil and gas activity from those given off by automobiles, cow manure or other sources of volatile organic compounds.

Mental health issues, social stressors and indirect impacts from UG operations (stress, anxiety, noise, light, road accidents, increase in violent crime and STD's) are increasingly recognized as additional aspects of health requiring consideration. [13]

3. **The literature recognizes a need for substantially more study to understand the extent of risk, the types of risk, and how, and to what extent, risks can be decreased. The literature recognizes significant information gaps, and points out that these information gaps make it difficult to accurately understand both the extent of risk and how risk could be managed.**

The existence of significant gaps in information and the need for more study are noted

repeatedly in the literature. As New Brunswick's Chief Medical Officer of Health notes:

> There are significant data gaps that limit assessment of health risks and there has been limited involvement of public health officials and experts in shale gas issues to date. Finally, few studies have been undertaken that consider the overall potential impacts on health and the environment over the entire lifetime of the industry.[14]

Several specific examples illustrate the existence of major gaps in understanding the extent of risk and how, and to what extent risks can be mitigated.

In relation to air emissions, a 2013 report[15] by the Inspector General of the EPA notes, "The oil and gas production sector and its various production processes emit large amounts of harmful pollutants that impact air quality on local, regional and global levels."

The report further states:

> Limited data from direct measurements, poor quality emission factors and incomplete NEI [National Emissions Inventory] data hamper EPA's ability to assess air quality impacts from oil and gas production activities. With limited data, human health risks are uncertain, and states may design incorrect or ineffective emission control strategies, and EPA's decisions about regulating industry may be misinformed.

An additional complication is that existing air monitoring protocols and analyses do not accurately capture risks. A study of air monitoring methodologies in UGD areas of Pennsylvania notes that current air monitoring protocols are "incompatible with the goal of protecting the health of those living and working near UNGD sites and that current methods of collecting emissions data as well as the analyses of these data are not sufficient for accurately assessing risks to individuals or protecting the health of those near UNGD sites."[16]

Setbacks between UG wells and homes, schools, daycare centres is a central concern in relation to human health and well-being, yet this is another area where there is little solid evidence to determine what is safe. In the paper "Setbacks: How Far is Enough?" submitted in response to New York's Draft Supplemental Generic Environmental Impact Statement (dSGEIS), Stanley R. Scobie (2012) points out that although New York's draft regulations increase proposed setbacks between homes and wells by over 200% (from 150 feet to 500 feet), no scientific rationale is given for this new proposed distance.

> "Five hundred feet away is better and safer, and that is what seems to be the entire DEC rationale for the proposal in the rdSGEIS and the regulations. But again, we must ask, 'is that far enough?' and most critically, what science can we

use to help decide?"[17]

Scobie contrasts the 500 foot proposed setback with "[a] peer-reviewed study from Duke University (Osborne, et al, 2011) [that] found apparent migration of substantial amounts of methane from gas wells to private water wells as far out as 3000 ft."

New Brunswick's proposed new regulations reflect a similar problem. NB's proposed 500-metre setback between wells and houses, while touted by the government as the best in the world, is still not supported by any scientific rationale. As in NY, the proposed setback is less than the distance at which apparent methane migration has been found. In some cases, setbacks have been determined based on distance which would protect against air emissions that could cause immediate fatalities, but do not take into account health risks from chronic exposures.

In order to determine safe setbacks, a solid scientific understanding of both potential water contamination, as well as health risks from air emissions, noise, light and other considerations is required. This work has not yet been done.

According to Bernard Goldstein, MD and professor emeritus of public health at the University of Pittsburgh:

> It is only when we recognize that research about health and safety impacts of new activities must occur before moving full speed ahead in using technology that the downward spiral into the frustrating inability to establish cause and effect relationships will end. Unfortunately, this has not happened with respect to shale gas drilling[18]

4. The literature recognizes that vulnerable populations face additional risks that must be considered.

The Pediatric Environmental Health Specialty Units developed informational fact sheets on hydraulic fracturing for health professionals and community members. They note:

> Children are more vulnerable to environmental hazards. They eat, drink, and breathe more than adults on a pound for pound basis. Research has also shown that children are not able to metabolize some toxicants as well as adults due to immature detoxification processes. Moreover, the fetus and young child are in a critical period of development when toxic exposures can have profound negative effects. … Because many questions remain unanswered, the PEHSU network recommends a precautionary approach to toxicants in general and to the NGE/HF process specifically.[19]

Pediatricians at Mt. Sinai Hospital submitted their concerns to a NYC Town Hall Symposium.

> As pediatricians specializing in environmental medicine, we at The Centre for Children's Environmental Health are opposed to the current use of hydraulic fracturing due to the multiple known risks to children's health, but also due to the substantial lack of research into the health effects of this practice. [20]

A Community Health Survey conducted in Pennsylvania by Steinzor et al[21] found:

> the youngest respondents (1.5-16 years of age), for example, those within 1,500 feet [of active wells] experienced higher rates [than average among those surveyed] of throat irritation (57% vs. 69%) and severe headaches (52% vs. 69%). It is also notable that youngest group had the highest occurrence of frequent nosebleeds (perhaps reflective of the more sensitive mucosal membranes in the young), as well as experiencing conditions not typically associated with children, such as severe headaches, joint and lumbar pain, and forgetfulness.

Seniors, persons with pre-existing illnesses, and developing fetuses are populations that are more vulnerable to environmental toxins. Low-income citizens are more vulnerable in a different way, as they are less able to afford measures which could help identify problems or provide partial mitigation, such as testing and retesting of home water or home air, or purchase of water or air filtration systems to somewhat mitigate exposures. Low-income populations are less able to leave the area for periods of time to get relief from exposures.

5. The literature points out a need to slow down and exercise caution.

There is an almost unanimous call from health professionals addressing the issue of hydraulic fracturing to slow down and exercise caution in the development of unconventional oil and gas using new methods of hydraulic fracturing.

Among health professionals this often takes the form of calling for a precautionary approach. The APHA Position Statement addresses the issues above, and concludes with the need for caution.

> Many uncertainties remain about the types of exposures and resulting health impacts that could be associated with HVHF. Vulnerable populations, particularly children and low-income rural populations, are most likely to be negatively affected by HVHF. There has been some HVHF in urban areas with the potential to affect large numbers of people. Due to the rapid growth of and highly varied (based on geography, drilling practices, and cumulative impacts) emissions from HVHF, it is impossible

> to precisely predict exposure patterns. Nonetheless, initial evidence gathered from the rapidly growing experience with HVHF, comparisons with other activities with similar emissions, and projections based on environmental models can inform a precautionary approach to the potential environmental public health impacts of HVHF. [22]

Numerous health professionals and professional organizations have called for a pause on any additional hydraulic fracturing until there is sufficient valid evidence to determine whether it is safe. The NY Medical Society, regional physician associations throughout New York State, the NB College of Family Physicians, medical staff at three New Brunswick hospitals, and the New Brunswick Lung Association are among organizations supporting a moratorium on hydraulic fracturing in their jurisdictions until there is valid evidence that it will not cause harm to public health.

Dr. Adam Law, endocrinologist at Weill Cornell Medical College in New York, argues that public policy in relation to fracking should take direction from a health approach:

> When it comes to hydro fracking, our guiding principle for public policy should be the same as the one used by physicians: 'First, do no harm.' There is a need for scientific and epidemiologic information on the health impacts of fracking. Frankly, no one should be unleashing even more fracking before we have the scientific facts. [23]

6. The literature establishes the need for a public health perspective and public health professionals to be involved in decision-making.

There is an almost unanimous recognition that a public health perspective must be included in assessment of risks and benefits and that in order to do this health professionals should play an active role at all stages of evaluation and decision making relating to hydraulic fracturing and UGD.

In "The Importance of Public Health Agency Independence" published in the American Journal of Public Health, Dr. Bernard Goldstein examines some of the consequences of excluding independent public health voices, and a public health perspective, from decision-making on UGD. In Pennsylvania, the Department of Health (PADOH) " has not been allowed to divert any of its $838 million budget for routine surveillance, training, or other public health activities related to the Marcellus." [24] One result is a lack of reliable information about health impacts.

Part 2: What does a public health perspective involve?
Considerations for evaluating health impacts of HVHF industry

As noted above, the first consideration in evaluating health impacts of hydraulic fracturing is to consider the full impacts of the HVHF industry, recognizing that there are potential risks to health at every stage of the HVHF industrial process, and evaluating the potential health impacts of **"those exposures and conditions that either would not occur in the absence of, or would be increased as a result of the HVHF industry,"** as the Maryland Health Impact Assessment has determined to do.

Understanding potential health risks also requires consideration of a number of other factors.

1. **Short, medium and long-term impacts**

Health impacts from UGD may be immediate (acute), medium or long term (e.g. cancers and reproductive impacts) and even multi-generational (pre-natal exposures, genotoxicity, epigenics).[25] Exposures can happen immediately (air emissions, immediate water contamination, environmental stressors), or in the mid to longer term (e.g. cumulative impacts of multiple exposures, pathways or mechanisms for water contamination developing over time (Myers, Fontenot, Brown).)

Establishing reliable information on the health impacts of UGD will take time.

> Shale gas and tight oil development is a relatively recent development and the most rigorous epidemiologic study designs can take several years to complete. For instance, prospective cohort studies, that follow groups to measure their exposures and their health outcomes, can take 15-20 years to generate quality data. Other studies that focus on diseases, such as cancers and cardiovascular illnesses, associated with long latency periods and chronic low-level exposures to environmental pollutants may not produce results for many years. [26]

"Balancing risks and benefits and taking a longer-term view are central to public health," Goldstein points out.[27]

An evaluation of health impacts of hydraulic fracturing needs to consider short, medium and long-term impacts of the industry. A limiting factor that should be recognized is the relative newness of the HVHF industry, such that many effects may not yet be measurable.

2. **Assess health risks on the basis of aggregate and cumulative exposure assessments, and assessment of peak emission impacts as well as averages. Synergistic issues and lack of existing toxicology data for chemicals found in UGD areas also need to be considered.**

Normally accepted methods for measuring and regulating exposures may be a poor fit for UG operations, and may lead to misleading health and safety assessments. Typically, industrial operations are assessed and permitted piece by piece; for example, in the case of UG on a well-by-well basis. This can lead to many individual assessments, each of which separately does not breach standards. In some jurisdictions, air emission information is not collected for projects that emit less than a set amount per year, or which employ less than a set number of people per year. The true impact of UG development can be overlooked using these approaches. In contrast, real world exposures and impacts are both aggregate (added together) and cumulative (added up over time), and may also include short-term peak exposures that alone can have hazardous impacts.

Because UG extraction is based on a dense grid system of multiple wells and well pads, and there are numerous processes involved in UG operations, evaluation of cumulative and aggregate impacts, as well as short-term peak exposures, is essential to understanding risk.

A letter from EPA Region 2 to the NY State environmental review of fracking in 2009 noted:

> The Environmental Protection Agency (EPA) is concerned that cumulative and indirect impacts need to be more thoroughly discussed in the dSGEIS [draft generic environmental impact statement.] Even with its generic format, the **EIS should discuss the impacts that may result from past, present, and reasonably foreseeable future projects as well as those impacts associated with drilling and hydrofracturing that may occur later in time and/or further from the immediate project site.** The SEQRA handbook states, "**Cumulative impacts do not have to all be associated with one sponsor or applicant. They may include indirect or secondary impacts, long term impacts and synergistic effects" and when two or more simultaneous or subsequent actions are related."** [28]

The APHA notes the need for

> Promulgating regulations that account for cumulative impacts and aggregate multiple sources: Individual drilling operations may not create air emissions that trigger regulation under existing environmental laws. However, the cumulative impacts of emissions may create significant public health threats for local communities or regions. [29]

Brown et al. present evidence that:

> current methods of collecting emissions data, as well as the analyses of these data, are not sufficient for accurately assessing risks to individuals or protecting the health of those near UNGD sites … Once a receptor is activated, a health event might be produced immediately or in as little as 1 to 2 h (11, 12). Alternatively, future exposures might compound the impact of the first one, eventually producing a health event. In some instances where there is a high concentration of an agent, a single significant exposure can cause injury or illness. Federal and state health standards for water and air, which are applied to UNGD emissions, ought to reflect and be evaluated in reference to these physiological realities; currently they do not. … In those few cases where short-term or hourly ambient air levels are measured, the purpose is generally to avoid poisoning from catastrophic releases (13).[30]

Comparable problems in accurately assessing impacts of air emissions from UGD on health exist in Canada, as well as in the US.

The experiences reported by residents of Lochend, Alberta illustrate the importance of capturing cumulative and aggregate impacts when evaluating public health risks. Approximately 80 wells are situated within a five-kilometer radius of residents' homes. Residents report abnormal health problems including frequent headaches, dizziness, rashes, muscle pain, and other symptoms.[31] The symptoms reported by these Alberta residents living close to UG operations in Alberta are similar to symptoms reported in community health studies close to UG operations in Texas and Pennsylvania.

3. Heavy industry located in residential and agricultural areas raises additional issues.

Allowing heavy industrial development in residential and agricultural areas raises additional public health issues that are generally not captured by existing exposure standards and regulatory approaches, which have most often been developed for industrial settings.

In *An Exploratory Study of Air Quality Near Natural Gas Operations*, Dr. Theo Coburn notes:

> Government standards are typically based on the exposure of a grown man encountering relatively high concentrations of a chemical over a brief time period, for example, during occupational exposure. Consequently, such standards may not apply to exposure scenarios faced by individuals (including pregnant women, children, and the elderly)

> experiencing chronic, sporadic, low-level exposure, 24 hours a day 7 days a week in natural gas neighborhoods. Safety standards also do not account for the kinds of effects found from low-level exposure to endocrine disrupting chemicals, which can be particularly harmful during prenatal development and childhood (Vandenberg et al. 2012).[32]

Populations living in areas with UGD experience chronic low-level exposures to a range of chemicals. They may also experience high-level exposures at peak periods. Low level chronic and peak exposure risks are often not captured by existing standards or protocols. Residents in UGD areas include vulnerable populations such as children, pregnant women, seniors, and people with pre-existing illnesses.

Exposures to UG air emissions take place inside homes, schools and workplaces, as well as outside, compounding the effects. Brown et al. note:

> A house with one air change per hour would experience 75% of the outdoor ambient air after 3 h and 98% after 6 h." and made calculations determining that "for a significant portion of each month, residents downwind from pollution sources experience levels of pollution inside their houses that are higher than the monthly averages. These are potentially significant exposures from a physiological standpoint. [33]

While a recent NIOSH study found that at all 11 sites studied in 5 states, "full-shift personal-breathing-zone (PBZ) exposures to respirable crystalline silica [a known carcinogen] consistently exceeded relevant occupational health criteria." However, no safe exposure levels for residents have been determined, and risks to residents from airborne silica remain unknown.

Widespread heavy industrial development in residential and agricultural areas is also recognized as having the potential to create significant disruption to quality of life, leading to stress and mental health impacts.

> The stresses of social change, uncertainty, isolation, inadequate housing and infrastructure, and substandard services feed into the fear associated with an incoming industry such as that of natural gas. Chronic psychological stress has been linked to respiratory health, both independently and in combination with air pollution exposures. Therefore, social stressors, such as those seen with the changes that natural gas drilling brings to an area, may have a cumulative wear-and-tear effect on individuals' emotional and psychological well-being that is difficult to quantify but significant. [34]

Exposures in residential areas are not a matter of choice. Unlike consumer choices, residents cannot choose whether to breathe the air or drink and bathe with their water. Unlike workplace exposures, protective gear is not used, and residents do not leave

after an 8-hour shift. Residents are limited in their ability to protect themselves and their families from exposures arising from heavy industry in their back yards.

4. The importance of assessing regulatory capacity in practice, not only in theory

We have pointed out above that at this point in time, because of critical gaps in information, there is little scientific evidence on which health protective regulations can be based for many aspects of the UG industry.

As well, it is important to consider that weaknesses in regulation, inspection and enforcement are common in this industry. [Additional information on this point will be included in a separate submission.] In Canada, as in the US, exemption from regulations, regulatory gaps, and non-enforcement of regulations is common.[35] The APHA notes that:

> Industry is not isolated in industrial park, but spread through residential and agricultural areas, in watersheds and close to watersheds and drinking water aquifers, with routes of exposure via air, water. HVHF compliance with existing law does not guarantee that the public's health is protected should the activities be exempt or if they were not anticipated at the time of the development of the current laws and regulations.[36]

As UGD spreads across Alberta (over 5,000 well licenses in 2012, compared to less than 500 in 2005)[37], reports are beginning to reveal significant gaps in regulation, enforcement and protection, contrary to government assurances. Exemption from regulations is not uncommon. Alberta residents living close to new wells report that flaring took place for 18 months, although under provincial regulation, flaring at these rates is only permitted for a maximum of 72 hours. However, in Alberta if conservation [of gas] is not found to be economic, continued flaring is permitted based on an evaluation of costs that is to be submitted to the regulator on an annual basis.[38]

Local resident Howard Hawkwood says, "It seems like the regulators have basically walked away." The Hawkwoods sent letters to the premier and to the ministers of health, agriculture, and energy, but they have been told to talk to the ERCB (now the Alberta Energy Regulator, AER). The ERCB would then tell them to speak with Alberta Environment, whose representatives turned them away on the grounds that they had received 400 similar complaints in southern Alberta alone.[39] The neighboring Tressider family tells a similar story.[40]

In response to those who propose regulations as an appropriate solution to shale gas problems at this point in time, it is critical to look not only at "can this problem be regulated" but to assess how likely it is to be. Even the US EPA, the continent's

strongest and best-funded environmental watchdog has dropped three critical investigations of water contamination under UG industry pressure.[41] Canada has no Superfund team to investigate potential cases of water contamination, at a cost of millions of dollars, to a standard capable of standing up to legal challenges. NS is unlikely to be able to enforce regulations more strongly than much more powerful and well-funded regulators like the EPA.

5. **Best practices, meeting standards, cannot be assumed to be health protective at this time.**

A common response to those who advocate caution is to hold up industry best practices as the answer to public concerns.

Best practices should not be confused with practices that protect public health. Best practices are, as described, better than other practices in at least some aspects, and are generally practices that industry is willing to adopt at a particular point in time and which are economically feasible for the industry.

A best practices approach does not address the facts that there remain major gaps in evidence relating to many aspects of the HVHF industry, such as those relating to air emissions and setback distances described above.

Best practices fit into a "regulate and mitigate" framework, which is most appropriate when risks are clearly known, and effective ways to mitigate risk are also well established. At the current stage of science relating to HVHF impacts, there is mounting evidence that this approach does not, and will not, protect public health, or protect against environmental damage that may lead to future public health impacts.

The issues raised in Brown et al. in relation to gaps in air monitoring and the findings of Colborn et al. of unexpected known toxic chemicals including PAHs and non-methane hydrocarbons (NMDHs) in air emissions around UG sites [42] are two examples that underline the importance of not assuming that present standards or best practices are health protective.

Colborn notes:

> New understandings of the potential impacts of low-level exposures need to be considered in evaluating potential health impacts of the HVHF industrial processes, which have "[H]uman exposures to thousands of environmental chemicals fall in the range of non-negligible doses that are thought to be safe from a risk assessment perspective. Yet the ever-increasing data from human biomonitoring and epidemiological studies suggests otherwise.[43]

6. Emerging evidence and the weight we give to interim sources of information

The first step in studying a problem begins with a hypothesis often arising from patterns of anecdotal information. The reports of health problems from communities across the US, and more recently in Canada, has given rise to a recognition that public health must be considered in assessing the risks and benefits of UG development. Based on this information, studies are being conducted that are beginning to document the problems in a more scientific way.

Once studies are undertaken, understanding the impacts of UGD on health will still take years.

> Shale gas and tight oil development is a relatively recent development and the most rigorous epidemiologic study designs can take several years to complete. For instance, prospective cohort studies, that follow groups to measure their exposures and their health outcomes, can take 15-20 years to generate quality data. Other studies that focus on diseases, such as cancers and cardiovascular illnesses, associated with long latency periods and chronic low-level exposures to environmental pollutants may not produce results for many years.[44]

Until more extensive studies have been done, there is some value to giving weight to what we might call "interim sources of information."

One such information source is community health studies. Steinzor, lead researcher of a community health study in fourteen Pennsylvania counties, notes:

> Across the gas patches of the United States, people experiencing health problems voice the simple wish to be believed. Many say that their health has worsened since gas development began in their communities and that they feel better when they are away from home. Often these conversations turn to what it will take for regulators and policymakers to view their stories not just as "anecdotes," but as valid concerns worthy of an effective response.[45]

Steinzor further notes the problems posed by waiting to act until "definitive causal links between gas between gas facilities and specific health impacts" are proven:

> There is no doubt that more research on the environmental and health impacts of shale gas development is needed and can play a critical role in making sound decisions about a complex and controversial issue.
> Yet an equally important consideration is how to respond to the presence

> of unanswered questions. For many proponents of unfettered gas development, the absence of definitive causal links between gas facilities and specific health impacts indicates the absence of a problem. But for impacted communities and others who believe health and the environment deserve protection and that water and air quality should be maintained, what we don't yet know makes the need for caution even greater.

In this context, she argues that Community Based Participatory Research helps to "bridge the prevailing knowledge gap and pointing the way toward possible policy changes needed to protect public health."

A second valuable source of "interim information" comes from investigative reports carried out by news organizations. Often based on intensive studies of primary government documents, including documents accessed via Freedom of Information (FOI) requests, these investigative reports tie together information about government practices and weaknesses in information gathering and enforcement that are not easily accessible to the public. The New York Times Drilling Down series (2011), based on over 30,000 pages of FOI documentation, a four state investigation into water contamination by Associated Press (2014), a joint investigation into air quality, enforcement, and political influence in Texas by the Weather Channel, the Center for Public Integrity and InsideClimate News (2014), and investigations by ProPublica (2009-present), including several focusing on regulatory and enforcement problems have brought to light evidence from official sources that counters government assurances that all is well in gas drilling areas.

Investigative reports from non-governmental organizations including the Natural Resources Defense Council, Earthworks and others, including NOFRAC in Nova Scotia, have also brought to light information that deserves serious consideration.

7. Occupational exposures and family exposures

Occupational exposures for UG workers remain generally poorly understood, aside from certain known risks, such as those from silica exposure.
The APHA notes:

> Many of the safety issues involved are well understood and regulated. However, the occupational health implications are less well understood. The rapid pace and geographic scope of expansion into remote locations inhibit monitoring of the drill sites to better understand and protect against the health risks involved. There are also unique concerns associated with HVHF, such as the potential for exposure to unknown chemical constituents of fracking fluids.

Emerging individual (anecdotal) reports of unexplained illness among industry workers who have been exposed to fracking fluids and other chemicals used in natural gas operations, or present in flowback water, is an area of significant concern which has not yet been studied. In Nova Scotia where high levels of radioactivity are likely to be found in wastewater, drilling muds, pipes, filters and other materials used by or generated from hydraulic fracturing, occupational and public health challenges related to these exposures are an additional concern.

The issue of indirect exposure of family members, where UG workers return to family homes after their shifts, is another area that remains unstudied. Workers involved in trucking, site cleaning and other jobs may expose their families through residues on clothing, footwear or bodies. The lessons from asbestos mining should raise flags about this additional potential route of exposure.

8. Related and spin off issues impacting health

There are additional unexpected consequences of shale gas development with potential health impacts that we would like to briefly mention:

- Physician attraction and retention. Rural communities in Nova Scotia already have a difficult time attracting and retaining physicians and other health professionals. Peaceful rural landscapes are one of the drawing cards for some healthcare providers. A significant change in the rural quality of life could impact communities' ability to keep or attract needed health providers.
- Access to health facilities and supports have been compromised in Pennsylvania, according to a report from Stacy Covey, President of Troy Regional Hospital. Covey reports that UGD locally has resulted in delayed or impossible access to hospital, delayed and hampered patient transport and response to emergency calls, and greatly impacted delivery of home care services due to traffic volume and poor road conditions.[46]
- Other issues noted by Covey and others are increased demand for health services from immediate health problems, greatly increased call volumes for EMS, increased traffic accidents and road rage,[47] and increased STDs, drug use and family violence.[48]
- Degraded outside environments can negatively impact exercise and outdoor activity, factors which are recognized as providing positive health impacts, and add to social isolation, a factor negatively impacting health.
- Climate changes and compromised availability of local healthy food are additional potential health impacts.

Conclusion:
Start where you are: Different options for different contexts

All jurisdictions looking at potential health impacts from the HVHF industry face the same question, how can we minimize harm? Yet there is no "one size fits all" answer. In different contexts, the best way to prevent harm may look quite different.

In the journal *Public Health*, Finkel and Hays state:

> Until research is properly conducted, the unconventional development of natural gas from shale formations should not occur in places where it is currently prohibited, e.g., New York and Maryland. In places now under development it should be constrained with strong regulations in direct proportion to inspection capability and closely monitored for its impact on the health of populations. Natural gas has been in shale formations for millions of years; it isn't going anywhere and will be around for future generations.[49]

While many peer-reviewed studies include suggestions for improving regulatory control in order to decrease health impacts, calls for improved regulations in the literature should not be interpreted as a conclusion that improved regulations are the universal next best step. In fact, the consensus in health literature relating to hydraulic fracturing tends in the other direction, in favour of caution and slowing down.

Nova Scotia, in company with areas like New York, Quebec and Maryland, has the option of preventing potentially serious and irreversible harm by deciding to extend the present moratorium on hydraulic fracturing until there is more clarity about potential for harm, and a clearer understanding of how, and to what extent, harm can be prevented.

No proof of harm does not mean no harm.

There are, of course, some articles in the literature which make the argument that because there is "no conclusive evidence" or "no proven evidence" that harm has been done, fracking is safe. The key words in this argument are "conclusive", or "proven." Scientific proof generally means a 97% certainty that there is a link between two things.

A key question facing decision makers is how to determine public policy before 97% certainty exists.

The precautionary principle, incorporated in *The NS Environment Act* establishes:

> the precautionary principle will be used in decision-making so that where there are threats of serious or irreversible damage, the lack of full

> scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation. [Purpose of the Act, Part 1]

Other sections of the Act provide relevant guidelines to the present review, including recognizing "environmental protection as essential to the integrity of eco-systems, human health and the socio-economic well-being of society."

The precautionary principle is particularly appropriate to situations where public health is at stake. In the Inquiry into the safety of Canada's blood system, Justice Krever specifically addressed the issue of scientific certainty and when society must act:

> Where there is reasonable evidence of an impending threat to public health, it is inappropriate to require proof of causation beyond a reasonable doubt before taking steps to avert the threat.[50]

An editorial in the *American Journal of Public Health* in May 1984 stated:

> The incomplete state of our knowledge must not serve as an excuse for failure to take prudent action. Public health has never clung to the principle that complete knowledge about a potential health hazard is a prerequisite for action. Quite the contrary, the historical record shows that public health's finest hours often occurred when vigorous preventive action preceded the crossing of every scientific "t" and the dotting of every epidemiological 'i.'

Phillips, masters of Laws candidate and Goldberg, Professor of Epidemiology and Bio-statistics at McGill argue:

> … Without immediate precautionary actions, costly (not just in monetary terms), irreversible externalities to human health and the environment will occur. … Natural gas development requires comprehensive safeguards to protect valuable resources and prevent against irreparable damage. **Yet, such safeguards are impossible to implement if there exists a significant lack of information and scientific data regarding the effects of development upon human life and the natural environment.** In particular, there are sizeable informational shortcomings surrounding the use of hydraulic fracturing within extraction activities.

And conclude:

> Our arguments indicate clearly that a precautionary moratorium on all natural gas development is required until the short- and long-term effects of extraction activities can be accurately ascertained.[51]

When the data is weak, risk analysis is compromised

The consensus in the literature is that evidence of risk of public health impacts from unconventional natural gas development exists. There is also consensus that present gaps in information limit an understanding of the range and seriousness of potential risks, to health and other areas. We do not yet know how to fully quantify the risks, and we do not yet know how to prevent them. We don't have a basis to determine how much prevention will be "good enough."

This underlines the limitations of applying traditional risk analysis to hydraulic fracturing and UGD at this point in time.

> Application of the risk assessment paradigm requires rigorous data on both exposure and toxicity in order to adequately characterize potential risks of contaminants to human health and ecological integrity. Weakness rendered by poor data, or lack of data, in either the exposure or effects stages of the risk assessment process significantly reduces the confidence that can be placed in the overall risk assessment.[52]

What's the rush?

There are an increasing number of articles in the literature posing the question, "what's the rush?" [53] and weighing the risks and benefits of slowing down against the risks and benefits of allowing continued accelerated spread of new UGD using hydraulic fracturing, even with new regulations.

The essence of the argument for slowing down is that, because natural gas is a limited resource, the same benefits of UG will be there when and if we decide to access it. There is no increased benefit to acting quickly. In fact, revenues may increase in future, if gas prices increase.

On the other hand, the literature argues that as the science develops, if it appears that this resource can be developed safely, it is almost inevitable that there will be a better understanding of how to prevent harm and that improved practices incorporating effective protective measures will become industry and regulatory standard in practice, rather than in word.

And, if it turns out that the resource cannot be developed without unacceptable risk, much harm, and the associated costs, will have been prevented.

Ethical issues involved

A growing number of articles address the ethical and human rights issues involved in a decision to allow continued UGD given present indications of potential for harm, and lack of knowledge as to whether, and how, harm can be prevented. [54]

Conclusion: First, do no harm

We are encouraged that the present government made the election commitment that **"**Unless we can definitively determine that fracking will not harm our resources, our environment, or the general public in any way, the extraction procedure should be prohibited."

Bearing in mind the government's stated intention, and the defined mandate of the review, EHANS urges the panel to adopt the approach set out in the Maryland HIA, and "focus on those exposures and conditions that either would not occur in the absence of, or would be increased as a result of the HVHF industry." A true understanding of the health impacts, and most other potential impacts of hydraulic fracturing requires adopting a broad perspective.

EHANS' understanding of the literature is that we are far from being able to definitively determine that hydraulic fracturing can be carried out with lack of harm in the area of public health. Even using the more limited question presently posed by the panel, we are far from being able to definitively determine that this practice can be done safely, if safety is understood as protection against harm from impacts arising from this operation.

For all of these reasons, EHANS urges the panel to recommend a continued moratorium on hydraulic fracturing for UG for a period of at least 10 years, until valid evidence exists as to whether, and how, the full industrial impacts of the hydraulic fracturing process and industry can be carried out safely and without harm to public health, or to the environment on which our health relies.

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April 16, 2014
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