

Chief Medical Officer of Health's Recommendations Concerning Shale Gas Development in New Brunswick

Office of the Chief Medical Officer of Health (OCMOH)
New Brunswick Department of Health

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Cover photo:

“Tight Gas” wells in the McCully Field near Penobsquis, NB

Photo from NB DNR – http://www.gnb.ca/0078/minerals/Images/Carbon_Photo-60.jpg

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Concerning Shale Gas Development in New Brunswick**

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Table of Contents

Message from the Chief Medical Officer of Health	1
Executive Summary	3
Summary of Recommendations	8
Part 1 - Guiding Principles for Protection of Public Health	11
1. Determinants of Health	12
2. Public Health Ethical Considerations	14
3. Health Objectives Related to Development of a Shale Gas Industry in NB	16
Part 2 - What We Know Now and What We Don't Know Now	17
1. Shale Gas – The New Brunswick Context	18
2. Experience from Other Jurisdictions	20
3. What We Don't Know Now	26
Part 3 - Recommendations for Protection of Public Health	33
1. Protection of Health and Community Wellbeing Related to Changes in the Social Environment	36
2. Protection of Health Related to Changes in Both the Social and Physical Environments	40
3. Protection of Health Related to Changes in the Physical Environment	42
4. Protection of Future Generations	49
5. Implementation and Oversight	55
Part 4 - Conclusions	59
Acknowledgements	62
Appendix - Summary of findings and recommendations related to public health and shale gas in other jurisdictions (selected references)	63
References	71

All internet links cited in this document were successfully accessed on August 28, 2012 except as noted.

Whoever wishes to investigate medicine properly, should proceed thus: in the first place to consider the seasons of the year, and what effects each of them produces for they are not at all alike, but differ much from themselves in regard to their changes. Then the winds, the hot and the cold, especially such as are common to all countries, and then such as are peculiar to each locality. We must also consider the qualities of the waters, for as they differ from one another in taste and weight, so also do they differ much in their qualities. In the same manner, when one comes into a city to which he is a stranger, he ought to consider its situation, how it lies as to the winds and the rising of the sun; for its influence is not the same whether it lies to the north or the south, to the rising or to the setting sun.

These things one ought to consider most attentively, and concerning the waters which the inhabitants use, whether they be marshy and soft, or hard, and running from elevated and rocky situations, and then if saltish and unfit for cooking; and the ground, whether it be naked and deficient in water, or wooded and well watered, and whether it lies in a hollow, confined situation, or is elevated and cold; and the mode in which the inhabitants live, and what are their pursuits, whether they are fond of drinking and eating to excess, and given to indolence, or are fond of exercise and labour, and not given to excess in eating and drinking.

“On Airs, Waters and Places”, Hippocrates, c. 400 BCE

Message from the Chief Medical Officer of Health

Doctors have known for thousands of years that the environment greatly impacts upon human health. Hippocrates, the Greek physician often referred to as the “father of Western medicine”, first wrote about it twenty-five centuries ago. Fortunately today in New Brunswick both residents and visitors still find here a healthy and pleasing environment. Indeed our vast networks of river systems are renowned for their fishing and other recreational pursuits. The key initiative of creating and maintaining healthy environments however requires ongoing attention: we must continue to invest in what truly makes people healthy. This requires the effort of an entire community led and supported by a whole-of-government approach.

Section 41 of the Canadian Medical Association Code of Ethics reads that a physician should ‘recognize that community, society and the environment are important factors in the health of individual patients’. Increasingly, doctors are expressing their concerns when any of these factors impact negatively upon their patients. Because of our training and experience in environmental health, we as Public Health doctors have a particular and important role to play. Furthermore, it is part of our mandate to advocate, and provide meaningful information so that people, communities, organizations and governments have the knowledge necessary to make the appropriate decisions when faced with balancing the potential benefits and harms of a given situation. Like any other doctor, we must consider all our patients – in this case the entire population present and future – and give thoughtful advice for actions that will promote fair opportunities for individuals, families and communities to enjoy good health.

Virtually every industry has potential health implications associated with it. The type, the frequency and the severity varies considerably with the nature and complexity of the industry – so too with shale gas production.

The gas and oil industry is not new to New Brunswick. However, it is only in the last 10 years or so that the combination of technologies has been developed that makes it feasible to extract gas from the layers of shale deep in the earth in an economically viable way. The methodologies used are complex and still evolving. With shale gas production, we not only have to consider what the health impacts are from the known conventional part of the industry but also factor in those considerations that relate to the new.

With industry, there may of course be economic benefits which should have a positive impact on health status. However, we cannot simply assume that more money equates to a healthier population – the money needs to be utilised strategically. Economic factors aside, the ultimate decision to allow industry expansion to proceed will need to take into account what appears to have become a polarized public debate, possibly a result of both the values based nature of the discussion and varying degrees of the public’s understanding of the facts. When people don’t understand an issue, or feel their values are being compromised, this has an adverse bearing on their health and wellbeing.

As Chief Medical Officer of Health, I am therefore providing these recommendations to our government to offer advice on measures that should be put in place to maximize the health benefits and minimize the health risks related to shale gas development if the decision is taken to go ahead with it. In addition, this document is intended to provide information to the many others who have a role to play in protecting the health of the public. This work is based on experience from other jurisdictions, a review of the available literature, and expert opinion from a variety of public health and environmental health professionals. As this process develops, new knowledge emerges and our understanding evolves, some of these recommendations may need to be adapted or adjusted.

Currently, the people of New Brunswick are among some of the most privileged in the world, enjoying one of its most beautiful social and physical environments; therefore, at this point in time, we must ensure that we all do our best to preserve that for ourselves and the generations to come.



Dr. Eilish Cleary
Chief Medical Officer of Health
New Brunswick Department of Health

Executive Summary

While large-scale development of a shale gas industry in New Brunswick may offer an economic growth opportunity for the province, it will be important to ensure that the overall health gains are greater than the losses. Economic status of individuals and communities can be an important determinant of their health, however there are many other factors resulting from industry development that can have strong negative impacts. Unless proper controls are put in place there is a risk of spoiling any benefits from economic gains through adverse health outcomes.

If an expansion of the unconventional gas industry takes place in New Brunswick, Government needs to take targeted and strategic actions aimed at prevention and mitigation of negative health impacts, which includes building capacity in local and provincial services and infrastructure. These will need to be put in place prior to further development as current infrastructure, capacity, processes and legislation are not adequate to meet these needs. In addition, as this industry is new and evolving, monitoring of the health of the population will be important on an ongoing basis to detect adverse impacts. This will allow for modifications, including if warranted, a slow down or halting of further development. Accordingly, the Chief Medical Officer of Health (CMOH) has developed the recommendations in this document which she believes are necessary in order to protect the health of the public.

While there has been considerable discussion amongst the public about potential impacts on water, it is important to remember that clean water and healthy air are not the only important requirements and determinants of health. The proposed areas for action address potential health impacts resulting from changes in either the social or physical environment. Protection of the health of future generations is also considered in order to ensure long-term sustainability of these actions. As the practice of public health results from an assessment of a complex balance of factors, and often has to contend with uncertainties, it is important that it be informed by a strong theoretical foundation. Therefore, all of the recommendations are grounded in the guiding principles for protection of public health, including scientific knowledge and reasonable judgement of the determinants of health, ethical considerations, public health values and principles, and the resulting health objectives.

This report identifies the known issues that should be addressed and the unknowns which require further investigation. The recommendations propose actions that should be taken in areas such as health equity, assessment of health impacts, monitoring of health and environmental impacts, strengthening of the planning process, ensuring transparency and community participation, filling knowledge gaps, requiring appropriate environmental controls, and enabling more effective government oversight. Attention is needed in order to protect vulnerable populations such as children, and those for whom the environment plays a particularly strong foundation to their health such as First Nations peoples.

This document was developed through a critical review of the experience of shale gas development in other jurisdictions through the lens of anticipated impacts (both positive and negative) to public health. Other sources of information include reviews of case studies reported in the scientific literature and other reports, current emerging issues in conference proceedings, discussions with public health and environmental experts, media reports, and listening to the current public debate on shale gas. This was done with a view to providing recommendations to Government for use prior to and during any expansion of the industry in New Brunswick.

Many of these recommendations are complementary to those proposed in the document entitled "Responsible Environmental Management of Oil and Gas Activities in New Brunswick -Recommendations for Public Discussion" (May 2012) which was developed to outline measures required to protect the environment. This document builds upon and enhances the proposed environmental measures as deemed necessary in order to provide added protection for human health. The recommendations that resulted are intended to help inform the Government's risk management and regulatory framework in such a way that it will be able to provide appropriate, and comprehensive public health promotion and protection along with its other goals. This document is also intended to provide information to the many others who have a role to play in protecting the health of the public.

With respect to the scope of this document, the primary focus is on health risks. However, some measures have been included in order to maximize possible health benefits. Not included are other potential impacts which could be both positive (e.g. economic gains in terms of income, employment, energy) and negative (e.g. green house gases, tourism, fishing, hunting, ecosystem damage and earthquake activity). There are others within government and amongst partners who are better positioned in terms of expertise to speak to these matters.

It is important to note that the CMOH's recommendations are not a full assessment of all health risks as they apply in the New Brunswick context. However, it is intended to help start a conversation on potential health impacts from shale gas development and what can be done about them.

The work of building a healthy population belongs to all of society and so many of the recommended actions will require considerable work from individuals and organizations in the community as well as from Government and industry. Because of their training and expertise, Public Health professionals will have a particularly important role to play in leadership and content knowledge. Ideally New Brunswick should be building efficiencies and expanding knowledge through a pan- Canadian approach when possible.

The cost of funding these recommendations has not yet been determined. It is recognized they may not be insignificant and there could be opportunity to have much of the costs absorbed by industry. This advice is based on what should be routine public health practice for all environmental health programs. The knowledge used is current, but as there are many data and information gaps it will need to evolve. In particular, it will be key to hear public thoughts and perceptions to better inform future actions. An implementation group should be established and an oversight mechanism put in place.

Document Overview

Part 1 of this document outlines the guiding principles for protection of public health, including aspects of the determinants of health, ethical considerations, public health values and principles, and the derived health objectives. This information provides a background for the reasoning behind public health promotion, prevention and protection decisions, and for the recommendations herein.

The main determinants of population health are factors that impact the social and physical environments. In addition to protecting the physical environment, investment in improving the social determinants of health today will translate into better health equity, improved population health and less money spent on treatment and rehabilitation tomorrow.

Ethical considerations, values and principles guide all actions intended to improve, promote and protect health because the practice of public health is always a balancing act between knowns and unknowns and decisions often need to be made in the face of uncertainty.

The health objectives, values and principles describe the different pieces of work that need to be undertaken to make a difference through improved health of the population. However, action on these issues needs to come from outside the health sector as well as from within it. The Public Health sector should play a leadership role, but achieving these outcomes needs to involve collaborative, multi-sectoral partnerships across the whole community.

Part 2 of this document examines the New Brunswick context, summarizes the key findings from a review of experience in other jurisdictions and outlines many knowledge gaps with respect to shale gas and public health in general. It also contains an overview of some of the work being undertaken elsewhere which will assist in contributing to the knowledge base related to this industry.

1. Shale gas – the New Brunswick context

While the oil and gas industry is not in itself new to New Brunswick, the combination of technologies and methodologies that enable recovery of gas from the shale layers is recent. This has led to considerable interest as it is believed that there is a rich reserve in the province although it is not uniformly distributed throughout. This would mean that not all communities would be equally impacted by any potential development. There is currently no estimate available of the rate, size, density, location or production capacity of the potential development which has made it difficult to do a full assessment on potential health impacts.

2. Experience from other jurisdictions

The principal lessons noted were that there are social and community health risks from this industry which can be compounded by inequities caused amongst the local populace. One could expect that as a result of economic gains due to increased income, energy and employment, there would be an indirect positive benefit in health status as a result of this industry, however clear evidence to support this was not found in the course of this review.

There are significant data gaps that limit assessment of health risks and to date there has been limited involvement in shale gas issues by public health officials and experts. The public discussion on shale gas has been dominated by chemical toxicity concerns but many other factors of potential concern to public health also need attention. Few studies have been undertaken that consider the overall potential impacts on health and the physical and social environments over the entire lifetime of the industry.

One particular possible social and community health risk that the Province will need to guard against is the “Boomtown Effect” that can arise during economic development. This effect occurs when a rapid change in population, industrialization and economic prosperity also leads to a host of social ills that impact community health. These can include increased rates of crime, drug and alcohol abuse, sexually-transmitted infections (STIs), and domestic violence; inadequate supply and quality of housing; increased cost of living; increased community dissatisfaction; increased mental health and social services case loads; increased hospital admissions; insufficient infrastructure; and insufficient capacity in public services, including policing, local government, social services, and health care.

The Boomtown Effect is thought to be more intense for small communities with a traditional way of life that did not previously involve the industrial sector responsible for the boom, so there may be a risk to New Brunswick communities unless this effect is anticipated and mitigated through strategic investments.

Potential impacts to the physical environment include more than just the risk of releases of the chemicals present in hydraulic fracturing fluids that are the main focus of the current public debate about shale gas. A portion of these fluids flows back to the surface with the natural gas stream, and these wastes may contain natural contaminants (such as petroleum, heavy metals, radioactivity and high salt concentrations) from deep underground, so waste management is an environmental and health issue. There are further potential health risks due to air quality, noise, vibration, continuous illumination and physical hazards due to extensive heavy truck traffic. In addition to the potential for toxicity or physical injury, there are other possible hazards to mental health and community wellbeing that result from a feeling of lack of control over one’s destiny in local communities in the face of these issues.

3. What we don’t know now

Some of the key information gaps identified during this review include a lack of standard methods for preventing and mitigating social impacts, a lack of health status studies before and during gas development, and a lack of systematic health impact assessments. Information needed to assess toxicity risks may also be lacking, such as the toxicological characteristics of industry products and wastes,

and accurate exposure data is usually not available. There is also a lack of knowledge about the extent, locations and rate of development which makes it very difficult to forecast local effects of specific projects and to assess the potential for cumulative effects over time.

There are many important pieces of work that are currently underway in Canada and the US which will contribute important detail on aspects of the shale gas industry and its connection to health. More study is needed, and while New Brunswick will benefit from these findings they will not substitute for in-province health impact assessments.

Part 3 of this document describes 30 recommendations that the CMOH believes are necessary to address the key findings and to protect or enhance population health through appropriate management of the shale gas industry. These recommendations may be grouped into the following categories:

1. Protection of health and community wellbeing related to changes in the social environment

Includes recommendations for optimizing equitable distribution of risks and rewards; revenue sharing; identifying a role for local governments in planning the location of gas industry infrastructure; identifying a role for Public Health in community planning; and implementing a transparent consultative process with the public and other stakeholders on the implementation process for these recommendations.

2. Protection of health related to changes in both the social and physical environments

Includes recommendations for developing a requirement to submit a health impact assessment (HIA) as part of the standard Project Registration process; developing a protocol for monitoring of health status of persons living, working, attending school or playing in proximity to the industry; and for linking this information to environmental monitoring data and socioeconomic data.

3. Protection of health related to changes in the physical environment

Includes recommendations for monitoring networks for ambient air and water quality; provisions for wastewater handling, testing, transportation, treatment and disposal; full and timely disclosure of chemicals used; less toxic alternatives for hydraulic fracturing fluids; safe setback distances that consider human health factors; limiting health impacts from noise, vibration and continuous illumination; traffic management plans; emergency response training; and promotion and protection for the health of workers.

4. Protection of future generations

Includes recommendations for a plan to anticipate and mitigate the “Boomtown Effect”; a strategic health impact assessment; identifying areas to be excluded from development; a strategic land use plan that considers health equity; consideration of vulnerable and disadvantaged populations; consideration of First Nations; a strategic water management plan; and public reporting of environmental and health monitoring data.

5. Implementation and oversight

Includes recommendations for strengthening government oversight capacity and resources; striking an implementation group to oversee implementation of the CMOH’s recommendations; establishing an on-going dialogue among community, government, academics and industry; and creating a multi-disciplinary advisory committee to Cabinet.

Part 4 of this document outlines the conclusions upon which the recommendations are based. The mandate of the Office of the Chief Medical Officer of Health is to improve, promote and protect the health of the people in New Brunswick. Based on this work it is clear that if the decision is taken to expand the shale gas industry in New Brunswick, Government must take targeted and strategic actions aimed at prevention and mitigation, including building capacity in local and provincial services and infrastructure, in order to minimize the risks of negative impacts on health.

The learnings from other jurisdictions that have undergone recent development of this industry indicate that it will be necessary to look at health in broad terms, and so, in addition to physical factors, plans will need to address the social determinants of health. This will be particularly important if there is an expectation of benefitting the health of the population through economic gains. The review also found that there are major information gaps that will need to be filled through research and ongoing monitoring of health surveillance as well as requiring Health Impact Assessments.

Process issues have been identified which highlight the need for openness, transparency and availability of reliable information. Participation of local communities and governments will be key to ensuring that the most informed decisions about planning and mitigation can be put in place. To date there is not enough information available about the specific way (in terms of scope, size, well pad density, rate, etc.) that the development of the shale gas industry would unfold, but this information will be important to enable strategic project plans, land and water use planning and to inform assessments of potential cumulative impacts.

In summary, the CMOH has provided the recommendations in this document to inform Government decision-making. This advice is the best possible at this time given the assessment of limited current knowledge and so may have to evolve over time. Absent from the inputs to date has been consultation with the public and this is considered a key next step. In addition, this document is intended to provide a solid information base for that discussion. It is recognized that these recommendations would require a formal implementation and oversight structure and require participation from across the community.

While the recommendations in this document may seem onerous, rather they should be seen as routine public health practice. It is important to consider the impact that industry can have on human health. In so doing, New Brunswick could be a leader in establishing a path to balance the contentious and sometimes polarized views within society regarding the increasing number of vital issues of environmental health - locally and globally.

Summary of Recommendations

1. Protection of Health and Community Wellbeing Related to Changes in the Social Environment

Recommendation 1.1: The Province should establish mechanisms to measure, monitor, and optimize equitable distribution of risks and rewards that maximize benefits to the socioeconomic determinants of health for all New Brunswickers

Recommendation 1.2: The Province should develop a method based on a clear set of principles with input from Public Health that will enhance the proposed revenue sharing approach so that an appropriate portion of monies from royalties and other sources will help to offset negative impacts on the social determinants of health

Recommendation 1.3: The Province should implement structures and processes to ensure a role for local governments in planning the location of gas industry infrastructure such as roads, well pads, pipelines, compressor stations and water storage and treatment facilities

Recommendation 1.4: The Province should implement structures and processes to ensure a role for Public Health in community planning in order to ensure that the built environment is optimized for the determinants of health

Recommendation 1.5: The Province should undertake a transparent consultative process with representative members and sectors of the public and other stakeholders on the implementation process for these recommendations in order to achieve better health outcomes

2. Protection of Health Related to Changes in Both the Social and Physical Environments

Recommendation 2.1: The Province should implement a requirement for submitting a Health Impact Assessment (HIA), prepared according to the specifications of Department of Health (DH), as part of the standard Project Registration process managed by Department of Environment and Local Government (DELG).

Recommendation 2.2: The Province should develop and implement a protocol for monitoring the health status of persons living, working, attending school or playing in proximity to the industry.

Recommendation 2.3: The Province should develop and implement methods to link health status information to environmental monitoring data and socioeconomic status data.

3. Protection of Health Related to Changes in the Physical Environment

Recommendation 3.1: The Province should put in place monitoring networks for ambient air and water quality, as well as drinking water quality in the local areas expected to have an industry presence, in advance of industry development and continuing throughout the lifetime of development, production and post-production.

Recommendation 3.2: The Province should put in place special provisions for wastewater handling, testing, transportation, treatment and disposal.

Recommendation 3.3: The Province should require full and timely disclosure of all chemical compounds (rather than products or compound classes) which must include their identities, concentrations and quantities.

Recommendation 3.4: The Province should require that all hydraulic fracturing fluids contain additives that are the least toxic of any available alternatives.

Recommendation 3.5: The Province should develop and implement reasonable, safe setback distances approved by Public Health that consider human health and which are based on exposure risk assessments in addition to established precedents.

Recommendation 3.6: The Province should develop and implement standards approved by Public Health to limit health impacts from noise, vibration and continuous illumination.

Recommendation 3.7: The Province should require site-specific traffic management plans for all projects, including route plans and designated times of day for heavy truck movements.

Recommendation 3.8: The Province should enhance local and provincial emergency response training, capacity and preparedness to respond to the most likely and most serious emergencies that might pose a threat to human health.

Recommendation 3.9: The Province should enhance the mechanisms that are in place to promote and protect the health of workers in the industry and others who may be at the work sites (government inspectors, support industry workers, emergency responders, etc.).

4. Protection of Future Generations

Recommendation 4.1: The Province should develop a plan for anticipating and mitigating the “Boomtown Effect”.

Recommendation 4.2: The Province should undertake a Strategic Health Impact Assessment (Strategic HIA) to estimate the long-term cumulative health and social benefits and costs.

Recommendation 4.3: The Province should designate areas that are to be excluded from development, including drinking watersheds and wellfields, sensitive natural areas, specified agricultural lands, and other areas of special significance (scope to be defined).

Recommendation 4.4: The Province should prepare a strategic land use plan with considerations of health equity and with input from Public Health and other experts and stakeholders.

Recommendation 4.5: The Province should implement a process that will allow planning and regulatory decisions to consider vulnerable and disadvantaged populations that are at greater risk to environmental contaminants.

Recommendation 4.6: The Province should require that planning and regulatory decisions consider First Nations even if reserve lands are not directly affected.

Recommendation 4.7: The Province should prepare a strategic water management plan to protect the quality and availability of water for public water supplies, private well water supplies and fresh water in general.

Recommendation 4.8: The Province should encourage, promote and financially support research in New Brunswick, such as long-term longitudinal health studies and research on potential health effects, social impacts, and other aspects.

Recommendation 4.9: The Province should commit to periodically reviewing and reporting to the public on environmental and health monitoring data.

5. Implementation and Oversight

Recommendation 5.1: The Province should establish sufficient capacity and resources to enable relevant Government departments to oversee the development of this industry including conducting

project reviews and approvals, inspections, monitoring, enforcement and management of environmental, health or social consequences.

Recommendation 5.2: The Province should establish an implementation group for the recommendations in this report that is led by Public Health and includes representatives from other relevant government departments and other stakeholders.

Recommendation 5.3: The Province should sponsor a series of summits led by Public Health to better understand and communicate public health information and issues and to foster an effective ongoing dialogue among community, government, academics and industry.

Recommendation 5.4: The Province should create a multi-disciplinary Advisory Committee to Cabinet charged with reviewing government oversight throughout the lifetime of the industry in NB.

Part 1

Guiding Principles for Protection of Public Health

1. Determinants of Health

Taken together, the social and physical environments are the main influences on population health. In general, the lower a person's social and economic position is, the worse their health, so addressing the social determinants of health is fundamental to achieving health equity. Investment in the social determinants of health today translates into better population health and less money spent on treatment and rehabilitation tomorrow. While Government programs, policies and law provide opportunities for improvements, the action needed to improve health equity must come from outside the health sector as well as from within.

The World Health Organization defines health as *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"* (WHO 1948). Health is influenced by a broad range of both individual and collective factors, and their interactions: these factors are referred to as 'determinants of health'. The Public Health Agency of Canada lists twelve key determinants of the health of a population (see sidebar). The US Centers for Disease Control and Prevention has a very similar list, but instead groups them under five key categories: genes and biology, health behaviours, social environment or social characteristics, physical environment or total ecology, and health services or medical care (CDC 2012). The importance of these determinants of health has broad agreement worldwide among first ministers, health ministers, and many local, provincial, national and international organizations. This document will focus principally on the determinants of health related to changes in the social and physical environments.

The impact on health from each of these determinants varies, but research estimates that in general the health of a population depends principally on the social and economic determinants, which amount to roughly half of the total influence on health (Senate of Canada 2008). This estimate also attributes approximately 25% of the population's health to the health care system, 15% to biology and genetic factors, and about 10% to the physical environment. Another estimate (CDC 2012 and Tarlov 1999) suggests that the combined influence of social/ societal characteristics (the social environment) and the total ecology of all living things (the physical environment) amounts to more than half of the total influence on population health, followed to a progressively lesser extent by health behaviours, medical care, and lastly genes and biology.

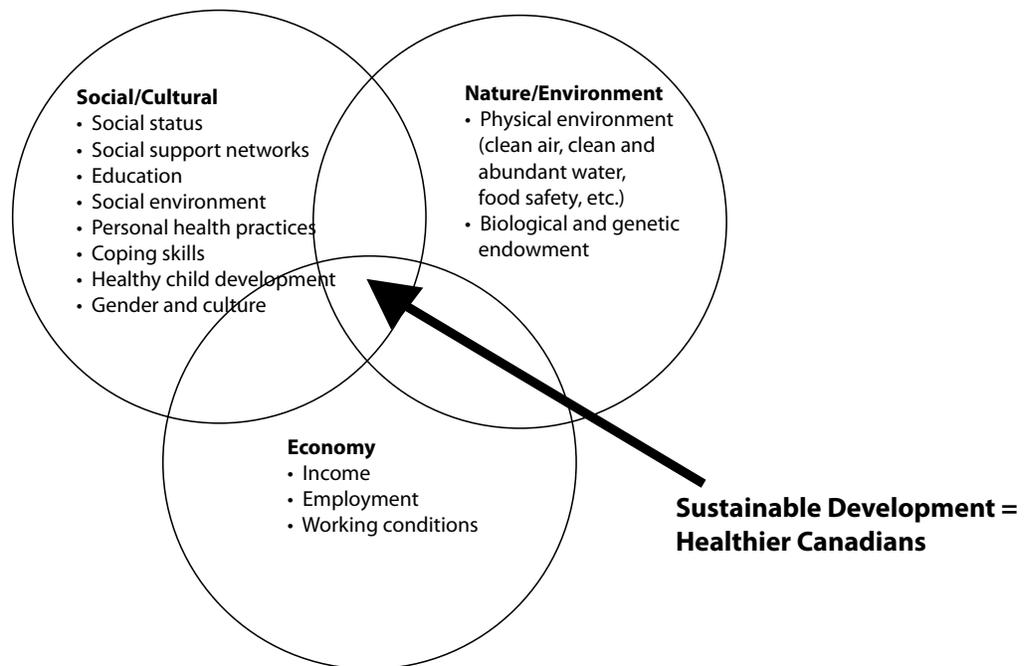
These estimates lend support to social and economic circumstances as powerful determinants of health, and in recent years there has been widespread international attention to this issue. Most recently, the World Health Organization organized the 'World Conference on Social Determinants of Health' in Brazil in October 2011, which underlined that addressing the social determinants of health is a cornerstone of public health practice. In other words, sustainable development equates to healthier Canadians, as shown below in PHAC's description of the relationship between the key determinants of health and the three pillars of sustainable development.

Determinants of Health (PHAC 2012)

- income and social status
- social support networks
- education and literacy
- employment/working conditions
- social environments
- physical environments
- personal health practices and coping skills
- healthy child development
- biology and genetic endowment
- health services
- gender
- culture

"Investing in the social determinants of health upfront is strategic and advantageous"

Relationship between Key Determinants of Health and the Three Pillars of Sustainable Development



http://www.phac-aspc.gc.ca/about_apropos/sd-dd/health-sante-eng.php

In broad terms, better social and economic conditions lead to a healthier population. It has been noted that as their income increases Canadians have less sickness, longer life expectancies and improved health (FPTACPH 1999). The improvement in health status among Canadians over the past century and why there are still important differences in health status among Canadians can be largely explained by the social determinants of health (Senate of Canada 2009).

Addressing the social determinants of health is fundamental to achieving health equity. Health equity is “when everyone has the opportunity to ‘attain their full health potential’ and no one is ‘disadvantaged from achieving this potential because of their social position or other socially determined circumstance’” (CDC 2008). Health inequities are the consequences of systematic, unequal and unjust distribution of the social and economic resources and conditions that give rise to the social determinants of health. However, health inequities can be reduced: government policy and law are the forces that provide an opportunity to do so. Furthermore, investing in the social determinants of health upfront is strategic and advantageous: not only are healthy and productive citizens more able and likely to contribute to the economy and to the tax base, investment in the social determinants of health today translates into smaller amounts of money being spent on treatment and rehabilitation tomorrow.

Lastly, it is very important to note that action to address these health issues must come from across the whole of the community. For example, the World Health Organization (WHO 2008) has stated that:

“The health sector will also play a leadership and advocacy role in the development of policies to deal with the social determinants of health. But lack of health care is not the cause of the huge global burden of illness: water-borne diseases are not caused by lack of antibiotics but by dirty water, and by the political, social, and economic forces that fail to make clean water available to all; heart disease is caused not by a lack of coronary care units but by the lives people lead, which are shaped by the environments in which they live; obesity is not caused by moral failure on the part of individuals but by the excess availability of high-fat and high-sugar foods. The main action on social determinants of health must therefore come from outside the health sector.”

2. Public Health Ethical Considerations

The practice of public health is always a balancing act. Decisions often need to be made in the face of scientific uncertainty and without clear research evidence of benefit or harm. However, the failure to act may produce even greater risk to health.

Ethical considerations underlie all public health objectives, and by extension, the recommendations in this document. Ethics are as fundamental to public health practice and professionalism as is evidence-based decision-making. Public health ethics are a standard of care as well as a duty of care. They are the values and principles that guide actions intended to improve, promote and protect health, and they must be relied on particularly in the face of uncertainty and controversy.

Public health ethics is often more clearly understood when compared to clinical ethics. The provincial Chief Medical Officer of Health (CMOH) and the Regional Medical Officers of Health are physicians and have the same ethical obligations as any other physician would, but in their case the “patient” is the public rather than an individual. As a result, the following comparisons can be made:

- The ultimate obligation of physicians and other health care providers is to act in the best interests of the individual patient before them: this is known as fiduciary responsibility. *In public health, the duty of care is toward the community or society as a whole.*
- In the clinical setting, the individual patient seeks out the health care provider and any intervention is legitimized by informed consent. *With public health interventions, informed consent could be contextualized as transparency – an open decision-making process where the Public has the right to be informed about the reasons for decisions and the right to appeal.*
- Clinical ethics is oriented to autonomy, while *the orientation in public health is essentially communitarian (namely, what is good for the whole community, not just the individual).*

Ultimately this simply translates to, what is the cost of being wrong about estimating risk? If we believe the risks are moderate and acceptable and can be mitigated but we are wrong, what is the worst that could happen? If we believe the risks are extreme and unacceptable and we are wrong, then what?

Because public health decision making depends on an assessment of complex and interacting factors, key values and ethical principles are used for guidance. In addition to general values such as accountability, respect, integrity and collaboration, the following are the main ethical considerations, values and principles that underlie all public health objectives and which give rise to the recommendations.

“The practice of public health is always a balancing act”

Public Health Ethical Considerations

- **Autonomy** – actions taken to protect public health should respect self-governance, self-determination, and informed decision-making
 - **Beneficence** and **Non-maleficence** – do good; i.e. protect the Public’s health, and refrain from doing harm
 - **Burden of Proof** – the burden of proof that an activity is not harmful falls on those undertaking it rather than on Public Health authorities to prove that the activity is harmful
 - **Communitarianism** – apply what is good for the whole community, not just individuals
 - **Equity** and **Distributive Justice** – always seek equitable distribution of benefits and burdens. This principle applies to both social and environmental justice
 - **Evidence-based** – risk assessment and decision making should always be evidence-informed
 - **Harm Principle** – to protect the public from harm, Public Health authorities may have to take actions that restrict individuals’ liberty
 - **Leadership** – Public Health authorities have a fiduciary responsibility to protect the public
 - **Precautionary Principle** – when an activity or occurrence raises threats of serious or irreversible harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically
 - **Prevention** – a focus on primordial (steps taken prior to emergence of problems) and primary (direct control measures) prevention is always preferable to mitigation of impacts and remediation of problems after they occur
 - **Proportionality** (Least Restrictive Means Principle) – restrictions imposed should be proportional to what the problem warrants, using the least restrictive means to achieve the desired outcome
 - **Reciprocity** – if individuals are asked to curtail their liberties for the public good, there is a reciprocal obligation on the part of society to ensure that they do not suffer undue hardship from complying
 - **Transparency** – the decision-making process should be open, the specifics of balancing risks and benefits should be clearly explained to the Public, and there should be an appeal process
 - **Utilitarianism** – achieve the greatest good for the greatest number
-

3. Health Objectives Related to Development of a Shale Gas Industry in NB

Just as a clinical doctor has a range of treatment options available to manage a patient, so too has Public Health a number of ways it can intervene to achieve the desired outcomes of improved health of the population. These can be described as health objectives and represent the different pieces of work that need to be undertaken in order to make a difference. They describe what must be achieved rather than who has responsibility. Fulfilling these objectives goes far beyond the work of the public health sector, which however must play a leadership role. Achieving the outcomes will involve collaborative, multi-sectoral partnerships across the whole community.

1. **ADVOCACY, LEADERSHIP & PARTNERSHIP** – Promote and protect the health of New Brunswickers through leadership, partnership (intragovernmental and with the public, industry, academia etc.), innovation and action in public health during all phases of the shale gas industry in NB.
2. **PROVISION OF INFORMATION** – Generate and disseminate information from a public health perspective (health hazard identification, exposure assessment, risk assessment and characterization, risk communication) which will support evidence-based decision making for policy and practice and help to ensure that all phases of the shale gas industry in NB are done safely and responsibly.
3. **PREVENTION OF PUBLIC HEALTH HAZARDS** – Identify, prevent and respond to health hazards that pose a risk to public health during all phases of the shale gas industry in NB. Fulfilling this objective will involve planning, implementing and evaluating risk assessment and management strategies to address these hazards, as well as enforcement, and enhancing data collection systems for population health assessment, surveillance and dissemination.
4. **PUBLIC HEALTH EMERGENCY PREPAREDNESS** – Prepare for and respond to public health emergencies that may arise during all phases of the shale gas industry.
5. **HEALTHY WORK ENVIRONMENT** – Promote a healthy work environment for those employed by and in close proximity to the shale gas industry.
6. **COMMUNICABLE DISEASE PREVENTION AND CONTROL** – Anticipate, prevent and control communicable diseases given the potential for the increase in population and its density in communities hosting the shale gas industry.
7. **SOCIAL DETERMINANTS OF HEALTH EMPHASIS** – Continue to build healthy and resilient people, communities and environments by using a population based health approach that addresses the social determinants of health, and makes effective, efficient and equitable use of the economic opportunities from the shale gas industry in NB.
8. **NATIONAL AGENDA** – Participate in collaboration with federal/provincial/territorial public health agencies across Canada to refine public health roles and responsibilities in the context of a shale gas industry and to facilitate national approaches to public health policy and planning in this sector.
9. **SCHOLARLY ACTIVITY** – Contribute, through scholarly activity and research, to the body of knowledge on the public health impacts of the shale gas industry and their mitigation.

Part 2

What We Know Now and What We Don't Know Now

1. Shale Gas – The New Brunswick Context

Despite experience in this province with the oil and gas industry over a long time frame, the shale gas industry is in its infancy in New Brunswick. Current conditions may result in a boom in activity as has already taken place in other jurisdictions. How this would affect different communities and regions is not yet known, but both the potential risks and benefits may be different between different areas of the province.

While the oil and gas industry is not new to New Brunswick, it has historically been a relatively minor component of economic activity in the province. Although the largest oil refinery in Canada is located in Saint John, almost all of the crude oil processed there comes from foreign sources, and there has historically been only small scale local oil and gas production.

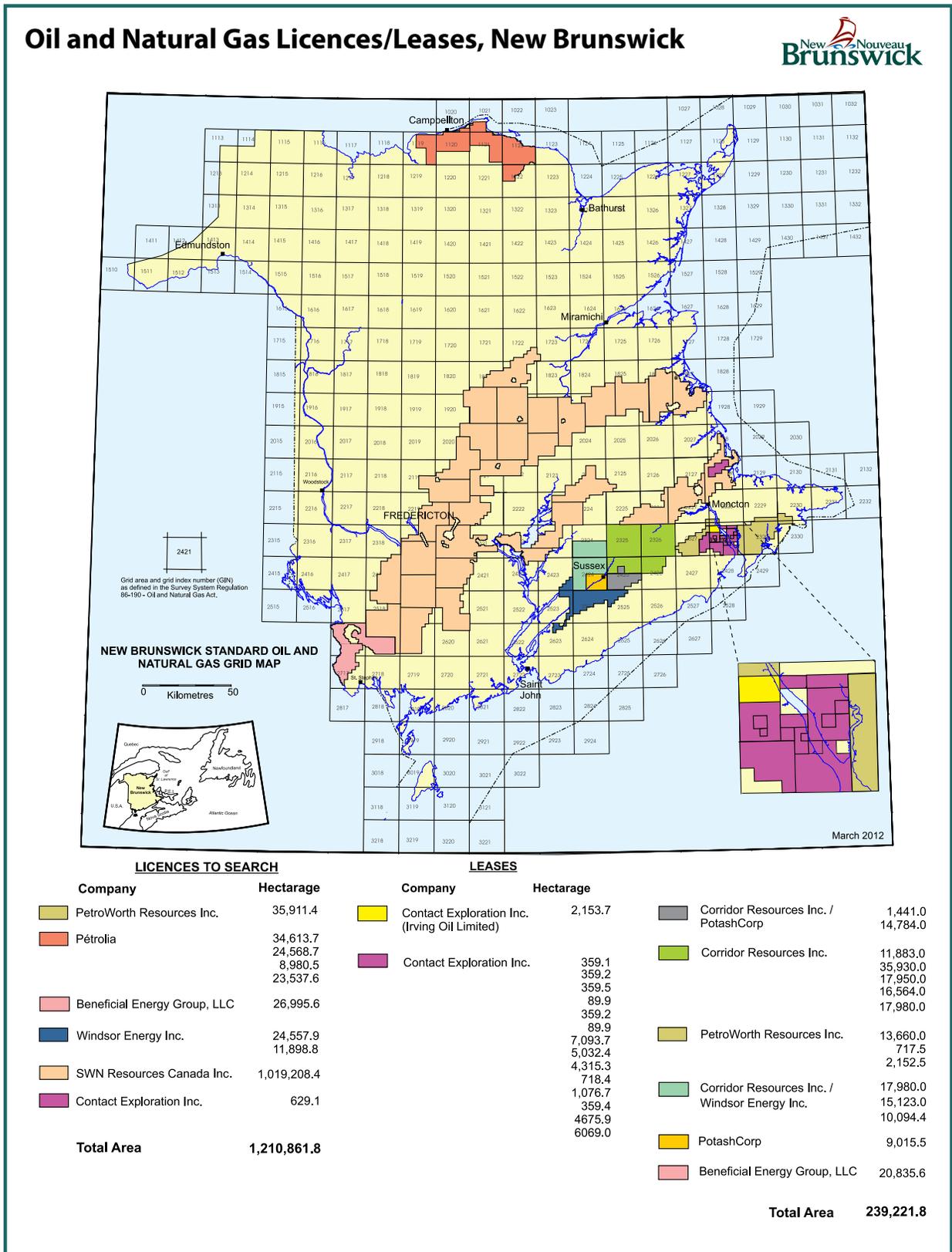
The first oil well in the province, and indeed one of the earliest in North America, was drilled in 1859 near Dover, in Westmorland County, and the first successful gas well in the Province began production in 1909 near Stoney Creek in Albert County (St. Peter, 2000; Fundy Engineering / Atlantica Centre for Energy, 2011). To date over 300 oil and gas wells have been constructed in the Province, with most of the activity in first half of the 20th century, little activity post-1950, and a resurgence of interest in the 1990s (St. Peter, 2000). Since then, approximately 40 new oil wells and 40 gas wells have been drilled and there are 30 producing gas wells at present (NBNGG, 2011).

With respect to the new technologies used in shale gas development, New Brunswick has had some limited experience in recent years. Since 1990, 49 oil and gas wells have been fractured by various methods (including hydraulic fracturing and liquefied petroleum gas or LPG fracturing) and 9 wells (5 gas and 4 oil) have used directional drilling (NBNGG, 2011). However, so far only a handful of wells have used all of the hallmarks of modern shale gas technology (directional “horizontal” drilling into shale source rock as opposed to sandstone reservoir rock and high-volume multistage slick-water hydraulic fracturing). These include 2 exploratory wells in the Elgin area: Corridor Resources Green Road B-41, which was the first horizontal shale gas well in New Brunswick, begun in June 2010, and G-59 (Fundy Engineering / Atlantica Centre for Energy, 2011; GLJ Petroleum Consultants Ltd, 2011).

At present there is considerable interest in exploration, and nine gas companies currently hold leases or licenses to search in specific areas of the province that amount to approximately 20% of its land area (see Figure 1). This interest has arisen because of recent estimates of gas reserves that suggest that there may be a world-class shale play in the province, potentially even richer than the Barnett Shale in Texas (Fundy Engineering / Atlantica Centre for Energy, 2011) and due to the existing Maritimes and Northeast Pipeline infrastructure (built in 2000 to convey natural gas from the Sable Island offshore field to New England). The Province is therefore poised to experience growth in this industry in the near future, and if gas yields and economic factors are favourable, a boom in activity may occur as it has in other jurisdictions.

One important factor to note also from Figure 1 is that not all geographic areas of the Province have the potential to be directly involved in or affected by shale gas development. This is also true in other jurisdictions (see, e.g., Nature Conservancy 2010; Considine, 2010; Sierra Research Inc. 2011) and is simply a consequence of the local geology (i.e. the development will only occur where the resource exists). This effect has implications in that both the potential risks and benefits could be different between different New Brunswick communities and regions.

Figure 1 (from NBDNR, 2012)



2. Experience from Other Jurisdictions

Because there has been little direct experience to date in New Brunswick, the recommendations in this document draw on experience from other jurisdictions where the shale gas industry has already undergone significant expansion and/or study, such as the US states of Pennsylvania, Texas, Colorado, Wyoming and New York, amongst others, as well as other provinces in Canada. New Brunswick is in the fortunate position of being able to learn from both positive and negative experiences elsewhere.

The principal lessons noted were that there are social and community health risks from this industry which can be compounded by inequities caused amongst the local populace. Likely there could be indirect benefits from economic gains due to increase income, energy and employment, however clear evidence to support a positive impact on health status related to this industry was not found in this review.

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.

Some of the principal lessons related to public health from experience in other jurisdictions are itemized here.

a. There are significant data gaps that limit the ability to thoroughly assess risks to public health.

Some of the public health knowledge gaps that have been identified include development of approaches to planning for social impacts, a lack of prior health status studies, a lack of comprehensive health impact assessments, specific chemical toxicity information on chemicals used by the industry, chemical toxicity information on wastes, a lack of exposure data, a poor ability to forecast the extent, rate and locations of development, and little information on cumulative or full life-cycle effects. These issues are discussed in more detail in Section 3 (What We Don't Know) below.

b. In cases where the public health impacts of shale gas development have been considered, there are some common themes regarding types of potential hazards to public health.

OCMOH staff have identified some common themes regarding what types of potential hazards to public health should be considered: Appendix 1 lists some of the findings and recommendations from studies, health impact assessments, commission reports and other published information that speaks directly or indirectly to potential public health impacts.

From the information in Appendix 1 and other sources the types of potential hazards identified include:

- **PHYSICAL** - Physical hazards due to accidents, malfunctions, emergencies, etc.
- **ENVIRONMENTAL** – Hazards to the quality of air, water, soil or food
- **MENTAL** – Mental health impacts to individuals
- **SOCIOECONOMIC** – Impacts to communities
- **OTHER** – Other impacts, such as cumulative effects, radiation, etc.

These potential hazards form part of the basis of the framework used for the recommendations in Part 3.

c. The public discussion on shale gas has been dominated to date by chemical toxicity concerns and as a result many other factors of potential concern to public health also need attention.

The focus in the public discourse to date on water and hydraulic fracturing chemicals runs the risk of overlooking other considerations that are potentially even more problematic, such as community health issues. Most media reports relating to public concerns over shale gas development have focussed almost entirely on the impact from hydraulic fracturing chemicals to drinking water wells. There have also been a smaller number of reports about concerns related to air quality, but these two issues alone account for almost all of the public discourse about potential health effects.

With regard to the scientific and medical literature, factors such as potential impacts to community health, mental health and socioeconomic wellbeing have also not been as widely reported or studied as some of the issues surrounding potential environmental toxicants. These are nevertheless very important determinants of health, and are of interest to the public health community worldwide, so there has recently been an increase in the level of attention to these issues.

Furthermore, some of the studies that address community health issues have pointed out some potential negative consequences when planning for development did not adequately take these factors into account. Some of these mental health and socioeconomic impacts are discussed further in Sections 2e and 2f below.

Another area that needs better understanding is the potential for physical injury, both at the work site itself and in the vicinity of development. There are potential hazards that warrant further consideration: for example, it has been estimated that up to 2,000 truck trips are needed per well developed (European Parliament 2011; New York DEC 2011) and these are often on rural roads that were not designed for such traffic. As a result, the potential for increased truck traffic accidents that could impact residents near development areas is a concern.

d. Public Health officials and experts have often been late to the table or absent from discussions about shale gas regulation in other jurisdictions

Although health concerns are often noted as an important preoccupation among the Public, there has been a notable lack of participation by Public Health agencies in many of the ongoing initiatives to regulate the industry elsewhere. This may be due to a general lack of understanding about the potential impacts on health, little precedent to draw on for learnings or plans that could be followed, a narrowing of the scope of what “health” means, and/or a belief that engineering controls and regulations can mitigate all of the potential impacts.

In one example noted in New York state, a group of over 250 concerned health professionals and organizations wrote to the state governor in October 2011 regarding the lack of consideration of human health impacts during the New York State Draft Supplemental Generic Environmental Impact Statement process (a large scale multi-year strategic review of potential risks), and the lack of a health professional representative on the state’s High Volume Hydraulic Fracturing Advisory Panel (New York Health Professionals 2011).

Furthermore, this issue has been illustrated elsewhere (Goldstein 2012) by the observation that health effects typically rank among the most important preoccupations stated by opponents to shale gas, but nevertheless three recent major US advisory commissions studying shale gas issues (one federal and the states of Maryland and Pennsylvania), all of which refer explicitly to protection of public health in their mandates, appointed no commissioners with expertise in public health,

medical health or environmental health (out of 51 persons in total). In addition, no state or U.S. federal government agencies with direct public health responsibilities (e.g. the federal Department of Health and Human Services, the National Institute of Environmental Health Sciences, the Center for Disease Control, the Agency for Toxic Substances and Disease Registry, or similar state departments and agencies) participated in the proceedings of any of these commissions.

e. There have been economic benefits associated with expansion of the industry, but this may come with socioeconomic risks that can adversely impact individual and community wellbeing

The economic benefits of shale gas development are potentially very large. Large-scale increases in employment, tax and royalty revenues could have the potential to improve overall health status in this Province. However, these potential improvements can be limited or even counteracted by negative social impacts that can arise during an economic boom (this is known as the “Boomtown Effect”). These negative impacts can include increases in crime, drug and alcohol abuse, sexually-transmitted infections (STIs), and domestic violence. An inadequate supply and poor quality of housing along with increased cost of living resulting from the boom can lead to increased community dissatisfaction. These problems can be further compounded due to inadequate infrastructure and public services capacity (including policing, local government, mental health services, social services, and health care) that can lag far behind the growing need for them.

Because the Boomtown Effect is thought to be more intense for small communities with a traditional way of life that did not previously involve the industrial sector responsible for the boom, there may be a risk to New Brunswick communities unless this effect is anticipated and mitigated through strategic investments.

One estimate of economic activity in the Marcellus Shale (Considine 2010) found that the contribution to the regional economy in the states of Pennsylvania and West Virginia in 2009 was \$4.8 billion, with over 57,000 direct and indirect jobs created, leading to increased local, state and federal tax revenues of \$1.7 billion. This is perhaps the most active shale gas area in the world, however, so these estimates may be unrealistic for New Brunswick, but they nevertheless illustrate the possibilities for economic benefits.

Royalties on Crown-owned resources are also an important consideration in the New Brunswick context, as they represent a very large potential source of government revenue. Possible royalties for the Province of New Brunswick (Fundy Engineering / Atlantica Centre for Energy, 2011) were estimated to be up to \$225 million annually at full development, totalling \$5.7 billion over the life of the industry if all estimated resources can be fully exploited (although based on natural gas prices at the time of writing, these estimates would have to be adjusted down by about 40%).

Increases in employment levels and revenues from taxes and royalties have the potential to improve health status in this Province. Socioeconomic status of a population is a strong predictor of health status, so employing persons who were previously unemployed, or enabling them to take up higher paying positions, or improving social programs through increased government revenues should result in health benefits to the population.

However, these potential improvements in health status due to improved economic status can be limited or even counteracted by the Boomtown Effect (also known as the Boomtown Impact Model). There have been many documented cases since the 1970s (Jacquet 2009) of energy boomtowns where a rapid change in population, industrialization and economic prosperity also led to a host of social ills that impacted community health. These include increased rates of crime, drug and alcohol abuse, sexually-transmitted infections (STIs), and domestic violence; inadequate supply and quality of housing; increased cost of living; increased community dissatisfaction; increased mental health and social services case loads; increased hospital admissions; insufficient

infrastructure; and insufficient capacity in public services, including policing, local government, social services, and health care.

The Boomtown Impact Model was shown to be a close fit to a case study of natural gas development in Sublette County Wyoming (Jacquet 2009) and similar impacts have been commonly encountered in other communities where large-scale energy developments have taken place. Some current Canadian examples of energy boomtowns where such effects can be seen include Fort McMurray Alberta (oil sands development), as well as Fort Nelson, Fort St. John, Dawson Creek and other communities in northeastern British Columbia (shale gas).

In the Fort McMurray region (Regional Municipality of Wood Buffalo), a number of negative social impacts typical of the Boomtown Effect were noted, and the overall community health status was found to be lower than the provincial average, even when the major centres of Calgary and Edmonton, which generally have better health status than rural areas, were excluded from the data (Royal Society of Canada 2010). In spite of the evident problems, the Royal Society report stated that *“we were unable to identify any public health intervention programs specifically targeted towards resolving these conditions... A coordinated public health effort needs to be organized to address the evident health disparities”* and that *“such health disparities are difficult to reconcile with the wealth the region generates”*.

Other reports of identified social issues in the Fort McMurray area included levels of reported crime per police officer that were three times the national average (Ruddell 2011), a severe shortage of family physicians, with only 14 of them for a population of 82,000 (a ratio that was one-sixth that of Edmonton) and inadequate hospital facilities despite having the third-busiest emergency room in Alberta (Sauve 2007). These issues point to a general problem in boomtowns where infrastructure and public service capacity can lag far behind the growing need for them.

Northeastern BC also shows typical boomtown issues, such as increased substance abuse and demand for public health services for young families (Medd, undated) and higher than provincial average rates of teen pregnancy, STIs, men’s health issues, and socioeconomic indicators like school dropout rates, illiteracy, and child poverty in spite of very low unemployment (Badenhorst 2012). The community demographics almost certainly play a role: the median age of the population is almost 10 years younger than the provincial average, there is a preponderance of young males (either single or with young families), gas industry workers have an average annual salary more than double the provincial average for full-time workers, and the transient population, which has little stake in the community but nevertheless overwhelms local services, is much greater than the base (e.g. Fort Nelson’s population of about 5,000 swells seasonally to as much as 15,000, see Medd).

The BC Ministry of Health recently commissioned a 3-phase Human Health Risk Assessment for Northeastern BC that has just completed Phase 1. In addition, community leaders have been calling for the development of a Public Health Plan for the region to address the many community health issues in addition to environmental health concerns (Badenhorst 2012).

f. There can be inequitable distribution of risk and reward to the local populace

Although all residents in a gas development area share in the potential risks, in many cases not all of them have gained from it thorough employment or access to revenues, and indeed many of the specialized jobs may be taken by non-resident workers who already have the necessary expertise. In addition, even when local people are hired some existing local businesses and local public services can suffer due to loss of their employees to the gas industry.

In addition to the factors noted in the previous sections, the positive effect of economic gains can be further limited due to inequitable distribution of risk and reward among local residents (Gever 2011; Perry 2011; Brasier 2011). For example, all of the people in a given community will share in

the risks (real or perceived) of having the industry located nearby, but only some of them will gain from it: some people will benefit from new jobs in the industry or jobs serving the industry, but obviously not all of them will, and some long-standing local businesses and public services will be adversely affected by loss of their employees to higher-paying jobs in the gas industry. Similarly, some people will gain economically by leasing access to their land to the gas companies, while their neighbours won't. In some jurisdictions there have even been a few reports of inequity to the extent where some participants in the industry get rich and move away, leaving their non-participant neighbours behind to shoulder all of the risks with none of the rewards.

Another limiting factor is the threat that a portion of jobs created, including many of the more specialized and higher paying jobs may go to transient workers and non-residents, as the necessary expertise already exists elsewhere but is uncommon in New Brunswick due to limited previous experience with the oil and gas industry. In addition to less-than-anticipated improvements in the socioeconomic status (and therefore health status) of the local people, this effect could also lead to less growth of the Provincial tax base and less development of the skilled knowledge base than might have been desired or expected.

Unlike some jurisdictions where the mineral rights are in private hands, New Brunswick is fortunate in that all mineral rights are vested in the Crown, and so the Province will have access to income from royalties that could help to mitigate the effects stemming from these factors. However, the Government of New Brunswick would have to reinvest these revenues strategically to bring socioeconomic and health status benefits to all who share in the risk, otherwise this opportunity will be lost.

g. More discussion is needed on the potential cumulative impacts of the industry over its lifetime

While the potential health and environmental risks of individual well pads can be evaluated in order to prevent or mitigate negative impacts, it is much more difficult to do this for the total impacts of all of the large number of well pads that would be developed over a 20-, 50- or even 100-year timeframe should a major expansion of the gas industry take place.

Although cumulative effects are acknowledged as an important consideration, to date there have been few studies that consider the overall potential impacts on health and the environment over the entire lifetime of the industry. The scarcity of cumulative impact assessments may stem from the fact that the scale of the industry, rate of development, duration, and precise locations of gas well development are very difficult to predict. This is because industry development generally varies depending on economic factors and where the best gas yields are obtained, which makes it very difficult to forecast local effects of specific projects and to assess the potential for cumulative effects over time.

As an illustration of the potential scale of development, one of the few published cumulative environmental effects forecasts (Nature Conservancy, 2010) predicts that a medium development scenario in Pennsylvania could result in drilling 60,000 new gas wells in that state over the next 20 years. Assessing the environmental and health implications of these well developments one at a time as individual projects could risk "missing the forest for the trees", but reliable prediction of cumulative impacts is limited by the uncertainty in possible future scenarios.

Another important factor in estimating cumulative effects is the density of well development. In 2006, the Jonah Field in Wyoming (Figure 2) had 533 existing gas wells on 497 pads in 2006 (US Department of the Interior, 2006) but an "infill project" to add a further 3,100 wells (some by directional drilling and some by way of many new pads constructed between the existing ones) was approved and is ongoing. The current well spacing is one well pad for every 40 acres, and the infilling project will reduce this spacing to as little as 10 acres for every pad (where each pad is itself up to 3 acres in size).

It is acknowledged that the Jonah field is a conventional gas/tight sand field and not a shale gas development and was developed predominately without the use of recent horizontal drilling technologies. Nonetheless, it provides a useful illustration of what can result if cumulative effects like well pad density and permitting of later infilling are not addressed prior to development. Better use of horizontal drilling technologies and multi-well pads would have resulted in vastly less surface disturbance and a lower density of well pads. New York State has historically also used a 40-acre well pad spacing (16 pads per square mile) for conventional vertical gas wells and also allows infilling to higher densities in certain cases, but the state's Department of Environmental Conservation (New York DEC, 2011) forecasts that with expanded use of directional drilling and multi-well pads in shale gas exploitation, the well pad density will be less: 9 pads per square mile (one pad per 71 acres) for a single horizontal well per pad, and as low as one pad per square mile (one pad per 640 acres) if multi-well pads are mandated and if infilling is not carried out. Overall surface disturbance for access roads and pipelines will also be less if multi-well pads are used.

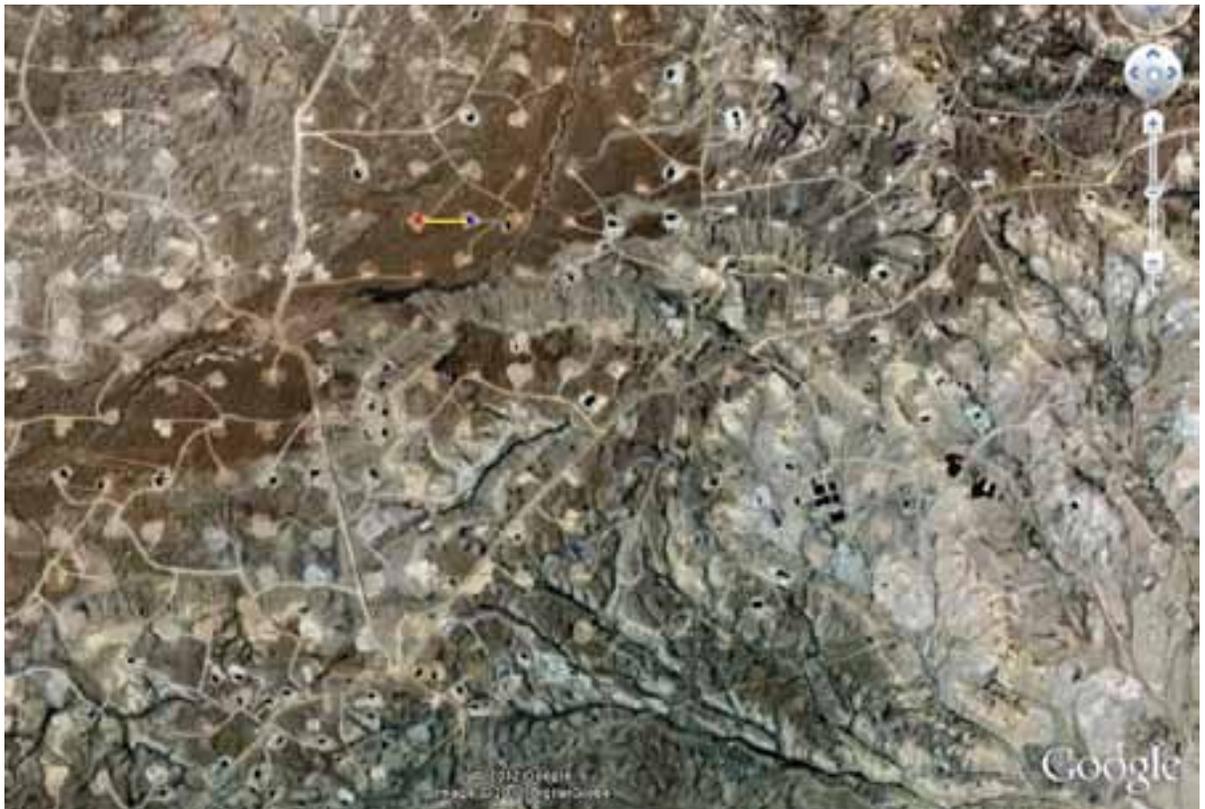


Figure 2: *Satellite photo of part of the Jonah Field, Wyoming (retrieved from Google Earth 2012/02/08, image dated 2006/08/14). The light spots are gas well pads, the dark rectangles are water pits for either hydraulic fracturing fluid or flowback/produced water and the light lines are access roads or pipeline networks. Approximate spacing between the pads (yellow line) is 400 metres, which equates to a pad density of 1 pad per 16 hectares (1 pad per 40 acres) prior to the infilling project. The Jonah Infill Project Drilling Area extends over approximately 30,500 acres (about 120 km²) in total.*

3. What We Don't Know Now

a. Public Health knowledge gaps

Significant knowledge gaps relating to unconventional gas development still exist. These knowledge gaps require further investigation due to their importance in the assessment of the risks associated with potential public health impacts. Some of the key information gaps include methods for preventing and mitigating social impacts, a lack of health status studies before and during gas development, and a lack of systematic Health Impact Assessments. Information needed to assess toxicity risks may also be lacking, such as the toxicological characteristics of industry products and wastes, and accurate exposure data is usually not available. Finally, a lack of knowledge about the extent, locations and rate of development makes it very difficult to forecast local effects of specific projects and to assess the potential for cumulative effects over time.

- 1. Planning for social impacts.** At present there is no standard approach for minimizing the Boomtown Effect. The significance of this gap should not be underestimated. Unless a plan is put in place for assessing, preventing and mitigating the negative impacts of the Boomtown Effect, the social and community health risks may reduce or even outweigh the potential economic benefits of shale gas development.

Due to the lack of a standard approach, one will have to be developed. However, the ability of the Province to do this will be greatly limited by the lack of accurate forecasts for the scale of the industry, rate of development, duration, and precise locations of gas well development (see also point 7 below). Thus, more information on these factors will be needed in order to prepare an effective plan for dealing with social and community health impacts.

- 2. Health status studies.** Other jurisdictions where shale gas development has already taken place have in general not conducted targeted studies of population health status prior to, during or post-development (Schmidt 2011). As a result, monitoring systems to detect changes in health status typically do not exist, and little is known about potential direct consequences to health resulting from gas development.

In addition, the lack of a well-defined baseline description of health status prior to development that can be used for comparison is a serious problem. Even if health studies were now to be undertaken in gas development areas to address the gap, retrospective (backwards-looking) studies that do not have baseline health status data prior to development are always less conclusive than prospective (forward-looking) studies that do have it.

- 3. Health impact assessments (HIAs).** There has been a general lack of comprehensive analysis and forecasting of potential health effects in nearby communities that could arise from large-scale unconventional gas development projects. However, suitable methodologies to fill this gap such as Health Impact Assessments (HIA) are available and should be used.

There is one notable case to date (Colorado School of Public Health 2011) where a comprehensive HIA has been conducted in a shale gas development area. This study identified potential risks related to chemical exposures, accidents, psychological impacts (such as depression, anxiety and stress) and social impacts, and proposed over 70 recommendations for minimizing the risks.

Other health impact studies have also been conducted (Wolf Eagle Environmental 2009, ATSDR 2010, Eastern Research Group / Sage Environmental Consulting 2011, etc.) but these have been focused only on toxic chemical exposures, usually via a single exposure route (e.g. air toxics or drinking water) and do not comprehensively assess all potential health impacts.

- 4. Chemical toxicity information on products used by the industry.** The precise nature of chemicals used by the industry at each location, the amounts used and toxicological information about them can often be lacking. This can occur even when there has been disclosure of the chemicals in use, as disclosure rules designed principally for transparency and accountability may not be sufficiently stringent for toxicological risk assessment. This gap can make risk assessment for potential chemical exposures very difficult or impossible.

In addition to knowledge gaps about toxicity of some of the known chemicals, this issue is greatly complicated by the difficulty of identifying which chemicals are in use. There are various estimates of the number and nature of chemicals used in unconventional gas development (INSPQ 2010; New York DEC 2011; USEPA 2011; US Congress 2011; Colborn et al. 2011) but there are likely up to a thousand chemicals potentially in use, and although only ten or twenty of these may be used at a given site, the precise “recipe” can vary significantly from one well to the next.

Furthermore, even when there has been disclosure the ingredient information provided sometimes includes only a general description of contents, chemical categories rather than specific chemical compound names, or proprietary ingredients that are not named. In addition, Material Safety Data Sheets (MSDS) are often used for disclosure, but these must only identify the chemicals in a product that are deemed to be hazardous in an occupational setting. As a result, MSDS might not include other chemicals in the product that could be hazardous via environmental exposure routes (USDOE 2011a). For example, one study (Colborn et al. 2011) noted that out of 944 products surveyed, their MSDS specifically identified less than 1% of the total chemical content in 407 (43%) of the products.

In order to address this gap, the commitment to chemical disclosure must be complete enough to provide the specific information required for toxicity risk assessments (chemical identities of all compounds, toxicological information, and dose, i.e. the quantities and concentrations used). Disclosure rules designed principally for transparency and accountability may not be sufficiently stringent to require this necessary information.

- 5. Chemical toxicity information on wastes.** Solid and liquid wastes for each gas well site are not always fully characterized, and may be quite variable from one well to the next. As a result, toxicological information for exposure risk assessments can be lacking.

Wastes such as drill spoils and flowback/produced water can contain not only the chemicals used by the industry and their breakdown products, but also potentially hazardous naturally occurring compounds recovered from underground. These can include varying amounts of radioactive isotopes, liquid and gaseous petroleum hydrocarbons, other gases such as hydrogen sulphide, heavy metals and high levels of salts. As a result of the wide variation, a generic toxicological profile of wastes cannot be prepared.

Furthermore, the effectiveness of wastewater treatment and methods for solids disposal may not be appropriate for these types or concentrations of wastes in all cases. If such waste were to be treated inappropriately it could lead to unexpected human exposures to contaminants.

In order to address this gap, solid and liquid wastes for each gas well site should be characterized so that toxicological information can be obtained for exposure risk assessments. Characterization can also be used to ensure that appropriate waste treatment systems are used in all cases and to provide measures for evaluating the effective performance of these treatment systems.

- 6. Exposure data.** Accurate exposure data has been very difficult to obtain, in part because emissions of chemicals can be quite different at different locations and times, but targeted monitoring of air, water and wastes could help to bridge this gap.

The identities and quantities of chemicals used or emitted, identification of potential exposure routes to these chemicals via air, water and wastes, and the timelines and duration of exposures are all areas where information needed to assess health risk is lacking. Furthermore, the issue is complicated in that emissions are dispersed both spatially (because the development occurs at many small sites rather than one large industrial site) and temporally (because different emissions will occur at different times during the lifetime of well construction, completion, development and production, and because these stages can overlap when many wells are developed on one pad or many pads are developed in sequence). However, appropriate targeted baseline and ongoing monitoring of air, water and wastes could help to bridge this gap.

- 7. Extent, locations and rate of development.** To date it has not been possible to estimate well pad densities that might occur in the New Brunswick context, nor in what localities they might occur, or over what extent of land area, as this is expected to depend on where profitable gas discoveries are made. This significantly limits the ability to forecast the potential cumulative impacts to health and the environment in this province. However, examples like the Jonah Field and existing fields in New York state and elsewhere should be helpful in assessing possible cumulative impacts of various development scenarios once more information becomes available.

The extent, locations and rate of development are also important factors in assessing potential social impacts (discussed in point 1, above) so better information on these factors will help to address this gap as well.

b. Ongoing work that may help to inform some of the knowledge gaps

A number of major efforts are currently ongoing in Canada and the United States that should help to inform some of these knowledge gaps. None of them, however, will touch on all potential health outcomes related to gas development (for example, none of them specifically address the social determinants of health in detail), and not all of the knowledge gaps will be filled once these efforts are complete. The outcomes of these studies will be very valuable information, but they are not a substitute for conducting health impact assessments in the New Brunswick context.

Key health topics being addressed include a review of the state of knowledge of potential health hazards from shale gas development via drinking water and air exposure routes (Health Canada), a risk assessment of factors identified as public concerns about health related to gas development (Province of British Columbia) and a small environmental justice study as part of a larger environmental impact study (US Environmental Protection Agency).

Other studies are mainly environment-focussed, such as identifying potential impacts to groundwater (US Environmental Protection Agency), identifying chemicals in use and management strategies for them (Environment Canada), strategic reviews of possible environmental impacts in general (New York state and the Province of Québec) and the state of knowledge about environmental impacts and mitigation options (Council of Canadian Academies). However, since the physical environment is a determinant of health, these studies will also have a bearing on health.

An overview of these initiatives follows below:

1. Health Canada's Healthy Environments and Consumer Safety branch is currently undertaking a review of the state of knowledge of potential health hazards from shale gas development via drinking water and air exposure routes (Health Canada 2011). This effort is part of a wider initiative by a Government of Canada Interdepartmental Task Team working on a Science and Policy Integration Pilot Project (Energy / Water Nexus –Shale Gas).

This study will help to identify possible health hazards due to impacts to the physical environment, and as such will be useful information for New Brunswick in conducting HIAs or risk assessments, but it is not designed to address all determinants of health.

2. In January 2012 the British Columbia Ministry of Health contracted the Fraser Basin Council to undertake a human health risk assessment of oil and gas development in northeast British Columbia (see www.hhra.ca). This assessment will consist of three phases:
 1. Public engagement to inform the scope and terms of reference and identify concerns relating to oil and gas development
 2. A human health risk assessment based on findings from phase one and a comprehensive scientific review of evidence
 3. Reporting findings to the Province, stakeholders and the Public

Phase 1 concluded in March 2012 following a series of community public meetings and online consultations. At the time of writing, no information about the outcomes of these consultations or about terms of reference or timelines for the remainder of the project had yet been published.

Once complete, much of the outcome of this study should be applicable to the New Brunswick context, and will help to inform health protection strategies here.

3. The United States Environmental Protection Agency (USEPA, www.epa.gov/hfstudy/index.html) was commissioned by the US Congress in 2010 to investigate potential impacts of hydraulic fracturing on drinking water and groundwater. Although this will probably be the most definitive study ever regarding potential impacts to water, it is not designed to assess all possible health risks and as such is not a comprehensive Health Impact Assessment.

The study plan was finalized in November 2011 and will include analysis of existing data, case studies (five retrospective and two prospective study sites), scenario evaluations, laboratory studies, and toxicity assessments. An interim report is expected at the end of 2012 and the full report will be available sometime in 2014.

Most of the report will focus on well construction, chemicals in hydraulic fracturing fluid, handling methods, waste disposal and testing of water for impacts, but there is also an environmental justice component that will examine where gas wells are located versus demographics, which may provide some limited information on health equity (see http://www.epa.gov/hfstudy/ProgressUpdate02_2012.pdf).

This USEPA effort has often been touted as the “definitive study” but there are concerns that the scope is too limited for a complete Health Impact Assessment (Bamberger and Oswald, 2012). Based on a review of the study plan, OCMOH staff agrees that, with the exception of the

environmental justice component, this project will only address the physical environment as a determinant of health and is not a complete assessment of potential health impacts from gas development.

4. The New York State Department of Environmental Conservation (DEC) is in the process of completing a draft Supplemental Generic Environmental Impact Statement (dSGEIS, see New York DEC 2011) regarding high-volume hydraulic fracturing used in the shale gas industry in order to satisfy the requirements of the State Environmental Quality Review Act. Additionally, the dSGEIS is intended to inform future revisions or additions to the DEC's regulations associated with high-volume hydraulic fracturing including mitigation measures that would prevent or minimize any significant adverse impacts, and criteria and conditions for future permit approvals and other regulatory action.

The dSGEIS was submitted for a first round of public review and comment in 2009. The extensive public comments revealed significant concerns with potential contamination of groundwater and surface drinking water supplies, potential for gas migration, impacts from disposal of solid and liquid wastes, and consideration of visual, noise, traffic, community character and socioeconomic impacts. Accordingly, in 2010 the state Governor ordered the DEC to issue a revised dSGEIS, which was published in September 2011 (New York DEC 2011). The Executive Order also provided that no permits authorizing high-volume hydraulic fracturing would be issued until the SGEIS was finalized.

At present, public consultations on the September 2011 dSGEIS have concluded. A report to the Governor on the status of the Final SGEIS and the regulatory conditions that the New York DEC believes are necessary to include in oil and gas well permits in order to protect public health and the environment is still pending.

5. As mandated by the *Loi sur la qualité de l'environnement*, the province of Québec engaged the *Bureau d'audiences publiques sur l'environnement* (BAPE) to conduct a public inquiry and prepare a report on the sustainable development of shale gas industry in Québec, which was published in February 2011 (BAPE 2011a). The testimony submitted to this inquiry included a report from the *Insitut national de la santé publique du Québec* on the state of knowledge of the relationship between shale gas activities and public health (INSPQ 2010) as well as testimony from Public Health officials in several regions of Québec (BAPE 2011b).

As a result of the BAPE report, the province of Québec commissioned a strategic environmental evaluation (Québec 2011) to address the knowledge gaps in determining the environmental risks that shale gas exploration and production might entail. While this evaluation is ongoing, the BAPE report recommended that exploration could continue, but hydraulic fracturing should not be authorized except for what is required as part of the evaluation. A final report on the outcomes of this strategic environmental evaluation is expected by November 2013.

6. The Council of Canadian Academies was commissioned by the federal Minister of Environment in September 2011 to undertake an authoritative and evidence-based assessment to answer the following question: "What is the state of knowledge of potential environmental impacts from the exploration, extraction, and development of Canada's shale gas resources, and what is the state of knowledge of associated mitigation options?" The assessment is expected to take 18 to 24 months to complete (<http://www.scienceadvice.ca/en/assessments/in-progress/shale-gas.aspx>). However, this assessment does not appear to consider any other determinants of health besides environmental exposures.

The Council of Canadian Academies is an independent not-for-profit body that supports science-based assessments to inform public policy, and encompasses the Royal Society of Canada, the Canadian Academy of Engineering and the Canadian Academy of Health Sciences.

7. At the same time as the request to the Council of Canadian Academies, Environment Canada was also tasked to develop an internal work plan to examine any potential environmental consequences of shale gas development. At present, Environment Canada is working in conjunction with Health Canada to undertake an information gathering exercise to fill information gaps on the identity and quantities of chemical substances being used in hydraulic fracturing across Canada, as well as related management practices. This exercise is expected to be completed by the winter of 2012.

Part 3

Recommendations for Protection of Public Health

Recommendations for Protection of Public Health

As risk is a function of hazard and exposure, increased activity necessarily implies increased risk. It is timely therefore for Government to better understand the risk and benefits associated with the shale gas industry prior to further development in New Brunswick. To that end, the CMOH has developed the recommendations in this document to support the Government's risk management and regulatory framework in such a way that it will be able to provide appropriate, complete and comprehensive public health promotion and protection along with its other goals.

The CMOH believes that it is important for the Province to enact the following recommendations in order to protect public health should an expansion of the unconventional natural gas industry take place. Many of these recommendations will need to be enacted prior to expansion of the industry, along with many others that will have to be in place throughout the entire lifetime of the industry in this province. The funding of their implementation and ongoing maintenance will not be insubstantial and it is recommended that options for industry levies be explored as a matter of priority.

These recommendations were developed based on an analysis conducted by staff in the Office of the Chief Medical Officer of Health (OCMOH) that is summarized in the information in this report. This analysis included a critical review of experiences in other jurisdictions, recommendations proposed elsewhere, case studies reported in the scientific literature and other reports, as well as current and emerging issues discussed in conference proceedings.

Each recommendation is grounded in public health promotion and practice and clearly linked to the public health ethics, values and principles (outlined in Part 1) most relevant to it. Pending input from public and other stakeholders, as well as new learnings, these recommendations may need to be adapted and will evolve. Many of these recommendations are complementary to those proposed in the document entitled "Responsible Environmental Management of Oil and Gas Activities in New Brunswick - Recommendations for Public Discussion" (May 2012) which was developed to outline measures required to protect the environment. This document builds upon and enhances the proposed environmental measures as deemed necessary in order to provide added protection for human health.

The recommendations are grouped and summarized into the following categories for ease of reference:

1. Protection of health and community wellbeing related to changes in the social environment

Includes recommendations for optimizing equitable distribution of risks and rewards; revenue sharing; identifying a role for local governments in planning the location of gas industry infrastructure; identifying a role for Public Health in community planning; and implementing a transparent consultative process with the public and other stakeholders on the implementation process for these recommendations.

2. Protection of health related to changes in both the social and physical environments

Includes recommendations for developing a requirement to submit a health impact assessment (HIA) as part of the standard Project Registration process; developing a protocol for monitoring of health status of persons living, working, attending school or playing in proximity to the industry; and for linking this information to environmental monitoring data and socioeconomic data.

3. Protection of health related to changes in the physical environment

Includes recommendations for monitoring networks for ambient air and water quality; provisions for wastewater handling, testing, transportation, treatment and disposal; full and timely disclosure of chemicals used; less toxic alternatives for hydraulic fracturing fluids; safe setback distances that consider human health factors; limiting health impacts from noise, vibration and continuous illumination; traffic management plans; emergency response training; and promotion and protection for the health of workers.

4. Protection of future generations

Includes recommendations for a plan to anticipate and mitigate the “Boomtown Effect”; a strategic Health Impact Assessment; identifying areas to be excluded from development; a strategic land use plan that considers health equity; consideration of vulnerable and disadvantaged populations; consideration of First Nations; a strategic water management plan; and public reporting of Environmental and Health monitoring data.

5. Implementation and oversight

Includes recommendations for strengthening government oversight capacity and resources; striking an implementation group to oversee implementation of the CMOH’s recommendations; establishing an on-going dialogue among community, government, academics and industry; and creating a multi-disciplinary advisory committee to Cabinet.

1. Protection of Health and Community Wellbeing Related to Changes in the Social Environment

Recommendation 1.1: *The Province should establish mechanisms to measure, monitor and optimize equitable distribution of risks and rewards that maximize benefits to the socioeconomic determinants of health for all New Brunswickers*

The World Health Organization has noted that wide socioeconomic disparities within countries and communities have been associated with poorer overall health outcomes (WHO 2008). As a result, the Province needs to safeguard against inadvertently developing disparities that may stem from gas development in order to maximize benefits to the health and security of New Brunswick communities. This is not simply about a sense of fairness – there are real health consequences from not addressing this issue.

It is important to distinguish inequity from inequality in this context: inequality refers to unequal distribution of potential benefits and risks within a population, but inequity as used here means that in some situations these differences are unjust, unfair, and avoidable (St-Pierre 2010; WHO 2008).

Some sources have noted that economic benefits from development of the shale gas industry in other jurisdictions have been inequitably shared, as some residents in a given locality have benefitted financially while others haven't, even though the potential (or perceived) health and environmental risks are borne by all people who live in close proximity to the industry. These risks are particularly acute where there are already vulnerable populations (see Recommendation 4.5).

Although some inequality in receiving economic benefits is unavoidable, this inequality progresses to inequity when some of the people who bear the risk have no access to the rewards. This separation of "haves" and "have-nots" resulting from the arrival of the shale gas industry has in some cases pitted neighbour against neighbour and contributed to erosion of the social fabric of communities (Perry 2011; Brasier 2011).

Because socioeconomic inequity has community health consequences, the Province needs to ensure that these types of inequalities are minimized in order to safeguard the health and security of communities in New Brunswick. This is the reason why the World Health Organization has called for "health equity in all policies, systems and programmes" as a cornerstone of improving health status (WHO 2008). This position was echoed in Canada by the Standing Senate Committee on Social Affairs, Science and Technology, which called for governments to implement "a health lens in all policies" (Senate of Canada 2009).

Safeguarding health equity is not simply about fairness, but is a key to preventing some negative health outcomes that may inadvertently arise as a result of development.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, social determinants of health emphasis

Public Health Values supported:

beneficence & non-maleficence, communitarianism, equity & distributive justice, leadership, prevention, utilitarianism

Recommendation 1.2: *The Province should develop a method based on a clear set of principles with input from Public Health that will enhance the proposed revenue sharing approach so that an appropriate portion of monies from royalties and other sources will help to offset negative impacts on the social determinants of health*

A portion of royalties and other revenues should be allocated for investments designed specifically to address the social determinants of health in those local areas with gas development and elsewhere in the province. In addition, upfront contributions, potentially funded by industry, will be required prior to gas development so that these improvements do not lag until a significant royalty stream is established. Public Health should approve the principles upon which these investment decisions are based.

This approach adds an extra dimension to the revenue sharing approach already proposed by the New Brunswick Natural Gas Group (NGG 2012c) which recommends returning a portion of royalty revenues to communities in the vicinity of natural gas development and to landowners who host natural gas facilities on their property but which does not speak specifically to utilizing revenues for improvements in health.

In some other jurisdictions (e.g. certain U.S. states) mineral rights are privately held and the royalties go directly to the mineral rights owner only (who may or may not also own the surface rights). The landowners where the gas industry infrastructure is physically located also obtain some direct economic benefit from leasing their surface rights to the gas companies, but there are no direct economic benefits from royalties to any other local residents who nevertheless share in the risks (real or perceived) from having the industry located nearby. This is a major source of disparity and can create “winners” and “losers” in each gas development area.

In New Brunswick the Crown holds all of the sub-surface mineral rights, which means that the majority of direct economic benefits from royalties will not go to mineral-rights speculators who may not be resident in the development areas (as has sometimes been the case in other jurisdictions). However, as these royalties are general government revenue, there is currently no requirement for these funds to be applied to the communities where the royalties were generated. In the absence of a formula to return an appropriate portion of these monies to the local communities, the Province risks having a similar disparity as has been seen in some US jurisdictions, with the local community as “losers”, but with the government being the “winners” in place of private interests.

The types of strategic investment needed and the appropriate portions of revenue will have to be determined in such a way as to maximize benefits to the social determinants of health both at the local and at the provincial levels, so that there is an overall health benefit to New Brunswick as well as to the local communities. To ensure that decisions are founded on population health based principles, Public Health expertise will need to be engaged.

In addition, Government will have to make some strategic investments before significant royalty revenues are obtained. This will ensure that appropriate capacity to address the social determinants of health is not delayed until after royalty revenues reach significant levels, as such a delay could contribute to public service capacity lagging behind and being outstripped by the growing need for it (see cautions regarding this issue in Recommendations 4.1 and 5.1). Options should be explored for generating the required upfront funding from industry.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, communitarianism, equity & distributive justice, leadership, prevention, transparency, utilitarianism

Recommendation 1.3: The Province should implement structures and processes to ensure a role for local governments in planning the location of gas industry infrastructure such as roads, well pads, pipelines, compressor stations and water storage and treatment facilities

Providing local governments with some of the decision making power in planning of infrastructure could help to provide community health benefits by reducing stress and anxiety among the people affected and improve local input into gas developments. The zoning powers possessed by different types of local governments in New Brunswick is a significant challenge to implementing this recommendation, but the ongoing work on the *Action Plan for a New Local Governance System in New Brunswick* (NBDLG 2011) is an opportunity to overcome this limitation. Conversely, failure to take action on this issue could be a source of health inequity between New Brunswickers based solely on where they live.

Lack of local control over the location of industry infrastructure has been a commonly heard issue in other jurisdictions (Jacquet 2009). Since lack of control over destiny is a broad-based risk factor for disease (Wallerstein 1992), this can have important implications for health status, mental health and social well-being of communities. Involving local government would also enable upfront prevention and mitigation including reinforcement of roads, more appropriate siting of well pads, and enhancement of local services.

Providing local governments with some of the decision-making power could empower the local community to participate in the process and thereby achieve development that is more acceptable to local residents. Such empowerment would speak to self-determination, informed consent, social justice, and a local voice, all of which can lead to positive outcomes for social wellbeing and mental health of individuals.

A particular challenge to implementing this recommendation will be to make the zoning capabilities of local governments as consistent as possible in order to ensure equity between municipalities, rural communities and local service districts with respect to decisions that affect them. At present, local service districts in NB do not have the same zoning powers as municipalities or rural communities, and there is also some variability within categories (RSNB 1973). However, the current work on the *Action Plan for a New Local Governance System in New Brunswick* (NBDLG 2011) provides an ideal opportunity to address this issue.

With respect to shale gas development, this difference in zoning powers is potentially a source of health inequity between New Brunswickers based simply on where they live. The Province should seek ways to remove this inequity as much as possible so that Recommendation 1.3 can be effectively implemented.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, communitarianism, equity & distributive justice, leadership, prevention, transparency, utilitarianism

Recommendation 1.4: The Province should implement structures and processes to ensure a role for Public Health in community planning in order to ensure that the built environment is optimized for the determinants of health

The built environment is the sum of the human-made surroundings and the natural environment in the communities where people live, work, and play, and it can have a profound effect on community health

outcomes. As a result, public health needs to be considered as part of the community planning process. Such an approach, and engagement of trained expertise, could contribute to long term economic and social development for New Brunswick through the growth of healthy communities.

The Pan-Canadian Public Health Network has stated that *“urban planning decisions can advance or hamper health goals”* (PCPHN 2009). Similarly, the World Health Organization has stated that *“communities and neighbourhoods that ensure access to basic goods, that are socially cohesive, that are designed to promote good physical and psychological well-being and that are protective of the natural environment are essential for health equity”* (WHO 2008). Essentially, this describes a community where the built environment has been constructed with the determinants of health in mind.

However, other jurisdictions where shale gas development has proceeded rapidly may not have had the benefit of growth through appropriate built environments. For example, Fort Nelson’s BC’s population of about 5,000 swells seasonally to as much as 15,000 (Medd undated) and during peak periods of activity more people reside in “man camps” than in the town itself (Badenhorst 2012). The man camp residents have less of a stake in the community than they would if they were to become residents, but relying on a built environment based on temporary housing does not encourage this. Unrestrained and poorly planned community growth can lead to loss of social cohesion, inadequate housing and all of the other social ills typical of the Boomtown Effect.

In contrast, a focus on community planning with the determinants of health in mind can lead to a growing community that is a more desirable place to live, which could encourage settlement rather than temporary accommodation. In New Brunswick, such an approach could lead to healthier communities and contribute to long term economic and social development for the province. Realizing such benefits is one of the reasons why the World Health Organization recommends *“[placing] health and health equity at the heart of urban governance and planning”* (WHO 2008).

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, communitarianism, equity & distributive justice, leadership, prevention, transparency, utilitarianism

Recommendation 1.5: The Province should undertake a transparent and consultative process with representative members and sectors of the public and stakeholders on the implementation process for these recommendations in order to achieve better health outcomes

The CMOH believes that it is of the highest importance that the Public are fully informed of all identified potential risks and benefits related to shale gas development and that the implementation process is as inclusive and transparent as possible in order to maximize benefits to the social determinants of health.

It has been noted elsewhere that a public perception can remain that engagement and education on shale gas issues were insufficient even when governments have undertaken public consultations (Medd undated). Research has also shown that public trust in governments regarding shale gas issues is not nearly as high as for other actors such as scientists and education-based sources, and trust in the industry is even lower (Brasier 2011). This research also indicated that despite communication efforts there is still a need for even more information on the processes and impacts of gas development, ideally from the sources that the Public perceives to be the most credible, and that “more education can provide a neutral space for dialog and learning” (Stedman 2011).

Public consultation and participation in the decision-making and planning process beyond simply receiving information provided by government or other parties helps to respect public health values and principles such as autonomy, communitarianism, reciprocity, and transparency. Furthermore, this would demonstrate a desire for collaboration with and a respect for the Public, which are important factors in building trust. For these reasons, the CMOH proposes to make the process of implementing these recommendations the subject of a public consultation process.

The Province of New Brunswick has already undertaken a series of public information sessions designed to help inform residents living in potential development areas, and has launched a website (www.gnb.ca/naturalgas) with extensive information. In May 2012, a series of public consultations on specific recommendations prepared by the New Brunswick Natural Gas Group (NBNGG 2012 a-e) was also announced. Consultation with the public and key stakeholders on implementation of the CMOH's recommendations would build upon the efforts made to date and so further strengthen the Government's commitment to openness and transparency.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, social determinants of health emphasis

Public Health Values supported:

autonomy, communitarianism, reciprocity, transparency, utilitarianism

2. Protection of Health Related to Changes in Both the Social and Physical Environments

Recommendation 2.1: The Province should implement a requirement for submitting a health impact assessment (HIA), prepared according to the specifications of Department of Health (DH), as part of the standard Project Registration process managed by Department of Environment and Local Government (DELG)

HIA are seldom required as part of environmental assessments by any jurisdiction, despite providing a focus on human health outcomes that might not otherwise be examined. The Province should implement a mandatory requirement for submitting an HIA that includes assessment of short term, cumulative and long-term health impacts to the general public and any vulnerable populations for each shale gas project registered under the DELG project registration process. This would increase the breadth of protection by specifically focusing on identification, prevention and mitigation of health impacts associated with gas development.

At present the environmental project assessment process includes Department of Health (DH) as a Technical Review Committee member, but does not have a mandatory requirement for Human Health Risk Assessment (HHRA) or Health Impact Assessment (HIA), although these can be required for a particular project if requested by DH.

HHRAs and HIAs differ in several respects: HHRAs are expert-driven, quantitative, have a narrow focus on how particular contaminants affect physical health, and do not consider socioeconomic status or other social or health issues. In contrast, HIAs are stakeholder driven, qualitative, have a broad focus on multiple determinants of health, and examine the distribution of health risks across a population (Toronto Public Health, 2010). Given these differences and the broad spectrum of potential health impacts noted throughout this document, HIA is the preferred methodology for general application.

The general lack of HIA as part of environmental assessments has been noted elsewhere. In a review of the environmental and health impacts of Canada's oil sands industry, the Royal Society of Canada

concluded that the environmental impact assessment (EIA) process used by the Province of Alberta and in some cases by the Canadian Environmental Assessment Agency was “*seriously deficient in formal Health Impact Assessment (HIA) and quantitative socioeconomic impact assessment (SEIA)*” (Royal Society of Canada 2010).

As part of an improved approach to DH review of all industrial projects, a requirement for conducting an HIA should also be extended to industrial projects in other sectors as well (scope to be defined). DH should design a template for the requirements of these submissions to ensure consistency and comprehensiveness with respect to environmental exposures and the other types of potential health threats identified in Part 2 Section 2b. Furthermore, it may be possible to design such a template in collaboration with other Federal/Provincial/Territorial partners across Canada to ensure a coordinated national approach.

Finally, in the same way that DELG has the ability to require a full Environmental Impact Assessment when warranted, DH should continue to be able to require a more detailed HIA or a quantitative HHRA if deemed necessary for a particular project.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Recommendation 2.2: The Province should develop and implement a protocol for monitoring the health status of persons living, working, attending school or playing in proximity to the industry

There has been a general lack of targeted studies of population health status prior to, during or post-development of the shale gas industry (Schmidt 2011) and this has contributed to uncertainty about whether measures to protect health are effective. New Brunswick should develop and implement such a monitoring system prior to any significant expansion of the industry in order to capture the pre-development status and to detect any changes in health status going forward.

Recommendations in other jurisdictions (PA Governor’s Commission 2011; PA Citizen’s Commission 2011) have called for a “population-based health registry” as a key factor in assessing whether environmental and health protection measures are effective. Design of such a health registry could include a variety of health status indicators (emergency room visits, admission and discharge records, calls to 811 NB Tele-Care / Télé-Soins, etc.) and should as much as possible build upon existing sources of data. The power of such a system would be increased by also implementing Recommendation 2.3, which would permit more in-depth analysis of trends and root causes.

Such a system needs to be clear, measurable and timely so that it can be used for decision making and it should bring the same level of scrutiny to this area as currently exists for e.g. communicable disease outcomes.

Implementation of this recommendation must be done prior to any significant expansion of the industry to capture the pre-development status and implement a prospective study design as discussed in Part 2, Section 3 a 2).

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, healthy work environment, social determinants of health emphasis

Public Health Values supported:

beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 2.3: The Province should develop and implement methods to link health status information to environmental monitoring data and socioeconomic status data

To maximize the effectiveness of a health status monitoring system (Recommendation 2.2) the Province should also develop and implement methods to link health data to environmental and socioeconomic data. This would provide powerful analytical capability to investigate cause-and-effect relationships for any health status changes noted (both positive and negative).

Furthermore, it is likely that there will be cases of disease clusters in future, whether causally related or not (Goldstein 2011). Having an information system that tracks both health status and environmental status would be very valuable in investigating any such issues that might occur in order to see whether or not environmental factors may be contributing to the effect. In addition, adding the socioeconomic dimension would allow a more complete analysis with respect to all of the determinants of health.

Although there may be many challenges in terms of developing key measures and indicators, linking databases across several partner agencies, and the need for obtaining data before, during and after development, work should be started immediately and concurrently with developing the system described in Recommendation 2.2. Because of the scale of the problem and the timeframe this may be best approached as a pilot project in a particular area, with eventual extension to all areas of the Province.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

3. Protection of Health Related to Changes in the Physical Environment

Recommendation 3.1: The Province should put in place monitoring networks for ambient air and water quality, as well as drinking water quality in the local areas expected to have an industry presence, in advance of industry development and continuing throughout the lifetime of development, production and post-production

Implementation of monitoring networks for air and water quality (including drinking water quality) is essential for ensuring that environmental protection measures are adequate and that human health is protected. Monitoring must be in place prior to significant development in order to capture

the baseline status for comparison of future results. Monitoring must also be ongoing and continue throughout the lifetime of the industry and beyond because there may be a long time between contaminant release and impact to a receptor (such as a drinking water well).

Lack of baseline data availability prior to industry development has been cited by many sources as a limiting factor in assessing the success or failure of environmental protection measures.

Furthermore, monitoring efforts should be ongoing and not be restricted to only “before” and “after” snapshots, because if impacts do occur they would typically not be evenly distributed in time or location, and so relying on one or two discrete sampling events could overlook impacts and lead to overconfidence in the environmental quality.

To be successful, this effort would have to be multi-faceted and include monitoring of e.g. surface water watersheds, the groundwater table, private drinking water wells, and public water supplies. Furthermore, the Province would need to ensure that sufficient data (i.e. frequency, duration and locations) are available on environmental contaminants and environmental quality to permit analysis of whether control measures are working. Monitoring throughout the lifespan of the industry and beyond is essential because many environmental contaminants can cause impacts a long time after release (for example, groundwater contaminants that may take a long time to travel from the release location to a drinking-water well).

In addition, air quality monitoring programs should consider not only local air quality impacts but also the potential for regional air quality effects due to, e.g. ozone and NO_x.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, healthy work environment

Public Health Values supported:

beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 3.2: The Province should put in place special provisions for wastewater handling, testing, transportation, treatment and disposal

Wastewater handling is a critical control point in the protection of public health with respect to hydraulic fracturing activities. Special treatment and disposal processes will be needed because the potential contaminants are different from those in other industrial or municipal wastewaters.

Under the proposed standards in the *Responsible Environmental Management of Oil and Gas Activities in New Brunswick* discussion documents (NBNGG 2012a-b), considerable effort will be spent on containment in the geological formation (great depth + microseismic monitoring to verify containment) and in the wellbore (casing standards and testing). Consequently, handling of the flowback and produced water once it reaches the surface is one of the most likely sources of exposure: if a contamination episode, spill or leak were to occur it could lead to exposure of the population to environmental contaminants.

Salts, hydrocarbons (including gases, volatiles, semi-volatiles and heavier hydrocarbons), heavy metals, radioisotopes and fracking additives are all potential contaminants that can make this waste quite different from other industrial wastes. In addition, typical wastewater treatment plants (such as municipal treatment plants) are not optimized for removing these contaminants, which may be inadvertently discharged in the treated water as a result. Treatment plant sludge disposal might be problematic also due to the potential presence of these contaminants in sediments.

The potential contaminants in these wastes are sufficiently different from those in other industrial or municipal wastewaters to warrant special consideration. Under no circumstances should the wastewater be treated by a facility that is not specifically designed for the types of contaminants expected (e.g. municipal waste water treatment plants should never be used to treat flowback or produced water). Furthermore, land application of sludge from this waste should not be handled in the same way as conventional wastes.

The appropriate provisions will need to be defined, but could include aspects such as enhanced waste characterization requirements and special monitoring provisions for designated waste handling facilities that use specialized treatment processes.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, healthy work environment

Public Health Values supported:

beneficence & non-maleficence, burden of proof, communitarianism, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency

Recommendation 3.3: The Province should require full and timely disclosure of all chemical compounds (rather than products or compound classes) which must include their identities, concentrations and quantities

This recommendation is intended to provide greater certainty as to the level of chemical disclosure needed to evaluate potential health risks. Proper risk assessment requires full knowledge of the specific identities of all chemical compounds, their concentrations, the amounts used, and their toxicological characteristics. Such disclosure will also ensure that the most appropriate monitoring parameters are used for air and water quality monitoring (Recommendation 3.1).

The Province has already announced (GNB 2011) that there will be a requirement for full disclosure of chemicals used in hydraulic fracturing. This should be enhanced so that identification of chemicals is appropriate for conducting human health and environmental risk assessments and monitoring by appropriate authorities as required. Information needs to be made available on a timely basis to enable proper patient evaluation. Furthermore, the requirement for disclosure should extend to all chemicals used by the industry, not just those that are used as ingredients in hydraulic fracturing fluids. Responsibility for development of the specific disclosure requirements framework could be assigned to the implementation group (see Recommendation 5.2).

As noted in Part 2, Section 3a 4), there are many challenges in assessing the chemical toxicity of products used by the industry, in many cases because of lack of clarity in ingredient information even when it is disclosed. To avoid this, the Province should require disclosure of all specific chemical compounds and their quantities so that information on specific environmental fates, transport characteristics and toxicological profiles can be gathered as part of a proper risk assessment.

Furthermore, chemical ingredient information needs to be available in a timely fashion, with appropriate lead times for e.g. EIA reviews. Finally, as much information as possible should be released publicly to increase public confidence in the oversight process.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, healthy work environment

Public Health Values supported:

beneficence & non-maleficence, burden of proof, communitarianism, evidence-based, leadership, precautionary principle, prevention, transparency

Recommendation 3.4: The Province should require that all hydraulic fracturing fluids contain additives that are the least toxic of any alternatives available

In the interest of focusing on prevention, the Province should require that hydraulic fracturing fluids are of as low toxicity as possible based on currently available information. This would add an additional safeguard to the many layers of engineered containment of hydraulic fracturing fluids and flowback/produced wastewater as proposed by the Natural Gas Group (NBNGG 2012a-b), so that in the event of a failure of containment the impact would be as low as possible.

Implementation of this recommendation will require development of a standardized approach for assessing the toxic potential of hydraulic fracturing fluids. This is necessary because the assessment of toxicity is complex: it depends upon the nature of the possible toxicants, their concentrations and overall amounts, their environmental fate and transport characteristics in the event of a spill, the existence of an exposure route, and the duration of exposure.

The current state of science related to a particular chemical compound's environmental fate and bioavailability in the event of an exposure also influences the assessment of toxicity risk, and past assessments may change as new information becomes available. Furthermore, toxicity can result from both direct human exposure and toxicity to the environment that could lead indirectly to toxic effects in humans. All of these factors will need to be taken into account in the development of the approach to be used.

Health Objectives supported:

provision of information, prevention of public health hazards, healthy work environment

Public Health Values supported:

beneficence & non-maleficence, burden of proof, communitarianism, evidence-based, precautionary principle, prevention, transparency

Recommendation 3.5: The Province should develop and implement reasonable, safe setback distances approved by Public Health that consider human health and which are based on exposure risk assessments in addition to established precedents

The state of knowledge as to what constitutes appropriate setback distances continues to evolve, and many jurisdictions have mandated specific setback distances only to have to increase them at a later date once new information became available. New Brunswick should develop setback distances based on minimizing impacts to the determinants of health in addition to using precedents from other jurisdictions so that these setbacks can be demonstrated as being reasonable and safe.

The required setback distances between natural gas developments and nearby population vary greatly between jurisdictions. The recommended setbacks in the *Responsible Environmental Management of Oil and Gas Activities in New Brunswick* discussion documents (NBNGG 2012a-b) are based upon the most stringent of these that are currently in use elsewhere.

However, other jurisdictions such as Colorado and Pennsylvania have increased their required setbacks over time as new information emerged. In order to increase confidence and reduce the possibility of repeatedly changing setbacks in future, this Recommendation proposes building on the current approach by conducting exposure risk assessments to possible chemical spills, air pollution, noise, illumination and other factors, and also by asking the public about their attitudes toward acceptability. This approach may simply validate that the current proposed setbacks are protective, or it may indicate that additional protection is required: either way, conducting this work in the New Brunswick context and with a focus on the determinants of health would add to the level of certainty.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards

Public Health Values supported:

beneficence and non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 3.6: The Province should develop and implement standards approved by Public Health to limit health impacts from noise, vibration and continuous illumination

Noise, vibration and continuous illumination are known to be issues affecting health and quality of life for residents near to gas well development sites (Colorado School of Public Health 2011; INSPQ 2011). In order to address these issues in New Brunswick, this Recommendation builds upon the Natural Gas Group proposal regarding noise levels (NBNGG 2012a-b) by extension to these other potential health hazards. Development of standards for these factors could be conducted as part of the work toward developing setback distances based on exposure risk assessments (Recommendation 3.5).

Impacts due to noise, vibration and continuous illumination can arise from activities such as general truck traffic, well pad construction, well drilling, site operations, flaring and gas compressors.

Because these types of impacts can arise in different time frames (e.g. during different phases of well development and subsequent development of other nearby well pads) and potentially from many sites near to a receptor, a strategic approach to preventing and mitigating these effects is needed rather than addressing them one at a time. This should be undertaken prior to initial development and should address effects that could occur throughout cumulative development of multiple well pads in a given area over the long term.

The approach to addressing these considerations could build upon the proposals in the *Responsible Environmental Management of Oil and Gas Activities in New Brunswick* discussion documents (NBNGG 2012a-b) regarding noise levels, with extension to other potential health hazards including vibration and illumination. This work could also be conducted as part of the work toward developing setback distances based on exposure risk assessments (Recommendation 3.5).

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, healthy work environment

Public Health Values supported:

benevolence and non-malevolence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Recommendation 3.7: The Province should require site-specific traffic management plans for all projects, including route plans and designated times of day for heavy truck movements

A dramatic increase in heavy truck traffic on small rural roads that were not necessarily designed for such traffic is one of the consistently repeated issues found in other jurisdictions (see Part 2 Section 2c). This additional traffic can lead to a rise in air pollution, damage to road infrastructure, increased risk of traffic accidents, and hazardous materials spills. Traffic can also contribute to additional noise and vibration (see Recommendation 3.6) so public health could be adversely affected in many ways unless suitable precautions are taken.

The high volume of truck traffic at certain stages of gas well development can be incompatible with other uses for these roads. However, careful planning of routes and timing of truck movements can help to mitigate the risk of traffic accidents (for example, by simple measures such as not permitting truck movements at the same times of day as school bus trips).

A comprehensive traffic management plan that ensures that the most suitable routes are used, reduces peak truck traffic intensity and minimizes risk to other road users should be required for every work site. In addition, monitoring of motor vehicle injuries (see Recommendation 2.2) could be used as a specific indicator of the impact (both positive and negative) on traffic safety.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards

Public Health Values supported:

benevolence & non-malevolence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Recommendation 3.8: The Province should enhance local and provincial emergency response training, capacity and preparedness to respond to the most likely and most serious emergencies that might pose a threat to human health

Shale gas developments typically consist of many industrial sites spread over a wide area, so proper emergency response is a challenge. Particular challenges to overcome include ensuring that sufficient emergency response staff capacity exists nearby, that these staff are appropriately trained, that work sites can be found easily in the event of an emergency, that efforts are coordinated among many agencies and that emergency plans are tested to ensure that they will work as designed when needed.

The Province should verify that sufficient emergency response capacity exists in the local areas near gas well developments and augment staff capacity in any areas that are lacking. In addition, the Province should provide appropriate detailed training to hazmat workers, volunteer and professional fire fighters,

Department of Environment and Local Government inspectors, WorkSafe NB staff, hospital emergency room staff, and others as needed, to ensure that they have the knowledge of industry practices required to safely and quickly respond to any emergencies. The Province should put in place mechanisms and resources to ensure that the planning, response and recovery actions and plans of the many different agencies are optimal in terms of standards, integration, coordination, and governance.

Furthermore, the Province should consider mandatory 911 addressing of all work sites, as well as development and mandatory testing of emergency plans, as it has been noted in other jurisdictions that implementation of emergency response plans has often been unsuccessful due to the many logistical hurdles to be overcome. For example, there is a unique challenge in that, unlike most industries, there are many industrial sites spread over a wide area, and responsibility for response may be fragmented.

Finally, note that these preparations also need to consider the longer term response and recovery.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, public health emergency preparedness, healthy work environment

Public Health Values supported:

beneficence & non-maleficence, evidence-based, leadership, precautionary principle, prevention, proportionality

Recommendation 3.9: The Province should enhance the mechanisms that are in place to promote and protect the health of workers in the industry and others who may be at the work sites (government inspectors, support industry workers, emergency responders, etc.)

Protecting and promoting the health of industry workers and others who may be working at the work sites is an important component of overall public health protection and promotion, but achieving this will require special efforts. For example, tracking injuries and accidents may be difficult among transient workers, and it may also be difficult to deliver health promotion and injury prevention programs to them due to their continual rotation in and out of the local area. Careful oversight of safety practices and ongoing provision of targeted training will be needed to ensure safe work sites and a healthy workforce.

Experience in other jurisdictions has shown that safety practices are not always consistent with best practices (Werntz 2011) and that some companies are far better than others with respect to preventing environmental violations (Goldstein 2011), which can be inferred to be an indicator of how responsible their operations are overall. As a result, careful government oversight of safety practices and provision of targeted training will be necessary to ensure a safe work environment for all workers in this industry. In particular, WorkSafe NB may need additional resources to properly oversee this industry.

In addition, overcoming these limitations will require further enhancements to existing programs such as public health promotion activities in order to effectively reach all workers involved directly or indirectly with the industry.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, healthy work environment

Public Health Values supported:

beneficence & non-maleficence, burden of proof, evidence-based, leadership, precautionary principle, prevention, proportionality

4. Protection of Future Generations

Recommendation 4.1: The Province should develop a plan for anticipating and mitigating the “Boomtown Effect”

The highly negative health and social consequences of the Boomtown Effect have the potential to spoil the benefits of economic gains unless the Province is prepared and ready to head off these problems before they occur. For New Brunswick to realize the full benefits of economic growth that may result from expansion of the shale gas industry, it is essential for the Province to mitigate the appearance of this effect. Furthermore, the Province needs to be prepared for the “bust” phase that inevitably follows any boom (often in repeating boom/bust cycles).

Although the word “Boomtown” may seem very positive, the “Boomtown Effect” refers to a series of potential negative outcomes on individual and community wellbeing that can result following a sudden and dramatic increase in industrial activity and the large influx of people that comes with it. As noted in Part 2, Section 2e, the Boomtown Effect is a common result of energy developments in cases where the rate of development outstrips the capacity of the local community to absorb the growth.

Boomtown threats such as increases in sexually-transmitted infections (STIs), drug abuse, crime, family violence and prostitution are very real threats unless preventative actions are taken. In addition, poor health of transient workers, displacement of local people due to rising housing costs and temporary communities with poor living conditions (“man camps”) can compound the misery. Finally, loss of public sector workers to the industry and demands for new infrastructure that continually outstrip capacity can weaken Government’s ability to do something about these problems. Taken together, these negative consequences of the Boomtown Effect have the potential to spoil the benefits of economic gains unless the Province is prepared and ready to head off these problems before they occur through strategic investments in community capacity.

In addition, in the long term the Province also needs to be prepared for the “bust” that will inevitably follow any boom (often in repeating boom/bust cycles). In cases where this has occurred in the past, effects have been seen such as new infrastructure that is no longer needed, economic depression, out-migration of workers, and over-capacity of housing, retail services and government services (Jacquet 2009). As such, boom/bust cycles are a “Catch-22”, as many of the things that are lacking in the boom phase are the same things that are in oversupply in the event of a downturn, which presents significant difficulties for proper planning. Ideally, diversifying the local economy when times are good could help to mitigate the bust phases, but this is not easily accomplished.

Accordingly, the Province will have to implement specific and targeted actions in dealing with the above potential negative outcomes in advance of development and throughout the lifetime of the industry in order to realize real socioeconomic and health status benefits for New Brunswickers along with the economic gains.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, communicable disease prevention and control, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 4.2: The Province should undertake a Strategic Health Impact Assessment (Strategic HIA) to estimate the long-term cumulative health and social benefits and costs

Recommendation 2.1 proposes undertaking site-specific HIA as a means of prioritizing risks that will require management for individual projects, but the intent of this recommendation is to carry out a more globally-focussed assessment across the full extent of industry development in New Brunswick. As such, a strategic HIA would include development scenarios covering the entire lifespan of the industry across all potential locations to be developed in NB.

Since the total extent of development is unknown in advance, this approach will of necessity depend on various scenarios (e.g. low, medium, high development) in order to forecast possible outcomes. These models will help to inform the nature, extent, and timing of strategic interventions that the Province will need to make in order to appropriately manage the growth in such a way as to optimize benefits for and reduce risk to health and society.

There are only a few examples to date of health impact assessments carried out in other jurisdictions, such as the Battlement Mesa HIA (Colorado School of Public Health 2011) and these in general have been site-specific. However, other jurisdictions are undertaking or have proposed strategic environmental impact assessments (New York DEC 2011; BAPE 2011a; Québec 2011) or full life cycle analysis of costs and benefits to society (European Parliament 2011), and developments in these projects will help to inform a strategic HIA for New Brunswick.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Recommendation 4.3: The Province should designate areas that are to be excluded from development, including drinking watersheds and wellfields, sensitive natural areas, specified agricultural lands, and other areas of special significance (scope to be defined)

This recommendation proposes a prevention strategy to avoid common situations that could otherwise lead to human exposure routes in the event of accidents, spills or releases of contaminants, or negative impacts to other determinants of health. It also protects areas that have high value in order to avoid irretrievable loss or costly remediation. Ensuring the preservation of these high value areas and protecting them from any possible negative impact would result in a positive impact to the determinants of health both today and for future generations.

This recommendation is also linked to Recommendation 1.4 (role for Public Health in community planning) and Recommendation 3.5 (setbacks).

Recommendations to exclude specific sensitive areas from development have previously been made in other jurisdictions (New York DEC 2011; European Parliament 2011; USDOE 2011a-b) but additional work would be needed among partner agencies in NB to more clearly define the zones to be excluded from development and examine the risks and benefits of each of these designations in the New Brunswick context.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 4.4: The Province should prepare a strategic land use plan with considerations of health equity and with input from Public Health and other experts and stakeholders

It has been noted that due to a rapid decrease over time in the yield of gas from any individual gas well, large-scale shale gas production requires ongoing drilling of new wells and constant development of new land in order to ensure a continuous or increasing supply of gas (Considine, 2010). As a result, the potential for conflicts over land use may never go away.

Indeed, these conflicts may become even more acute in future. It is likely that in the early stages of development in the province, well sites would be chosen that are as far removed from populated areas as possible, but still accessible by road. As these locations become developed, new development is likely to become increasingly near-urban, and ultimately, urban. Thus, it is possible that the types of communities that host nearby shale gas sites will change as the development of the industry progresses. This has important implications for assessing potential impacts to the determinants of health over time and into the future.

A proactive strategic approach to land use planning with consideration for health equity would help to streamline development and also minimize negative impacts to the determinants of health. Such a process could also encompass work related to Recommendation 1.4 (role for Public Health in community planning), Recommendation 3.5 (setbacks) and Recommendation 4.3 (designating zones to be excluded from development).

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 4.5: The Province should implement a process that will allow planning and regulatory decisions to consider vulnerable and disadvantaged populations that are at greater risk to environmental contaminants

Vulnerable and disadvantaged populations deserve special consideration, not only to ensure a fair, just and equitable society but also because they are the most easily affected and most likely to suffer adverse impacts to the determinants of their health. In addition, good control of health impacts for the most vulnerable will result in better control of health impacts for the general population.

It was noted in Part 1 that socioeconomic status is strongly linked with health status. As a result, people with low social and economic status can be viewed as a vulnerable population, because their health status already suffers due to the conditions affecting their social determinants of health. Accordingly, any additional impacts to any of the determinants of health are more likely to affect this population more profoundly than the general population. Such potential impacts to vulnerable populations should be identified as part of Health Impact Assessments (Recommendation 2.1) and approaches to health equity (Recommendation 1.1).

Children provide a good example of another type of vulnerable population. They have special vulnerabilities due to lower body weight (which can result in a higher body burden of environmental contaminants), as well as faster respiratory and metabolic rates that can make them more profoundly affected by contaminants. They also have unique exposure routes (e.g. crawling, play areas, hand to mouth behavior) and sensitive life cycle stages during gestation, growth and development where certain contaminant exposures can cause lifelong damage. As a result, it is not appropriate to simply consider them as smaller versions of adults with respect to environmental health issues.

Furthermore, children are the future of our province and deserve special protection such as articulated in the UN Convention on the Rights of the Child (UN 1990), which was developed because it was recognized that people under 18 years of age often need special care and protection that adults do not. The Convention has become a legally binding instrument of International Law and states, in part:

Article 24: 1. States Parties recognize the right of the child to the enjoyment of the highest attainable standard of health and to facilities for the treatment of illness and rehabilitation of health

Article 27: 1. States Parties recognize the right of every child to a standard of living adequate for the child's physical, mental, spiritual, moral and social development

Vulnerable and disadvantaged populations should always be considered in planning and regulatory decisions because they are the most easily affected and most likely to suffer adverse impacts to the determinants of their health. Furthermore, good control of health impacts for the most vulnerable will also translate into better control for the general population as well.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidenced-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Recommendation 4.6: The Province should require that planning and regulatory decisions consider First Nations even if reserve lands are not directly affected

Because First Nations communities can face greater challenges related to health and socioeconomic status compared to the general population of Canada, they can be considered as a vulnerable population. As a result, planning and policy decisions should make special considerations for health equity of First Nations people. Defining these considerations will require an in-depth engagement with First Nations leaders and organizations. This will be needed even if reserve lands are not directly affected by gas development, as First Nations peoples have a strong sense of protecting the natural environment that extends to off-reserve areas that are part of their traditional territory.

First Nations people also deserve special consideration because of their holistic sense of wellbeing that includes spiritual, emotional, physical and mental aspects that grow out of respect for traditions, culture and the environment. For example, First Nations' traditions and culture include a strong sense of protecting the sustainability of Mother Earth: air, land and water are extremely important, and the wellbeing of First Nations' peoples is powerfully intertwined with the harmony of the environment. They have traditionally used natural resources as required for their needs and the greater good but at the same time strive to respect the Earth and ensure that resources are protected for future generations. In fact, in all major decisions, First Nations' peoples traditionally always consider the impact on the seventh generation to come.

The reverence of First Nations' peoples toward nature extends to lands off-reserve, and First Nations communities typically utilize many of these areas as their traditional territory. As a result, it is not sufficient to simply designate reserves as areas that are to be excluded from development, and a more in-depth engagement with First Nations is needed to ensure that benefits to the social determinants of health are maximized and risks are minimized.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Recommendation 4.7: The Province should prepare a strategic water management plan to protect the quality and availability of water for public water supplies, private well water supplies and fresh water in general

The shale gas industry is potentially a significant water user, and although other industries may use as much or more water, the industry could add significant demands to the provincial and local water budgets resulting in conflicts over water use.

Since lower water tables can result in changes in water chemistry and risk of microbiological contamination, quantity and quality of water are inextricably linked. Furthermore, sufficient availability of drinking water of appropriate quality is essential for community prosperity and sustainability.

One estimate of water usage by the shale gas industry states that about 5 million gallons (approximately 20 million litres) are needed to develop each gas well in the Marcellus Shale (PA Governor's Commission 2011). Although the total quantity used annually in this case was similar to or less than many other industries, a large scale development of the industry in New Brunswick could nevertheless add significant demands on water availability. This could potentially lead to conflicting water uses, such as obtaining fresh water from a small municipal supply resulting in over-pumping the wells to meet total demand.

Although the New Brunswick Natural Gas Group has recommended a hierarchy of water sources where fresh water is used as a last resort (NBNGG 1012a-b), water use planning should still be carried out because wastewater from hydraulic fracturing operations will impact the quality of receiving waters and the amount of water entering, stored within or leaving a watershed.

In addition, tracking of actual injected hydraulic fracturing water volumes and comparison to recovered volumes of flowback/ produced water should be a fundamental component of water use planning in order to ensure on an ongoing basis that forecasts were accurate and that water management measures are sufficient.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Recommendation 4.8: The Province should encourage, promote and financially support research in New Brunswick, such as long-term longitudinal health studies and research on potential health effects, social impacts, and other aspects

New Brunswick has an opportunity to position itself as a leader in not only the shale gas industry, but also in the protection of health and the environment in relation to this industry. A clear commitment to supporting research in these areas (such as long-term longitudinal health studies and research on potential health effects, social impacts, and other aspects) would solidify the Province's reputation as a leader in these fields.

In addition, New Brunswick has an enviable advantage in that a relatively "clean slate" currently exists so that longitudinal studies will have a suitable baseline condition that can improve the confidence in research results. This is an advantage that other jurisdictions may not have and New Brunswick should capitalize on it to foster leading edge research in the province.

Research of this kind is important to public health protection because it verifies whether or not control measures, such as investments in community health and health impact assessments are having the desired effect. Thus, research outcomes and improvements in scientific knowledge can be used to inform industry expansion throughout the lifetime of the industry in the province and elsewhere, both nationally and internationally.

New Brunswick should act quickly (e.g. establish pilot projects at least in the very near term) in order to begin capitalizing on the conditions that currently exist that can aid in the development of world-class research programs in our province.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis, national agenda, scholarly activity

Public Health Values supported:

beneficence & non-maleficence, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 4.9: The Province should commit to periodically reviewing and reporting to the public on environmental and health monitoring data

Recommendations 2.2, 2.3 and 3.1, as well as some recommendations by the Natural Gas Group (NBNGG 2012a,b) propose establishing a variety of environmental and health monitoring systems in order to provide quality control data during all phases of the gas industry in New Brunswick. However, establishing these monitoring systems is only one part of the puzzle: there must be a clear commitment to analyzing the data, reporting on the findings, interpreting what they tell us regarding the effectiveness of control measures and regulations, and whether any changes are needed as a result. These reports also need to be made public in order to ensure transparency and earn the trust of the Public.

There are many logistical questions still to answer regarding responsibility for producing these reports in a timely fashion, enforcement of corrective actions if warranted by the findings, and resources needed (see Recommendation 5.1) but the commitment is needed as a first step. Ideally, a commitment to public reporting would be made by Government as a whole by way of a public position statement on this issue, and the specific reporting mechanisms would be then implemented by individual departments.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

5. Implementation and Oversight

Recommendation 5.1: The Province should establish sufficient capacity and resources to enable relevant Government departments to oversee the development of this industry including conducting project reviews and approvals, inspections, monitoring, enforcement and management of environmental, health or social consequences

As shale gas development activity increases there will likely be additional strain on all implicated government departments and a boom in activity could create a sudden and severe shortage of government capacity in these areas. A proactive approach is necessary to protect both the social and physical environments and to avert the conditions that can lead to the negative impacts of the Boomtown Effect (Recommendation 4.1).

Implementation of these recommendations and those proposed by the New Brunswick Natural Gas Group (NBNGG 2012a-b) will require an initial upfront investment in the capacity of a variety of government departments in order to prepare for the arrival of the industry. With respect to the Department of Health in particular, additional resources would be required to develop strategic approaches to managing the social determinants of health (Recommendations in sections 1 and 4), to monitor and analyze population health status within the context of environmental monitoring data (Recommendations 2.2, 2.3 and 4.11), to review and oversee HIA studies (Recommendation 2.1) and provide comments to environmental impact assessments for individual projects (Recommendations

in section 3), to undertake a strategic HIA (Recommendation 4.2), and to partner with and assist other agencies that will be leading implementation of other recommendations.

Furthermore, additional capacity in medical health service delivery in terms of doctors, nurses, health care facilities; public health services; mental health services; and social services will also be required. Other government departments and agencies that would also require additional capacity building include but are not limited to: Regional Health Authorities, Social Development, Environment and Local Government, Natural Resources, Public Safety, Transportation and Infrastructure, Education and Early Childhood Development, and others.

In addition, as shale gas development activity increases there will likely be additional strain on all implicated government departments, which could lead to a sudden and severe shortage of government capacity in these areas even if initial capacity investments have already been made.

Thus, in order to properly oversee and manage any environmental, health or social consequences, government capacity should increase initially through upfront investments and again on an ongoing basis along with industry activity as required. This proactive approach is necessary to avert some of the conditions that can lead to the negative impacts of the Boomtown Effect (Part 2, Section 2e and Recommendation 4.1) and help protect both the social and physical environments.

One possible way to provide for this would be to tie a portion of royalties¹ or an industry levy to providing funding for government oversight and public services so that funding would increase as industrial activity increases. As an example, Pennsylvania has proposed to levy a per-well "Impact Fee" totaling \$160,000 per gas well scaled over the first 10 years² of each well's lifetime to provide funding at the state and local levels for a variety of government services needed to benefit the host communities, to aid public protection, and to help offset any detrimental effects of development (PA Governor 2011). These funds would be provided with strict rules for how they may be used by the various agencies that receive them, and are intended for such things as infrastructure, emergency preparedness, affordable housing, social services, increased judicial system costs, and inspection, oversight and enforcement. At Pennsylvania's current rate of well development, this levy would raise \$120 Million in total designated funds in the first year and growing to nearly \$200 Million per year after the sixth year.

Another possible mechanism would be to ensure that enforcement penalties are appropriate and that funds from them could also be directed to enhancing government capacity.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

beneficence & non-maleficence, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

¹ Note that in New Brunswick's case a similar objective could be attained through designating a portion of royalties – Pennsylvania does not require any gas royalties payable to the State and so a separate fee was necessary.

² Note also that the specifics of Pennsylvania's funding formula and funding level are not directly applicable to the New Brunswick context because many more government services in Pennsylvania are provided at the local and county levels than at the State level, because levels of industry activity are not likely to be similar (at least initially) and because health care costs are generally not borne by government in Pennsylvania.

Recommendation 5.2: The Province should establish an implementation group for the recommendations in this Report that is led by Public Health and includes representatives from other relevant government departments and other stakeholders

Since implementation of these recommendations will require action from outside of the health sector as well as from within it, it is recommended that an implementation group be struck that is led by Public Health (i.e. OCMOH) but which has representation from a broader set of stakeholders. As noted under Recommendation 5.1 regarding agencies that will be subject to resource and capacity issues, this group should include but is not limited to Regional Health Authorities, the Departments of Social Development, Environment and Local Government, Natural Resources, Public Safety, Transportation and Infrastructure, Culture, Tourism and Healthy Living, Education and Early Childhood Development, and others as appropriate.

Note that the implementation group would also be charged with ensuring that a transparent and consultative process with the Public and other stakeholders is undertaken with respect to the actual implementation process to be used (see Recommendation 1.5).

Having this implementation group led by Public Health will ensure that the actions and timelines undertaken will remain focused on appropriate protection of public health as per the intent of the recommendations in this document.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 5.3: The Province should sponsor a series of summits led by Public Health to better understand and communicate public health information and issues and to foster an effective ongoing dialogue among community, government, academics and industry

Implementation of this recommendation would establish an ongoing framework for communication of changes in science and technology, updates about the progress of the industry in the province, and a forum for discussion of changing concerns as development progresses. Committing to keeping all parties informed now and into the future is an important aspect of risk communication, and would provide an enhanced level of transparency going forward.

Creating such an ongoing forum would place New Brunswick in the national spotlight as a progressive leader in developing creative solutions to the multi-faceted issues related to the potential effects of shale gas development on both the social and physical environments.

A conference held in Moncton June 3-5, 2012 (FORUMe 2012) was a good initial opportunity to bring together these sectors, but a truly effective open and informed exchange of ideas will require an ongoing forum.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, transparency, utilitarianism

Recommendation 5.4: The Province should create a multi-disciplinary Advisory Committee to Cabinet charged with reviewing government oversight throughout the lifetime of the industry in NB

The New Brunswick Natural Gas Group and contributors from other government departments have laid the groundwork for responsible management of natural gas activities in New Brunswick but there needs to be an ongoing responsibility centre. This is needed to ensure that the Government can adapt to changing conditions in the future and can update requirements as new information becomes available. Such a group would ensure that regulations and other protective measures derived from the work to date are working as intended (through e.g. periodic review of legislation, non-compliances, violations, monitoring data, etc.) and that they continue to improve in future so as to optimize sustainability. In addition, such a group could be charged with reviewing the status of implementation of recommendations and evaluating the effectiveness of them.

As a result of the complex nature and wide scope of specializations represented in the recommendations to date, this group would of necessity have to be multi-disciplinary and experienced in natural gas industry issues. Membership and terms of reference of such a committee could be developed following public and stakeholder consultation.

An Advisory Committee to Cabinet is recommended as the appropriate level for such a body because it would be accountable to the elected government of the day, could draw on the expertise housed in any or all government departments and would not be dominated by the prerogatives of any one department.

Health Objectives supported:

advocacy, leadership & partnership, provision of information, prevention of public health hazards, social determinants of health emphasis

Public Health Values supported:

autonomy, beneficence & non-maleficence, burden of proof, communitarianism, equity & distributive justice, evidence-based, leadership, precautionary principle, prevention, proportionality, transparency, utilitarianism

Part 4

Conclusions

The mandate of the OCMOH is to improve, promote and protect the health of the people in New Brunswick. In light of the potential scale of the proposed shale gas industry and the public debate on the issue of its development, it is of utmost importance that OCMOH fulfill its mandate by helping Government understand how this industry could potentially impact the health of the people in New Brunswick and provide recommendations as to how to plan and prepare. These recommendations are based on current knowledge, but as there are many data and information gaps the advice will need to evolve. In particular it will be key to hear public thoughts and perceptions to better inform future actions. In order to do the work an implementation group will need to be established and oversight mechanism put in place. As all of society has a role in the health of the population, it will be important that the participation in the work extends well beyond the traditional health sector.

The shale gas industry is in its infancy in this province. If the industry is developed to its full potential, it has the ability to greatly positively and negatively impact the health of the people in New Brunswick, and so proper controls and mechanisms to protect and monitor health must be put in place to reduce the risk of spoiling the potential benefits from economic gains through adverse health outcomes. Action should be taken well in advance of any proposed expansion. Current infrastructure, capacity, processes and legislation are not adequate to meet the needs. The funding of these recommendations will not be insignificant; however there may be opportunity to have much of the costs absorbed by the industry.

Some of the key findings are summarized below and include a lack of participation from Public Health in other jurisdictions' regulatory regimes where industry exists; lack of information needed to assess toxicity risks; lack of accurate exposure and health data; lack of standard methods for preventing and mitigating social impacts; lack of health status studies before and during gas development; and a lack of systematic health impact assessments. A lack of information about the extent, locations and rate of development makes it very difficult to forecast local effects of specific projects and to assess the potential for cumulative effects over time.

Taken together, the social and physical environments are the main influences on population health. In general, the lower a person's (or community's) social and economic position is, the worse their health, so addressing the social determinants of health is fundamental to achieving health equity. Government policy and law are the forces that provide an opportunity to achieve health equity and so these recommendations to government include ways to support the equitable and just distribution of the social and economic resources and conditions that give rise to the social determinants of health.

Although the public has voiced a preoccupation with health concerns, there has been a notable lack of participation by Public Health agencies in many of the ongoing initiatives to regulate the industry elsewhere. This may be due to a general lack of understanding about the potential impacts on health, little precedent to learn from, or plans that could be followed, a narrowing of the scope of what "health" means, and/or a belief that engineering controls and regulations can mitigate all of the potential impacts. Systematic and early inclusion of trained expertise would ensure that a public health lens was brought to bear which would certainly help identify and solve many potential issues. This complementary but targeted focus on human health is essential not only for shale gas but for most industrial development.

The public discussion on shale gas has been dominated to date by chemical toxicity concerns and has focused on water and hydraulic fracturing chemicals; while these are important, there is a risk of overlooking other potentially more problematic considerations, such as community health issues and the potential for physical injury. The scientific and medical literature has not widely reported or studied factors such as potential impacts to community health, mental health and socioeconomic wellbeing but rather also has been focused on issues surrounding potential environmental toxicants. The unbalanced discussion highlights the need for open and informed sharing of information and in particular good data to be produced through routine surveillance and targeted research. As many jurisdictions across Canada, the US, Europe and the world are facing similar concerns, significant advantages could be garnered by collaborating with others.

Potential for physical injury, both at the work site itself and in the vicinity of development is significant and warrants careful planning. Local government and community involvement in planning and development could

help prevent morbidity and mortality: for example, to reduce the potential for increased truck traffic accidents that could impact residents near development areas. Ensuring that there are appropriate mechanisms in place to look after workers' and visitors' health and safety both on and off site, and optimal emergency response capacity will also be important in reducing the consequences from physical threats.

In addition to knowledge gaps about toxicity of some of the known chemicals, this issue is greatly complicated because it can be difficult simply to identify which chemicals are in use at each location. Solid and liquid wastes for each gas well site are variable and not always fully characterized. As a result, a generic toxicological profile of wastes cannot be prepared. In order to address this gap, solid and liquid wastes for each gas well site should be characterized so that toxicological information can be obtained for exposure risk assessments and that appropriate waste treatment systems are used in all cases.

The economic benefits of shale gas development are potentially very large and if appropriately managed could contribute to improving the overall health status in this province. Socioeconomic status of a population is a strong predictor of health status, so employing the unemployed, or enabling higher incomes or improving social programs should result in health benefits. However, these potential improvements can be limited or even counteracted by negative social impacts that can arise during an economic boom ("Boomtown Effect") e.g. increased rates of crime, drug and alcohol abuse, sexually-transmitted infections (STIs), domestic violence, inadequate supply and quality of housing, and increased cost of living. These problems could be mitigated by improving infrastructure and public services capacity (including policing, local government, mental health services, social services, and health care).

Because the Boomtown Effect is thought to be more intense for small communities with a traditional way of life, there may be a risk to New Brunswick communities unless this effect is anticipated and mitigated through strategic investments. The positive effect of economic gains can be further limited due to inequitable distribution of risk and reward among local residents. At present there is no standard approach for how to prevent or mitigate the Boomtown Effect, so this will have to be developed, ideally in collaboration with national partners. More information on accurate forecasts for the scale of the industry, rate of development, duration, and precise locations of gas well development will be needed in order to prepare an effective plan for dealing with social and community health impacts. Involvement of local governments and communities would allow mitigating measures to be targeted and more effective.

There are gaps in existing data sets to assess both the environmental and health effects from this industry. Accurate exposure data has been very difficult to obtain, in part because emissions of chemicals can be quite different at different locations and times, but targeted monitoring of air, water and wastes could help to bridge this gap. Well-defined baseline description of health status and monitoring systems to detect changes in health status typically do not exist, and little is known about potential direct consequences to health resulting from gas development. There has been a general lack of comprehensive analysis and forecasting of potential health effects in nearby communities that could arise from large-scale unconventional gas development projects. However, whatever suitable methodologies to fill this gap (such as Health Impact Assessments (HIA) etc) are available should be used. More information on accurate forecasts for the scale of the industry, rate of development, duration, and precise locations of gas well development will be needed in order to prepare an effective plan for dealing with social and community health impacts.

While the potential health and environmental risks of individual well pads can be evaluated in order to prevent or mitigate negative impacts, it is much more difficult to do this for the total impacts of all of the large number of well pads that would be developed over a 20-, 50- or even 100-year timeframe should a major expansion of the gas industry take place. To date it has not been possible to estimate well pad densities that might occur in the New Brunswick context, nor in what localities they might occur, or over what extent of land area, or at what rate of development. These are expected to depend on where profitable gas discoveries are made. This information will be essential in order to better forecast the potential cumulative impacts to health and the environment in this province and thus inform further recommendations if needed.

Poorly planned site locations and intensive resource use could have a negative impact on the health and wellbeing of individuals and communities. Access to clean air, good quality water, recreational facilities and other attributes of a healthy community are essential. A strategic land use and water management plan, as well as designation of protected areas and setbacks, and consideration of public health as part of the community planning process will be important in preserving the quality and length of life for the people of this province. These plans must give consideration to vulnerable populations such as children, and those for whom the environment plays a particularly strong foundation to their health such as First Nations peoples.

A number of major efforts are currently ongoing in Canada and the United States that should help to inform some of the knowledge gaps outlined above. The outcomes of these studies will be very valuable information, but they are not a substitute for conducting health impact assessments in the New Brunswick context. It is essential therefore that the mechanisms and capacity to do internal assessments are developed. There would however be great value in developing a pan- Canadian approach in order to develop consistent and high quality frameworks and templates in an efficient manner.

The recommendations describe actions that are necessary to protect or enhance population health through proper management of the shale gas industry. It is recognized that funding will be needed for government to complete or implement some of the recommendations herein. Some may require legislation change and all will require the work of many partners both within and outside of government. While the recommendations in this document may seem onerous, rather they should be seen as routine public health practice. It is important to consider the impact that industry can have on human health.

Taking such proactive and positive action will certainly establish New Brunswick as a leader in a field of critical global importance.

Acknowledgements

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Appendix

**Summary of findings and
recommendations related
to public health and shale gas
in other jurisdictions
(selected references)**

Colorado (Colorado School of Public Health, 2011)

Battlement Mesa Health Impact Assessment, Colorado School of Public Health, February, 2011

<http://www.garfield-county.com/environmental-health/battlement-mesa-health-impact-assessment-ehms.aspx>

Eight areas of concern were reviewed (need to mitigate negative impacts/ support positive impacts):

1. Air Quality
2. Water and Soil Quality
3. Traffic and Transportation
4. Noise, Vibration and Light
5. Community Wellness
6. Employment/Economy
7. Health Care Infrastructure
8. Accidents/Malfunctions

>70 recommendations http://www.garfield-county.com/public-health/documents/8_HIA_2nd_draft_findings-recommendations.pdf

Major ones are:

- Reduce chemical exposures
 - Decrease emissions
 - Monitor air and water
- Safe industrial operations
 - Move traffic off residential roads
 - Accident prevention
 - Emergency planning
- Stakeholder communication
 - Community advisory board

Gaps identified included:

- Baseline and ongoing air, groundwater, surface water, and soil data around well pads and the centralized water storage facility
- Collection and analysis of baseline and ongoing health information (the report recommends that health studies should include *“measurements related to physical health, lifestyle and social cohesion, education, crime, sexually transmitted infection, mental health and suicide, substance abuse, and economic impacts”*)
- Specific timelines for development and maintenance activities

New York (New York Health Professionals 2011)

Letter to New York State Governor Andrew Cuomo from over 250 concerned Health Professionals and Organizations regarding omission of human health impacts in the New York SGEIS process, Oct. 5, 2011

- Letter <http://www.psehealthyenergy.org/data/lettertoGovCuomofinal.pdf>
- Press Release http://www.psehealthyenergy.org/data/Release_Medical_Authorites_Urge_Cuomo_to_Order_Health_Assessment_of_Fracking_final_10-5-11.pdf

(Excerpt)

Dear Governor Cuomo,

On behalf of the undersigned organizations and health professionals, we are writing with regard to the revised draft of the Supplemental Generic Environmental Impact Statement (SGEIS) on the Oil, Gas, and Solution Mining Program issued in full in September 2011. We are greatly concerned about the omission of a critical issue related to the development of natural gas using high-volume hydraulic fracturing, or “fracking”: human health impacts.

For the reasons detailed below, we believe that the Department of Environmental Conservation (DEC) must correct this oversight in the continued stages of the State Environmental Quality Review Act (SEQRA) process.

Specifically, we request that the draft SGEIS be supplemented to include a full assessment of the public health impacts of gas exploration and production. This should include analysis of the existing documentation of the baseline health status of the New York State population; systematic identification and analysis of direct and indirect health effects; a cumulative health impacts analysis that includes a reasonable “worst case” assessment; and any potential measures to eliminate these impacts.

Notably, a comprehensive assessment of health impacts is likely to include information—such as mounting costs for health care and air and water pollution mitigation—that could inform how DEC and other agencies, such as the Department of Health (DOH), evaluate and assess cumulative impacts and how DEC reviews any proposed gas development permit applications. A comprehensive Health Impact Assessment (HIA) would be the most appropriate mechanism for this work, conducted by an independent entity such as a school of public health. This request is based in part on the fact that the New York DOH is unwilling to perform this function. Please refer to attached communication from Dr. Howard A. Freed, director of the DOH Center for Environmental Health, stating that “another methodology such as Health Impact Assessment would not provide significant additional information that is not already being covered” in the SGEIS. The undersigned disagree with this conclusion because the SGEIS does not, in fact, consider health impacts.

Next, we believe that a comment period of less than 180 days is not acceptable, for either the medical profession or the public. The medical profession was not adequately consulted during the scoping of the SGEIS and had little input into the draft SGEIS. A minimum of 180 days is necessary for health professionals to review and comment on the current draft SGEIS which must be reviewed in its entirety since there is no chapter dedicated to human health. The 96 day comment period which DEC has now proposed is also not enough to afford the public an adequate opportunity to express its concerns about potential health impacts given that DEC is also asking the public to comment on draft regulations during that same time period, and that potentially drill-impacted communities are now facing significant post- Irene challenges.

Finally, we strongly request that an independent health professional be appointed to the High Volume Hydraulic Fracturing Advisory Panel, such as a medical doctor with public health experience.

Pennsylvania (PA Governor's Commission, 2011)

Governor's Marcellus Shale Advisory Commission Report, July 22, 2011

http://www.portal.state.pa.us/portal/server.pt/community/marcellus_shale_advisory_commission/20074

96 recommendations (see report, Chapter 9), in the areas of:

1. Infrastructure
2. Public Health, Safety and Environmental Protection
3. Local Impact and Emergency Response
4. Economic and Workforce Development

The bulk of this report was not concerned directly with Public Health issues, but those recommendations that had a direct bearing on Health were:

9.2.37 – The Department of Health should work in partnership with the Commonwealth's graduate schools of public health and other appropriate medical institutions to better protect and enhance the public health interests of citizens, such as through the establishment of the population-based health registry and curriculum development.

9.2.38 – The Department of Health should collect and evaluate clinical data provided by health care providers.

9.2.39 – The Department of Health should routinely evaluate and assess Marcellus Shale-related environmental data, such as air, water, solid waste, and fish and other food samples, that is collected from a variety of entities, such as PA DEP, US EPA, the US Geologic Survey, water works or treatment facilities, industry and academic partners.

9.2.40 – The Department of Health should create, or oversee the creation of, a population-based health registry with the purpose of characterizing and following over time individuals who live in close proximity (i.e. one mile radius) to gas drilling and production sites.

9.2.41 – The Department of Health should establish a system to provide for the timely and thorough investigation of and response to concerns and complaints raised by citizens, health care providers or public officials.

9.2.42 – The Department of Health should educate health care providers on the presentation and assessment of human illness that may be caused by material in drilling constituents.

9.2.43 – The Department of Health should establish public education programs regarding the constituents used in the drilling process, potential pathways to humans, and at what level, if any, they have the potential to cause human illness.

Pennsylvania (continued) (PA Citizen's Commission, 2011)

"Marcellus Shale: A Citizens View", Citizens Marcellus Shale Commission, October 24, 2011

<http://citizensmarcellusshale.com>

Over a hundred recommendations covering a wide variety of topics, including:

- General Recommendations
- Better Control Air Emissions Emanating from Gas Production and Transmission Facilities
- Reduce the Potential for Wastewater Degradation of Surface Waters
- Better Protect Property Owners from Gas Production Impacts
- Create Revenue Sources from Natural Gas Extraction
- Protect Public Lands and Waters

- Better Protect the Property Rights of Citizens
- Limit Water Withdrawals to Protect Other Uses
- Protecting Aquifers
- Reduce Impacts from Pipelines and Transmission Facilities
- Better Protect Public Health
- Long and Short Term Employment Impact
- Improve Enforcement of Environmental Laws
- Address Impacts on Individuals and Communities

The specific recommendations under “Better Protect Public Health” include:

- *Immediately create a health registry and database to track illnesses in drilling communities; use pre-existing data gathered in other states where appropriate. Adequate funding must be supplied to the PA Department of Health to cover the costs of creating a health registry and database.*
- *Industry should be required to disclose both the identities and amounts of each chemical (by common name and brand name) used in the hydraulic fracturing process to help health officials understand the likely health effects and treat exposures.*
- *Occupational health of shale gas workers should be monitored by the Department of Labor and Industry.*

Pennsylvania (continued) (PennEnvironment 2011)

“In the Shadow of the Marcellus Boom: How Shale Gas Extraction Puts Vulnerable Pennsylvanians at Risk”, PennEnvironment Research and Policy Center, May, 2011 <http://www.pennenvironment.org/news/pae/new-report-shale-gas-extraction-poses-risk-vulnerable-populations-pennsylvania>

Policy recommendations to the State include:

...these new protections do not go far enough. Instead of enabling more and faster gas extraction, state leaders and the Pennsylvania Department of Environmental Protection should increase oversight of gas companies and hydraulic fracturing. Among needed improvements are:

- *The Commonwealth should designate pristine places and locations near where people live or work off-limits to gas extraction*
- *Pennsylvania should strengthen its clean water laws*
- *Pennsylvania should require gas companies to halt the use of toxic chemicals in the hydraulic fracturing process*
- *The state should recognize the public’s right to know by requiring gas companies to report to the general public as well as the DEP the types and amounts of chemicals used during drilling and fracturing and the composition and disposal of wastewater, in a timely fashion and on a well-by-well basis*
- *Pennsylvania should increase the resources available to state regulators for enforcing the law*
- *The Commonwealth should increase bonding requirements for gas companies*
- *The DEP should revoke drilling privileges for the worst offenders*

The report also calls for specific improvements to Federal legislation (Safe Drinking Water Act, Clean Water Act, Clean Air Act, National Environmental Policy Act, Resource Conservation and Recovery Act, and the Toxics Release Inventory under the Emergency Planning and Community Right-to-Know Act).

Québec (INSPQ, 2010)

« État des connaissances sur la relation entre les activités liées au gaz de schiste et la santé publique – Rapport Préliminaire », Institut national de santé publique du Québec, Direction de la santé environnementale et de la toxicologie, Novembre 2010, ISBN : 978-2-550-60591-1 (PDF) http://www.inspq.qc.ca/pdf/publications/1177_RelGazSchisteSantePubRapPreliminaire.pdf

This report reviews the current state of knowledge regarding links between Public Health and shale gas activities. These factors were discussed under the following headings (translated from French in the original document):

1. Technological risks that could lead to Public Health emergencies
2. Risks related to air pollution
3. Risks related to water contamination
4. Risks of effects to quality of life
5. Identifying areas where knowledge needs to be developed in order to assess the risks to the Québec population

Findings included:

- Technology risks
 - Accidents and incidents have been documented that result in effects ranging from light injuries to deaths among workers as well as the general population
 - Multiple causes
 - Not enough info to estimate frequencies, however
 - Implementing emergency response plans is a major challenge
- Air pollution
 - Activities can contribute to local increases in NO_x, SO_x, VOCs, etc.
 - Effects of these pollutants are well known, but exposure levels are not and depend on multiple factors, so the overall health risk cannot be estimated
- Water pollution
 - The process uses and/or discharges many chemicals, some of which are known to be toxic
 - Few studies on water contamination in the vicinity of gas well developments
 - Some cases of groundwater contamination (by a variety of substances) suspected to be caused by shale gas activities, but none confirmed
 - However, some cases of methane intrusions into homes via drinking water wells (which have resulted in a few explosions of homes and some deaths) have been linked to shale gas activities
 - Wastewater management is a major issue
 - The nature, toxicity, environmental concentrations and exposure levels for a variety of chemical constituents in the wastewater are unknown, so the overall health risk cannot be estimated
 - As a result of suspected cases and the knowledge gaps, the USEPA was mandated to do an exhaustive study on health and environmental impacts to sources of drinking water resulting from hydrofracturing activities; preliminary results are expected in late 2012
- Quality of Life
 - Rise in certain nuisances for nearby residents: traffic, noise, luminosity and vibrations
 - Social effects noted in many cases, due to the rise in population and the “boomtown effect”
 - Short term improvement in economic activity, but some negative effects in the middle and long term
 - New social dynamics and demand for increased services and infrastructure

It is not currently possible to estimate the health risk to the population in Québec due to the lack of certain key information in each of the themes above

US Department of Energy (USDOE, 2011a and b)

Shale Gas Subcommittee of the Secretary of Energy Advisory Board, Ninety-Day Report, August 11, 2011
http://shalegas.energy.gov/resources/081111_90_day_report.pdf

Shale Gas Subcommittee of the Secretary of Energy Advisory Board, Second Ninety Day Report, November 18, 2011
http://www.shalegas.energy.gov/resources/111011_90_day_report.pdf

Report recommendations (abridged)

- Improve public information about shale gas operations
- Improve communication among state and federal regulators
- Improve air quality
 - collect methane and other air emissions data and make these data publically available
 - analyze the full life cycle GHG footprint of shale gas operations compared to other fuels
 - expand efforts to reduce air emissions using proven technologies and practices
- Protection of water quality
 - Measure and publicly report the composition of water stocks and flow
 - Manifest all transfers of water among different locations
 - Adopt best practices in well development and construction, especially casing, cementing, and pressure management
 - Field studies on possible methane leakage from shale gas wells to water reservoirs
 - Require background water quality measurements and reporting
 - Modernize rules and enforcement to ensure protection of drinking and surface waters
- Disclosure of fracturing fluid composition
- Reduction in the use of diesel fuel for surface power in favor of natural gas engines or electricity where available
- Managing short-term and cumulative impacts on communities, land use, wildlife, and ecologies
 - Use of multi-well drilling pads to minimize transport traffic and new road construction
 - Evaluation of water use at the scale of affected watersheds
 - Formal notification of anticipated environmental and community impacts
 - Preservation of unique and/or sensitive areas as off-limits to drilling and support infrastructure as determined through an appropriate science-based process
 - Undertaking science-based characterization of important landscapes, habitats and corridors to inform planning, prevention, mitigation and reclamation of surface impacts
 - Establishment of effective field monitoring and enforcement to inform ongoing assessment of cumulative community and land use impacts
- Continuous improvement of best practice
- Research and Development

European Union (European Parliament, 2011)

"Impacts of shale gas and shale oil extraction on the environment and on human health", Directorate General for Internal Policies, Policy Department A: Economic and Scientific Policy, European Parliament, June 2011

<http://www.europarl.europa.eu/document/activities/cont/201107/20110715ATT24183/20110715ATT24183EN.pdf>

Recommendations (note those pertaining specifically to European Union law are not included here):

- *In the framework of a Life Cycle Analysis (LCA), a thorough cost/benefit analysis could be a tool to assess the overall benefits for society and its citizens. A harmonized approach to be applied throughout EU27 should be developed, based on which responsible authorities can perform their LCA assessments and discuss them with the public*
- *It should be assessed whether the use of toxic chemicals for injection should be banned in general. At least, all chemicals to be used should be disclosed publicly, the number of allowed chemicals should be restricted and its use should be monitored. Statistics about the injected quantities and number of projects should be collected at European level*
- *Regional authorities should be strengthened to take decisions on the permission of projects which involve hydraulic fracturing. Public participation and LCA assessments should be mandatory in finding these decisions*
- *Where project permits are granted, the monitoring of surface water flows and air emissions should be mandatory*
- *Statistics on accidents and complaints should be collected and analysed at European level*
- *Where projects are permitted, an independent authority should collect and review complaints*
- *Because of the complex nature of possible impacts and risks to the environment and to human health of hydraulic fracturing consideration should be given to developing a new directive at European level regulating all issues in this area comprehensively*

References

References

- ATSDR 2010** – “Evaluation of Contaminants in Private Residential Well Water, Pavillion, Wyoming”, Agency for Toxic Substances and Disease Registry, August 31, 2010 http://www.atsdr.cdc.gov/hac/PHA/Pavillion/Pavillion_HC_Well_Water_08312010.pdf
- Badenhorst 2012** – Dr. Charl Badenhorst, Medical Health Officer, Board of Northern Health, Fort St. John, British Columbia. Personal communication, April 27, 2012.
- Bamberger and Oswald 2012** – “Impacts of Gas Drilling on Human and Animal Health”, Bamberger, M, and RE Oswald, New Solutions, Vol. 22(1) 51-77, 2012. http://www.psehealthyenergy.org/data/Bamberger_Oswald_NS22_in_press.pdf
- BAPE 2011a** – « Développement durable de l’industrie des gaz de schiste au Québec - Rapport d’enquête et d’audience publique », Rapport 273 du Bureau d’audiences publiques sur l’environnement du Québec (BAPE), Février 2011, ISBN 978-2-550-61069-4 (PDF) <http://www.bape.gouv.qc.ca/sections/rapports/publications/bape273.pdf>
- BAPE 2011b** – « Développement durable de l’industrie des gaz de schiste au Québec : Mémoire présenté au Bureau d’audiences publiques sur l’environnement par les directions de santé publique Mauricie et Centre-du-Québec / Chaudière-Appalaches / Montérégie », 273 DM100, Novembre 2010 http://www.bape.gouv.qc.ca/sections/mandats/Gaz_de_schiste/documents/DM100.pdf
- Brasier 2011** – “Community Impacts of Natural Gas Development in the Marcellus Shale: A Research Summary” presented by Kathy Brasier, PhD, at the 2nd Annual Conference on the Health Effects of Shale Gas Extraction hosted by the University of Pittsburgh Graduate School of Public Health, Pittsburgh PA, USA, November 18, 2011.
- Video at <http://www.shalegas.pitt.edu/index.php?q=node/10>
- CDC 2008** – “Promoting Health Equity: A Resource to Help Communities Address Social Determinants of Health”. Brennan Ramirez LK, Baker EA, Metzler M. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2008. <http://www.cdc.gov/nccdphp/dach/chhep/pdf/SDOHworkbook.pdf>
- CDC 2012** – Centers for Disease Control and Prevention, Frequently Asked Questions – Social Determinants of Health <http://www.cdc.gov/socialdeterminants/FAQ.html> (accessed May 30, 2012)
- Colborn et al. 2011** – “Natural Gas Operations from a Public Health Perspective”, Colborn, T. et al., Human and Ecological Risk Assessment *17*, 1039-1056, 2011. Preprint available at <http://www.endocrinedisruption.com/files/GasManuscriptPreprintforweb12-5-11.pdf>
- Colorado School of Public Health 2011** – Battlement Mesa Health Impact Assessment, Colorado School of Public Health, February, 2011 <http://www.garfield-county.com/environmental-health/battlement-mesa-health-impact-assessment-ehms.aspx>
- Considine 2010** – “The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia. A Report to the American Petroleum Institute” by Timothy J. Considine, Natural Resource Economics Inc., July 14, 2010 <http://www.api.org/~media/Files/Policy/Exploration/API-Economic-Impacts-Marcellus-Shale.ashx>
- Eastern Research Group / Sage Environmental Consulting 2011** - “City of Fort Worth Natural Gas Air Quality Study – Final Report”, Eastern Research Group Inc. and Sage Environmental Consulting LP, July 13, 2011 http://fortworthtexas.gov/uploadedFiles/Gas_Wells/AirQualityStudy_final.pdf
- European Parliament 2011** – “Impacts of shale gas and shale oil extraction on the environment and on human health”, Directorate General for Internal Policies, Policy Department A: Economic and Scientific Policy, European Parliament, June 2011 <http://www.europarl.europa.eu/document/activities/cont/201107/20110715ATT24183/20110715ATT24183EN.pdf>

FORUMe 2012 – “FORUMe : Evolving social values, natural resources and the economy”, conference hosted by L' Université de Moncton's Clément-Cormier Research Chair in Economic Development in collaboration with the University of New Brunswick, Moncton NB, June 3-5, 2012 <http://www.amiando.com/FORUMeParticipate.html>

FTPACPH 1999 - “Toward a Healthy Future: Second Report on the Health of Canadians”, Prepared by the Federal, Provincial and Territorial Advisory Committee on Population Health for the Meeting of Ministers of Health, Charlottetown, P.E.I., September 1999 (accessed July 31, 2012) http://www.phac-aspc.gc.ca/ph-sp/report-rapport/toward/pdf/toward_a_healthy_english.PDF

Fundy Engineering / Atlantica Centre for Energy 2011 – “Considerations for Responsible Gas Development of the Frederick Brook Shale in New Brunswick”, Fundy Engineering and the Atlantica Centre for Energy, March 25, 2011, <http://www.atlanticaenergy.org/uploads/file/ACfE%20Shale%20Gas%20Paper%20-%202025%20March%202011%20FINAL.pdf>

Gever 2011 - Gever, J., “Special Report: Gas Drilling Brings Stress, Social Ills”, MedPage Today, December 5, 2011 <http://www.medpagetoday.com/PublicHealthPolicy/EnvironmentalHealth/30010>

GLJ Petroleum Consultants 2011 – “Corridor Resources Inc. Elgin Contingent Resources Effective December 31, 2010”, GLJ Petroleum Consultants Ltd., March 5, 2011 <http://www.corridor.ca/investors/documents/ElginContingentResourcesSum.pdf>

GNB 2011 – “Province announces stronger requirements for natural gas development”, Government of New Brunswick news release June 23, 2011 http://www2.gnb.ca/content/gnb/en/news/news_release.2011.06.0703.html

Goldstein 2012 – “Missing from the Table: Role of the Environmental Public Health Community in US Governmental Advisory Commissions Related to Marcellus Shale Drilling”, Bernard D. Goldstein, Jill Kriesky, and Barbara Pavliakova, Environmental Health Perspectives ahead of print online version, January 10, 2012, <http://dx.doi.org/10.1289/ehp.1104594>

Goldstein 2011 – “Public Health, Sustainability and the Marcellus Shale”, presented by Bernard D. Goldstein, MD, at the 2nd Annual Conference on the Health Effects of Shale Gas Extraction hosted by the University of Pittsburgh Graduate School of Public Health, Pittsburgh PA, USA, November 18, 2011.

- Video at <http://www.shalegas.pitt.edu/index.php?q=node/10>

Health Canada 2011 – “Shale Gas: Health Canada Activities”, presentation by Richard Charron at the Natural Gas Development – Public Health Workshop, Fredericton NB, Dec. 2, 2011

INSPQ 2010 – « État des connaissances sur la relation entre les activités liées au gaz de schiste et la santé publique – Rapport Préliminaire », Institut national de santé publique du Québec, Direction de la santé environnementale et de la toxicologie, Novembre 2010, ISBN : 978-2-550-60591-1 (PDF) http://www.inspq.qc.ca/pdf/publications/1177_RelGazSchisteSantePubRapPreliminaire.pdf

Jacquet 2009 – “Energy Boomtowns & Natural Gas: Implications for Marcellus Shale Local Governments & Rural Communities”, NERCRD Rural Development Paper No. 43, The Northeast Regional Center for Rural Development, Pennsylvania State University, prepared by Jeffrey Jacquet, January 2009 <http://nercrd.psu.edu/publications/rdppapers/rdp43.pdf>

Medd (undated) – Medd, LM, “Population Health and Oil and Gas Activities: A Preliminary Assessment of the Situation in Northeastern BC”, Northern Health, undated http://www.northernhealth.ca/Portals/0/About/NH_Reports/documents/OilandGasreport.pdf

Nature Conservancy 2010 – “Pennsylvania Energy Impacts Assessment, Report 1: Marcellus Shale Natural Gas and Wind”, The Nature Conservancy, Western Pennsylvania Conservancy and Audubon Pennsylvania, November 15, 2010 http://www.nature.org/media/pa/pa_energy_assessment_report.pdf

NBDLG 2011 – “Action Plan for a New Local Governance System in New Brunswick”, New Brunswick Department of Local Government, December 2011 <http://www2.gnb.ca/content/dam/gnb/Departments/lg-gl/pdf/ActionPlanLocalGovernance.pdf>

NBDNR 2012 – Map of Oil and Natural Gas Licenses/Leases in New Brunswick http://www.gnb.ca/0078/minerals/PDF/Oil_NG_Agreements-e.pdf

NBNGG 2011 – “Shale Gas: The New Brunswick Approach”, presentation by Mark Wies of the New Brunswick Natural Gas Group at the Natural Gas Development – Public Health Workshop, Fredericton NB, Dec. 2, 2011

NBNGG 2012a – “Responsible Environmental Management of Oil and Gas Activities in New Brunswick: Executive Summary of Recommendations”, New Brunswick Natural Gas Group, May 2012 <http://www2.gnb.ca/content/dam/gnb/Corporate/pdf/ShaleGas/en/ExecSummary.pdf>

NBNGG 2012b – “Responsible Environmental Management of Oil and Gas Activities in New Brunswick: Recommendations for Public Discussion”, New Brunswick Natural Gas Group, May 2012 <http://www2.gnb.ca/content/dam/gnb/Corporate/pdf/ShaleGas/en/RecommendationsDiscussion.pdf>

NBNGG 2012c – “Responsible Environmental Management of Oil and Gas Activities in New Brunswick: Sharing of Royalty Revenues from Natural Gas Activities in New Brunswick, A Discussion Document”, New Brunswick Natural Gas Group, May 2012 <http://www2.gnb.ca/content/dam/gnb/Corporate/pdf/ShaleGas/en/RevenueSharing.pdf>

NBNGG 2012d – “Responsible Environmental Management of Oil and Gas Activities in New Brunswick: Case Studies and Lessons Learned”, New Brunswick Natural Gas Group, May 2012 <http://www2.gnb.ca/content/dam/gnb/Corporate/pdf/ShaleGas/en/CaseStudies.pdf>

NBNGG 2012e – “Responsible Environmental Management of Oil and Gas Activities in New Brunswick: List of References”, New Brunswick Natural Gas Group, May 2012 <http://www2.gnb.ca/content/dam/gnb/Corporate/pdf/ShaleGas/en/ListOfReferences.pdf>

New York DEC 2011 – “Draft Supplemental Generic Environmental Impact Statement (SGEIS) on the Oil, Gas and Solution Mining Regulatory Program”, New York State Department of Environmental Conservation, Draft 2 September 2011 <http://www.dec.ny.gov/energy/75370.html>

New York Health Professionals 2011 – Letter to New York State Governor Andrew Cuomo from over 250 concerned Health Professionals and Organizations regarding omission of human health impacts in the New York SGEIS process, Oct. 5, 2011

- Letter <http://www.psehealthyenergy.org/data/lettertoGovCuomofinal.pdf>
- Press Release http://www.psehealthyenergy.org/data/Release_Medical_Authorites_Urge_Cuomo_to_Order_Health_Assessment_of_Fracking_final_10-5-11.pdf

PA Citizen’s Commission 2011 – “Marcellus Shale: A Citizens View”, Citizens Marcellus Shale Commission, October 24, 2011 <http://citizensmarcellusshale.com>

PA Governor’s Commission 2011 – Pennsylvania Governor’s Marcellus Shale Advisory Commission Report, July 22, 2011 http://files.dep.state.pa.us/PublicParticipation/MarcellusShaleAdvisoryCommission/MarcellusShaleAdvisoryPortalFiles/MSAC_Final_Report.pdf

PA Governor 2011 – “Governor Corbett Announces Plans to Implement Key Recommendations of Marcellus Shale Advisory Commission”, Pennsylvania Office of the Governor, Oct. 3, 2011 news release <http://www.governor.state.pa.us/portal/server.pt?open=18&objID=1201686&mode=2>

PCPHN 2009 – “Bringing Health to the Planning Table: A Profile of Promising Practices in Canada and Abroad”, Pan-Canadian Public Health Network, 2009 <http://www.phac-aspc.gc.ca/publicat/2009/be-eb/pdf/be-eb-eng.pdf>

PennEnvironment 2011 – “In the Shadow of the Marcellus Boom: How Shale Gas Extraction Puts Vulnerable Pennsylvanians at Risk”, PennEnvironment Research and Policy Center, May, 2011 <http://www.pennenvironment.org/news/pae/new-report-shale-gas-extraction-poses-risk-vulnerable-populations-pennsylvania>

Perry 2011 – “‘It’s like we’re losing our love’: Documenting and Evaluating Social Change in Bradford County, PA during the Marcellus Shale Gas Boom (2009-2011)” presented by Simona Perry, PhD, at the 2nd Annual Conference on the Health Effects of Shale Gas Extraction hosted by the University of Pittsburgh Graduate School of Public Health, Pittsburgh PA, USA, November 18, 2011.

- Video at <http://www.shalegas.pitt.edu/index.php?q=node/10>

PHAC – Sustainable Development and Public Health http://www.phac-aspc.gc.ca/about_apropos/sd-dd/health-sante-eng.php

PHAC 2012 – “What Determines Health?” Public Health Agency of Canada webpage accessed May 17, 2012 <http://www.phac-aspc.gc.ca/ph-sp/determinants/index-eng.php>

Québec 2011 – Comité de l’évaluation environnementale stratégique sur le gaz de schiste, Gouvernement du Québec, <http://ees-gazdeschiste.gouv.qc.ca/>

Royal Society of Canada 2010 – “Environmental and Health Impacts of Canada’s Oil Sands Industry”, The Royal Society of Canada Expert Panel, December 2010. Executive summary available at http://www.rsc.ca/documents/expert/RSC_Exp_ExecutiveSummary_ENG_Dec14_10_FINAL_v5.pdf

RSNB 1973 - Municipalities Act, RSNB 1973, Chapter M-22; Community Planning Act, RSNB 1973, Chapter C-12, both available at <http://laws.gnb.ca/en/BrowseTitle>

Ruddell 2011 – Ruddell, R, “Boomtown Policing: Responding to the Dark Side of Resource Development”, Policing 5(4), 328-342, 2011. Abstract at <http://policing.oxfordjournals.org/content/5/4/328.abstract>

Sauve 2007 – Sauve, M, “Canadian dispatches from medical fronts: Fort McMurray”, Can. Med. Assoc. Journal 117(1), p.26, 2007 <http://www.cmaj.ca/content/177/1/26.long>

Schmidt 2011 – Schmidt, CW, “Blind Rush? Shale Gas Boom Proceeds Amid Human Health Questions”, Environ Health Perspect. 119, a348-a353, 2011. <http://dx.doi.org/10.1289/ehp.119-a348>

Senate of Canada 2008 – “Population Health Policy: Issues and Options”, Fourth Report of the Subcommittee on Population Health of the Standing Senate Committee on Social Affairs, Science and Technology, The Senate of Canada, April 2008 <http://www.parl.gc.ca/Content/SEN/Committee/392/soci/rep/rep10apr08-e.pdf>

Senate of Canada 2009 – “A Healthy, Productive Canada: A Determinant of Health Approach”, Final Report of the Subcommittee on Population Health of the Standing Senate Committee on Social Affairs, Science and Technology, The Senate of Canada, June 2009 <http://www.parl.gc.ca/Content/SEN/Committee/402/popu/rep/rephealthjun09-e.pdf>

Sierra Research Inc. 2011 – “Screening Health Risk Assessment Sublette County, Wyoming”, Sierra Research Inc., January 2011 <http://www.sublettewyo.com/DocumentView.aspx?DID=438>

Stedman 2011 – “Natural Gas Development: Views of New York and Pennsylvania

Residents in the Marcellus Shale Region”, Stedman, R. et al., Cornell University Community & Regional Development Institute, Research & Policy Brief Series, Issue 39, January 2011 http://devsoc.cals.cornell.edu/cals/devsoc/outreach/cardi/publications/upload/Policy_Brief_Jan11-draft08.pdf

St. Peter 2000 – “Oil shales and oil and natural gas in New Brunswick: Historical and current industry related activities”, by C. St. Peter, New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Information Circular 2000-5, 2000 http://www.gnb.ca/0078/minerals/pdf/ONG_History-E.pdf

St-Pierre 2010 – St-Pierre, L, “HIA and Inequities: HIA Series”. National Collaborating Centre for Healthy Public Policy, March 2010 http://www.ncchpp.ca/133/Publications.ccnpps?id_article=317

Tarlov 1999 – Tarlov, AR, “Public Policy Frameworks for Improving Population Health”, Annals of the New York Academy of Sciences 896 (Socioeconomic Status and Health in Industrial Nations: Social, Psychological and Biological Pathways), 281-293, 1999.

Toronto Public Health 2010 – “Health Impact Assessment in Relation to Examining Health Inequities”, Toronto Public Health, January 22, 2010 http://www.simcoemuskokahealth.org/Libraries/JFY_Communities/787_-_CAP_Jan_22_-_HIA_Metrolinx_1.sflb.ashx

UN 1990 – Convention on the Rights of the Child, United Nations, entered into force September 2, 1990 <http://www2.ohchr.org/english/law/crc.htm>

US Congress 2011 – “Chemicals Used in Hydraulic Fracturing”, United States House of Representatives Committee on Energy and Commerce, Minority Staff, April 2011 <http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf>

US Department of the Interior 2006 – “Record of Decision, Jonah Infill Drilling Project, Sublette County, Wyoming”, US Department of the Interior, Bureau of Land Management, March 14, 2006 <http://www.blm.gov/pgdata/etc/medialib/blm/wy/information/NEPA/pfodocs/jonah.Par.5187.File.dat/00rod2.pdf>

USDOE 2011a – Shale Gas Subcommittee of the Secretary of Energy Advisory Board, Ninety-Day Report, August 11, 2011 http://shalegas.energy.gov/resources/081111_90_day_report.pdf

USDOE 2011b – Shale Gas Subcommittee of the Secretary of Energy Advisory Board, Second Ninety Day Report, November 18, 2011 http://www.shalegas.energy.gov/resources/111011_90_day_report.pdf

USEPA 2011 – “Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources”, EPA/600/D-11/001/February 2011, United States Environmental Protection Agency, Office of Research and Development, 2011. http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711-08.pdf

Wallerstein 1992 – Wallerstein, N., “Powerlessness, Empowerment, and Health: Implications for Health Promotion Programs”, American Journal of Health Promotion: January/February 1992, Vol. 6, No. 3, pp. 197-205. Abstract at <http://www.ajhpcontents.com/doi/abs/10.4278/0890-1171-6.3.197?journalCode=hepr>

Werntz 2011 – “Occupational Health Issues of Marcellus Shale Drilling and Hydraulic Fracturing”, presented by Carl Werntz, DO and MPH, at the 2nd Annual Conference on the Health Effects of Shale Gas Extraction hosted by the University of Pittsburgh Graduate School of Public Health, Pittsburgh PA, USA, November 18, 2011.

- Video at <http://www.shalegas.pitt.edu/index.php?q=node/10>

WHO 1948 - Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19 June – 22 July 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948 http://whqlibdoc.who.int/hist/official_records/constitution.pdf

WHO 2008 – “Closing the gap in a generation: Health equity through action on the social determinants of health”, World Health Organization Commission on Social Determinants of Health, 2008 http://whqlibdoc.who.int/publications/2008/9789241563703_eng.pdf

Wolf Eagle Environmental 2009 – “Town of DISH Texas Ambient Air Monitoring Analysis Final Report”, Wolf Eagle Environmental, September 15, 2009 http://townofdish.com/objects/DISH_-_final_report_revised.pdf **PHAC** - Sustainable Development and Public Health <http://www.phac-aspc.gc.ca/about-a-propos/sd-dd/health-sante-eng.php>