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SELECT COMMITTEE REGARDING THE RISKS AND BENEFITS OF HYDRAULIC FRACTURING

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Wednesday, May 28, 2014 — 8:30 a.m.

Chair: Patti McLeod

SELECT COMMITTEE
REGARDING THE RISKS AND BENEFITS OF HYDRAULIC FRACTURING

Chair:	Patti McLeod
Vice-Chair:	Lois Moorcroft
Members:	Hon. Currie Dixon Darius Elias Sandy Silver Jim Tredger
Clerk to the Committee:	Allison Lloyd
Witnesses:	Dr. Brendan Hanley, Chief Medical Officer of Health, Yukon Dr. Eilish Cleary, Chief Medical Officer of Health, New Brunswick Dr. Charl J. Badenhorst, Regional Medical Health Officer, Northeast Health Service District of British Columbia Donald Reid, Associate Conservation Zoologist, Wildlife Conservation Society Canada John Hogg, Vice-president, MGM Energy Corp.

EVIDENCE
Whitehorse, Yukon
Wednesday, May 28, 2014 — 8:30 a.m.

Chair: I would like to call these proceedings of the Yukon Legislative Assembly's Select Committee Regarding the Risks and Benefits of Hydraulic Fracturing to order.

Allow me to introduce the members of the Committee. I am Patti McLeod, the chair of the Committee and Member of the Legislative Assembly for Watson Lake. To my left is Lois Moorcroft, who is the Committee's vice-chair and Member for Copperbelt South. To Ms. Moorcroft's left is Sandy Silver, the Member for Klondike. Behind me is Darius Elias, the Member for Vuntut Gwitchin. To Mr. Elias' left is Jim Tredger, the Member for Mayo-Tatchun, and to Mr. Tredger's left is the Hon. Currie Dixon, the Member for Copperbelt North, Minister of Environment, Minister of Economic Development, and the minister responsible for the Public Service Commission.

On May 6, 2013, the Yukon Legislative Assembly adopted Motion No. 433, thereby establishing the Select Committee Regarding the Risks and Benefits of Hydraulic Fracturing. The Committee's purpose, or mandate, is set out in the motion and it specifies that the Committee is to develop a science-based understanding of hydraulic fracturing, and also allow for an informed public dialogue. To this end, we will hear several presentations concerning both the potential risks and benefits of hydraulic fracturing.

I would like to welcome the visitors in the public gallery and our first presenters of the day, Dr. Brendan Hanley, Yukon's Chief Medical Officer of Health; Dr. Eilish Cleary, Chief Medical Officer of Health for New Brunswick; and Dr. Charl J. Badenhorst, Regional Medical Health Officer for the Northeast Health Service District of British Columbia. Dr. Hanley, Dr. Cleary and Dr. Badenhorst will each give a presentation focused on the health impacts of hydraulic fracturing.

Following the presentations, we'll take a short recess before proceeding with questions. If visitors in the public gallery would like to submit questions, forms and pencils are available at the entrance to the gallery. The page will collect the written question forms shortly before the end of the presentations.

After asking a few questions, each member of our Committee will randomly select written questions from those that have been submitted by visitors in the gallery. Time may not guarantee all public questions will be asked and answered but we will do our best with the time that we have. I would ask that questions and answers be kept very brief and to the point so that we may deal with as many as possible. Please note that these proceedings are being recorded and transcribed. If your question is selected, the information you fill out on the form may be read in to the public record.

I would like to remind all Committee members and the presenters to wait until they are recognized by the Chair before speaking. This will keep the discussion orderly and allow those listening on the radio or over the Internet to know who is speaking.

I would also ask that visitors in the gallery respect the rules of the Legislative Assembly. Visitors are not allowed to disrupt or interfere in the proceedings. Please refrain from making noise, including comments and applause, and mute any electronic devices.

Our first session will carry on until 10:30 a.m. or up to 10:30 a.m. depending on the length of time that is required by presenters. Now we are going to proceed with Dr. Hanley. Dr. Hanley, please.

Dr. Hanley: Thank you. Am I on?

Honourable members of the select committee and members of the public, thanks for your invitation for me to speak once again to the Committee on this important matter of shale gas development. These sessions already demonstrate the value that you place on public health as a key consideration when it comes to contemplating a new industry to the territory, such as shale gas development. I will also congratulate the government for commissioning this select committee to consider the risks and benefits of shale gas at this moment in Yukon's fractious history.

As a jurisdiction, we have time only if we use it properly and we must take the time to consider the various pros and cons of developing shale gas here, including the health effects, before a company or a project is on our doorstep. Both on the global and regional scale, I see some urgency to address these issues and our proper place in the world of resource development. It is only a few months ago that the Centre for Global Development based in Washington ranked Canada dead last, out of 27 OECD countries, for environmental protection due to rising fossil fuel production and due to Canada's withdrawal from the Kyoto treaty.

Yukon should not underestimate its potential to demonstrate innovative approaches to energy development and consumption to the benefit of the entire country, particularly as polar regions are already bearing the brunt of global warming. With the spectre of permafrost meltdown and therefore global warming increasing its relentless march, our thirst for fossil fuels must be managed by reducing demand, increasing efficiency and investing in renewable energy.

Before debating and dissecting the safety record of the plethora of chemicals used in hydraulic fracturing, we need to stop and take a hard look at the single biggest global threat to our health — climate change and global warming — and our responsibility as global citizens to act.

Today, you are not going to hear me either endorse or condemn hydraulic fracturing in itself. My interests and I think your interests as members of the Committee and of the public here should be to understand the health implications of developing the shale gas industry. By understanding the various health implications, I think we can build a framework to approach the development of an unconventional oil and gas industry or, indeed, of any industry, from a public-good point of view.

I'll discuss with you what I believe are the key health considerations and how we could organize these considerations under what I think are two key umbrella themes. One is that shale gas development is best assessed not in isolation, but as one potential part of our economy and as one potential part of our energy production or use. The second theme is that much of what I say about the public health approach to shale gas development should also apply to any new major project or policy that we contemplate in Yukon.

In working toward these goals of establishing a public health framework, I'll take you through the following steps: first, I would like to define what we mean by health and what are the important determinants of health; second, I'll briefly walk you through health impact assessments — or HIAs — as we do have some brief but important local experience in this area. Included in this part would be our experience and lessons from the Keno City HIA carried out in 2012, and a look at how Yukon government has an opportunity to integrate the HIA process into project planning. Third, I will review broadly the health impacts associated with hydraulic fracturing in various categories of local, regional or global importance. I'll then offer some conclusions and recommendations that I hope will embrace a broad vision of health and lead us to a healthier and lower carbon Yukon with or without a shale gas industry.

Before proceeding, I would like to throw out a caveat: it has already been clearly pointed out to me that I'm neither an expert in fracking nor in environmental health, and I can readily admit to that, but I have read a lot of material and I've talked to many people in the industry, economists in the government, in the oil and gas regulatory sector, to geologists in the Yukon Geological Survey, to doctors, to public health folks and to concerned members of the public. Reviewing literature on fracking could easily be a full-time job and it is difficult to do justice to this huge topic within the current scope of my practice as CMOH. The literature demonstrates a constantly moving target as the technology of fracking is improving all the time and the regulatory environment is also remodelling as it learns its lessons with this new industry. We have to maintain open minds as information changes and the science starts to be done.

What is health and what is wellness? Defining what we mean by health, by wellness and by public health is important before drilling further down into fracking health's effects. As you will note, my view is that the broader health effects are more significant to consider than most of the specific ones that often generate the most public angst. First, we should remind ourselves that the World Health Organization's definition of health is: "A state of complete physical, mental, social well-being and not merely the absence of disease or infirmity."

Beyond defining health, there is the concept of wellness, which is particularly important to note as Yukon moves toward supporting a wellness plan. From Yukon government's wellness office comes the following definition: "Wellness is a positive state of feeling good and functioning well that enables people to achieve their full potential, enjoy quality of life, and contribute positively to their community."

Now that we can build a picture of what health and wellness means, people who are free as possible of infirmity are in an optimal state of well-being, are well-fed and not overfed, are active, and who contribute to their communities and participate actively in the community.

What does that have to do with shale gas? Obviously, one would want industrial development not only to be compatible with such a concept of health and wellness, but to nurture such concepts. Economic benefits should filter through the community. Parents should feel that their children are safe and able to thrive and have a solid future.

People should feel good about where they are, where they work and what they would like to explore and enjoy in their leisure time. They should have reliable and equitable access to services, jobs and quality education. People should enjoy abundant clean air and fresh water.

In public health, our job is to support that health and wellness. Our job is to ensure that the public's health is protected. We do our best to promote good health. We should measure as best as we can indicators of child and adult health, communicable diseases, immunization rates, birth defects, injuries, chronic diseases and risk factors so that we can assist in preventing disease and disability by designing public health programs and policies. We help to assure that we can respond effectively and quickly when it comes to public emergencies.

In such thinking about health and public health, we therefore acknowledge that health has many drivers and influences. What determines good health? Income, social standing, the social milieu and social networks that people connect to, education and the physical environment, including the man-made or built environment are the most important areas for this particular discussion.

The list also includes a number of other areas, such as early childhood experience, underlying biology and genetics, gender, culture, and somewhere down that list, health services. I review these determinants because we will visit some of them shortly as we look at health effects, but it's also important to consider how many of these determinants — arguably most — lie outside the domain that we traditionally consider health and outside the reach or even the influence of any department of health. Remember this external position of most determinants of health as we talk about health impact assessments.

I would like to discuss the importance of health impact assessments and include what we have learned locally as a result of the Keno HIA experience.

A health impact assessment is a tool for assessing the health effects of a policy, a procedure or a project. The goal is to understand the range of health effects that might occur as a result of this endeavour, so that one can maximize the positive effects while minimizing the negative. The elements of a health impact analysis are described here. We can go through the different steps — the important steps: scoping, which means identifying who the stakeholders are and identifying

the preliminary health areas of concerns; composing a baseline health profile — the current health status of the local population of interest; the actual assessment of the impacts, where we describe and characterize, in this case, potential impacts of shale gas activities; then there's the making of recommendations, including mitigating any identified health harms and enhancing any health benefits; and then the communication part — the report writing and bringing this back to stakeholders.

What's important here is the order of things. An HIA is best done, not in the middle of a project, as we had to do for Keno City in 2012 for example, but as the project is being planned or proposed. An HIA can be on any scale. For example, assuming accessible shale gas is actually found in Yukon, we could apply an HIA process to the whole of Yukon for development of shale gas. What we have had so far is lots of discussion and a few experts speak, but to fully understand the potential impacts, both positive and negative, we should apply an orderly framework, work through it and come up with recommendations to maximize the gain for Yukon and minimize the negative impacts. This HIA could then be applied on a smaller scale to any particular project proposed for Yukon.

Let's review quickly what happened with the HIA for Keno City. As you know, Keno City is a tiny community that has historically seen the coming and going of mining activity. Indeed, many Keno City residents have experienced prior working lives in the mines. But since the close of the Keno Hill silver mine, the little community entered a quiet phase for over 20 years. Keno City remodelled itself as a wilderness community and cultivated tourism with Yukon government support. A few years ago, Alexco mine started reworking the silver when silver prices made such mining worthwhile. Many citizens felt they had not been adequately involved in this new mining phase for Keno, and concerns about dust exposure, noise, air quality and contaminated water from previously worked adits continued to mount.

I requested that the Department of Health and Social Services commission a health impact assessment, especially as further expansion of mining activity was being planned. I felt we needed a comprehensive, third-party review of all existing data and information to determine where there were gaps in data and where further mitigations to health concerns or risks could be recommended.

In September 2012, the report was published along with many recommendations. To make a long and ongoing story short, the recommendations have not been easy to implement and oversee. There is no existing mechanism to coordinate and supervise a government response. Given these difficulties, we were able to establish a project to examine more comprehensively how health impact analyses could be better managed by Yukon government. I have worked with Health and Social Services and other government departments to see how we can improve the process and establish a more comprehensive and consistent approach to examining health impacts of major projects — thus, the importance of this process with regard to oil and gas development, especially from unconventional sources.

In short, although we still need leadership from Health and Social Services supported from my office, we need to develop a formal process that involves Yukon government as a whole committing to a response to the recommendations arising out of an HIA.

The other important lesson is that an HIA should be able to address a current deficiency of the YESAA assessment approach — its weakness in being able to address cumulative effects. If project B happens after project A, the effects of project A are not necessarily taken into account. Clearly, when it comes to issues like shale gas development, assessment of cumulative effects from expansion, changing technologies or additional projects in the area all need to be considered in addressing the effects of resource development.

We have looked at defining health and public health and discussed the need for integrating health impact analyses into project assessments. We can finally zero in on assessing some of the important impacts. But how do we begin? Obviously we need to learn from the experiences and lessons learned in other jurisdictions. In Dr. Cleary's report — which most of you are familiar with, and I am very happy to have her here to speak in person — she pointed out that public health has not been at the table in most initiatives to regulate the industry in other parts of the continent.

There are few studies where the overall health and environmental impact of the entire lifetime of the shale gas industry is included. We have data gaps that limit the ability to assess risks to public health. It is difficult to forecast local effects of specific projects due to data gaps. There is often a focus on chemicals and not so much on the other public health issues of importance. There are many methodological obstacles, including the need, often for many years, to carry out the gold standard type of studies that we often rely on in the health field, and exposure assessment can be very difficult to sort out.

I will begin with an area that we do not always consider as a health effect — the socio-economic impact — but remember, from our determinants of health slide, how highly these determinants of health rank.

Resource development may well bring economic benefits. There are royalties and there is an opportunity for new sources of income.

Note, however, that the income comes in at the territorial level in terms of royalties, and determining the pathways for the rest of the money flow can be pretty difficult. How much money stays in the territory? Are there lost opportunities for economic gain from other sectors not developed?

The boomtown effect must be considered, anticipated and planned for, and my public health colleagues will discuss that in more depth. Resource development often comes in quickly when the markets determine that harvesting a certain resource is profitable. Development can shut down just as quickly, as we observe so often here in the mining industry. If money is made, how is the money distributed? It has been pointed out

that the distribution of risk and reward is not always equitable. The risk of collapse is borne by the community while a company reaps its rewards and can leave when profits dry up.

This is not meant to be doom and gloom, but a glimpse at the fiscal ups and downs of resource industries. Economic benefit must be soberly measured against the risk of boom and decline. Community planning must be in place to harness in a fair way the economic potential that resource extraction or development can bring.

Another health effect that may not be intuitive — and I have already touched on it in my opening. Greenhouse gas emissions are a contentious area of health impact that must remain a part of this discussion. Now, we probably all know that there are two main culprits associated with natural gas production: carbon dioxide, which is less potent but with a much longer greenhouse gas effect, and methane, far more potent as a greenhouse gas but shorter lived. In these two slides, which many of you will have seen, with shale gas estimates here on the left compared to other industries — conventional gas, coal and diesel further to the right — we see the more intense effect that methane, in pink, has on the total. If we flip back and forth, we'll see how the purple methane changes in its importance over the 100-year horizon versus the 20-year horizon.

While carbon dioxide levels depend on the gas field itself, methane is a by-product. It depends on how much is allowed to leak. Estimates of methane leakage vary so much that it is not useful to put out a number that will be shot down by one side or another, but it's important to note the significance of methane for two reasons.

One is that the short term — that is a 20-year time horizon — is still highly significant when we project the immediate future of global warming. As permafrost melts, more and more methane is released, which in turn accelerates global warming, especially at the poles. Beyond that, though, anything we can do to address methane leakage — not over the next 100 years, but over the next few years — could have huge benefits in reducing further global warming.

Before I get to that, I have trouble seeing this as a simple equation — for instance, a "fracking bad; diesel good" kind of argument. There are many considerations in assessing the complete pathway of fossil fuel production and its effect on greenhouse gas production.

For example, Yukon, in its 2009 energy strategy, has rightly pointed out the benefits of local fossil fuel production, even while recognizing — at least on paper — the need to reduce consumption. The report states — and I quote from the report: "Using Yukon's oil and gas resources within the territory could reduce the amount of energy that is consumed in order to transport imported fuels from outside the territory. These transportation savings would result in lower energy costs and fewer greenhouse gas emissions." The key point here — natural gas is a fossil fuel. It will add to greenhouse gas emissions. Much depends on how well methane leakage can be prevented. The best gains to reducing greenhouse gas reduction are in reducing fossil fuel dependence.

It's no secret that air quality can be threatened by all kinds of pollutants at all stages of gas production and transport. How important these pollutants are depends on the proximity and size of the adjacent population.

An illustration of the types of pollutants emitted, depending on the stage of production as shown here — for example, truck traffic being a major source of nitrous oxide, particulate matter and other toxins. To me, the most remarkable part of this slide is the column on the right — the poor data quality shown for this industry, an example of where we still have deficiencies of good data. The conclusion from here is that a health impact analysis of any project needs to consider, end to end, the production and transportation of gas, including building a supporting infrastructure. Good industry practice and excellent regulations with monitoring and enforcement of those regulations are essential to keep emissions below acceptable levels.

Impacts on water are threefold. The first is the impressive amounts of water required for the fracturing process — estimated at anywhere from 12 million to 80 million litres per well. The second is the possibility of contaminating groundwater through leakage from the cement casing or through connectivity through shale levels. The third — of most concern — is, as we still lack an ideal solution, disposing of the wastewater that is generally laden with either natural chemicals from deep down or from the frack fluid itself.

The chemicals themselves, of course, need management, and going into any depth here is beyond the scope of my expertise or time for this presentation. Suffice it to say that where there are frack chemicals, naturally occurring chemicals dredged up from the depths of the drilling, or frack sand itself, the effects to any locally residing population, as well as the workforce, need to be determined. Full public disclosure of chemicals used is now considered essential industry practice. Exposure prevention — again, through a tight regulatory practice — is also essential.

The physical environment brings us to more familiar, but not less important, effects of industrial projects — things like noise, light, the effects of heavy equipment and traffic. All these factors need to be duly considered, not just for their direct physical effects, but for their ability to wear away at the stress levels of nearby residents.

We must note — and again, I only touched on this, as I believe Dr. Cleary will likely have a chance to elaborate — that not all people are affected in the same way. When assessing the health impacts of a project, those most vulnerable — the poor, young children, pregnant women, the elderly and those with underlying medical conditions — must be considered.

Now that we know some of these more important effects, what can be done? Can these effects be offset or prevented? Well, to some extent, technology will help as it evolves and improves. Carbon catcher sequestration techniques, for instance, can significantly reduce greenhouse gas emissions. New techniques for handling waste water are being developed,

but these effects must still be considered and estimated. Technology, of course, cannot replace risk assessment.

We have reviewed some of the key aspects of health impacts of shale gas development, and I hope I have made it clear how complex and uncertain some of these areas are. Advocates of fracking demonstrate the superiority of natural gas as a fossil fuel to coal burning or to diesel. We can debate the attributes back and forth and further debate as to the abundance of natural gas, thanks to fracking — whether that's a bridge to a lower carbon future or is instead a huge fossil-fuelled procrastination. Either way, fracked gas remains a fossil fuel that has all the standard attributes: a non-renewable, greenhouse gas aggravant that fossil fuels carry.

Given that this is basically about a new technique for recovering an old fuel, if the subsurface geology does reveal an abundance of gas, then we will be obliged to consider: Is it better left in the ground or can we make good, responsible use of it that will bring a net benefit to Yukon?

I know the Committee has spent long hours and days and deliberating over this, but public health must be considered at every step in the following ways.

A formal health impact analysis must be carried out that weighs all the elements I have discussed and considers the latest science and panel reports, such as the recently published report from the Canadian Council of Academies. All specific oil and gas projects deserve health impact assessments in themselves. HIAs, in addition, need be integrated into government approval processes along with implementation plans.

Shale gas projects can bring economic benefit if carefully managed and if boomtown effects are avoided. The problem lies in anticipating and avoiding that boomtown effect.

Greenhouse gas contributions are significant and must be factored into an energy strategy. Yukon's energy strategy must be compatible with its goals in reducing climate change effects and both should set hard targets that consider greenhouse gas emissions, local production capability and reduction of consumption.

Other health risks can be managed in a climate of progressive legislation and best industry practices. I have been criticized for this statement, as many have interpreted this as my green light — go ahead and frack. It is not intended as such. It is not intended as such. It's more to point out that the physical effects are largely preventable or lend themselves to mitigation with a good regulatory environment that absolutely needs to include adequate monitoring and adequate enforcement. My recommendations are as I previously presented to the Committee. I've covered these areas in what I have already discussed, but I'll reiterate them here and spend a little detail in each of these categories.

In optimizing the socio-economic effects, I mean that planning comes first. Again, I know that Dr. Badenhorst will talk a little more on this. Robust, transparent community planning with consideration of vulnerable populations and equitable revenue-sharing are key components.

Again, managing physical effects requires not just good regulations but good processes for tracking possible effects. To this end, there must be robust air- and water-quality monitoring, dust-monitoring and management, monitoring and mitigations for noise, vibration and light. A significant deficit in scientific understanding of fracking has been the lack of baseline monitoring. Yukon is ideally positioned to obtain such baseline data. Waste-water management remains a thorny issue. It must be completely planned and disclosed, including adequate assessment of disposal options, including suitability for deep waste-water injection. In addition, full disclosure of chemicals used in fracking should be standard practice.

Traffic management and promotion and protection of workers' health are also essential components of working with the involved community. Resource development can be very stressful to nearby communities. The best way to prevent that stress and to optimize mental health is to include the community in the planning. To this end, we need to support and encourage community and land use planning. We need to have maximal transparency and accountability. We must validate and respond to citizen concerns. We must encourage the industry to support health and wellness. We have to pay attention to the inequities and protect the vulnerable and we need to include crisis and emergency planning in a transparent way.

Again I have stressed — and again stress here — the importance of formally assessing health impacts. This process involves the following aspects: the high-level scenario-based HIA that I previously alluded to — specific HIAs that are integrated into the YESAA process; implement a process for action by government to respond to recommendations; public accountability, so that public input and regular reporting of how the recommendations are being addressed is carried out; monitoring the health of persons living, working and attending school in proximity with the industry — this can be done in a number of ways, whether by survey, biomonitoring or other techniques.

And reducing greenhouse gases — whether shale gas development takes off for Yukon, this, again, is a critical area for concrete action. Here, we can review and revisit the goals for reducing the carbon footprint and fossil fuel usage in Yukon. We can review, monitor and publicize achievement of energy goals that have already been stated. We need to adapt and update the Yukon energy strategy, including the goals of sustainability and self-sufficiency, increasing the renewable energy supply in Yukon and reducing energy consumption from housing and transportation.

That's where I'll stop. Thank you very much.

Chair: Dr. Cleary, will you be presenting next? Dr. Cleary, please.

Dr. Cleary: Thank you for inviting me to talk to you. It's an honour to be allowed to share my thoughts with you. I've been working on this subject, among many others, for several years now. My thinking has evolved a lot in that time and it's nice to be able to talk about it and share my thoughts.

I know the context in the Yukon is quite different from New Brunswick. There are many things that are different about the makeup of the communities, particularly the geographical size and the density of the population. But I think a lot of the concepts are similar, even though the actual impacts may vary. I think what I have to share will still be relevant here.

I am going to build upon what Dr. Hanley said and particularly, some of the reasons why health is concerned and needs to be engaged in this process and other industrial development processes. My presentation is building upon some of his slides in the area of socio-economic and psychosocial health. Then I want to share with you some of our recent experiences in New Brunswick.

We developed a report. It was published in October 2012. The context of that report was about — if the industry was to go ahead and the decision had been taken in New Brunswick at that time that the industry would go ahead — what are the things that we would need to do from a health perspective to minimize the risks and maximize any potential benefits? It wasn't a document about should we go ahead or not. It really was focused just on the immediate health impacts, both direct and indirect. It didn't include assessments of other areas like impacts on agriculture, tourism, fishing and all of those other areas. It didn't go much into the area of greenhouse gases, which of course is hugely important in the long-term for human health.

With those caveats for that report, the key question that we wanted to answer at that time was that, given that any development will have risks and benefits, will the shale gas industry bring a net benefit to public health or net harm? This is hugely important. As medical officers of health, we are doctors for the public — for the population at large. I think all of us have a practice in clinical practice as well. I used to be a family doctor. When you're a family doctor, you look at one patient at a time. The difference with a medical officer of health is that we look at populations. We look at the population of a region or a province and see what needs to be done to improve their health, but we're still doctors, so it's about people.

Having a healthy environment is critical for having a healthy population, but the ultimate benefits are for the people of the province or the region. If there is no benefit ultimately for them, well then, we could ask, why would we take a particular decision? Also, given that interventions will be needed, how could we influence the balance in favour of the health of people and of the environment as opposed to benefiting the industry?

It might be difficult to read some of my slides. I apologize if they're a little bit dark. The purpose of this slide is really that in public health, there are things we have to look at. It's always a balancing act.

We look at the rights of individuals, the rights of people, the need to prevent problems when we can anticipate them and the need for public health to demonstrate leadership. On the other hand, we look at the burden of proof that is needed to establish cause and effect. We look at things like equity and proportionality, and one very fundamental principle that we hold is a precautionary principle, because, as doctors, one of our fundamental beliefs is that first we do no harm.

When we set out to do our report, we did a very extensive review of the literature. We talked to people in other jurisdictions who had experience. Some of the data gaps Dr. Hanley reviewed, so I won't go through this in any detail, but we did find out that there are many significant data gaps that limit the ability to thoroughly assess the risks to public health. This report was written two years ago, but I think that this is still true today. We have done a follow-up literature review and there is nothing out there that has changed my mind in terms of having more information upon which to base our recommendations, although there is some work being done. There are many studies being undertaken in the United States, for example. The body of literature still has not been substantive enough to address the data gaps. So there are still significant data gaps. There was also a report that came out from the Council of Canadian Academies, which I'm sure you have heard about. It's a very new report and also pointed out that there are many data gaps still in existence.

There are some common themes regarding the potential hazards and Dr. Hanley reviewed these: physical, environmental, socio-economic, mental health and others, and that public health has not been involved in Canada, in the States or, indeed, in Europe, and have been noticeably absent from much of the discussion about regulations.

There have been some benefits associated with the expansion of the industry, but that can result in socio-economic risks. There can be inequitable distribution of risk and reward. These are two things that I have sort of — as I say, my thinking has evolved over the time since we came out with the report, so you won't find these written in the report. But I did become aware that if you start to ask questions about this industry, you can be seen as obstructionist and can be marginalized, and that's true whether you work in government or are a member of the public. Another thing that I became aware of is that media is not always objective. Maybe I shouldn't be surprised at that, but I found that to be true.

So our recommendations in our report focused on a number of areas: protection of health and communities related to changes in the social environment; the physical environment; and then the overlap between the two. Because public health doesn't just care about the populations that are in front of them, but also future generations, we included a component about thinking ahead and thinking about the communities in the future. Then there were some general recommendations regarding implementation and oversight. So that document is available. It's on-line if people want to take a look at it.

Now I want to go to the question — because I had many questions since we came out with that report — well, what has fracking got to do with health anyway? There was one comment that I heard: "Doctors should stick to writing prescriptions and not be putting their nose into this sort of

thing, which really is the domain of engineers." I hope to explain to you a little bit about why we think that it is important for health to be involved.

The World Health Organization came out with a charter for health promotion in 1986. It was actually following a conference in Ottawa and it is well worth looking at, if you have not had a chance to look at it before. It talked about the things that are fundamentally necessary for health — prerequisites for health.

Dr. Hanley described the determinants of health, and those are things that make up the health of the population — of individuals or communities. The prerequisites are even more fundamental than that. Without these things, people cannot be healthy — peace, shelter, education, food, income, a stable ecosystem, sustainable resources, social justice and equity. It talked about the fact that political, economic, social, cultural, environmental behaviour and biological factors can all favour health or they can all be harmful to it. Health promotion tries to make those conditions more favourable. Professional, social groups and health personnel have a major responsibility to mediate between differing interests in society for the pursuit of health.

I think that this document is a foundational document for the practice of public health and those messages still hold true today.

You have probably come across in your work — and I know Dr. Bharadwaj yesterday would have gone through it — the toxicological components of the discussion, so I am not going to go into a lot of detail here but, really, the point of this slide is that there are many ways that physical contaminants can get into humans. They can come through the water, through the air and through the soil, but if we were to take one aspect of this — air pollution — it is evident that air pollution can cause problems for people's health.

One way of measuring air pollution is through the number of premature deaths attributable to air pollution. We know this to be a fact — that air pollution can cause premature deaths. This is work that was done in Muskoka that looks at the estimated number of people who are projected to die from air pollution in that jurisdiction over the next 10 years. It is thought that there will be an increase in the number of people dying from air pollution, both from acute deaths, which are sudden, short-term deaths, or due to chronic disease deaths related to air pollution. It clearly demonstrates that there is a link between air pollution and premature deaths. For that reason alone, if we were only to look at the physical aspects of fracking and shale gas development, we would say that health does need to be involved, if only to find ways to mitigate against that.

Also, I put this slide and the next slide in here to point out that premature deaths related to air pollution are only the tip of the iceberg in terms of the amount of illnesses that are caused. If you look at the number of hospital admissions, emergency room visits, people who go to their family doctor or people who just have problems and don't seek medical attention, we would find that the air pollution health effects are much greater than we probably count. In fact, one of the core functions of public health that Dr. Hanley pointed out was to count and measure health impacts. To be honest, I don't think we do a good job in Canada — certainly not in our jurisdiction, but I don't think it's different anywhere else — of clearly looking at health effects related to industry.

We don't have the baseline data in place, by and large, and we don't have the mechanisms in place to collect this information in a very thorough way.

We can talk about having the regulations in place to mitigate it, but we also really need to think about how we are going to look to measure if there are problems as we go. Looking at the pyramid and the iceberg effect is one way of demonstrating that the health impacts are often much greater than we think if we were to clearly count them. There is nowhere in the world that I have come across that does a good job of measuring health impacts yet as a result of shale gas development.

Does more money equal health? We hear about, "Well, we should need to go forward with rapid development because we need the money and we need the jobs." The point I want to make here is that the relationship between money and health is complex. Yes, higher income and social status is linked to better health. We know that poverty is a key factor in how healthy people are, but it's not as simple as you think because, actually, as the income increases, it actually levels off. If you're thinking about the impact of any industry on their health, you can't say, "Well, we'll have more money and then we'll have healthier people."

In fact, the biggest determinant is not the actual income; it's the difference between the rich and the poor — the gap between those who have a lot of money and those who don't. I read a statistic yesterday in the paper — it didn't have a reference in it, so I can't say how accurate it was, but it did ring true — and it said something like: for every new dollar that has been earned in Canada in the last 14 years, 66 cents has gone to the top 20 percent of the income earners. So we don't have a good history in this country of getting money from any industry and redistributing it so that it does improve people's health. We do have a good history of making rich people richer.

This graph is hard to read, but it shows that the countries that have the narrowest gap between rich and poor — so you could take Japan, which is actually down there on the bottom left — have much better health. Those countries that have a large gap between rich and poor — you see at the very top, right-hand corner is the U.S.A., and they have a very poor health status as compared with other countries. I think that is a good reason to be concerned about the argument that, well, we need the money because we have a lot of health problems that we want to fix. When we are close to spending 50 percent of the budget in most jurisdictions in Canada on health services, and yet we know that the health services are not the most important thing for making people healthy — Dr. Hanley showed you the determinants of health slide — we really have

to think about, "If we get this money, how are we going to use it?"

I think the fact that your government here in the Yukon is taking the time to think about this is really important. I admire the fact that you're doing what you're doing, because it does mean that you have the opportunity to think about where you want to be and where you want to get to.

The health gradient — we all don't start out on a level playing field. There are some people who have less money. They also have poor housing. They also have employment. They have inadequate food and nutrition, a lack of education and environmental health hazards. So some people have to push that ball up a much steeper hill. If we want people to be more equal and have a level playing field, then we need to have our spending designed in such a way that it does that, because what we don't want with an industry is to bring it in and have some people at the end climbing a steeper hill, which has been the case as I demonstrated in the previous slide. So the conclusion is that, on this part, we must plan to have equitable distribution of the financial rewards in order to have a positive impact on health.

The other point I would like to make is wealth is not only about money. This is Canadian work — it came out in 2009 in the Chronic Diseases in Canada journal — and on the left-hand side, it talks about material wealth. As you gain material wealth, yes, it does have an impact on health. Material wealth is basically money and things — so cars, housing and so on. But there also is a strong relationship between social deprivation and health.

Social poverty is when you don't have good relationships within your family or your community. Those factors are also very important for health. When we talk about poverty, it's not just poverty of money; it's also poverty of relationships that impacts on health. If you have both, that's even worse.

Health is not just about money, but it's also not just a physical thing. We think a lot about having short surgical wait-times and the best drugs, but for those of us who work in public health or mental health and presumably for those of you who are working in communities, you realize there's a lot more to being healthy than that. The reason for that is because as people, we are designed in such a way that our mental attitudes to health or our mental well-being is really key to how we feel and it actually has a very strong relationship with our physical health as well. This is the description of the sympathetic and parasympathetic nervous system that you might remember from your biology days in grade 10. Basically, we're all designed so that our sympathetic nervous system kicks in when there's a little bit of stress. That can be a good thing. It can cause motivation; it can cause us to get up and go, and there also is protective thing. If you are being chased by a bear, you know to — actually, that's not a good example. You don't want to run away, I suppose, if you're being chased by a bear. But if there's a fire, you want to escape the burning building. The parasympathetic nervous system is the one that generates the calm and keeps the basic functioning going.

There is a relationship between our performance and levels of stress. If you have no motivation at all and you're bored, you can actually have poor quality of life and poor health. There is a certain amount of — there is an optimum point where you can increase your health. The excessive stress, particularly long-term stress, can increase the risk of ill health.

The reason I'm bringing this up is because I think that the psychosocial aspects of industrial development has been one of the things I have learned more about in the last number of years, and probably if I were to write that report again I would focus a lot more on the psychosocial aspects because that is where I have seen the biggest problems, even before the significant development of industry. There is a lot of work going on in the States on this aspect.

When you're under stress, the body — particularly if it's prolonged stress or overwhelming stress, it does manifest itself in many physical ways, including the glucose levels in body, decreased protein synthesis and effects on the heart, blood pressure, increased stomach acids — and also the immune system, which is quite interesting. I will come back to this slide. This is actually one slide and in other slides it shows the relationship between personal control and relationship harmony and health. As you feel you're in control and you have good relationships, your health goes up. If you have relationship strain, your health goes down. This holds true for different jurisdictions. This is a comparative study between the U.S. and Japan.

In terms of psychosocial stress, this was a study that showed the rate of infection with the common cold and stress. As your stress index went up, the number of colds that you got went up. This is a study that is about 14 years old now, but I think it demonstrates well the relationship between stress and the immune system. To a medical person, this is quite interesting to me. This actually held true for different types of viruses as well.

With shale gas, I think we do have to think about the impact of stress and the perception of stress that communities are undergoing. We cannot just assume that communities can change. The things that are important to people, whether it is the love of a rural lifestyle, or the peace, quiet and tranquility of the outdoors, the wilderness — if you take those things away from them, especially if they have not been engaged in the process, there is a real risk of increased stress. One of the interesting things is that it does not have to be fear or belief or the perception of stress. The threat does not have to be even real for it to have that impact, because the body — when I showed you the difference between the parasympathetic system — doesn't discriminate between a real threat or a perceived threat.

I have had conversations with people who say, "Well, people don't have to worry because the concerns that they are talking about — water contamination or air contamination — are not real. They can be controlled and they can be mitigated." The point is that it doesn't matter, because if those people believe that it's real, it is real.

That's not saying that they're not real. There are actually risks with air and water, but it does mean that you have to be very careful about how you manage working with people. Again, I think that the fact that you're having these public proceedings and this debate is really admirable. I congratulate you on this.

With shale gas development, there was a study done in the States fairly recently — published last year — and it was an assessment of the health impacts and stressors perceived as a result of shale gas development in the Marcellus region. The participants attributed 59 unique health impacts and 13 stressors to the development, and stress was the most frequently reported symptom.

Knowing what people want is actually really important and engaging people is key. It's interesting — this is another study out of the States last year, and it talked about the people who were more likely to oppose or support fracking. It found that the people who were more likely to oppose fracking are women, people who hold egalitarian world views, who read the newspaper more, who are actually more familiar with the process, and those who associate the process with environmental impacts.

The people who are more likely to support it tend to be older, have a bachelor's degree or higher, politically conservative, watch the T.V. news more than once, or associate the process with positive economic or energy supply outcomes. I think that is important to understand. I know that in New Brunswick it has been described that people who are concerned about shale gas development are really just getting their information off the Internet and don't know what they're talking about. That was not supported by this study.

This is another interesting one. Dr. Jacquet, who is based in South Dakota, looked at the perception of local shale gas energy impact and found that the perception actually really depended a lot on whether there was money involved that went to the individual. If there was no income to the person, the perception was much worse than if the person had gained from lease and royalty. The same researcher, Dr. Jacquet, found that there are a lot of gaps in knowledge about which communities gain and which don't, and why some communities are more susceptible to stress and adverse outcomes and others are not.

If we really want to deal with the psychosocial stress, I think we need to understand it more, because I think it is a real entity. It is really important in terms of health impacts so we have to understand how to address it.

To me, community engagement and public acceptability is critical because, as I started out, I think if we're not doing it for people, why would we doing it?

The conclusion of this part is, seeing that health is not just about physical things and wealth is not just about money, how you go about things is just as important as what you do. We still need to learn more about the "how" but in the meantime, we need to be trustworthy. We need to talk to people. We need to not only hear what has been said, but actually listen. We need to be open to suggestions for improvement and we have to accept that we don't know it all.

For those of you who read the Council of Canadian Academies report, I think it was evident from that report that there actually have been a lot of misrepresentations of the industry. For example, it has been said by the industry repeatedly, "We've been doing this safely for 50 years without any problems." That is quite a stretch of the truth, because in Canada, this industry has not been in existence in this form for 50 years as is claimed by the industry. It does have a non-proven safety record. I think we need to be honest. The industry needs to be honest if it wants to get any public acceptability. I think it is really important for us in public health, but also for governments, to say, "We're here. We're all trying to do the best we can to make the best choices we can, but we have to know what the facts are and we have to be fair to represent them accurately."

One other area I want to draw attention to is that many jurisdictions already have significant health problems. These are select New Brunswick morbidity and mortality statistics in the year 2012. We have a large number of people who lose their lives every year from road traffic accidents. We have a lot of diabetes, cancer and heart disease. We are an aging population, but we also have health behaviours that probably could be improved. We have people who smoke, and we still have a high incidence of depression and suicides. One of the things that we really need to think about is how, if we are having an industry come to town, can we prevent current health problems from getting worse or causing new ones. Planning is very important, and we talk a lot about having regulations, but regulations really are only one part of the puzzle, because if you don't know what the right regulations that you want are and what the outcomes you want in terms of communities or environment, how can you get there?

The planning process is really important. You need to really define the — for example, the types of things that I have up there on the top left-hand side is a picture I took a couple of weeks ago. I was out canoeing on a river in New Brunswick, and these are the fiddleheads — I don't think you get fiddleheads here, though. These are the curled-up fern tip and they open up to ferns, but before they open up, they curl and you can pick them and eat them. They grow in the flood banks of the river, so when the rivers recede you can canoe down and you can pick them, and they are really nice to eat. But because they are where the flood waters are and there is mud, you really want to make sure that that water is clean and you pick them from good, clean rivers. Some of these things really depend on having clean rivers, but it is a good, healthy thing for people to be able to go out and eat nutritious foods and get out and about.

We need to think in the bigger picture. What do we need to preserve so that we can have healthy populations? It is not about how you protect damage. It is about how you can get more people out canoeing and having clean fiddleheads to pick. We need to make sure that people can get out fishing and catch fish because fish is healthy, but if there are a lot of

contaminants in fish, that is not good. We do not want to have roads that just have lots of truck going down them, because then the kids can't get out and bicycle.

We need to plan our communities in a way that they are good places to live and that they are healthy places to live, so planning health communities has to come first before you can have the regulations to meet those. I was thinking that yesterday, as I was walking around the town here in Whitehorse. It really is a nice town to walk around. But as you get further out — I was walking down Fourth Avenue and as you get out beyond — is it Ogilvie — the streets get wider, the traffic gets heavier and the trucks get bigger. It is a less easy place to walk around than downtown. Communities need both. You need somewhere where the big trucks are going to go. But, first of all you need to say what you want to preserve in our towns, so that people can be living downtown and getting out and walking around.

Building healthy communities is really part of the planning ahead of time before industries come and it is not just in towns; it is in rural areas. What are the areas that you need to conserve? What are the wilderness areas you want to protect? What do you want your province to look like and where are the no-go areas?

That is essential because in most current regulations, they don't have it clearly established where industry can go or not. There are some regulations that have setback distances, which are, to be honest, quite arbitrary, but it doesn't talk a lot about density of development or rate of development. So those are things that we need to try to look at.

This is another factor that I think you need to consider. This is a graph of the crimes, Canada Code offences, and policing in a northern Alberta community during a time of rapid growth. At the time, there was a lot of — basically, it was going through a boom effect, and the number of offences increased by a factor of four in that time. They eventually had less officers in that community than most places in Canada, but they had to relocate a lot of officers in and, eventually, they were able to start bringing down the crime rate at the very end.

The fact is that we can create problems as well without proper planning, so some of these effects can be anticipated, but planning is key.

Health impact assessments can certainly help identify some of these impacts. For example, if we're talking about transport, a health impact assessment would look at some of the things like the noise from the transportation, psychosocial effects, the climate change, but also the loss of land, the loss of opportunity for physical activity and recreational use of road spaces.

If we were looking at waste, we would look at environmental degradation but also breeding ground for disease vectors or the transmission of agents or chemicals to humans and exposures.

This is just to reinforce the point that when you're talking about planning, a health impact assessment is not really just an add-on to environmental impact assessments to sort of mitigate against protectants. It really can be used much more as a planning tool, which is not possible really with the environmental impact assessments as currently set up.

I would like to finish up now with some of our experiences in New Brunswick. New Brunswick has had some shale gas development over the last number of years, but really is sort of at the very brink of significant major exploration. I would just like to share some photographs of some of the impacts or the experiences we have had.

There has been strong government and industry support for the development of shale gas in New Brunswick. There have been a lot of announcements to the public and a lot of institutes set up. There were videos launched to support the research panel. SWN, which is one of the companies developed, talked last week and said that shale gas supporters should speak out so there has been a lot of promotion of the industry.

We have had the minister address many, many groups talking about the different oil and gas royalty structure. We have had former premiers talking about the need to grab the rope because New Brunswick is in fiscal crisis and this is a very important opportunity. We have had visiting premiers talking about the fact that developing it would be a wise move and pointing out that they have done it for 50 years in British Columbia — it's absolutely safe and it is going to have a huge benefit for Canada and she hoped for New Brunswick. We have had the Natural Resources minister talking about how the province's shale could go to the world markets.

It's also brought some humour — many very good cartoons. This one talks about the hydro fracking explained: "Basically we inject chemicals into the ground corrupting the water supply while extracting natural gas." "Hydro fracking politics explained: Basically we inject money into politicians' pockets corrupting the democratic process while extracting corporate profits." I apologize. I just thought that it is humorous. There are lots of really good cartoons, but I decided not to bring too many to share.

There has been peaceful protest. There are people dressed up as "frack fries" and there has been a lot of community participation. It has brought some beautiful art, brought some music, brought landownership questions and spurs treaty debates in New Brunswick.

In New Brunswick, there have been no land agreements or land treaties. There have been peace and friendship treaties in the past, but the lands have not been ceded, so there has been much discussion recently. There has been cultural bonding.

I'm not a native New Brunswicker, as you might be able to tell from my accent. I've been there about seven years so I'm learning a lot about it, but I have been told that this is the first issue that the anglophone population, the Acadian population and the First Nation population have ever agreed on — the fact that there shouldn't be shale gas development. There has been frustration, heavy policing and, as a result, increasing unrest. This happened last October in a rural community. Irrespective of where you land in terms of

whether this is something that is good for a province or a territory — I have talked to many of the people in those communities and I think they are very stressed communities right now.

I think that, in terms of the health of the population, there have been lots of problems already, and, most recently —

Thank you.

Chair: I have a request from the Committee for a brief recess of five minutes.

Recess

Chair: Order please. We're going to continue on with the presentations.

Dr. Badenhorst: Good morning to you, and honourable members of the Legislative Assembly and the select committee and the public. I would applaud the government for having the wisdom to put this committee together. I had a very wise mom and I quote her a lot in my life, and she said, "Think first and then do it" or "think first and don't say it."

After listening to my colleagues, I really don't know what to say because they took out a lot of my slides. I have learned one thing from First Nations and that is that you can tell very complex things in stories. I am medical health officer, but I am also a family doctor, I am still working in the ER, and I still have an addiction clinic where I do methadone patients. I can tell you a lot of things I have learned and what might be involved in this and what I have learned from them.

I can tell you a story. For instance, the other day I had a father with a son 22 years old come to me, saying that his son is heavily involved with addictions stuff. I asked him what happened. He said, "I left school at grade 10." Why? "Well, I can make more money than my mom and my dad." He is earning $80,000 to $90,000 a year. What happened then? "We make a lot of money, we spend six weeks in camps, and then we come to town and spend $5,000 on cocaine for a weekend." What happened then? "I lost my job or I had a job injury." What happened then? "The doctor prescribed to me opiates — morphine, OxyContin, percocet." What happened then? "Well, I needed more, so I went back to him and then they started talking to me as if I am an addict and they said I am a drug seeker." What happened then? "The doctor got a call from the college that said you cannot prescribe so many opiates to people." What happened then? "Well, the doctor said, 'I can't support you anymore.'" What happened then? Then this guy went to the street, so all his investments, all his savings went down the drain within a few months' time, buying street drugs. So what happened then? "I got arrested." Why? "I stole some stuff; I stole food. Now I have a criminal record. I lost my driver's licence. I lost my family. I lost everything. I got involved with IV drug use and now I have hepatitis C." So, what now?

This is just a short story of what happens in the communities and it's about what I see every day. I wanted to share some of that with you. I became aware of what are the social impacts of an industry in a community like Fort St. John, where I am based. We are a booming city with a very low unemployment rate — less than four percent. In the old days, they said if you can pass a pee test or you have a driver's licence, you can get a job, but today, they talk about the fog test. If you can breathe against the window and it makes a fog, then it means you're alive and you can have a job. People are looking for people all over the place. What is happening is that a lot of people are flooding to our communities and I wanted to share some of that with you.

As I am a medical health officer, we are part of the Health Officers Council — HOC — and we meet twice every year for two and a half days. We are about 50 to 60 medical health officers in B.C. Then we share complex things. I took this issue to them and they said, "Well, let's talk about this," and I suggested a full-day workshop at one of our conferences, which was the first time that the Health Officers Council did that. I want to share some of the information that we learned from that.

As a medical officer, we are appointed under an order-in-council by the government. We are actually an extension of the Minister of Health. As Dr. Cleary said, we actually are there to act as activists for our community. Our job is described and depicted in the *Public Health Act*, particularly section 3 of the act, which says that the Minister shall — not have to — develop a health plan if the medical officer is concerned about a health issue. We did that. By doing this workshop, we brought it to their attention.

Sometimes policies are well-intended but they create for us a public health hazard. There is a difference between a hazard and a risk. A hazard is like if you have an open electric wire in a room and there is nobody in the room, then there is a hazard but there is no risk. If there's a baby crawling in the room with an open electric wire, then the risk is very high. People must use these words carefully as we talk about that.

Policies can create enormous problems for us. Economic growth does not always address poverty. Politicians will use job creation and economic stimulation as a way of winning elections — and you see it all over the world and they still do it today — by promising opportunities. If you look at the past, economic growth does not always address poverty. For instance, on our website — the B.C. government site — it is the best place in the world to live, but we have a child poverty rate of over 20 percent. The northeast of B.C. creates over 20 percent of the income for B.C., but if you look at the health indicators in the northeast, it doesn't reflect that. I couldn't understand this paradox and I thought, well, on the one side, people make a lot of money, but why all these health problems?

Then someone said to me: "You're not so smart. This was actually described in the 1850s by a very wise guy who was a journalist, Henry George. He said that it's industrial growth. If you don't manage it, it will create poverty for most people. It's a very small number of people who make the money. The people who make the money are not the people in your area. It would probably be companies outside in the Caribbean."

Then I started reading on this work and I couldn't see the difference between a gold rush, especially in your history — if you see how the gold rush developed and the pains and the problems associated with that — and if you look today at the oil, gas and shale gas rush. I don't think there's a big difference. The only difference is that with the gold rush there was nothing, but now you have something and people are flooding into your communities.

It is worthwhile reading this document. The cycles of boom and bust are very well-described. Sometimes you will hear that, yes, we need more evidence or there's a gap in information, there's no proof and so on — but you don't need proof for this. There are certain things we know in life and there are certain things we'll never know or we'll know too late, but there are certain things that you can't argue and that have been well-documented.

If you look at the policies of government, industry, regulatory bodies, health authorities and so on and health professional bodies, they all have something in their vision statements about community participation — reach out to communities and the importance of communities.

So if communities are so important, then why is so difficult to form partnerships, to respect communities, to plan and prepare communities better, to perform environmental assessments, socio-economic and environmental impact assessment studies? Why is it difficult to ask communities, "How do you think this project will involve you and impact you?" One call to a very significant community member will probably give you 90 percent of the answers. If you just have the time to call him or her for an answer, they will tell you, "This is going to happen to us."

Ask local governments what they need to prepare. Small communities have to have new lots for people coming in. People moving into town fight for accommodation, and they increase the information**.** There is a struggle between the old-timers and newcomers, and we can go on and on and on. It creates enormous problems and debt over time for communities.

Then the question that is always here is this. You see the big companies coming to town with the town hall meetings and then people ask, "Is this just window-dressing or do you just do this to tell us that we rubberstamped your project?" They misuse and abuse that many times — asking us our opinion.

Can these cycles be better managed in our current economy? Socio-economic impact assessments are an essential step to identifying and evaluating the potential direct or indirect impacts of proposed economic developments, programs or projects. We talk about health impacts, but I don't think we use the words right, because to do a health impact — that means, from an epidemiological point of view, you need exposure in a controlled group to say that this industry caused this, and you cannot say it unless you spend a lot of money and do a lot of research to try to prove it. The question is: Do you really have to prove it? You know what the hazards are. You know industry has these kinds of hazards and it's well described that hazards can cause this cancer or this lung problem. You don't have to prove that. If you manage your hazards well and your risks well, then at least let's do what we can do well.

I mentioned the struggles between old-timers and new-timers, people flooding communities, and if you look at how they — like in our area, a lot costs $150,000 to $250,000 just for a lot. You can't find a small house for $200,000 or $300,000. People come to our communities with hope from New Brunswick, Nova Scotia, Newfoundland, and they earn a lot of money, but they spend a lot of money on accommodation. They pay $1,000 for a basement room. They live in camps. They are away from their families. They use their money unwisely. They create enormous problems for themselves — violence against women. Young children leave school at grade 10. Where will they go if something goes wrong in life?

How can socio-economic impact assessments help government, industry and communities? It provides a framework to address the changing demographics and the impact on local services and infrastructure, economic structures, including employment, and business opportunities. For instance, if you have a big boom now, people will start fighting for workers, truck drivers, and old businesses working very productively for years suddenly lose their staff, so they have to increase their employment conditions. Salaries will go up. That company is now at the risk of failure. They get involved with new equipment in a business that they don't know really well and, after three years, that industry is gone and they are in debt.

The quality of life overall and the well-being of the population suffers. If that suffers, health suffers. If health suffers, health services suffer. If that suffers, your health budget will suffer. If you look at your expenses — I'm not sure what it is, but it will gobble up a big chunk of your budget. The thing that will eat up your budget is the chronic stuff that is preventable — things that we can prevent if we plan better. Sometimes it's wise to say that if it's not worthwhile doing it, let's not do it.

We also have cultural values of a community that is usually disrespected by industrial development or not well-listened to. If you change those values, it's like cement in a building that keeps things together. Your values — if you break that, then you lose a lot of good things in life.

Further on, you can ask the question: What will be added and what will be taken away from us? Do we leave something behind? Some industries will take what they can and go. Some industries plan it better and say, "What will you leave behind?" Skills, trained people, or small industries that can continue going on if the main industry is gone.

Revenue distribution — what is happening to the tax money? What part of that tax money comes back to the community — where that money comes from — and then that creates ethical dilemmas. One community has a resource and another one does not have a resource. How do you distribute that feedback money that comes back to communities? What

seeding funding is put to a community to prepare them better for that to come? Can public health, acute services, social services, the police, the fire guys — can they cope with the number of people flooding to your communities? What do they need to prepare for that?

I mentioned the gold rush. Did we learn from the past? Communities that host rapid industrial development often follow a predictable story: rapid industrial development, operational stability and then over-production, competition with world markets, industrial decline. What is left behind, and what is the cost to the communities and government over the short and long term?

How much intellect do we need to understand that if everybody is going to start fracking — and if you look at what is happening for us — we had over 30,000 wells over 30 years, but now we will have 10,000 new wells in the next four or five years, so anyone who can frack, fracks. Anyone who can develop new techniques does it. Companies invest billions in this game. It is not only in this area, but all over the world they are going to do it now.

Shale gas is now more accessible, more productive and easy to get cheaply — relatively cheap energy. If you overload the market, the price will come down. Currently, the price for a unit is $4, I think, to break even. The profit margin now is about 60 cents. They sell it for, I think, for $4.60. You don't need much of a dip to put those companies in significant financial distress.

How would we get this conversation going? With B.C. on the cusp of significant industrial development, some mentioned the Health Officers Council at this workshop. We hosted the collaborative workshop and we really did it collaboratively. We started the workshop by saying to the medical health officers, "Well, there is no airport in Fort St. John. You have to fly to Prince George, which is a six-hour drive". They actually believed me because 10 percent of them were in Fort St. John before. My boss said, "Let's put them on the bus. Let's use the northern health bus and they will fly to Prince George and drive for eight hours to Fort St. John just to see the area. In this process, we will pick up the mayors from the small towns and they will tell their stories of how industry impacted them." That helped a lot to give people exposure.

On the day of the workshop, we had 100 people and we invited anyone from the activist community partners to health people, acute care people, and we had one very well-planned day to say, "What do we think should be in a socio-economic impact assessment tool?"

The outcome of this workshop was that we drafted the first report that was accepted by the Health Officers Council and findings of this process were reported and published in a peer-review journal that was just accepted this month. You all have a copy of this. Also we received a reward of excellence for public health in the province for the work that we have done. We thought nobody cares about us in the north, but people did see that.

This is the publication that we published and we will send out an electronic copy to you. This is the cycle that is well-known — the peak and the trough. In the beginning, it creates its own problems. People come to towns and bring all of the social issues I've mentioned to you now. Then what happens is something goes wrong. If the price dips or the resource is developed completely, companies will disappear. What companies do — company A will sell to company B and B to C and C to D. Then company D goes bankrupt, and then who takes responsibility for the cleanup? Who is going to do the assessment of the impacts when those guys disappear?

What the big companies do is they have a core group of permanent people working and then they subcontract and they subcontract and they subcontract. The responsibility does not get diluted and we have no handle on the small amounts of contamination of spilling of 35- to 40,000 wells in our area. How can you measure that? How do you know the impact of that unless you fly over the area and you see our pristine forests are devastated by oil patches and the roads?

Just building a road in a community influences the migration of animals. We see wolves now in areas we have never seen before. Hunters will tell you they couldn't find a moose this year and the previous year. Young guys coming into town want to hunt now and they take out a massive number of moose legally, but it impacts our communities — just a few issues to think of.

I've mentioned the political issues about elections, the migration of people, the money spent, the increase in the crime rate and then the income for regions. B.C. has a fair-share kind of policy that brings some of the taxes back to communities, but it has been used for infrastructure to balance the budgets and it is maybe not used how it should be or was intended. Who makes the real money? Not the local people. Then I mentioned the battle between the old-timers and the newcomers. Don't underestimate that.

The bust — you can't fight the economic laws and we can't change them. The price will be determined on what is needed in the world and what's not needed. We have heard stories about the pipelines through B.C., and that the gas will be liquefied and sold to China. I understand — I'm not sure if it's true, but they pre-sold for the next 10 to 20 years at the fixed price, and the pipes they are building can absorb all the gas we have and at 50-percent less capacity. So we can actually easily put in more wells to feed that oil pipeline. But as we heard this morning, it doesn't matter how clean the gas is, how cheap it is, it is CO_2. It's going to get burned somewhere, and we all pay that price. This is like credit card effect. It's nice to buy now, but it will come back at a price, and we will not even know what that price will be.

Then the bust — the job losses, people move on, debt in families, family crises, out-migration of people and money, unqualified youth and big social problems. We have the highest number of children leaving school at an early stage, and we have not good education indicators so far, but I'll come back to that later. There's less revenue from royalties and taxes, budget cuts and so on.

We see now in B.C., because the price of gas dropped, the government is in serious trouble and now they try to get

money from other resources and liquefied gas, and it's a massive rush to get into that game first and to get established in that field. It will be awhile, and I can just predict — I'm not an economist, but there will be a dip very soon. You can already see some companies that get bought out by other companies, and so on.

Without planning, the quick buck we intend to make from resource development — does it outweigh the socio-economic disasters it creates? I've mentioned the credit-card philosophy. Unplanned community development will cost the government probably more at the end. You will make $5 but the socio-economic impacts will cost you $15.

Have a quite look at northern and northeast health indicators. Despite more than 10 years of economic growth, keep in mind the billions of dollars investment, zero percent unemployment rate, significant oil and gas development, natural liquefied gas development, pipelines, coal mines.

I saw in Chetwynd the other day that a coal mine was opened a few months ago, or a year or two ago, because the coal price went up, and then everybody sold coal. What happens? The coal price came down. Chetwynd shut down the coal mine. Overnight, 600 people lost their jobs.

If we look at our profile in our communities, the yellow is the northern First Nation and the blue is the northern residents and the red is B.C. overall. We have more young people in our community. Why? Because so many young people flood into our communities and try to establish themselves and they have replaced other people in our communities now.

What is happening in our town? We have got record birth rates. It is so high that we cannot cope with it. Public health cannot find all the babies to chase with their needles because there are just too many. It absorbs all our public health resources. We have now a prenatal clinic, so if you get pregnant, you do not know who is going to deliver your baby. There are record low physicians. Doctors left our towns for many reasons. We have 50-percent less physicians now. We have a crisis. Hudson Hope is one of the small towns without a physician for a long time and they are going to build a big dam there. Government — more money for unattached patients — they throw money at doctors and say that if you can attach a patient to your clinic you get so much money. How many patients can a doctor see? You cannot make doctors — you can pay them, but they cannot do more work than they can do.

How do you balance the quality of health care and taking on more patients? There are more walk-in clinics in our town than ever. Now they are shutting down because there are no doctors left to do it anymore. Overuse of the ERs — in the past, if you worked in the ER, every patient who came in had a family doctor — now they do not have a family doctor. Who is going to look after them if they get admitted or discharged?

This is the percentage of youth receiving employment insurance. The northeast, which is where we are, and the northern interior and northwest — in the northern part of B.C., we are the highest compared to the rest of B.C — motor vehicle accidents, hospitalization rates. The industry is associated with high accident rates. Look at the blue lines again. The total serious crime charges per 1,000 population, ages 12 to 17 — we win all the prizes. The percent of 18 year olds who did not graduate — so compared to B.C., it's the red line. We are also highest there.

Alcohol sales — we win. This is a few, I can go on — there are a lot of these kinds of slides. With this in mind, look at the specific health issues. These are standardized mortality ratios. If you look at motor vehicle crashes, it's from the highest, compared to B.C. Potential years of life lost — the northern part is the second blue bar; very high. Motor vehicle crash deaths, standardized mortality ratios — standardized means it is comparable, apples to apples, to other parts of the country or similar populations.

Deaths attributed to alcohol and gender — you can see in 2001 and 2006, is very high — hospitalizations due to illicit drug use, unprecedented economic boom, new B.C. immigration policies. As I mentioned, industry fracking or oil and gas or mining is one problem, but with that comes a lot of small industries around that, which is still to support the big industry and they all have to expand, so it's a mushroom effect into your community. If something goes wrong, it's a big cut for everybody.

The focus on the workshop that day was to work with the B.C. medical health officers, learn from our many guests, share experiences, learn from the past, make those connections to collaborate and figure out how you collaborate. How do you talk to each other? How do you share information? Unfold our communities — don't mold them, unfold them. Get all the potential out in a healthy, respectful way. Take the lead and develop a draft document that can guide collaborative processes forward. We have done that now. We are working on a document to say this is a way or an approach on how to do an assessment in your community. Prepare our communities better for economic boom and bust phases. That means you really have to have a policy to say if you develop an industry, get a lot of the people around the table, get the guys in this room who can tell you a lot of the answers that we need to know.

Then Dr. Bowering, one of our philosophers in public health said: "Who would have thought that economic growth may become our biggest public health challenge?"

Will we do more good than harm? Does science and available evidence change the industry? Yes. We will always chase our tails because we can't keep up. We don't have the hard evidence and industry will use this and say, "Bring me the evidence" and we don't always have it.

Just something to remember: What are the ethics in resource development? This is a specific field that you have to take time to think about. That is more or less why I shared this with you and I hope this will give you another way of looking at it.

In summary, what we say is that any development in a community should not be top-down but bottom-up. If you want to develop something, have a good plan in place, talk to your local governments, talk to your local municipalities, your

activists, your Committee members. Figure out a plan how to do this. What do you need to prepare for this industry — housing, health care? What is going to happen if the price drops? Who is going to take care? Who is going to clean up and so on? Thank you.

Chair: Thank you, Dr. Badenhorst. I want to remind the gallery to please hold your applause.

At this time, we are going to take a short recess and reconvene at 10:45 a.m. All written questions from the public gallery should now be submitted to the page.

Recess

Chair: Order please. We're going to proceed with questions now and, as mentioned earlier, I would ask everyone to wait until they're recognized by the Chair so we can ensure microphones are turned on. For those questions that are directed to all presenters, I would ask that you indicate to the Chair if you will be speaking so I can recognize you in turn.

Hon. Mr. Dixon: Thank you Madam Chair, and thanks to our three presenters. I know some members were discussing this before and some are going to have specific questions and some will have more general questions. I'll start with some specific ones.

I'll start with Dr. Hanley. Thank you for your presentation. You discussed a number of different issues related to the effects of hydraulic fracturing, and in this specific case, you discussed the physical effects. You listed them as air and water quality, monitoring, dust monitoring, improving waste management, chemical usage, et cetera.

You concluded in your presentation that other health risks can be managed in a climate of progressive legislation and best industry practices. I wrote this down, so if I misquoted you, I stand to be corrected.

You said, "Those physical effects lend themselves to mitigation by good regulations." I was wondering if you could expand on that a little bit and explain some of the context of that comment.

Dr. Hanley: Sure, thanks for that question. This is really the crux of managing the risks of exposure. For instance, if we talk about leakage of contaminated water into groundwater, it is: How well is your well constructed? How solid is the cement casing? How tested is it for time? Have you done the right work in establishing the separation distance in the shale? What is the thickness of the shale? For air quality — what are the chemicals used? What is the procedure for managing leaks? For dust that may be created, what are the sources? How are you mitigating? How are you monitoring? What I mean is that these are all the effects that should be part of the regulatory framework — that should be considered and covered as part of the regulatory framework. That's what I mean by them lending themselves to a regulatory approach.

Hon. Mr. Dixon: A number of the presenters, both today and previously, have indicated a need for baseline data. From a health perspective, how much data would we need to have a suitable baseline and how long would that take to collect?

Dr. Hanley: Certainly it is a repeated theme in the Council of Canadian Academies report — that attempts to determine risks have been hampered by the lack of baseline data. I think that when it comes to the details of how much do you need to establish data, it really depends on what you are looking for and a lot of that is going to be beyond my scope. I am putting it out as a general concept that there are opportunities to gather baseline data.

For instance, if you are looking at air quality — depending on the region. If you are looking at Eagle Plains development, for instance, what is your baseline for air quality and how well is that monitored? What about regional effects? Are you going to be concerned about regional effects on communities that may be in the region? Although they may be 500 kilometres downstream, how do you incorporate wind effects and venting?

That would have to be an individualized assessment, depending on what you are looking at and depending on the region, but I think it is a need and an opportunity for us to be able to do that.

Chair: Dr. Badenhorst, did you want to speak on this?

Dr. Badenhorst: I just want to add to that to understand what we mean by "baseline". It is really complex. If you focus on air quality, you will probably find nothing. If you do surface water, you will probably find nothing.

If you do dust effects of elements on the roads, you will find maybe something but not many people live there. Industry will say, "Well, it's safe." We had our prime ministers who say it's safe.

But you have to look at it really carefully. On the one side, you suck out gas in a vacuum. It creates a vacuum. On the other side, you push concentrated contaminated water under huge pressure deep — three kilometres back into the Earth and old wells. Who knows where that water will go? How do you get a baseline on that? How do you know what's going to happen in the next five to 10 years? How do you know where that contaminated water will come out? What does a living body do? It moves. It has been there for millions of years.

Studies already show that if they start fracking in certain areas, because all under-surface waters have like a radioactive fingerprint. They can measure it, and when they start fracking, it can pop up in surface water three, four or five kilometres downstream or upstream. One should be careful just to focus on what is a baseline. You have to think carefully on what you mean by that.

Mr. Tredger: Thank you to the presenters. I found their presentations very informative and well-thought-out.

I have just a couple of questions around public health. The Council of Canadian Academies just released a report and said that public health surveillance or rigorous health impact assessments of shale gas extraction activities have not been conducted.

I have heard from people in southern Alberta about concerns around health issues, around volatile organic chemicals from flaring, respiratory conditions and skin conditions. We heard in the Legislature from people in the Fort Nelson area about numerous health problems, as well as wildlife problems, and a lot of concerns.

I've also heard that health officials are unable to determine accurately the causes, and they've cited things like lack of access to well sites, lack of consistent and credible monitoring, limited access to information due to non-disclosure and confidentiality agreements signed between some residents and industry.

We keep hearing from basically everybody about concerns about lack of reliable studies, lack of monitoring and inadequate information. I know that health professionals and community wellness people have felt they have been asked late to participate. They lack the baseline data.

Given that there's a tension between the economic challenges of producing the gas in a timely fashion and the environmental concerns, and the struggle between the two of those — if we look at flaring, it's recognized that flaring is not a healthy thing to do, and the Canadian Association of Petroleum Producers and Alberta Energy all recognize that. Flaring was on the decrease, yet when natural gas prices went down, flaring increased again due to economic challenges.

The Council of Canadian Academies said that the gathering of proper baseline data — air, water and health data — will require significant commitment of time and resources to do. However, there are no established examples of such monitoring program.

What have your experiences been in your jurisdictions? Why has it not been done in northeastern B.C., given the almost universal recognition of the importance of it in a modern regulatory regime? I know some efforts are being made. I was pleased to see the health impact assessment out of New Brunswick and the work you and Dr. Hanley referred to today.

What are your experiences in your jurisdictions? What are the challenges? I know Dr. Hanley mentioned that it's all very doable — in theory, we can accommodate many of the situations — but in practise, it doesn't seem to be happening. We talk about learning from other jurisdictions and past experiences but we don't seem to be learning. We can do it. Will it be done? Is it being done? What are your experiences around that? I will just ask all three of you to answer that if you don't mind.

Dr. Cleary: Thank you for the question and it's a big question.

First of all, the words "health impact assessment" are used in a number of different ways. When we were talking — I think all of us talked about the process of assessing potential impacts at the beginning of development — it's a process by which you can evaluate the potential positive benefits or negative benefits — and then working with communities and industry to put in place planning tools and mechanisms to mitigate that risk. That can be done in the big picture and it can be done regionally as well.

That is a recommendation that certainly in New Brunswick we have made be done — specifically for the shale gas industry — because we believe it's necessary to mitigate against the health risks. At the moment, that is not current practice in New Brunswick.

The other area is in measuring the actual impacts — so the health problems caused. The words can sometimes be a little bit confusing, so I will try to use different language. If we are looking at basically counting the health problems, the idea of having baseline data is so that you have something to compare to. If you don't know what the health of the population is now — or the state of the water, the state of the environment — how can you compare whether it is better or worse later? That is the reason for doing that baseline work.

I would say that — and I said in my presentation — we don't really do a very thorough job at looking at those types of things routinely in public health. We're reasonably good at measuring population health at a macro level, and then we tend to follow-up on specific diseases, more in the communicable diseases area or some chronic diseases, like diabetes. But in terms of measuring impacts related to environmental health — that's a whole new area, I think, for us. We don't really have the tools well developed yet. I think there is work going on right now, but if I was asked today to say what you actually need to do, the first thing would be to start to develop those tools and mechanisms to do it. They are not in place right now, so even to know the right questions to ask now before the industry starts and then to have comparisons later — that is a challenge.

In addition, I think one of the challenges that we have in New Brunswick — and you would probably face too in the Yukon and also in northern B.C. — is that we tend to have smaller populations and getting enough numbers to make the number significant is always going to be a problem. We will also always be dependent on research being done in other jurisdictions or perhaps across jurisdictions, comparing research. There are a lot of questions. There is a lot of work to get ready for that and the reason it is not being done is probably because that will require new investment of dollars to support that work. Typically public health tends not to have the resources to take on extra stuff.

Dr. Hanley: It is true that we may be asking the impossible and that is to have all the data before you begin. I think Dr. Badenhorst's point about chasing your tail — the technology is changing all the time — can the science keep up. I think it comes back to process and since, Mr. Tredger, you asked the question, I will use another Keno analogy.

An example is the use of the new dry stack tailings facility in the Alexco mine and there was a lot of uncertainty, certainly, in the population over whether this was appropriate usage — or the best way to get rid of your tailings when, in the opinion of many, this was unproven technology. There were obviously arguments back and forth — yes, this is

significantly proven, or, no, this is yet unproven in this kind of setting.

To me, it comes back to process. Is there transparency? Is there enough science to make a decision and how is the decision made? Is the decision being made with stakeholder input, including community input? Can we get the process right? I don't know, but I think we need to get the process right in terms of timing of making these decisions, in terms of appropriate democratic participation and getting the best state of the science — and, not only just the sciences out there, but doing the science as we go and making sure that we are doing the adequate monitoring and that we do have the baseline data. Having that scientific approach and having that participatory approach are very important. To me, it's what we need to do. We should have been doing this 20 years ago but, certainly when entertaining something new, I think it really highlights the need to get our processes right.

Dr. Badenhorst: Thank you, Madam Chair, and thank you for the good question. I think just the fact that you asked that question answers the problem. In the medical field, where we come from, you don't prescribe or do a procedure if there is no evidence. Everything we do is checked, published and reviewed, and we may change our policies as we go on. Here you have a fantastic technology that's developing overnight. To a certain extent it is old technology but is modified now. It is used without evidence of the effect on the environment and so on.

If you ask for baseline or ask for information, it's not available and we don't have the expertise to answer those questions, so why would you get involved in a technology that you don't understand and you don't know where you're going? That's my first question. It's like an aircraft. You don't develop an aircraft and fly it for the first time. It is with baby steps until you are safe and you still make changes as you go on.

Secondly, in the northeast, especially in B.C., why is it that the oil and gas industry is waived from any environmental impact assessment? We also have over 30,000 wells and have another 10,000 coming — I'm not sure how many more — and it is still not assessed.

The third question is: Why is it that the industry is regulated by the Oil and Gas Commission that is paid by the industry to regulate them? Then, if you ask: Do you have a good handle on the massive amount of water that has been used? I don't find that. How many companies have closed down because of inappropriate policies? I don't know.

I'm not against development. I'm not an activist. I'm just asking public health questions because I'm a physician for my community and I'm worried about what I see.

People are worried about flaring. People retire and see a flare. They can't sleep because it wakes them up at night. They smell things. They see sick animals. You hear about lung problems. All those questions are impossible to answer because, from an epidemiological point of view, there are things like confounders, there are effect modifiers, and industry will tell you it's the lifestyle of the people.

Our standard mortality rate, or deaths, in B.C. is 1.3 percent. That means you have a 30-percent higher chance of dying earlier than anywhere else in B.C. I'm severely criticized because I use that, but I didn't get that information. It was published by Statistics Canada on the community surveys. Why is it? I don't know. I can't say it's industry and I can't say it's lifestyle — we don't have control groups — but I can say that you have an unhealthy population. Why would you add something else to make it unhealthier? There is more than enough evidence to show that the socio-economic impacts of a rapid industry will have significant impacts on a community, but who cares about 30,000 people living in the north? There is not one oil or gas well in the middle of Vancouver. I don't think they will allow that. Why don't we have a say when it comes to our backyards, where we live? I am living in that community. I'm not even from Canada. I've been here 10 years now. I'm a Canadian now. But why would I ask those questions? What about the poor people living there, suffering, and nobody takes care of them?

I have just one more point. B.C. is planning a BC Hydro dam in the Fort St. John area, which has been controversial now for five years and more. We presented at the panel and there were about 30 people there in the panel. Not one was from the northeast. Why would you allow that? You don't even ask the people living there what they think. That's one question. What do you think? It's not difficult to answer.

I think your question is summarizing a lot of unanswered questions. Why would you chase an industry that is going to cause conflict, problems, social problems for you and the government and your budgets if you know that is coming?

Mr. Elias: Thank you for your presentations today. I will put my first question to Dr. Hanley. It's again about these health impact assessments. While you were making your presentation, I wasn't on Facebook. I was actually trying to figure out whether or not the Yukon Environmental and Socio-economic Assessment Board's designated offices — under their values components — actually had community health impact assessments when projects near communities are assessed. I couldn't find it, and I may be wrong, but it doesn't seem to be included as a values component under the Yukon Environmental and Socio-economic Assessment Board's assessment of projects.

I guess my question to you is: When these health impact assessments are included, how can we formalize this process? I think there is an opportunity in our territory to actually do that, because we don't have a one-window approach here. There are a lot of organizations that have a responsibility with regard to water and air quality and all that other stuff, but maybe if you can provide some insight to me as to how you see this happening. Do you see governments doing these? Because when it happens in other jurisdictions, people don't trust government information. Or do you see non-government organizations doing this? Do you see industry participating in this? Do you see independent health organizations participating in this, or all of the above? I think that as we progress in addressing this issue — because I think it's an

important issue — I would just like to hear some of your insights on how we can formalize this process in the Yukon.

Dr. Hanley: Thank you for the question. I think it's a really important question and I do have some ideas. As I alluded to, I have done a little bit of work internally to try to see where we could fit this in as a process. First of all, you're right, the existing YESAA, the socio-economic assessment process, does not include health. Except for a couple of basically small items, it has not included health, and health has not really been at the table at all, although more recently we have improved that process with having the Department of Health reviewing all the YESAA looking for health aspects. That part has already improved.

But there's more than that. One of the things that I alluded to is that it's not just the doing the assessment, but it's how you carry out the recommendations of the assessment. You can write all the HIAs you want and make recommendations, but if there's no mechanism to evaluate and to carry out — to address those recommendations — then you've just wasted a whole lot of money. As I said, that was one of the things that we are still learning from the Keno experience.

One of the examples — we've done some work with the Development Assessment branch, and they are, as you may know, piloting a cumulative effects management program to address one of the deficiencies of the YESAA process, as it's not very good at assessing cumulative effects.

Is there a way to manage cumulative effects? We would like to insert health into that process because that process already has — if it works; as I said, this is kind of a draft and pilot process — a way to bring in all government departments in term of who and how we implement recommendations.

When a health impact assessment makes its recommendations, those recommendations usually are not for health to carry out. The usual recommendations about how you build roads and how you do the monitoring fall under many, many different departments, so it is important to have the process laid out. I think there has been some initial work, but I think it is baby steps — it is in the right direction — and we need to really continue that with a corporate commitment to have a process to carry out health impact assessment recommendations.

As to who pays, I think it is important — you are right — to have independence in the actual conduct of the HIA. The funding I think — industry should certainly play a major role in the funding, and that is where the advantage is of having it at the beginning. You want to come in, you put your money on the table. Alaska, for instance, has established a mechanism where industry comes in and they put their money into a pot from which the funding for health impact analyses can be withdrawn. I think an upfront mechanism like that — a deposit as it were — is probably the most effective way to have funding.

I'm not sure that it's fair for government to have to pay for health impact assessments because of resource developments. At the least, it needs to be a shared mechanism.

I don't know if I've addressed all the aspects of your question.

Ms. Moorcroft: Good morning, and welcome to the presenters. I want to acknowledge that we're on the Kwanlin Dun First Nation and Ta'an Kwäch'än Council traditional territories. Yukon First Nation leaders and elders and community members honour the land. The late Tagish elder, Angela Sidney, said of her people, "We are part of the land, part of the water." Yesterday one of the presenters spoke about water as being sacred. I wanted to start with that acknowledgement because Yukon First Nations have resolved that the children of the future — seven generations from now and seven generations beyond that — will be able to safely drink the water directly from the Yukon River that flows outside this building and north to the ocean.

Dr. Cleary, in your presentation, you showed us fiddleheads, and I think virtually all Yukoners appreciate fish and country food and the physical, heritage, spiritual and cultural values of the Yukon environment and wildlife. It's now a couple of years since you wrote your first report, and you talked about how important proper planning is and about a constantly changing environment of new technologies. I noted that the 2014 Council of Canadian Academies report on shale gas said that unconventional hydraulic fracturing has been occurring for about 20 years in the United States and about half that in Canada.

You spoke about mitigating against health risks — that it's not occurring in New Brunswick and that developing tools and mechanisms is a challenge. The question that I have for you relates to that amount of work to get ready and to ask you to speak about what a workplan for the chief medical officer of health for New Brunswick would look like — since you're somewhat ahead of us — in mitigating those health risks and other concerns.

Because of the time, I would also like to put my other questions for the other two presenters on the record before you respond. Dr. Badenhorst, you spoke about the fracking boom in northeastern B.C. as an example of the effects of a boom-and-bust cycle and discussed social problems and challenges for governments, support services, health care, municipalities and communities. You mentioned out-of-province workers flooding small towns, heavy truck traffic on rural roads and problems with policing, social services, violence against women, and overwhelmed local housing. The Government of B.C. has initiated a human health risk assessment of oil and gas activities and there is still significant pressure on communities to accept the rapid pace of fracking development. I would like to ask you if you know of instances where fracking operations were stopped due to health concerns identified by public health officials.

The third question I would like to ask is for Dr. Hanley — I looked both at your presentation in the fall and the update of your presentation. There is a strong body of research that certain groups and individuals experience greater harm to their health from oil and gas development in Canada. These can be both whole communities that are closer to industrial activities

or people with particular vulnerability to chemicals and emissions.

You also spoke — as did all of the presenters — about socio-economic factors. There are challenges in Yukon communities, including different health outcomes between aboriginal and non-aboriginal people, substance abuse, poverty and unemployment. I wanted to ask if you were aware of how other jurisdictions may have addressed concerns for particular groups or individuals who may experience greater harms associated with fracking.

Just to close, I wanted to thank Dr. Badenhorst for his comments about using words carefully and putting the words "hazard" and "risk" and "harm" out there. They're not the same; they're similar, but there are some important concepts that we have to grapple with there. Thank you.

Dr. Cleary: As the chief medical officer of health — as I said, the work of a medical officer of health is really to look at what, in my professional opinion as a doctor, is the best advice I can give the patient, which in this case is the population. One of the challenges I have is that I don't know exactly what the population is worried about. I think consultation with the public to better understand their concerns is really important. I think that, in terms of finding a solution, the public has to be engaged, because the patients' participation in their solution is the key to making it work.

The biggest thing that I have to offer, in terms of where I would like to go, is I think the recommendations we put forward in the document in 2012 still stands — that's my best advice. I would like to have the opportunity to have them complemented by building on them, based on public participation. I think that one of the mechanisms to do that is through formalized health impact assessments, because you can't do a health impact assessment in isolation.

The other thing is that I think we're at somewhat of a crossroads in the work of public health, but also in the whole area of resource environment and health, because 100 years ago the concerns of people and the concerns of public health were about basic sanitation and hygiene. Now the threats to our health are different. We have evolved. The threats to our health are actually related to chronic disease, cancers, and so the biggest challenge is not against preventing physical exposures; it's about promoting health and healthy lifestyles.

I hear a lot of people talking about the things that they value. You brought up the fiddleheads. In New Brunswick, a lot of people really do value the outdoors, they value the forests and they value the rivers. Those are things that are important to them, and they're also good for their health. I suspect that a lot of the same things would ring true here in the Yukon. We need to somehow say, well, if those things are things that people value, and they're also things that promote health, how can we better make sure that we take that into account when we're making decisions like this?

Dr. Hanley: My question was about how — if I'm aware — I think of other practices where more vulnerable groups are receiving recognition and particular treatment when it comes to health issues and health effects. No, I'm not aware and certainly I'm willing to learn if there are, but I think that's one of the areas I think needs recognition, which is why I brought it up. I know that this is a strong theme from Dr. Cleary's work. Also, even within the public health field, I would say what has gained a lot of currency in the last few years is: How are we being more equitable in even health programming and health services? I think somewhat of an emerging theme is the recognition that impacts are different depending on who is being affected. I think it is a theme that we need to apply not just within health, but to how we consider the health effects of projects and policies.

Dr. Badenhorst: My question was: Am I aware of any fracking being stopped in our community? No. I think there are many reasons for that, but I know that putting up a B.C. Hydro dam in our valley has been stalled for many, many years because of community consultation, so that process went well.

When it comes to who is a community, I do not know who the people are living in our community because they call our community a community on wheels because we have so many transient workers there. Who is going to be taking care of the community really, because they earn their daily bread there, those are their jobs.

Secondly is that industry will say, "Well, we will put people in camps." In Fort Nelson, at some stages, there were more people living in the camps than in the towns. B.C. has over 1,800 camps, so who is looking after those people? I am not sure how you will stop the process because it was just announced that this development will go on and people do not really have a say in that process.

I know the liquefied gas pipeline process has more community involvement now, I think based on the work that we have done, and that process goes on. I am not sure to what extent we are just rubberstamping, because part of the environmental assessment process is that they will consult northern health. Then we get the short timeline, like three weeks or four weeks, to answer certain questions. Number one, northern health does not have the expertise to do all the work. We do not have all the data that they ask us for. Who is paying for northern health to provide all these resources to answer those questions?

To come back to the gentleman — Mr. Elias — I think you need a specialized department in government, which is part of the EA office. Part of that is to look at environmental assessments. You need specialists in that and a big chunk of that funding should come from preceding money — upfront money paid from industry — to drive that process, because the local communities cannot answer those questions and don't collect the right data to answer those questions. If you have a formal process in place, then at least you can get prepared and collect information to answer certain questions.

Mr. Silver: Thank you to the doctors today for their presentations. Thanks to the folks in the gallery and to the people who are listening at home as well. We all know summer is about as short as a sneeze around here, so it's great to see that you're giving us your time today. I'm going to start

with a question for Dr. Hanley, and I'll ask one question for each of you. Most of the questions have been asked already.

As far as health impact assessments, we have heard a lot about the timelines for such endeavours, and you have been asked here today how long you think it would take to have a comprehensive HIA. My question would be, how much of the scope and the baseline health profile and assessment impacts have already been addressed in the Yukon, if any? Also, could some of this be borrowed from other jurisdictions?

For Dr. Cleary, in your 2012 report, the chief medical officer of health's recommendation concerning shale gas development in New Brunswick, you said, and I quote: "We cannot simply assume that more money equates a healthier population. The money needs to be utilized strategically." This is in terms of prevention and mitigation of negative health impacts prior to development. Your report was written, it seems, as a preparation to a political will to move forward in this, and it did study many other jurisdictions through a lens of anticipated impacts, as you say.

How ready was New Brunswick to go down this path, in your opinion at that time, in terms of baseline health profile, infrastructure, capacity and legislation?

And for Dr. Badenhorst, how much of the B.C. health budget is being used for mitigating the negative health impacts caused by this boom-and-bust gas industry? Has this been calculated? Have budgetary increases been allocated, based upon a realization of this phenomena?

Dr. Cleary: Thank you. In terms of why I made that comment about money needing to be invested strategically, it was because of the reasons I gave in my presentation, that money and its benefits of health have to do more with equity rather than actual income. So I think the way to address that is through policies, such as royalties and how they're distributed, and having processes and mechanisms in place to look after those most in need, which is a big change in the way of thinking of government spending — not conceptually, but as it relates to industry. I'm not aware yet of governments that have managed to build that into their royalty regimes or their processes for distributing wealth. There may be some, but I'm not aware of ones that have done that successfully.

I think that's a work-in-progress, but change is always slow and we have to start talking about it. In terms of how it has progressed in New Brunswick, I would say it's a work-in-progress.

Dr. Hanley: Thank you. My question was about baseline data and establishing baseline data and where and how that would be sourced.

A lot of data already exists. For health impact assessment to take on new research and new data collection, obviously that's something that is expensive and long and usually not necessary. It kind of depends on the level, but there is certainly fairly good existing data that would paint a portrait of, say, Yukon as a whole that could be applied to a sub-population as well. Probably one of the best data compilations we have is what was done to inform the recent clinical services plan, which really put a lot of different sources of health and data together. I think that exists, but we are always hampered by a relative lack of ability to interpret data because of small numbers. I think that's where we need to draw from what we know of the risks, based on data that is collected elsewhere. I think it's a combination.

Part of it also is just establishing what could be done fairly simply — just community consultation — so that as part of that baseline data, you have a profile of not only community demographics, but community values and what they consider important concerns — and that feeds into that baseline data profile.

Dr. Badenhorst: The question was: Am I aware of the health budget that was used for assessing impacts in our area? Two years ago, the B.C. government announced a human health risk assessment study. I think that's part of the work that we've also been asking for. It's a three-year or four-year project — about $300,000, I think — in three phases to do some kind of a health risk assessment. It's a very limited study. It is done in certain places — three places, I think. B.C. has a fair-share kind of system where some of the tax comes back to the community, which is millions, and it has been used, but not for health assessments. It is used, as I mentioned, mainly to balance the budget and for roads and things like that.

Then there was an air quality study — also about $200,000 or $300,000 — in certain areas where they have a mobile air-monitoring system. The problem with that was that someone else decided where the stations should be and we were not involved with how and where they should be. We thought we would be asked, but they actually put it in places where there is access to electricity because you can't use diesel engines when you do this kind of stuff, so there are also limitations in that study.

What was needed, I think, for community like this is to do a forum where industry, government, health services, some other key role players around the table, and say: What is the industry coming to town? How will it impact our town? How many people are coming? What funding do you need to prepare for this? What information do we need? Then you can start from there. Then you take baby steps and, if it doesn't work and you see red lights, you have an exit plan to stop if things go wrong.

Chair: Thank you. We're going to proceed now with our questions from the public gallery and I'll ask Mr. Dixon to start us off.

Hon. Mr. Dixon: This question is from Werner Rhein to all doctors. Because of the lack of baseline data about the environment and the health impact from fracking, would you recommend a ban of fracking for Yukon and spend money and time for the future with alternate energy sources?

Dr. Badenhorst: I think this is a critical question and a very honest question. I say no, because we don't know the effect. What we know is that I think overtime it will cost you more money. The quick gains in cash will not balance out the long-term effects, and I think you have an excellent situation to sit and wait and learn from other people's mistakes and

then maybe decide whether you go ahead with that or not. Personally, it's not for my institution where I work from or the government's — my opinion is, I think, to wait, rethink and learn from experiences.

Dr. Hanley: As I said in my presentation, I don't advocate a ban. From my point of view, it's not my place to say we should ban or that we should proceed. I think there is a lot of time if we use the time well.

As I have said, just saying that we have lots of time is a way of procrastination if we are not putting the steps into place and that's getting the process right. I think there may well be a place for oil and gas development, if it is within the values that I have already identified as important. For instance, localization of energy production is an important value to balance against importation of fossil fuels from elsewhere, all of which should be within an environment of an ultimate aim to reduce fossil fuel dependence.

I think that is where looking at it in isolation, I think, is risky, because there may be a place for it in terms of an overall strategy. We are highly dependent on imported fossil fuels. We are a highly subsidized economy. We may not always have that grace. There are realities that we have to deal with. We do use fossil fuels — this may be a potential source. I just think we have to make sure that we have the mechanisms in place to make sure that we have a transparent process where citizen concerns are taken into account; that we use the best science; that we use the best technology of the day in combination with health impact assessments that are done; and that it is consistent with an overall climate change strategy and energy usage strategy.

Dr. Cleary: I would be reluctant to make a recommendation to Yukon on this, because I do not think I understand all of the context of the conversation here. I think Dr. Hanley is in a much better position for that.

I can share with you what I advised our government in New Brunswick. I think I put it up on the last slide. There is a link to an interview I gave on CBC a couple of weeks ago, which gives the rationale for my perspective at that stage. If people want to check it out, it is available on-line. What I suggested at that stage — what I advised — is that the New Brunswick government stall for now. I don't see a compelling rationale to move forward quickly. There is a finite amount of gas in the ground and, given the gaps in information, the technologies that are new and evolving, the lack of a science base for the recommendations that we have, the fact that there is not public acceptance for it and the fact that we do not have the tools, the resources and the capacity within public health or other areas of government to adequately put in place regulations or to monitor it, that there is an absence of planning processes to protect what is already there — for all of those reasons, I said we should wait. That doesn't mean to say that at some future point it may not be something that we should pursue, but there is not, in my opinion, an advantage to rushing forward right now.

Mr. Tredger: This is question for Dr. Hanley. You demonstrated considerable agility to hold opposing points of view in your presentation, but given all that is known about health impacts of hydraulic fracturing, how can you not at the very least sound the precautionary principle before proceeding with hydraulic fracturing?

Dr. Hanley: I think I have to go back to covering the concepts in my presentation. I think there is a need, as my colleagues have expressed, for caution and a cautious approach and taking the time to make sure the right questions are addressed and to make sure that health considerations are part of the pathway.

Although the precautionary approach is always an important value to consider, at times I think there are also risks with doing nothing. If we do nothing and if we continue fossil fuel dependence as we do now on high fuel consumption — importation of diesel fuel, for instance — then that's not necessarily the right approach either.

What I'm saying is that there may well be a place for oil and gas development within an overall use of fossil fuels. I think we need to be looking at renewable sources more. We need to reduce our footprint. We can be leaders. We have an opportunity to be leaders. I do agree that this isn't something that we should be rushing into, but I would stop short of saying that this particular technology should be banned in favour of other fossil-fuelled technologies that also have their drawbacks and their adverse footprints.

Mr. Elias: This question is also for Dr. Hanley. It doesn't have a person associated with it, but the question is: Is the "go slow approach" of the CCA report part of your plan for the Yukon?

Dr. Hanley: The first thing is that I don't have a plan for the Yukon. I'm making recommendations into what I think should be a Yukon plan. I think that's a nice way of capturing it. Yes, I think "go slow". I think that probably is the closest match to what I'm trying to say. There is no hurry. Like Dr. Cleary says, the gas is not going anywhere. There are still uncertainties. The longer we wait, the better the science becomes and the more we learn from other jurisdictions. We are in kind of a good position. It is also a great opportunity to get our processes right — how we include the health considerations into all our processes.

Chair: I have an anonymous question for Dr. Hanley. Do you think a 700-man camp will make our town healthier and richer? Do you think oil and gas jobs are healthy?

Dr. Hanley: I think these are variations on a theme, and I think they're all very important questions to be considered. How do we match up all our values in Yukon? These are very important questions.

We do have part of our economy that depends on resource extraction, including mining. Mining is part of the value of Yukon just as wilderness and preservation of wilderness and access to nature are large parts of our value as Yukoners. Embracing First Nation values — Ms. Moorcroft appropriately identified that connection to the land is a value, not just for Yukon First Nations, but a value that permeates all of our attitudes.

I think that oil and gas development as a part of resource extraction needs to be part of how we see development of Yukon, and our need in some ways to achieve better, for instance, energy self-sufficiency. These are not strict health values, but from a health point of view, I think we need to recognize that there are many things to reconcile. Someone, I think, referred to some agility in reconciling opposing views. Maybe that's part of it.

We have diverse views of where we need to go, but achieving localization of energy production is one of those values and I think that is an important one.

Overall, again, I would look to the larger aims of not only achieving better energy self-sufficiency but a lower carbon footprint. I think that if oil and gas camps — just as we have mining camps and just as we have other camps associated with resource development and resource extraction — fit into an overall approach that fits Yukon — that we are getting to lower greenhouse gas production overall, that we are getting more reliability in localization of our resources that increases our economic independence — then they may well have a place.

Of course all of that needs to be considered under the question: Are we recognizing all of the potential health impacts, and are we moving toward a healthier population?

Ms. Moorcroft: I have a question from Jacqueline for Dr. Badenhorst.

What is the strongest recommendation in Henry George's book, *Progress and Poverty*, to avoid the boom and bust?

Dr. Badenhorst: This is a difficult one. This is a fascinating book. He said it is the landowners who cause the poverty. He said it is the landlords who cause poverty. It is government's need for funding that causes poverty.

He said that people should be taxed based on their assets so, if you have land, you should be taxed on the land or the facility you have or the potential of the land. You shouldn't tax people. This has like a social kind of flavour to it, but his common sense says that, if you have land and you don't use it, you are actually denying people access to land to have a life, or, if you have a landlord, you determine the price of the rent.

If you have industry, you'll pay minimum wages to make maximum profits, so you will force your workers into a poverty environment where they live. If you have land that can produce a certain something, like a farm or a mine, you should be taxed as if that land is fully operational.

That would force people to think about how they utilize the land. It actually should be owned by the people. It's a different concept in today's life. It's a very tricky one and it will get my head chopped off.

Mr. Silver: This question does not have a name attached to it, but it's for Dr. Hanley. Where do you see the benefits of regulating the oil and gas industry compared to investing in solar or wind?

Dr. Hanley: I think Yukon has a chance to play a leadership role. I'm, of course, not an energy expert, but I think that, as part of a commitment to reducing a carbon footprint, renewable energy sources need to be explored. I don't have enough expertise to say that we need more investment in these energies. What I do think is that we need more investment into exploring how appropriate these are and how feasible they are for Yukon, as part of an overall responsible use of energy and as part of a commitment to reducing our carbon footprint.

As I said in my opening comments, I think the greatest environmental issue in public health is climate change. It is of particular importance to Yukon because of the exaggerated effects in the polar regions and, therefore — even though our overall impact is tiny on the global scene — I think we have more of an importance because of our polar positioning to do something. Part of that requires that we explore, in a committed way, renewable energy sources such as solar and wind.

I definitely agree that this is the way forward. Having said that, it's unlikely in the near future that that would become our principal sources of energy. I think if that were to happen, that would be ideal, and we wouldn't need to be talking about natural gas. But I'm aware that there are realities of fossil fuel consumption, of which natural gas is one of those sources.

What I'm saying is I think we need to look at the whole end-to-end pathways in terms of determining carbon footprints. I am concerned about methane leakage, as I mentioned in my presentation, because of its short-term, highly potent effects and thus the importance of up-to-date science and pristine regulations to prevent methane leakage, should this source of energy be developed.

Again, what I have tried to do is paint a portrait of the health implications of developing this greenhouse gas as one of the greenhouse gas sources as a fossil fuel. As I said, it has all of the marks of a fossil fuel. I think it's unfair to portray it as something different from a fossil fuel.

I have probably said enough. It goes back to the question about going slow. I think what I would add to going slow is it's not just about going slow; it's about doing things the right way around. It's putting health at the front of our considerations, rather than as an after-effect, after industry is already here. Part of the going slow is using that time properly so that we are putting the community planning ahead of industry, so that we can see where industry fits into community planning, rather than the other way around. Thanks.

Hon. Mr. Dixon: This question is from Don Roberts, not to any specific panelist. The very fact that countless chemicals, water and sand are used to break down shale to extract gas/oil and mix with radioactive material like radium, uranium et cetera, how will the public health system deal with the health consequences of this unconventional drilling process like fracking?

Chair: Who would like to respond to that one?

Dr. Cleary: Well, obviously we don't want to have to deal with any health consequences, which is why I think it's important to think carefully about what are the hazards, what are the risk and how best can they be prevented. Some of them can be potentially reduced. I don't think they can be

eliminated completely and there are a lot of what-ifs that have to be sorted out to assure us that we're not in the position of dealing with the toxic chemicals.

That being said, I've come to believe that the bigger problems are the more macro-level things that we talked about in terms of numbers of people affected, the socioeconomic consequences, the psychosocial cases and the impacts of climate change — these are things that we really do need to pay a lot of attention to.

Chair: Anyone else?

Dr. Badenhorst: The B.C. Oil and Gas Commission took some lead on this. They put out in the permits and the licensing processes that you have to purify and treat your waste-water through plans and stuff like that. How effectively this is done, I don't know. What is the effect when they are injected under the wells? I don't know. How to not lose control over so many subcontractors in the area with 40,000 wells? I don't know how they are going to do that. So you need very clear legislation. Built into the permits, there should be a clearer system in place as to how and when the medical officers are involved. To date, I have not had one call from anyone saying, "Can you come and have a look at this plant or take samples or control it?" We are not part of that process and we should be part of that process. I think you can change it by legislation and regulations — very tight — and it should be built into the permit system. If you don't comply, then your licence will be pulled.

Mr. Tredger: Dr. Badenhorst, there is no name on this one. The question is: How many air quality monitoring sites are there in northeastern B.C.? How many active well sites are there, and how many instances of H_2S exposure were there in recent years?

Dr. Badenhorst: As I said, we have between 30,000 and 40,000 wells. How many exposures of H_2S? The Oil and Gas Commission can give you a report on that. It's in the thousands. If there are major outbreaks, we will probably get involved, but I can't remember the last year or two that I was involved with any of these outbreaks or problems of well blow-ups. What is the third piece of that question?

Mr. Tredger: How many active oil well sites are there? How many air quality monitoring sites are there in northeastern B.C.?

Dr. Badenhorst: This is a difficult one in the sense that different companies have their own air quality sites, but that information is not always shared. In B.C., we have certain air quality stations in the province that are managed centrally. I know in Fort St. John there is one site that has major dust — only dust — in the middle of town. Then they had this air quality monitoring program two years ago in three different stations to see if there was any so-called "high-risk areas" but those reports didn't show any contamination in the air.

It's difficult to interpret that and to generalize that information. I think the biggest problem is that there is a fractionation and disconnect between what everybody is doing. There are too many role players and you need some kind of a centralized place where your private collected data for water samples and air quality samples could be pooled collectively. There should be agreement that we collect it in the same way and that information should be pooled. Those reports should be transparent and shared with the public in an open way.

Chair: We have time for one more question, perhaps two, but we will see how the time plays out.

Mr. Elias: This question is from Don Roberts and it is not directed at anyone in particular. As a health professional and with what you understand about health impacts and consequences of fracking, do you believe that liquefied natural gas and fracking should be banned until such time as industry can return the polluted water to its original state?

Dr. Badenhorst: The word "ban" — I agree with my colleague that it is difficult to ban industry. I think the water should be treated, number one. No water should be disposed of if it is not very well controlled and, most importantly, we do not have a clue or have a handle on how much water is used during fracking.

I know from one of our big lakes, there is an 18-inch pipe going up to the north, flat-out day and night, to produce water. Previously they sucked lakes to puddles and streams to puddles for fracking. We have no clue really how much water is used and that is something that may affect us in the future, because drinking water — as someone said here — is sacred. It is a living body, it is what we have. If we do not treat it with respect, we are going to pay a price for that.

Ideally, if you can put it back in the way you get it, that would be a big achievement.

Dr. Hanley: I think Don is referring to, again, something that has not only a sacred value — water — here in Yukon, but is fundamental in public health, and that is how do we protect our water supply? Beyond that, pristine water is part of our wilderness and wilderness is one of the great values of Yukon. I think it is right to identify concerns around water in terms of consumption, as I pointed out, and the possibility of contamination of the water supply — and perhaps of most concern again, because I think this is where there is the most uncertainty, is waste water disposal.

It's another advantage to the CCA "go slow" approach, that the longer we wait, the better the science and technology is around disposal of waste water. Whether our water supplies can tolerate the demand on consumption really depends on the region. It depends where it is and what the sources are. I think the key point is recognition of water as not just a resource, but as a value.

Dr. Cleary: I would like to reaffirm the need for water as a prerequisite for health. If we don't have clean drinking water and safe drinking water, that will definitely compromise our health. We can't live without water, so we need to value that. I think water is just one of the considerations that we need to take into account. As I said before, I have not found any good compelling reason to move forward with development at this point in time. I think there is value in waiting until we have a better understanding, perhaps learn

from other jurisdictions, put mechanisms and processes in place and then see.

Chair: I want to thank everyone for attending this morning. Our time for questions has elapsed. I want to thank Dr. Hanley, Dr. Cleary and Dr. Badenhorst, and I want to thank all the visitors in the gallery who submitted their questions. The Committee will review the remaining questions and we'll do our best to follow up and ensure that they are answered.

We're going to break for lunch now and we will be reconvening at 1:15 p.m.

Recess

Chair: Welcome back to the proceedings of the Yukon Legislative Assembly's Select Committee Regarding the Risks and Benefits of Hydraulic Fracturing. For those joining us for this presentation, allow me to introduce the members of the Committee.

I am Patti McLeod, chair of the Committee and the Member of the Legislative Assembly for Watson Lake. To my left is Lois Moorcroft, who is the Committee's vice-chair and the Member for Copperbelt South. To Ms. Moorcroft's left is Sandy Silver, the Member for Klondike. Behind me is Darius Elias, the Member for Vuntut Gwitchin. To Mr. Elias' left is Jim Tredger, the Member for Mayo-Tatchun, and to Mr. Tredger's left is the Hon. Currie Dixon, the Member for Copperbelt North, Minister of Environment, Minister of Economic Development and the minister responsible for the Public Service Commission.

This Committee's mandate is set out in Motion No. 433, which specifies that the Committee is to develop a science-based understanding of hydraulic fracturing and also allow for an informed public dialogue. To this end, we are hearing several presentations concerning both the potential risks and benefits of hydraulic fracturing.

I would like to welcome the visitors in the public gallery and our next presenter, Dr. Donald Reid. Dr. Reid is a conservation zoologist with the Wildlife Conservation Society of Canada.

Following the presentation, we will take a short recess before proceeding with questions. If visitors from the public gallery would like to submit questions, forms and pencils are available at the entrance to the gallery. The questions will be picked up shortly before the end of the presentation.

After asking a few questions each, members of our Committee will randomly select written questions from those that have been submitted by visitors in the gallery. Time will not guarantee all public questions will be asked and answered, but we will do our very best with the time that we have. I would ask that questions and answers be kept brief and to the point so that we may deal with as many as possible.

Please note that these proceedings are being recorded and transcribed. If your question is selected, the information you fill out on the form may be read in to the public record.

I would like to remind all Committee members and Dr. Reid to wait until they are recognized by the chair before speaking. In that way, we can ensure that your microphone is turned on.

I would like to also ask that visitors in the gallery respect the rules of the Legislative Assembly. Visitors are not allowed to disrupt or interfere in the proceedings. Please refrain from making noise, including comments and applause and mute all electronic devices.

We are now going to proceed with Mr. Reid's presentation.

Mr. Reid: Thank you very much, chair of the Committee and members of the Committee, for this opportunity to come and speak to you today on what I believe to be an important topic. I've entitled by presentation "Speaking for Wildlife" because that is essentially what we in WCS Canada believe that we are doing in our work overall. As an organization we are a charitable non-profit registered in Canada, but our mission is definitely to work unabashedly for conservation of wildlife in wild places. We do that principally by doing our own novel science and interpreting existing science for the public and for decision-making processes. We are essentially a science-based organization. That's the context in which I would like to make this presentation.

I would also like to couch the presentation in terms of risk and benefit. The way I understand risk is that it's the probability of a particular outcome of a human activity multiplied by the anticipated cost of that outcome. Benefit is essentially the inverse of risk, where the benefit is the reward of an outcome. So we can think of them as flipsides of the same coin, perhaps, in many regards.

With those two things in mind — probabilities of an outcome and the cost or reward of that outcome — there are certain characteristics of each of those. Probabilities are largely the subject of science, in my mind. In natural ecosystems, many factors come into play and we often lack exact answers to the question of what is the probability of a particular outcome.

The cost or the reward of that outcome is partly the purview of science, but it involves tangibles and also intangibles, so quantifiable and often relatively unquantifiable outcomes. Therefore, we get into the purview of values and that obviously will come up later in the discussion. In this context, I see science as largely in the left-hand of those boxes of probabilities. What I will address today is what I think we understand in the scientific world as some of those probabilities. We will also get into the idea of values and costs later on in the discussion.

With regard to hydraulic fracturing and risk and benefit, I would like to summarize my comments under four different headings: water use, water pollution, air pollution and infrastructure. I'll go through each of these in turn and outline what I consider to be the general situation with regard to those and wildlife and ecosystems, and point out what I believe to be some of the issues or risks for each of those.

The issues and risks will be presented to you in purple type on the screen to try to differentiate them from the rest of the information being presented.

Let us first look at the question of water use and the amount of water that goes into hydraulic fracturing. Fracking fluid is 90 to 95 percent water, and each well uses somewhere between 2,000 and 80,000 cubic metres of water. A cubic metre is about 220 gallons, so we are talking about a lot of water. There is high variability here, depending on the geology.

The Horn River Basin in northeast B.C., is using the upper end of that range, close to 80,000 per well.

When most comparisons of this rate of water use are made, they are made with other human activities, like how much water we use in a golf course — 20,000 cubic metres in a summer perhaps. It is often pointed out that irrigation and domestic consumption use way more water than a particular hydraulically fractured well.

I think, given that general situation, some of these comparisons are somewhat misleading because, in most cases, water recycles. If we use it for domestic consumption, it goes into the waste-water system, through the waste-water treatment plant and comes back through the ecosystem through those processes. If we use it in irrigation, it gets respired by the plants or evaporated and it continues in the water cycle.

Fracking in itself can result in a net loss of water to the ecological water cycle. The main reason for that is that 10 to 60 percent of the water, depending on the well, actually stays underground.

It is buried deep in the geology of the earth's crust and essentially, if at all, it would only come back into the system extremely slowly through percolation into very deep saline aquifers. That's an interesting point. There's a net loss of this water from the hydrological cycle. Probably on a global scale it's relatively insignificant but, on a local scale, it's very interesting that we are doing that.

Perhaps more important is the fact that a lot of the water is also coming back to the surface — so 10 to 60 percent is staying underground, but the remainder is coming back to the surface and we have to deal with it after it comes back. I'll get into that a little bit more in the water pollution end of things, because what comes back has been influenced by the chemicals, both underground and what goes into it when it is injected.

What I'm saying here overall, though, is that the comparisons of the rate of water use that are made often in the literature — this comparison to golf courses or domestic consumption. Really what we should be doing is asking: What is the water use with regard to the amount that is available on the land in the area where we want to get it from to put down the wells? Specifically, if we go and look at those places in the Yukon where oil and gas exploration and development is potentially proposed — the Whitehorse Trough, the Liard River Basin down in the southeast, the Eagle Plains and Kandik basins up in the north. We're looking mostly at the darker orange areas on the map here.

To put water into a well, the water has to come from surface waters or subsurface aquifers. A little bit comes from recycling the pumped water that has already gone down the well and comes back out, but, for the most part, that originated from surface water in the first place, so we have to ask: What is available on the surface and in the subsurface aquifers that we can use for pumping into the ground for these wells?

Down in the Liard Basin, there really are no big lakes. We're looking at river systems. In the Whitehorse Trough, we have lots of big lakes, which are probably sufficient. In the Eagle Plains and Kandik basins, once again, there are no major big lakes. We're looking mostly at surface streams.

Let's look at some of the water-flow regimes in these streams and ask: How much water is there and is it sufficient? First I'm going to look at a couple of medium-sized rivers from a couple of these basins, just to give you a sense of where, during the course of the year, there might be enough water. In the hydrograph charts on the right-hand side here, the Y access up the left-hand side is in cubic metres of water coming down the river at any one point in time. They're in the hundreds. It may not be easy to read here — I'm not sure whether this will show. These figures here are in the hundreds, like 100, 200, 300, 400, 500 cubic metres.

The point here is that you can see the summer months in the middle of the graphs where the red lines go way up. That's high flow in spring and summer, but in the wintertime, which is often the time that we want to drill and actually implement this water use and push it down wells, the water-flow regime levels off at very low levels — around about 20 cubic metres per second.

The figures on the bottom there are just some examples of how much time it would take to satisfy a flow rate for a well to feed a well of, say, 40,000 cubic metres from these rivers.

In the wintertime, we would take up one percent of the flow for well over two days in order to satisfy a well. That could well be done, and I have not found any literature to say what exactly the threshold of taking water out of a river is beyond which we shouldn't proceed. But what I wanted to point out here is that during the wintertime there are frequently relatively low levels of water, and even in a relatively big system — the Beaver River in the Liard Basin oil and gas field is the biggest river in that whole basin. That's basically the water that is available to feed that basin locally, unless you import it, so we have a potential water amount issue even with these medium-sized rivers.

If we look at the really small-sized streams — and it's hard to find enough hydrometric water stations with long-term data, but the Ibex River is an example here of a relatively small drainage. It's in the Whitehorse Trough, but the point here is that on the Y axis on this hydrometric graph, these figures are in tens, so we're not getting up to even 100 here.

Even during the summertime here, the red lines of peak flow in the summertime are at about the level of the winter flow in those medium-sized rivers like the Beaver.

So we have nowhere near enough water in these small streams to sustain the water flow in the stream and also supply a well. We are going to have to be careful about where we go to find water in these systems. My overall point here with regard to water amounts is that we run a risk of over-winter habitat loss for invertebrates and fish populations if we're not very careful in this regard.

Let's move on now to the question of water pollution. I'll just go over the fact that fracturing fluid once again is mostly water. It has a lot of sand in it and has a lot of chemicals in it. One well — say 40,000 cubic metres of water going down that well — could take up to 400 cubic metres of chemicals that are mixed into that water and injected. That is at one percent of the total fluid volume. The problem with chemicals entering into the system is that exactly what chemicals are being put down the well is often unreported because it's proprietary information of the company. Some injected chemicals are definitely toxic; that's well-known. Various reactions happen underground between water, these chemicals and things that are underground — other chemicals, hydrocarbons and also radioactive chemicals and elements that are underground. This flowback, this pushback of water back up the well under pressure is bringing a lot of this toxic material back to the surface after the well is injected. Let's think about each of those.

The graphic on the right-hand side here is once again showing a general picture of a well with the water being injected way down into deep shale deposits and pushing out into fractures in the rock. Generally speaking, what we call groundwater or the subsurface aquifer is relatively high up in the geological strata, closer to the surface — the light-blue line there. The bottom right is a picture of what is often referred to as a reserve pit, where waste-water or flowback water may be stored, although it is often stored in closed containers and that is definitely the better way to go. In some instances, the surface storage is also used like this.

I have listed some of the chemicals. We don't need to go through them in detail. Those outlined in red are some of the more dangerous ones. The literature points out that there are over 750 different chemicals used in this process, 29 of which are recognized as toxic or carcinogenic. The ones that are mobilized underground are potentially at least as risky as some of those that are injected. Heavy metals, radioactive elements — in particular radon — and various hydrocarbons like benzene and so forth that are interacting with some of these chemicals and producing other things that then come back up in the flowback.

The overall issue here is, to what extent do these chemicals in the water they are injected into the wells with leak or get mobilized into subsurface aquifers and groundwater? What actually is the risk of spills from this flowback occurring at the surface being lost from the well site and going into surface waters?

It's this subsurface leakage into aquifers that is one of the main things I want to talk about. How big is this risk? I think the most authoritative review of this has been the recent Council of Canadian Academies publication that was sponsored by the federal government and recently reported to the federal government. The graphic on the right-hand here, although not very clear to most of us from this distance, does point out the various pathways. The middle bullet there I think is the most important one. This Council of Canadian Academies report clearly states that in their view, the various pathways for contamination are very real and they have probably been underestimated by industry and by government regulators across North America in the past and that they have a long lifespan. They could well last up to 10 years, because this injected water going down the well with chemicals in it is under pressure and that positive pressure with respect to surface air temperature — ambient pressure, pardon me — can last an awful long time.

We have potential loss of this toxic water through well casings themselves into the aquifers. Generally speaking, a lot of effort goes into sealing the well casing itself as it passes through that near-surface aquifer. But that well casing seal does not go all the way down into the deep geology. Of course, in the deep geology, the intention is that the water seeps up through the various layers of shale and mobilizes the hydrocarbons there and brings them back into the well shaft itself so that the hydrocarbons can be drawn to the surface. The leakage upward through the bedrock geology into the subsurface aquifer is a potential real risk.

The really interesting point, from my point of view, that this Council of Canadian Academies document pointed out is that it's very difficult for anybody at this point in time to come up with any quantifiable probabilities of these risks. In certain circumstances and certain geologies, it may be zero; in other geologies, it may be relatively high. We just don't know enough about the baseline hydrogeology — the way the water is flowing through these underground rock layers. There may be more than one, and often is more than one aquifer. When there's a ground-level aquifer fairly close to the surface, there are often very deep saline aquifers that may have linkages with the closer groundwater aquifer.

We don't have maps of how those linkages might be laid out underground and we really do not know the assimilation capacity of the groundwater. That means, what volume of groundwater is there and how well could it dilute this chemical toxic mix that could conceivably leak up into it? We don't know what those linkages between the ground and the surface are. We don't have the baseline monitoring from the historical basis or even a current basis — a sort of pre-drilling basis — with which to compare what might be coming when we actually go out there and drill.

The risk I see here to wildlife is a question of the health of the animals, should they become exposed to some of these toxic chemicals.

Ultimately that's a question of food security because we're dealing with the potential of fish being contaminated in surface waters and any kinds of wildlife becoming exposed to spills on the surface or going down to water bodies that they normally drink from.

There are no control treatment experiments in the scientific literature to address this issue, but various inadvertent accidents have been quite revealing with regard to this risk. For example, die-offs of fish and invertebrates and heavy metal uptake by fish in spills into waters in the Midwest states, waterfowl dying on waste-water reserve pit ponds and cattle in Pennsylvania — some being exposed to fracking fluid spills on pasture whereas others on the same farm were not exposed, resulting in sudden death and major reductions in reproduction in those cattle.

You may say that those are extreme situations and they are in a sense because they were spills on the surface that were accidents and that most regulations would take charge of. But we still do not know what the risks are of some of these chemicals coming up into subsurface aquifers and ultimately the surface waters and wildlife becoming exposed to them in that way. We also will always have some potential for accidental spills on the surface when technology fails us in the containment of flowback waters. My overall point here is that there is a lot of uncertainty and that ultimately this is a food security issue that we need to be thinking off.

I'll move on here from water pollution to air pollution, the third of the major topics that I wanted to get into. I'll deal with this relatively quickly. The air pollution issue in terms of sources of gases and particulates is various gases coming back up the well after the pressurized water — fracturing fluid — has been injected. These gases are coming up along with the hydrocarbons that we're seeking by having drilled in the first place. They are also happening through leaks around the wellhead pipes and compressors after the hydrocarbon gases are brought to the surface. They also can be happening from evaporation of some of these fluids that are brought back from flowback to the surface and held in reserve pits.

There are number of risky gases here: volatile organics which are known carcinogens like benzene. Benzene is probably the most common of these. It's frequently found underground in conjunction with the natural gas that we are trying to get out of the ground for energy consumption. There are various nitric and sulphur oxides, hydrogen sulfide, radioactive gases — in particular radon, which is a carcinogen and combinations — in particular the nitrous oxides and some of the hydrocarbons like benzene and aldehydes that produce ozone.

I would just quickly focus on ozone and hydrogen sulphide, because they are gases that are denser than air and they sink. It has been documented from domestic livestock situations that — and obviously human health issues — these sinking dense accumulations of these gases in certain circumstances can be lethal. They definitely cause severe respiratory and other ailments if you don't get out of there quickly enough and you don't get your livestock out of there quickly enough.

For the most part, these can probably be dealt with. The main way that industry deals with them is by flaring the gases as shown in the picture on the bottom-right at the wellhead. There's a flaring of gases in an attempt to contain them at source.

I'm particularly concerned about the heavier-than-air gases in a mountain environment, such as in the Yukon, where we may well be doing this. Because those gases sink into low levels, it will be often trapped in valley bottoms without substantial wind. In the winter, we frequently have inversion effects, especially further north in the Kandik and Eagle Plains Basins, that show up in the vegetation, not because of these gases, but just because of the cold air seepage to lower elevations that constrain tree growth. We often see animals responding to that. But in particular, the temperature regime in a lot of these northern valleys is colder at the bottom and warmer on the higher slopes for considerable portions of the winter. That cold air seepage will keep those gases down in the valley floor, should they leak to any substantial amount and they could be quite lethal. That is my main concern with the particular gases and wildlife that might come from this drilling procedure.

I will now go on to the last and fairly involved of the four topics which is infrastructure. Hydraulic fracturing is often referred to as unconventional oil and gas extraction. It's unconventional in terms of the extraction mechanism with the pressure, but it definitely relies on the conventional approach of exploring for the oil and gas, going about developing it and transporting it out through pipelines and so forth. The particular footprint of hydrocarbon development — and unfortunately it doesn't show up very well in the mapped graphics on the right. The layout of seismic lines, roads, drill pads, compressor stations, pipelines, and so on and so forth are very much similar to the conventional layout. They may be somewhat more intense with a hydraulic fracturing play because of the need for more wells to get the injection, more well pads at a closer density, and more high-grade roads because each well pad has to be able to take the traffic of hundreds of different trucks to bring equipment and act as pumper stations.

We're basically dealing with some of the same infrastructure questions that oil and gas exploration and development throughout western Canada have dealt with. Infrastructure, in my mind, is the entire geographic and physical layout of all of these linear features of roads and seismic lines, pumper stations and camps on the ground, and also the noise that is produced from these.

Infrastructure has a potential influence through this list of various effects here. We convert habitat. We change habitat quality. We influence movements of animals. We directly influence mortality rates of animals and, cumulatively, we change the interactions among many of these animals across the landscape. I would like to go into each one of these in a little bit more detail.

In terms of habitat conversion, what we are doing is we are changing what were, generally speaking, mature forests to open habitats by clearing the land for seismic, roads, well pads and so on. In all the other influences I have previously talked about so far, I do not see any benefit for wildlife. When it

comes to some of these infrastructure changes, there are both species losing and species gaining from these changes in habitat.

Some of the species that definitely lose are caribou, bears, in part, and a lot of forest birds. Some of the species that may gain from some of these conversions to more open habitats with a more shrubby and herb complex are Arctic ground squirrels, voles, moose and deer, sometimes bears. These are generally species that are more opportunistic. Sometimes they are referred to as weedy species. They are ones that are adapted to deal with the more natural disturbances that we frequently find in the boreal forest, such as fire and insects, that remove the mature forest canopy. They are part of the ecosystem complex and there is some benefit to some of these species by putting some of these features in.

I won't go so far as to say they are ideal layouts for many of these species, but I have to acknowledge that some will benefit. Some of those benefits may have knock-on effects on those species that are losing.

In terms of reduced habitat quality, what I'm referring to here are the reductions in the quality of mature forest habitat that borders these features that we put on the landscape. That is because the noise and the activity along the features that we have built, like roads and camps and so forth, spread out through the mature forest adjacent to them and have an influential effect well beyond just the footprint of the feature itself. It has been documented that some of the breeding songbirds will avoid areas close to these noisy features. Caribou have been documented to avoid these features. There is a buffer area around each of them within which caribou activity definitely decreases.

There is also an issue of risk from sediment runoff from these roads and pipelines into surface waters and a reduction in the quality of fish habitat as a result of those sediment runoffs, which have to be dealt with and thought about.

With regard to disrupted movements, sometimes the pipelines we put in have to remain above-ground and that would probably be quite frequent in the north Yukon because of permafrost issues. If those go on for a considerable linear distances, we would have to consider crossing structures in order to deal with those.

High-grade roads and pipeline corridors act as partial barriers to movements of some animals, mainly, once again, because of the noise and activity along these features.

In a piece of research currently ongoing in northwest Alberta that we are, as an organization, helping to sponsor, it has been shown recently that adult female wolverine are tending to avoid some of the more well-travelled high-grade access roads in the oilfields around the Rainbow and Bistcho Lake areas, as an example. There are also potential breaks in wetland connectivity where high-grade road construction across wetlands can result in changes to water flow and reduced fish habitat quality.

Increased mortality will result in a number of ways. First, if these roads into oilfields and gas fields are publicly accessible, what we essentially end up doing is spreading our hunting pressure over a much larger portion of the land base and encouraging more hunting pressure at the same time, until we lose the unhunted landscapes in the territory as a whole, which often are acting as sources of animals and big game to the relatively well-hunted corridors that are already in existence.

I'll take an example of that in the Whitehorse Trough area, which would be the difference between the Nisutlin River corridor, with the road up to Quiet Lake and also the ease of access by boat traffic on the river, and the Wolf Lake area immediately to the east of it, which is relatively inaccessible except by plane, but can act as a source of moose to recruit into this heavily hunted population in the Nisutlin.

What this infrastructure of oil and gas fields tends to do is homogenize the landscape with respect to access, so you have the potential for people moving all over the place. The particular refuges and spaces that are built into that landscape as a whole region become very small in the little gaps between seismic lines and high-grade road networks. I think that, overall, there is a real risk of a net reduction in game regionally with this approach.

In terms of roadkill, there's a real risk here too. Obviously, the gas field roads themselves could act as a source of roadkill for a number of animals, right from the smallest up to the biggest. But I think we also need to think seriously about the kind of traffic volume that we're going to induce on major roads like the Alaska Highway, because there's an awful lot of equipment and supplies that have to be brought into a hydraulically fractured oil field above and beyond a conventional oil and gas field. I'm thinking particularly of sand here. It was pointed out that six to nine percent of the fracturing fluid is sand. We don't know whether there is a sand source clean enough in the Yukon to deal with that need. There is a sand source in the Peace River country that is currently feeding part of northeast British Columbia, but otherwise a lot of sand is even imported from the United States into Alberta for this purpose. The amount of road traffic coming up the Alaska Highway is going to increase the mortality risk for certain animals. In particular, I'm thinking here of caribou of the Southern Lakes and the Little Rancheria herds that are already subject to considerable road mortality, as it is, on the Alaska Highway. That's a very difficult issue to mitigate.

Now overall, these various things that I've been talking about here are often issues that may deal with only certain individual animals in the wildlife population or species population. The real question ultimately is how do they accumulate through ecosystem processes and have an effect at a population level on a whole species in a region. We do not know the answer to that question for very many case studies.

The best documented is with caribou in the boreal forest of eastern Canada, right from the east side of the Rocky Mountains out to the east coast. The general picture emerging from a well-studied system like that with caribou is that these disturbances, both the linear features created by the oil and gas infrastructure and also disturbances that create younger forests

because of fire and also timber harvesting, are having a net effect on removing caribou habitat, but definitely increasing moose and deer habitat quality.

Overall, we see the density of game on the land base can actually be increasing because moose and deer are doing well in these situations. The wolf densities can increase and the wolves can move readily through the landscape because of these linear features well-spaced in a fairly reticulate pattern over the landscape.

Prey densities increase; wolves have increased. Their ease of hunting is enhanced. The net effect of that on caribou has been a declining caribou population in most of the herds that have a heavy level of disturbance — the driving force in this sequence here. This particular issue has become the crux of the efforts by the recovery process for boreal caribou nationwide and was well-documented through the scientific assessment to identify critical habitat for woodland caribou. That scientific assessment was led by Justina Ray from my organization in our Toronto office and also by Dr. Fiona Schmiegelow here at Yukon College. Those two scientists together led this cross-Canada analysis that put this basic relationship together here, so this is a crystallization of that study.

This graph here is trying to show this disturbance threshold idea and on the left-hand side — unfortunately it's not very clear once again here, but on this left-hand axis here, the Y axis, right in the middle here is zero. This is a probability of a population of caribou staying stable or increasing. At zero, it's around about stable. If it's higher than zero up here it's likely to be increasing, and if it's down here on the Y axis it's likely to be decreasing. Across the X axis here is the percentage of the land base that is disturbed by this accumulation of linear features and wildfire and timber cutting disturbances, creating good habitat for moose.

The overall point here is that between 30 and 40 percent, somewhere in this breakpoint here, is a bit of a threshold where we traverse the probability of a population of caribou staying stable or increasing and we fall into this pit here; whereas, if we increase disturbances on the landscape, the chances of the population of caribou going into decline and ultimately becoming extirpated increases.

Some populations of caribou have disappeared as a result of this. Many are on the cusp, which is why there has been so much controversy in northern Alberta and is why the six populations of boreal caribou in northeast British Columbia in the Peace River country are currently on the decline and considered at real risk of extirpation, because this disturbance threshold has been exceeded for those herds.

I am pointing this model out to give you the overall picture of this risk. The caribou is one of the prime species to look at from this point of view, because it is an organism that travels widely on the land base and would, in the course of going about its general life history requirements, necessarily have to cut across a lot of these linear features and deal with a lot of these disturbances. It's a good example organism for this.

Unfortunately, we cannot transfer this model with this 30- to 40-percent threshold directly to our Yukon situation because the Northern Mountain caribou, which exist partly in the Liard oil and gas field basin or the Whitehorse Trough and the barren-ground caribou in the Kandik and Eagle Plains — their ecologies are different enough from boreal caribou east of the Cordillera that we can't transfer this relationship directly, but it's clear that the caribou's position in the food chain and the food web means that many of these same risk factors are going to come into play. Trying to keep caribou in close juxtaposition with moose and deer is going to be a big problem. If we are inducing disturbance on the landscape that is going to really increase the moose and deer populations at the same time as trying to maintain caribou, we are going to be increasing our risk of running into trouble with caribou.

This is, in my mind, an important area for potential research. What are the thresholds for our Yukon caribou with regard to this disturbance issue?

I wanted to point out also that here in the Yukon we're fortunate that we don't have a lot of timber harvesting yet on the land base. In the Liard River Basin in the southeast, we are at a situation where there is quite a bit of timber harvesting in conjunction with the oil and gas field, so it's a bit of a different issue there. Overall, my point here is that there is real risk from infrastructure. It's difficult to quantify exactly for some key species here in the Yukon yet. There are some potential ways to mitigate it, which I will quickly get into, but we need to consider it.

I'll try to wrap up this whole discussion fairly quickly now. In this table, I have put together a synopsis of some of the mitigation or regulation options that we might have for some of these potential risks. I won't go into these in any detail and I won't attempt to have you think that this is exhaustive. There are many others in the literature that I could lead you to. The main point here from my point of view is that when it comes to mitigation and regulation, we do have some options for most of the issues, except for this question of water pollution in the aquifers.

Our real dearth of knowledge on how fracturing fluid water works underground in different geologies and with different aquifer and groundwater situations is really creating a huge problem for us, I think, in terms of being able to quantify risk, understand exactly where the risk is coming from and, therefore, have any idea about how to regulate it or even monitor it.

That issue was raised by that Council of Canadian Academies report. I think that is the key one here and it really puts water pollution at the top of the list as an issue when it comes to wildlife.

I just wanted to say once again that risk is a probability of an outcome times the cost. I've pointed out here that uncertainty abounds in terms of the probability issues. In terms of the cost issues — ultimately this is going to be a question of deciding what is the cost of a bunch of unquantifiable or intangible effects. We are going to have to

get into a value-laden exercise when it comes to making decisions about this.

How to react to uncertainty and outcomes? The quote I've put in the top right-hand corner here — that the burden of proof should not be on the public to show impacts, but the burden of proof should be on industry to verify that their claims of performance are accurate and reliable over the relevant scales in space and time. I think that's a very important quote from the Council of Canadian Academies report, because it is really pointing out that many of the claims of industry have probably been over the top with regard to this water pollution issue and what happens to the water underground. The Council of Canadian Academies is really trying to bring that as a crux issue back to the surface here.

I've listed a few of the particular ways in which we could proceed here in dealing with uncertainty and outcomes. I want to focus on the idea of acting experimentally. We need to think about anything we do on the land base as an experiment and not as something that we are walking into with the hubris of knowing exactly what is going to happen. We could think even of the entire Yukon as a control for an experiment that is going on in northeast B.C. or in the Mackenzie River valley, or we could think of one of our Yukon basins as a control for an experiment that we start in another basin — or within one basin an experiment-controlled situation — but unless we learn from anything we do, I think we are going to be making big mistakes. It's not just on the wildlife front, of course; it's on all kinds of fronts.

How do we react to uncertainty in costs and conflicting values? Once again, we need to act with caution, but we need to try to bring the intangibles to the surface and apply some kind of ethical analysis to our understanding of risks and benefits of this technology. It is not just a question of quantifiable cost-benefit analysis in terms of economics and those few costs that can be quantified — for example, by losing a certain proportion of an animal population. There are other values there that are relatively intangible that need to be brought into the picture. I believe some of these have been addressed by some of the other speakers to your committee, in particular this morning in terms of human health.

But it is a question of getting the ethical values out on the table and having a discussion around them. Quite often, we default to a discussion around the quantifiable aspects of the problem, but what are the trade-offs in terms of the ethical aspects.

That is all I have to say at this stage. Thank you for your patience. I have gone over a little bit in terms of time. Thanks very much for the opportunity to speak.

Chair: Thank you, Dr. Reid. At this time, we are going to take a short recess and reconvene at 2:15 p.m.

I just want to let people know that the questions are being picked up now.

Recess

Chair: Order please. We're going to proceed with questions and, as mentioned earlier, please wait until you're recognized so that we can make sure your microphone is on.

Mr. Tredger, please.

Mr. Tredger: Thank you, Madam Chair, and thank you, Dr. Reid, for your excellent presentation.

Just a question — we have been hearing about human health studies and the impacts on human health in the other jurisdictions where fracking occurs. It has been less than satisfactory in terms of the ability to have consistent access to information. There seems to be a lack of data and understanding of the various effects of fracking on the general health of the population of not only humans but also livestock.

The Yukon, in my mind, is much more vulnerable. We are sparsely populated. We won't have the public feedback, the drinking water, the warning signs that they have in the south.

In your summary, you have listed risks and mitigations. Can you speak to the effectiveness of those mitigation efforts? How certain are we that they will work? How do we determine if they are working?

You mentioned monitoring and measuring, but to my mind often in a wilderness area, by the time we are observing things we may be too late to effectively mitigate it. You mentioned that the burden should be on industry to verify their claims of performance are accurate and reliable. How do we go about achieving that in a relatively sparse wilderness area?

Mr. Reid: Thank you. I guess I would start first by thinking about mitigation and regulation efforts in two bins. One is the set of efforts that we might put in place in a planning context in advance of doing any kind of oil and gas exploration and development or hydraulic fracturing. The other is the set of regulations that we might put in place that industry has to adhere to in the context of doing its work. I guess I should put in a third bin there, which is the monitoring and compliance aspect, which would really review how things are proceeding as development occurs.

In terms of the planning bin, a number of the things I have listed under infrastructure here would fit in that planning bin in terms of where we put developments on the landscape so that overlaps between different kinds of disturbances are happening, rather than spreading them widely — trying not to combine timber harvesting with oil and gas; putting well pads and camps and so forth well away from water bodies where there could be immediate risk of pollution; making helicopter-assisted seismic mandatory; and no public access on industrial roads. Those are planning initiatives that would have a mitigation effect up front.

Then, in terms of actually applying them on the ground, which is often the most difficult part, we have things like regulating water withdrawals. The only way to do that is you either totally trust the withdrawal agent, whoever it is, to not exceed certain rates of withdrawal of water from a water body or you put some kind of automated monitoring and compliance tool into the process so that there is a direct record of the flow rate of the water for example.

In terms of spills and so forth, once again, it does boil down to the integrity of the industry to report spills when they happen because there will be accidents. There always are, so it's whether or not these closed containment and berms work to contain a spill on a well pad as opposed to it leaking out into the broader landscape.

Then there's the kind of monitoring things that we need to do on a larger scale. Ideally, a lot of these should come into play even before we entertain any idea of going through with a drilling process or a drilling operation. We should have some kind of sense of what the water quality and the hydrometric flow rates are, and some attempt to map the three-dimensionality of the underground aquifers in subsurface groundwaters even before a drilling operation — such as what recently happened on Eagle Plains — goes into effect so that we have some data to compare as we monitor the ongoing effect of the industry's drilling activities.

There are different kinds of mitigation and regulatory procedures there. Your question also asked what kind of faith we might perhaps have or certainty we perhaps might have in terms of how well they work. I can't give a detailed answer on each one of these with regard to that. Overall, it does depend hugely on the integrity of the industry itself to self-police because it's always going to be the case that government is not there monitoring every aspect of the industrial activity from beginning to end. I do believe that a large part of it does play out in having confidence in industry. I'm not saying I necessarily have that confidence, but I believe that would be a necessary component of moving ahead with this kind of activity.

Mr. Elias: Thank you for your presentation, Dr. Reid.

You mentioned the Eagle Plains Basin in the north Yukon area — obviously an area that I'm very familiar with. In the Eagle Plains area, we have an approved *North Yukon Regional Land Use Plan*. In that plan, there are 23 land management units — I'm sure you're aware of this — that are based on the intensity of use. Within those land management units, there are four different types of zones, from low intensity of use to high development, basically, to put it in layman's terms. In those zones, from linear disturbance to surface disturbance and to cumulative effects indicators — they are all delineated in those land management units. Just looking at your presentation with regard to disturbance thresholds — the fifth slide back just before you concluded your comments — would that be a good starting point for using the land use plan's critical level of, let's say, 0.1 percent in linear density or intensity of use within a certain zone or within an approved land use plan?

Would that be a good place to start? Because once this oil and gas activity progresses, if it does progress, the intensity of use in those land management units is going to be watched very carefully because of the approved land use plan. I guess my question is: Is that a good starting point for the disturbance thresholds, especially for ungulate populations within the area?

Mr. Reid: Conceptually, yes, it is a good starting point. Unfortunately, the exact way it's being applied or was thought of being applied in the north Yukon plan may not play out to be the best application of the idea. When the north Yukon plan was written — and I don't mean to disparage those who wrote it, by any means — what they were looking for was exactly that concept. What is the disturbance threshold that the caribou could sustain?

They looked to what was in evidence from scientific studies across the country and, in particular, this disturbance threshold model from the boreal caribou. They borrowed that idea and some of the linear densities — so kilometres per square kilometre, which are the units used in the north Yukon plan. They borrowed some of those from the experience of Alberta under the hope that those would be applicable in the north, but fully realizing that they might not be. The north Yukon plan is an experiment in and of itself in the application of this disturbance threshold idea, and it will be up for review on a 10-year horizon, I believe. There will be a need to re-evaluate those.

That's where I made that point that, unfortunately, we can't directly take that eastern boreal disturbance threshold of 30 to 40 percent and plunk it down into the north Yukon with the barren-ground caribou herd, because barren-ground caribou use the land completely differently than the boreal herds do. They are migratory, they use different habitats, they select habitats differently, their predator densities seasonally are different, and so on and so forth.

Conceptually it was a good idea to take that approach. In effect, the particular thresholds they use to differentiate those four zones may not play out to be the best, but there is a process of review that will take whatever scientific evidence is available at that time to try to refine those. I think that is the best way I can answer.

Mr. Elias: I have just one quick follow-up question. When I fly to Old Crow and you look down onto the landscape in these — what are now the land management units that are of larger use for industrial activity on the surface. It is like a spider web. It is like a spider web from the 1960s and 1970s and 1980s of linear disturbances. Should that past use be taken into consideration? Because I believe this land use plan is for new uses.

Mr. Reid: It should be taken into consideration, yes. Depending on exactly how old those seismic lines are and how much they are regrown and therefore have lost — as they regrow and the vegetation gets taller, and some of the enhanced ability of wolves to find caribou by using seismic lines decreases because the line of site from the wolf to the animal is lost with the increased vegetation height.

There is a time threshold at which they essentially should fall out of the picture in terms of being considered in that equation of kilometres per square kilometre — that threshold density. I believe that Kirstie Simpson at Energy, Mines and Resources has worked considerably on that topic and is researching that question of vegetation regrowth to try to quantify that particular relationship.

I would also just say that a good deal of the impact of those seismic lines on the ecosystem process is the ability of the wolves to find the prey and specifically to travel readily in the habitat. It depends on how much those seismic lines are actually compacted in the snow season by human activity — snow machines or vehicles or whatever — because the compaction enhances the ability of wolves to travel readily along those lines, and that really is what's driving the relationships.

The spider web has a time duration of effect that is probably in the decades, but not, maybe, more than 30 or 40 years so it will taper off, but the extent to which people are using that spider web is hugely important as well.

Ms. Moorcroft: Thank you, Dr. Reid. I enjoyed your presentation this afternoon. Our Committee was mandated with gaining a science-based understanding of the technical, environmental, economic and regulatory aspects of hydraulic fracturing, among other things. We started asking: What do we know? Then that quickly became questions of: What don't we know and what do we need to know? All of the presentations that we've heard over the last couple of days are relevant to that approach.

We know that as much 60 percent of the water used in fracking fluids stays underground. You noted that the remainder of the water used is contaminated flowback water, much of which is disposed of in deep wells. Whether that is permanent or not is one of those questions we don't know about. The flow rates of our rivers and streams vary quite a bit throughout the year. You spoke about that and noted that winter water removal could seriously harm aquatic habitats. We also have a duty under First Nation final agreements to preserve our water for future generations.

I would like to ask you about what future technologies you think might help map those underground aquifers and water paths in different geologies. Could you also comment on your assessment of how other jurisdictions have managed this pressure of water resources needed in order to pursue hydraulic fracturing?

Mr. Reid: Thank you for that question.

I have to hesitate a little bit in answering because it's not really my area of expertise. I've uncovered it as a big risk to wildlife because of the water pollution aspect, but in terms of technologies for mapping groundwater reserves and so forth, I have to largely claim ignorance.

I don't know what those improvements might be. I know that the Council of Canadian Academies report has looked into that in detail and has come to the conclusion that I put up there that basically the risks are real and have probably been underestimated. But even they are saying that there is a lack of knowledge of what the hydrogeology is and how to measure it and how to really get a handle on it in order to come up with an assessment of these risks. It's really largely based on their assessment that I come to the conclusion that this is the biggest issue. It's a black box that we really don't have a good handle on.

Now I think I've lost the track of the second part of your question.

Ms. Moorcroft: I was speaking about water use and that water drawn for the fracking industry creates competition for limited water resources from our rivers, lakes and streams. You said that comparisons of rates of use should be with what is available. So given that there is a variable flow rate at different seasons of the year as well, I wanted to ask you about the management of water. What is your assessment of how other jurisdictions have managed the pressure on water resources from fracking, and are there jurisdictions that have been successful at sustaining the water stream flow after hydraulic fracturing? Is that something that is known?

Mr. Reid: Once again, I don't think I have as deep of a knowledge of that to really answer it clearly, as I ideally would have. I just have put forward in the Yukon context here that it is a risk because of the flow rates, compared to the water requirements of an individual well.

The way that other jurisdictions deal with it is not something that I have researched in detail, in terms of their regulatory mechanisms and so forth. As I pointed out, if you choose the right kinds of water bodies and the right seasons to do the water withdrawals, they are not necessarily an issue. The question in a Yukon context is choosing the right bodies of water, if you want to do it in the winter at all, because in the winter water is extremely limiting. That's the main point I wanted to make here, in the Yukon context.

Mr. Silver: Thank you, Dr. Reid, for your presentation today. It was very thorough and you did answer most of my questions during your presentation, but I would like to ask your advice on submitting references to our Committee for continuing research.

Your presentation made reference to the CCA's water pollution risk assessment. You referenced that pathways for contamination are real, may be underestimated and could last up to 10 years. Now, the industry in Canada, of course, has been ramping up considerably in the past 10 years, so we're imagining the scientific research is going to be lagging behind there. You did reference the Environment Canada 2011 report — scientific assessment — to inform the identification for critical habitat for woodland caribou boreal population, and there are many reports out of the States on wildlife effects, so if you could, either today or by way of a timely return, direct the Committee's attention to any other Canadian reports to which, in your opinion, would add value to our research in our efforts here.

Mr. Reid: Thank you. Yes, that's a good point. The notes in conjunction with my PowerPoint — I can amplify those with additional references that I have gathered in doing the research for this presentation. Those go over, in much more detail, many of the infrastructure issues in particular and some of the mitigation processes and procedures that have been suggested for those. I will commit to forwarding that.

Hon. Mr. Dixon: In your discussion around infrastructure — you spent a significant amount of your time discussing infrastructure for obvious reasons, but what I was

going to ask was: How many of the concerns about surface or linear disturbance are unique to hydraulic fracturing versus another land use, for instance, forestry or mining or any other resource development that would require similar or increased levels of infrastructure? To reiterate my question, how does the development of infrastructure and the surface or linear disturbances — how much of it is specific to hydraulic fracturing versus other land uses?

Mr. Reid: I would say that, generally speaking — and I think I made this point in one of the slides — is that, overall, relatively small amounts of the surface infrastructure are unique to hydraulic fracturing.

The general pattern of seismic exploration, road development to set up drilling paths, airports, pipelines and so on and so forth are very similar between the hydraulic fracturing play and a conventional play. Some of the hydraulic fracturing plays are a little bit more intensive in terms of infrastructure because well pads have to be bigger to support the higher numbers of vehicles that have to be on the well pad and containment devices and holding devices for sand and chemicals that have to be on the well pad at any one time, along with the reserve pit. The well pads themselves are often considerably bigger and sometimes there's a higher density of them. Sometimes the actual road network is more of a high-grade road network rather than a low-grade road network because of the higher traffic volume — all of those in a hydraulic fracturing play compared to a conventional play. But the basic disturbance threshold idea — the cumulative impact idea — is very similar between the two.

Chair: Thank you. We're finished with our Committee questions. We're going to entertain some questions from the public.

Mr. Tredger: Thank you, Madam Chair. This question is from Sean Smith of Kwanlin Dun First Nation: In your opinion, are Yukon First Nations' constitutional rights to harvest healthy fish and wildlife an issue if hydraulic fracturing is allowed to proceed — health and population?

Mr. Reid: Thank you for the question.

I believe there is a substantial risk that those rights would be at risk themselves as a result of the potential for water pollution from the deep well that then comes to the surface through groundwater and surface seepages and so forth. I will say that I think this risk is actually enhanced in the Yukon compared to many other jurisdictions because we are conceiving of doing hydraulic fracturing in a mountain environment. That necessarily means that the geology is more fractured because of the geological processes of mountain building. The strata in the sedimentary rock are more likely to be vertical, in part as a result of mountain- building activities, in comparison to the structures underlining the Peace River country or much of northern Alberta, where the sedimentary rock layers are much more horizontal. The more vertical nature of a sedimentary rock structure that is faulted and fractured that way would enhance the ability of polluted water at depth to rise up and get toward the groundwater.

The other reason why I think there is more risk in the Yukon is that with this relief, we have many more perched water tables. That is a water table's groundwater that is relatively high in elevation on slopes above valley floors.

You see strong evidence of this in the winter in many areas around here where there are lots of seeps, springs and resurgences — that is, underground rivers that come to the surface. You see this as open water on lakeshores. There are frequent open water areas right through the winter along most of our lakes in the southern Yukon. I don't know so well for further north, in the Old Crow basin or anywhere like that, but I'm amazed by this surface resurgence of groundwater in the southern Yukon.

If the water table did become polluted, there is a much-enhanced chance of that pollution reaching the surface at places where animals would go to drink and find water in the winter — and, of course, in the summer as well because the processes are year-round. In particular, these open-water habitats become fairly key for certain species in the winter as little foci of activity.

There are two processes there whereby I think the risks are potentially bigger in the Yukon, especially if the drilling happens somewhat on the valley sides where the groundwater could become contaminated.

Mr. Elias: I believe this question is from Sandy Johnston — it's the first name that I can't see here. The question is: Linear developments associated with oil and gas development — for example, seismic lines, roads, et cetera — have spelled the demise of caribou herds in northwestern Alberta and northeastern B.C. What are the risks of linear development on barren-ground caribou — for example, the Porcupine caribou herd?

Mr. Reid: Thank you for the question. I think the risks to the barren-ground Porcupine caribou herd are somewhat less than to the boreal caribou herds of northern Alberta and northeast B.C. The reason I say that is mainly because barren-ground caribou are migratory. In northeast B.C. and northern Alberta, the boreal caribou herds are essentially using the same seasonal habitats year-round. They are relatively restricted in space and they can gain all of their nutrient requirements by living life that way. They do not need to migrate to take advantage of seasonal pulses of vegetation on the tundra to enhance the growth of their calves. They can migrate south into the forest to take advantage of lichens in the winter. So the boreal caribou are just dealing with life in a different way and in a way that puts them cheek-by-jowl with the disturbance year-round. Therefore, the whole impact of these ecosystem processes working through wolves killing caribou, which is the proximate cause of the caribou declines, is going to happen no matter what. With the barren-ground herds, one of the main reasons why they migrate, along with going to the pulse of Arctic vegetation, is also to minimize the risk of wolf predation because they are essentially moving to an area where wolves aren't resident. Barren-ground caribou herds can probably deal with this infrastructure in a more ready way.

The issue boils down, though, to the extent of the range within which the infrastructure is being laid out — the seismic lines and so forth. What proportion of that range, which is generally the winter range for the barren-ground herds, is being hit by the infrastructure? We don't know yet what that threshold is right now, unfortunately. Barren-ground caribou use a huge area potentially as their winter range over many decades, and they probably move around in that largely to avoid a lot of the forest fires that reduce the habitat quality for good portions of the winter range. If we can put that infrastructure in the places where the fires are, or have been recently, which is not a good place for caribou to be in any case, that's a major mitigation step. I don't know to what extent geographically that can happen between Northern Cross' activities and fires, but if you can overlap disturbances in that way, you reduce the potential impact on caribou in a major way, I believe. That was one mitigation point I put up on that chart about overlapping disturbances.

Chair: I have question here from Werner Rhein. Dr. Reid, do you have any information on how much negative impact from solar or wind energy occurs on wildlife or the environment?

Mr. Reid: I have a cursory knowledge of those aspects. I haven't researched them in detail. I will say that wind energy can have detrimental effects on a variety of wildlife through two main mechanisms.

One is the direct conflict, or sort of collision, of various creatures with the windmills — bats and birds mainly. The other is the noise or vibrations — various sensations — that creatures feel from the motion of the windmills that may induce them to leave the immediate area.

With regard to solar, it's really largely a question of the footprint of the solar development. To gain very much energy from solar, one needs a huge footprint of solar-collecting cells and devices. It will necessarily result in the removal of a substantial portion of habitat for certain individuals in order to set up a solar farm. Above and beyond those generalities, I can't say any more.

Ms. Moorcroft: I have a short question but a vast subject from Sally Wright at Kluane Lake. What about climate change?

Mr. Reid: That is a topic in which I purposefully didn't engage in this presentation although I could have. I think it's an important topic for the Committee, if I may say so. Overall, it's a question of greenhouse gas emissions in the current global context of climate change and, ultimately, in my mind, it's an ethical question of — should we as a society be engaged in novel hydrocarbon developments that will necessarily bring new greenhouse gases directly and indirectly into the atmosphere in a time when we know that doing so is causing certain nation states around the globe to essentially disappear because of sea level rise, and when we know — I believe we know this categorically — that we will increase the risks of weather-related disasters, both to ourselves in Canada and also globally by doing so?

I believe we're at a cusp in terms of the ethical issue around greenhouse gas emissions, where we as a society need to grapple with the issue of whether or not we should even entertain the idea of putting new hydrocarbon developments on the table at all. That's my take on greenhouse gas emissions. That's my biggest take. There are some more subtle nuances around methane emissions from wells and so forth, but those are not unique to hydraulic fracturing and they are part of the overall picture of greenhouse gas emissions from hydrocarbon developments generally.

In response to that question, I would just say specifically that we as a society should be thinking about the ethical dimensions of greenhouse gas emissions and novel hydrocarbon developments at this time.

Mr. Silver: This question is from Werner Rhein from Mount Lorne. How much impact on wildlife will seismic testing and the correlating line-cutting is documented?

Mr. Reid: There are two aspects to that. There is the seismic testing — that is, the explosions themselves I presume is part of that question and then the line-cutting.

I do not know of any comprehensive studies of the actual impacts of the seismic explosions on organisms in terms — I mean there will obviously be some kind of an avoidance of noise that is induced by the helicopter activity moving the seismic crew down a line, setting up the small drill device in which the explosives are placed in order to let off the explosion, and so on and so forth. I do not know of any studies that have marked individual animals that have demonstrated a particular health response or a behavioural response to a particular set of seismic explorations. I think we are just inferring that there would be avoidance because of the noise. There has been a study on birds that has documented a movement away from permanent well-used linear corridors by birds because of the disturbance activity. That is one study I am aware of.

With regard to the broader question of the seismic line-cutting and the impact of that linear feature permanently on the landscape, there have been numerous studies trying to understand the mechanisms whereby wolves and other predators — in particular bears, but also coyotes — might use those lines in order to enhance their ability to get at big game and enhance their kill rates. That is all part of that disturbance threshold model, which has really demonstrated that the caribou declines in northern Alberta and northeast B.C., in a proximate sense, are a result of wolves using these lines and enhancing their kill rates on caribou.

So to that aspect of the question, there have been lots of studies investigating the longer term effects of these seismic lines and linear corridors on the ecosystem processes. I hope that answers the question.

Hon. Mr. Dixon: This question is from Kevin Alexandrovich. What would the future environmental harm be if places like Swan Haven became contaminated or obsolete?

Mr. Reid: Places like Swan Haven in particular, and more generally Lewes Marsh and the outflow to Marsh Lake, are very high-value habitats. Similarly, the Nisutlin River

Delta, the outflow to Frances Lake, the outflow to Kluane Lake — these are examples of water bodies which, if they did get contaminated, there would be huge impacts on wildlife. That is the kind of risk that we want to at least minimize if not get rid of from the discussion table entirely. Because trying to deal with a pollution issue once it's established in a circumstance like that would be almost impossible because you can imagine these contaminants in the groundwater and in the subsurface aquifers would gradually be coming to the surface over the period of a number of years.

It's not just like a short-pulse experiment where you put in a bunch of pollutants and they're diluted from the system quickly. There is a real risk with this water pollution issue that those contaminants underground are gradually going to come to the surface by various means over a prolonged period of time.

The real question then becomes, what is the risk of those particular hotspot wildlife habitats being close to springs, resurgences or seepages of water that are linked to subsurface aquifers and groundwater in a fairly immediate way. We don't have the answer to that question often. The main reason why those particular places like Swan Haven are open water and are attracting the wildlife densities of migratory birds at that time of year is because it's the outflow to a lake where the warmer deep water in the lake is coming to the surface in order to flow out of the lake and is keeping the ice from forming for much of the winter.

There is a huge dilution effect on a big lake like Marsh Lake, so I don't think the risk is huge in that particular circumstance of pollution unless there is an aquifer spring seep fairly close by that is bringing groundwater into that particular site at the time of year that the animals are there.

It's a bit of a convoluted answer there, but once again it points out the absolute necessity of understanding better the aquifers, the groundwater flows, the way in which water is moving under the surface of the earth and coming to the surface if we're going to grapple with this question of water pollution. Thank you.

Chair: The time for questions has elapsed and I want to thank you, Dr. Reid, for attending here today. Thank you to all of the visitors in the gallery and those of you who submitted questions. The Committee will review the remaining questions and do our best to follow up and ensure that they are answered.

Now we are going to take a 15-minute break before proceeding with our next presentation. We will reconvene at 3:15 p.m., please. Thank you.

Recess

Chair: Order please. Welcome back to the proceedings of the Yukon Legislative Assembly's Select Committee Regarding the Risks and Benefits of Hydraulic Fracturing. For those joining us in this presentation, allow me to introduce the members of the Committee. I'm Patti McLeod, the chair of the Committee and Member of the Legislative Assembly for Watson Lake. To my left is Lois Moorcroft, who is the Committee's vice-chair and Member for Copperbelt South. To Ms. Moorcroft's left is Sandy Silver, the Member for Klondike. Behind me is Darius Elias, the Member for Vuntut Gwitchin. To Mr. Elias' left is Jim Tredger, the Member for Mayo-Tatchun, and to Mr. Tredger's left is the Hon. Currie Dixon, the Member for Copperbelt North, Minister of Environment, Minister of Economic Development and minister responsible for the Public Service Commission.

This Committee's mandate is set out in Motion No. 433, which specifies that the Committee is to develop a science-based understanding of hydraulic fracturing and also allow for an informed public dialogue. To this end, we have heard several presentations over the past two days concerning both the potential risks and benefits of hydraulic fracturing.

I would like to welcome the visitors to the public gallery and our final presenter today, Mr. John Hogg. Mr. Hogg is the vice-president of exploration and operations at MGM Energy Corp. and will be sharing with us his experience with oil and gas development in northern climates.

Following the presentation, we'll take a short recess before proceeding with questions. If visitors in the public gallery would like to submit questions, forms and pencils are available at the entrance to the gallery. The page will collect the written question forms shortly before the end of the presentation.

After asking a few questions each, members of our Committee will randomly select written questions from those that have been submitted by visitors in the gallery. Time will not guarantee all public questions will be asked and answered, but we will do our very best with the time that we have. I would ask that questions and answers be kept brief and to the point so that we may deal with as many as possible.

Please note that these proceedings are being transcribed and recorded. If your question is selected, the information you fill out on the form may be read onto the public record.

I would like to remind all Committee members and Mr. Hogg to wait until they are recognized by the Chair before speaking. I would also ask that visitors in the gallery respect the rules of the Legislative Assembly. Visitors are not allowed to disrupt or interfere in the proceedings. Please refrain from making noise, including comments and applause, and mute any electronic devices.

We will now proceed with Mr. Hogg's presentation.

Mr. Hogg: First of all I would like to very much thank the Committee for the hard work that they've done. Thank you very much for the opportunity to be here in front of you and speak. I have spent a considerable amount of time following the Committee since our initial encounter in Calgary in early January. I have gone through all the presentations that were available to me on the websites and, other than yesterday morning when I was travelling to the Yukon, I have attended the meetings today as well. I think the Committee has done a fabulous job of trying to get the width and breadth of knowledge, and I'm sure you know far more

about fracking now than you ever thought you would when you started.

I would like to start with this beautiful picture of the central Mackenzie corridor — to your right in the centre of that is the Hamlet of Tulita — about 200 people. You are looking at what is a very sacred for the place for the Sahtu people, a bare rock. The picture is taken on the mighty Mackenzie, the Deh Cho, the great river, right before the Little Bear comes into the river.

At this point in the Mackenzie River, it's about a mile and a half wide, a little over two kilometres wide, and it is the source of transportation for us because, unlike the Yukon, there is no road in the central Mackenzie.

I'm going to give you a little bit about the MGM just so the people in the audience who maybe don't follow oil and gas know a little bit about us.

We have been around since 2007. We're only a northern exploration company. We are one of the largest leaseholders in the Northwest Territories in the Sahtu, the Inuvialuit Settlement Region, the ISR, which is on the Mackenzie-Delta. We operate a little more than 500,000 acres, around 200,000 hectares, of exploration land in the Sahtu. We drilled in our seven-year tenure about 10 wells in the Northwest Territories, and the reason I'm speaking to you today is about a well we drilled in the winter of 2013 that was drilled and hydraulically fracture-stimulated.

Just a little bit about me — I'm not going to read all of this, but I know that you may not know much about me. I'm a professional geologist by training. I'm registered in the Northwest Territories, Nunavut and Alberta, and I'm also a certified petroleum geologist with the American Association of Petroleum Geologists. I've spent more than 32 years exploring. I've explored in all provinces and territories except for Manitoba, and maybe you want to ask me a question about that later. I have been involved in drilling and fracture stimulating wells since the 1990s in a field in Alberta.

In terms of my volunteer roles, I have played a significant role with the Canadian Society of Petroleum Geologists and am a past president. I have spent two terms as a councillor with the Association of Professional Engineers and Geophysicists of Alberta, and I am currently president-elect of the American Association of Petroleum Geologists — some 44,000 members in 120 countries.

How I am going to set this presentation up is I am going to do an overview for you of the central Mackenzie in terms of operations, drilling, groundwater monitoring, wells, how we drill an exploration well, talk a little bit about the completions and the fracture stimulation, and then I am going to turn my attention to the Yukon and talk about exploration for shale resources in the Yukon and give you some of my observations of what you might consider if you choose to go forward with this type of development in the Yukon.

I have tried to compare here the size of the work that is being undertaken in the Northwest Territories to the Yukon. The map on your left is a map of the western part of the Northwest Territories and, of course, the Yukon. The inset in the middle there is the area that we are currently looking at as an exploration target for the Canol shale. That area measures roughly 50 kilometres wide by about 100 kilometres long. That is the area that has potential for this Canol shale.

This map on the right is an inset of that, showing in yellow — for the most part — the area where there is potential for the shale to be able to be produced. Of that area, only a small part of it — the best part of that shale — will be produced. Much of it will be considered uneconomic, but until we drill it up in the exploration time frame, we really won't know where the best parts of the shale are. Although the shale exists through that entire yellow area on the right-hand map, it's very difficult to know where the best parts are.

I would also like to draw your attention to the very centre of that map, the Town of Norman Wells. The Norman Wells oil field has been in operation since 1979. It has produced more than 330 million barrels of oil in a buried pipeline in the permafrost that goes to Alberta. The oil and gas industry in the central Mackenzie has been there for a long time and people are fairly familiar with oil and gas operations.

The project I'm going to talk to you about in east Mackay, just from this reference map, is just south of the Town of Tulita where I showed you that initial picture. It's just about 20 kilometres as the crow flies to the south of the Hamlet of Tulita and that's where I'll spend the majority of my discussion.

This is a land activity map for the area. What I mean by that is that these are like the licences that have been offered up for sale since the first sale in 2011. This map is active as of 2014. I want you to understand one thing about this map. Each of the blocks, which are called "exploration licences" or ELs, is about 80,000 hectares — 80,000 hectares is a little more than eight townships of B.C. land.

One of the interesting parts about the federal land tenure system — which is what you're in because of devolution and you've mirrored a very similar land tenure system — is that you don't have the same complications that you do in the southern provinces, B.C. and Alberta, where the land system allows for down to a quarter section of land — and let's remember that that would be in the order of 120 hectares of land — to be bought by a single company. So one of the challenges that we have in northeast B.C. and — when I listen to a lot of the presentations about northeast B.C. and the amount of activity and the number of companies and trucks and wells — is that this whole concept of a checkerboard of land — and here's an example from northeast B.C. — in all of that land, each one of these blocks here is a township. I can show that to you. So a township is made up of 9,300 hectares of land. If I take one of those blocks I just showed you on the previous map, it accounts for eight of these. So instead of having seven or eight or 10 companies all involved, you're only going to have one company exploring that land block and you're going to have one company controlling that block. So I think that you have to understand that what you see in northeast B.C. isn't really possible in the same way in the

Yukon because your land tenure system just doesn't allow for what we would call checkerboard land to happen.

You would grant land tenure to a company for 50,000, which is your maximum size today, and that's as large as they're going to have. You're not going to have all of these interspersed companies, each trying to and competing with themselves and building their own roads and multiplying the infrastructure. It's just not going to happen. I think the tenure system you have, which comes from devolution, is a very good one for you to maintain.

I'm going to move now to the high-level overview of the MGM 2012-13 program. Again, I've moved this map down to the point where now we can see the hamlet of Tulita on the far right here. Because we are infrastructure-poor and we have no roads, you start your program by barging — and I'm going to show you some of that, and here's our barging staging area up here. There's an ice road and a winter road that comes across the Tulita. The Government of the Northwest Territories built an ice road across and the winter road continues up to Norman Wells as an ice road. We built this infrastructure of our own road on the Mackenzie River to our staging area, and then we went down, using pre-existing lines, so that's why this isn't straight — mostly seismic cutlines. Then we came to our area here, in East Mackay I-78.

That whole project started from September, with move-out to the middle of March, when we were back out of the project area. It involved: doing the staging; building lease roads and construction of a lease; drilling three groundwater monitoring wells to ensure that we understood the groundwater conditions in the area; and then drilling a vertical exploration well, which we cored — took physical rock out of the two shale formations. We did three vertical fracture stimulations within that well and we did a short-term production test of that well. What I'm going to do over the next series of slides is highlight that to you as a montage.

In terms of the regulatory process in the Northwest Territories, it's far more comprehensive than it is in the south.

It took MGM, or the other players that are working in the same area as us: nine to 12 months to secure the approval to drill a well; multiple stakeholder consultations, both government consultations and community consultations; a review of the project description by more than 20 Government of the Northwest Territories and federal agencies; a review of the project description by local Sahtu boards, towns and hamlets. Coordination of the project description is done by the Sahtu Land and Water Board, which is sort of the equivalent of your YESAA process here, not quite the same, but pretty close.

The technical well design and jurisdiction when we drilled our well was the responsibility of the National Energy Board. Today, because of devolution, it is a joint responsibility of the Government of the Northwest Territories and the NEB.

I just want to give you a sense of the size of the project description to drill and fracture stimulate our wells. The pictures don't do it justice, but it is a 1,200 page document that took us nine months to compile. The entire document is available on the Sahtu Land and Water Board registry website, so everybody has the right to review the document before we gain our approvals, make comments — including the agencies both federal and territorial.

All aspects of the drilling and fracture stimulation, including all chemicals, are part of the public record in the Northwest Territories. I have heard some discussion today about — again — this whole idea of we keep these things secret. Before we actually get our permits to get on the land, there has been a discussion of all the chemicals that have been used by companies in the Northwest Territories.

Not included in this 1,200 page report are any of the other approvals related to the drilling or the hydraulic fracture stimulation because those are National Energy Board approvals.

Separate documents go into them to explain the technical aspects of physically drilling the well, cementing the well, ensuring that we have a good bond between the casing and the cement, and how we are going to hydraulically stimulate the well. All of the technical aspects are not part of what the Water Board manages. They are part of what the federal regulator managed at the time. In the territories, again, you have equally different regulators for that process, but they are two separate processes for drilling as well.

I believe that this is a very robust and thorough review process, and I can't say that I know of a process that's more thorough than what we've gone through in the Northwest Territories and continue to go through, and I support the process.

Before we can drill our well, there are a number of things we have to do and there is a lot of activity to do. The picture on the top right is the staging area that we used. Again, it was a pre-existing staging area right on the river. On the very top of that you can see bare rock again. To give you perspective, I was looking downriver and now you are looking upriver. You can see we had a staging area that had been pre-existing, so we didn't have any additional disturbance.

Before we could even get on that staging area, we had to have access and benefits agreements signed with the Sahtu, in particular the Tulita District Land Corporation. We rent this from the First Nations because it is on their surface land, and we pay fees to do that. We need land use and water permits. We would have to barge all of our equipment to the staging area because there are no roads. All the work we do, of course, is in the winter because we build our own ice roads. We have technical applications, as I said, to the NEB. We have surface water sampling, which we did in the summer before we got there and then in the summer after we got there, and, in fact, we're going back this summer again to continue that surface water monitoring. We drilled our three groundwater wells, which I'll talk a little bit more about in a minute. We drilled our well, and we hydraulically fracture stimulated and then we did a short test to flowback the fluids.

Just a sense for how long that takes, if you include the barging, load out and staging, which we started in September,

we were really on the land by late December constructing our roads, and by late January we had made it to our well site. We constructed our well site, which was an ice pad 80 centimetres thick. All the roads are 60- to 80-centimetre thick ice roads so that we're not affecting the tundra, and then drilling, coring, logging and fracture stimulating.

There is a lot of employment related to drilling, and so these next couple slides are really some of the benefits that I see of having oil and gas development in the Yukon as it is beneficial in the territories. Services that we need to do this — we need a drilling rig and we need that drilling rig populated, camp and catering, road and lease construction, general oil field hauling, service workers, wildlife monitors, logistic support, testing, fluid handling, and industrial fire protection. All of these projects require us, because of our access and benefits agreements, to employ northerners first. We do our best to ensure that the workers we use and the companies we use are northern-based companies so that the jobs go directly to the benefits to the communities.

In this project alone there were about 100,000 man hours of work required to do the job. More than 8,000 12-hour employment days and, of course, we work 24 hour days, so it is a significant amount of work and more than 50 percent of those hours were done by northerners for this project — who live everywhere from Tulita, Déline, Norman Wells, all the way up to Inuvik — because it's easier for me to bring workers from Inuvik than it is to bring them from Edmonton because it's a shorter flight, even though that seems strange.

This is not legible to the audience and I apologize, but you'll certainly be able to spend some time looking at it when you see the notes. This is a list of all of the northern services that we employed, from travel with Air North to drilling and communications and camps and catering and medical services and trucking. There's a significant amount of work that came out of Norman Wells, Tulita and the communities all up and down the valley to be able to run this program. Without the northerners, we couldn't do this job. It does bring a business focus to the companies here and it brings job opportunities and cash flow to the communities.

This is out of our benefits statement to AANDC. I just want to share with you how much of that money is devoted to each. I apologize if the audience can't see this. But you can see that of the total wages, $1.3 million of that money stayed in the north. Of that, more than $1 million of that stayed with First Nation people, whether they were Tulita, Dene and Métis, or they were of the larger group, the Sahtu Dene and Métis, or they were northerners who were not First Nation people. $1.3 million of our program stayed as wages in the north and only $1.5 million was for wages in the south.

The year we did this program there were three rigs running, so three operations were running, and it was very difficult for us to employ more than this because the workforce with the three rigs was really tapped out. As much as I would have loved to have seen even more of this be northerners, I know those other northerners had jobs — whether they were working with Husky or they were working with ConocoPhillips.

Now I'm going to just give you a travelogue of staging and construction. I've shown you this staging area both in the spring when we were looking at it in beautiful climates. This is minus 30 in a helicopter going to inspect the staging area after we had put all of our equipment on it. You can see the existing road that we had here, which was the pre-existing road from a previous use of this by another company and so that's what it looks like. This is the Little Bear River, which is on the top coming into the Mackenzie River.

Staging — because there is a lack of infrastructure, everything we do, we have to bring with us. You can see us in Hay River here loading up barges with everything from cats to drilling equipment to our water well drilling rig, which is sitting back in here, to end dumps so that we can use those. We then bring those all upriver and then we load them out in this area and then we go away and we wait for winter.

The one critical element of this was staging fuel, because we had to have start-up fuel before the river froze so that we could start. We staged about 200,000 litres of diesel in double-walled containment vessels which we then, again for additional safety, put into a bermed enclosure to ensure that we had triple redundancy and that there was no potential leak into the environment while that fuel was waiting for winter.

Preconstruction of the program involved making a 23-kilometre onshore road on the land and a 13-kilometre road on the Mackenzie River. The lease that we used for this exploration well was relatively small — 150 by 200 metres. It was an exploration lease and, again, it was 80-centimetre thick water-flooded ice lease, so 80 centimetres-plus of water over the tundra to ensure we were protecting the environment.

All the roads that we used were previous seismic lines — so no additional disturbance — and the total water usage from our project was roughly 40,000 cubes. Eighty percent of that was used simply to build roads. We get very good at building ice roads. Fifteen percent was used to build the lease and the staging area, which you saw earlier, and five percent was for camp use.

Preconstruction — so I'm going to give you just an example. This is a pre-existing seismic line that cuts through a little slough here. We made sure that we had, in summer, gone and scouted all these lines. We hoped for a good winter, which we had, which was very little snow in the beginning. There was a very good ground freeze and then we started pouring water, as we marched these 23 kilometres down these roads.

Post-construction — what we have looks very much like what they call the central Mackenzie highway. It's a fairly nice, two-lane road that two trucks could pass side-by-side. I'll show you two examples, because you may see other pictures in here.

This is very typical boreal forest up here — fairly thin trees. A lot of the area we are in is a 20-year-old burn site and some of it looks like this. If you see another picture where the trees look like this, we are in a burn area versus a non-burn

area. In the distance, you can see the lease. This is not a flare; this is our rig shining in the winter sun.

Water well drilling — we made a commitment to the Sahtu Land and Water Board, as did all the explorers in the central Mackenzie valley to better understand groundwater, the aquifers and the movement of that water. The central Mackenzie is a little bit different than a lot of the Yukon. We have very little quaternary deposits. We have very little gravel. Rock is very close to surface, so in the case of this area, I will go into it in a little more depth.

After about 150 metres, there is no water in the system all the way down to probably close to 3,000 metres, so it is an aquitard.

As many people have said, geology changes from place to place to place. Here we know where the water is — we can map it out fairly well. It is fresh water — it is drinkable — and so we wanted to ensure that we could drill the wells before, monitor those wells before, be able to test those wells during fracking and test them after fracking. We went back the summer of 2013 and sampled them again and we went back the summer of 2014 and sampled them again.

The drilling of a water well — and I know in the Yukon you use groundwater — so it is a fairly understood thing here. In the Northwest Territories, there is no use of groundwater. For the First Nations people, understanding why we are drilling these wells — understanding groundwater — all the water that the communities use in the territories is surface water.

But you have a very small drilling rig, you drill the well down, you put a piece of liner in it and then you are able to flow that well and understand both the potentiometric surfaces and be able to get the samples of the water whenever you need to.

Here is an example of the water wells: there are two of them here that have been drilled and capped, and a third one that was set up a little bit higher so that we could actually use this one to do a flow test on the water. The reason you would do a flow test on the water is to pump the water out and get a sense for if the other wells are changing their static radiant heights. If they are, you know you don't have a lot of water. If they aren't, you know that the water quantity is fairly large. So we tested this well for 24 hours. We flowed about 14,000 gallons of water out of it — about 55 cubes of water — to get a better understanding of the potentiometric surface and the amount of water within the reservoirs.

As I previously stated, we believe that groundwater monitoring wells are important, especially in areas like we are in the central Mackenzie where we can collect baseline data because there has been no drilling and there has been no production. We know that if we can establish that the water is safe to drink, that the water is not tainted, we have great baseline data and we're very happy to have that.

We also tested, as I said, the surface waters around the creeks, the sloughs and the small rivers that are running — all three here — to ensure that none of those waters had any hydrocarbon or any effects of the hydraulic fracturing.

In general, I just wanted to let you know the groundwater results. The results from our wells show that the freshwater was located roughly between 80 and 100 metres and is naturally a little bit high in fluoride, copper and zinc — again, not surprising given the local geology around there that the recharge would have this type of thing.

There is no trace of hydrocarbons in, before or after our operations and all of the water data is public. Again, I can't emphasize how important that is to us. The Sahtu Land and Water Board — I've left a link there which is a large link, but the Sahtu Land and Water Board has all of the projects, not only MGM's. All of the companies drilled water wells, all of that data is public and we're happy to share that data with both the communities and the Government of the Northwest Territories.

I wanted to comment a little bit about the use of hydraulic fracturing because I've heard a whole bunch of information here. In the Northwest Territories, and I think in general, exploration phases — so the very first understanding of is this going to work or not going to work, because not all shales work — most of the time we use surface waters. Why? Because it's very expensive in the north to be able to just explore to have to drill your own wells for water. It is not going to be easy if you don't know you have a project. The use of surface water in the beginning — it makes sense.

The other thing I want you to remember is, although we talk about wells going to 40,000 and 60,000 cubic metres of water use in northeast B.C., in the exploration phase, they probably use less than 10,000 metres of water because what you're trying to do is understand if the formation will flow, not to find out how much you can flow out of any one well. In the early phases, the water use out of surface waters is very small compared to what I've heard here today and what I've read in other peoples' publications.

Secondly, if development occurs in the Northwest Territories, there is most likely a use of subsurface non-potable water, so salt-laden waters from deep formations — probably below 3,000 metres — and they will be used not only to fracture stimulate, but that flowback water will also be disposed of in those same formations. I think if you check the literature on some of the work today being done in the Horn River by Apache and Encana, the largest wells that they're drilling now are not using any surface water. I want to make that apparent to you that if you go read the literature, especially Apache's website, they'll tell you: all of the water they're using for fracking today — or 99 percent of the water they're using for fracking today — is coming from subsurface aquifers. They are using that water; they're not using groundwater — sorry, surface water or subsurface potable waters. You have to be careful which term to use.

I just wanted to show you a little bit about the exploration drilling. This is the Akita rig that we used on our lease. You can see that the lease — compared to northeast B.C. pictures you've seen — is relatively small, you know, 100 by 150. Again, we're in a burn area so the vegetation around us — because of the snow you can't see it. It's quite green in the

summer, but in the winter, it's not the prettiest sight. But this is a typical set-up. You have a rig. You have some equipment around it. We chose not to have our camp at the lease area. We chose to have our camp at this staging area so that we had less disturbance of the land and less disturbance of bringing all of that equipment up here. Again, it was a decision we made. Other operators may have made a different decision.

This is a stratigraphic chart and, as a geologist, this is to me a normal thing to look at and understand. I just want to spend a little bit of time on this, especially for the audience. On the left here, you have what we, as geologists, consider time, our relative time scales: Mesozoic, the time of the dinosaurs; Paleozoic, the time of fishes, and the oceans, really, being the productive time. The water wells that we drill sit up here at the very top in the Little Bear, which is sandstone, probably related to an ancestral Mackenzie River that flowed through here millions of years ago.

Below that, as I said, we had what we refer to as aquitards, so we have the Slater River shale and we have the Imperial shale. We have all of these formations, which are more than 1,600 metres — a little more than a mile — thick, and it's all shale. There's no water in the system. It's all aquitards.

The Canol shale, which we drilled at around 1,800 metres and fracture stimulated, has two zones — an upper and a lower Canol, and then a Bluefish member, which we also fracture stimulated in the zone. You have to go below this Hume to the Landry and Arnica to be able to find waters down in here. These waters would be very salty — three or four times as salty as the ocean is today. Those are the areas where we know, as geologists, that, in the subsurface, water exists in these rocks in bountiful quantities. It's non-potable and we would use that water to fracture stimulate if this project went ahead.

This is a picture of the Canol formation and, for scale — and I know it might be a little hard to see — these are helicopters. The Canol formation is about 100 metres thick. It is naturally fractured, and the natural fracturing enhances our ability to take the hydrocarbons out of it. In close-up, this is what it looks like. You can see these vertical breaks in the rock. This is due to two things: the rock is very, very silica rich — this glass is made of silica. Silica-rich rock tends to be brittle and fracture. Just because the rock is brittle and has a fracture pattern doesn't mean the water is going to leak out of this rock and get to the surface.

As I said to you back here, we have the Canol formation, which is very brittle. We have thousands of metres of shale above us, which is not brittle and it's not fractured in the same way. Two different shales will react very differently to stress — some break, some strain, some get a little squished up — but in our view, and in the view of a subsurface geologist, the potential for the Canol formation to be leaking into the subsurface groundwaters through permeations of water moving vertically — it's just not going to happen. It's not going to happen. There may be cases of specific basins where there is a connection of sands through the system or reservoir rocks through the system that would allow for waters used in fracture stimulation to make it to the surface, and I would say to you that if you have a basin like that, it's not a good idea to have us open it up for business. It's probably not a basin we would be interested in because, if that basin has those conditions, over geological time the hydrocarbons have already escaped. If I have a naturally fractured rock and that rock has an ability to have its gas come out through fractures — if the water can get out, the gas would have gone out a long time before and so would the oil, because both of them are buoyant to water, so they want to move away from water.

When I see these people suggest that the water would just magically over time move up and get into the groundwater, I just don't think they spent a lot of time working with rocks in the subsurface.

This is a picture of our fracture stimulation. It's a very different scale when you're exploring from what you have been shown by many people in a full field development scenario. We have a couple trucks that have our sand. Over here we have some fluid tanks in the back for the frack fluid, and then we have our horsepower to be able to fracture stimulate the unit.

This is the wellhead itself where the rig was in the previous picture, and you can see that the wellhead and the equipment around it is relatively small when you're exploring. I just want to emphasize that in the Yukon, like in the Northwest Territories, until we drill wells, we don't know if any of these shales are productive. Exploration is the first step.

I'm going to turn my attention now to the Yukon, and a little bit of this is my professional opinion from working 30-plus years in federal lands and from looking at the Yukon various times in my career. I think that the shale potential, in my personal opinion, is highest in the southeast corner of the Yukon and the Liard Basin. A conventional oil and gas in the Eagle Plains has certainly already been discovered, and I think there is a potential to establish an unconventional shale gas or shale oil play in the Eagle Plains area in the northwest.

I think the other basins are very, very high risk and very speculative places to start.

I want to compliment the work of the Yukon Geological Survey and Energy, Mines and Resources in particular. I think you have a devoted staff and they have done a lot of work. Unlike Alberta, where you have kind of one large basin and it kind of works up and down from Calgary to almost the border, you guys have very many different basins and I think your staff have done a great job.

I just want to highlight — this is a stratigraphic chart. This is the age of rocks down the edge and these are all your various basins and the types of rocks in them and a depiction of those rocks. Where those rocks have potential as source rocks, which are shale oil or gas rocks — like here in Eagle Plains — there is a little symbol here, which to a geologist means this rock can generate both oil and gas. Today this is a rock that you may want to explore for. What you see is that the Canol — the same rock that I am exploring for today — exists in a couple of the basins in Yukon and, in particular, in

the Eagle Plains area — and I think it has potential for either oil or gas. It depends on its depth and what it has gone through in its 300 million years of history, but I do think it has some potential.

As I spoke to earlier — I just want it documented though — I think you have a great disposition of rights or tenure system here. It does not allow for small pieces of land to be auctioned off. It allows for the minister and the Crown to be able to decide when — twice annually or, at the discretion of the minister — there are no sales.

Permits are issued as in most other federal lands to the rights to explore and test the hydrocarbons. The six- and four-year terms are very similar to the rest of the federal lands in Canada. Then you have some permits if you're holding it and waiting to develop it. Then, of course, if you had development, you would continue to hold the lands as long as you had production.

Just a couple of highlights about your system relative to the other federal systems that I have worked in over my career — your maximum size for posting is 50,000 hectares or 500 square kilometres. It's 30-percent smaller than the Northwest Territories — probably a good thing overall. The minimum bids for the Yukon are only $400,000, which I know sounds like a lot of money, but to our industry, that's a pretty low number — well less than half of the Northwest Territories' minimum bids, which is $1 million.

One of the things I think you should be concerned with or think about is that the existing regulations ensure that shale oil and gas extraction is done with the highest safety standards and highest environmental standards. To me, I think if I look at smaller numbers for disposition of land as minimum bids, I think what you do when you do that is you bring speculators in. You don't bring people in who are looking to drill oil and gas. They're looking to flip it to somebody else. I really don't think those are the people you want if you start oil and gas exploration for shale gas. I think you want bigger players who can do the type of work you want. Some of my ideas at the end will show you that. I think you want big players in here so that they can do some things and understand better before you move ahead about many things like groundwater.

I wanted to also share with you — because I keep hearing about these massive amounts of land that will be displaced in the Yukon. The Yukon, as I'm sure you're aware because this is your territory, is more than 480,000 square kilometres. Yukon shale gas will be some of the most expensive gas in North America to find and produce.

My personal opinion is that in 10 to 15 years less than 100,000 hectares of land will be developed for shale gas. So my question to Yukoners is: Is 0.02 percent of your land too much for oil and gas development? I think it's really important that Yukoners realize the size that we're talking about here. I think it's very small and I think there's an opportunity here for a made-in-Yukon solution for many of your energy needs. As an explorer, I'm going to tell you what I think the benefits of shale oil and gas development are. You're going to build a new industry by Yukoners for Yukoners for the diversification of your economy. I think that's always something resource-based economies look to.

I say to people who don't understand oil and gas exploration — as explorers, exploration was the first profession. It was the first profession in the world, because the first thing humans did was find things that they needed. They found rocks to kill animals; they found flint so they could make bows and arrows. We've always been explorers and resource extractors. Today, I believe there's an opportunity here in the Yukon to be a resource extractor and do that in a way that can increase local jobs and build businesses, allow for training and allow benefits to First Nations. I think you can displace diesel, which is not as clean a fuel as natural gas is, and you can produce oil and gas locally for your economy.

It's an opportunity to build a made-in-the-Yukon transportation system for LNG or compressed natural gas and in the long-term it's a look to liquefaction and gas-to-liquids technology to produce diesel in the Yukon for Yukoners.

I know you've had people come in and talk about LNG in particular, but I believe today that the technology exists for microscale CNG or LNG where you could take one of these units on the bottom here, which is just a skid-mounted unit, hook it up to a rig, take that gas and use it for Yukoners. I think the future, if we could find a significant volume of gas would be to go to a unit like this, which is a microgas-to-liquids unit. You can see a man for scale here. What you can do is you can turn natural gas into syn-diesel. These units will produce 500 to 1,000 barrels of diesel per day and you can make diesel in the Yukon for Yukoners. There are also exothermic reactions so you put the gas in, you get diesel out, and you make heat and heat can be turned into electricity. There are multiple ways to use these products to be able to help the Yukon.

Observations — I think you need to look at pacing the scale of development. I think you need to make sure that you start slowly. You start with one or two licences every two to three years. You make the licences smaller so you can control the scale of work and I would increase the minimum bid levels to ensure companies that are here have the wherewithal to do the jobs.

Access to information — I think all information should be in the public domain and that goes for groundwater, surface water, monitoring of all of those and also ensure that all chemicals and fracture stimulation design is public information. Let the public know everything that we're doing as the industry. They certainly don't trust us and I trust the government to be able to share that information freely with them.

Drilling regulations — I think you need to ensure clear rules around cementing, cement bonds; ensure that you have looked at natural gas hydrates and permafrost issues. We work with permafrost in the Northwest Territories — it can be done.

Hydraulic fracture stimulation — I think all of this information should be part of the public record — industry monitoring of fracture stimulation with microseismic so that

we know where the fractures are going, but then government monitoring of natural seismicity is important too.

Baseline data on natural seismicity — the natural earthquakes that are happening today is really important before we start so we can establish that.

Ongoing monitoring by both industry and government of surface and potable waters — I think that government should be looking at collecting waters as some people don't trust the industry to collect the waters. I think the government should be the ones who collect the water from our groundwater monitoring wells. I think that permafrost monitoring if we're far enough north is important, natural seismicity versus industry-induced seismicity, monitoring disturbance of flora and fauna as we heard previously, and host all of this information in one place. If I can complain about one thing in the territories, it is that it is everywhere and it is hard to find. Make sure that the government has it in one place and it's user-friendly to everybody.

I don't have a lot of time. I've spent some time with this report. I really think that, of the five distinct elements, the Yukon government has done a very good job of managing these, and maybe we can cover this a little bit more in the question period.

My very quick summary — I think shale resources can be explored and produced in a responsible manner in the Yukon. A number of the basins in the Yukon have potential, but they need to be explored, so let's not jump to the fact that we are going to look like northeast B.C. before we drill a single well and test this.

Shale requires horizontal wells and fracturing to be economical. If we're not going to allow for hydraulic fracturing, then we're not going to have shale exploration. Shale resources in my view hold a potential that could see the Yukon become energy self-sufficient through hydro, wind, geothermal and natural gas from shale. I thank you very much for your time and I'm looking forward to your questions.

Chair: Thank you very much for your presentation, Mr. Hogg. At this time, we are going to take a short recess and reconvene at 4:20 p.m.

Recess

Chair: Order please. We're going to proceed with questions. As mentioned earlier, please wait until you're recognized by the Chair and your microphone is on before speaking. We're going to start with questions from Mr. Elias please.

Mr. Elias: Thank you, Madam Chair. Thank you for your presentation, Mr. Hogg. I've asked this similar question about opinions from other presenters over the course of our discussions within the Committee and at the community level in our community of Old Crow.

I don't know where to begin, but I really care about the health of our community and how my constituents' stress level is or fear is about an issue. Since this discussion has happened in our territory, I've noticed, especially with the youth facet of our community, that the stress level and the fear level about this issue have really risen. When I'm sitting around the coffee tables with my citizens and they ask me: Have you watched *Gasland* and *Gasland 2*? Have you looked at these pamphlets — whether it's from local or national non-government organizations or whether they are new organizations in the Yukon that are against hydraulic fracture stimulation and send messages that the water is guaranteed to be poisoned? There are other political parties perpetuating that comparison.

Is it fair to compare what we see on an HBO documentary on what is happening in the United States of America to the Yukon? What is happening in the Barnett in Texas and what is happening in the Marcellus Shale in Pennsylvania and what is happening in the McLure Shale in California with regard to land ownership, land tenure, the regulatory regime and practices, the shale play width and lithology and with the companies that are actually working in the Lower 48 — to me, those factions do not simply exist here. In the Yukon, as we go through this valuable discussion, those comparisons are really prevalent, especially in my constituency in the community of Old Crow.

One, do you think that's a fair comparison in this discussion and, two, you mentioned some of the — I don't like using this word as I've said before — "unconventional" shale. One of them was the Canol shale that you mentioned. Depending on where you drill in the Eagle Plains Basin, the Canol shale is around 3,100 metres in depth until you get to that shale play. One, is it for oil? You don't have to answer this. Two, is it for gas or both? How deep is it in the area that you are working in Norman Wells, because that shale play goes right from the Eagle Plains Basin right to the Norman Wells region?

Mr. Hogg: There's a lot in that question. Let me just make a general comment about the U.S. versus Canada. There are very significant differences in the way land tenure systems work in the two countries. I could spend another day talking to you about the major ones, but let me just go to the very top one. The people who own the land own the subsurface. That doesn't happen, except in rare instances in southern Alberta, due to the railroad. In Ontario, early settlers owned their subsurface rights. But in all federal lands, which the Yukon is, the Crown owns all lands. You can't have a farmer deciding or an owner deciding to sell his land to company A and the next farmer sells to company B and the next farmer sells to company C and have an explosion — which I've heard many times — of work within the U.S. Because you can drill year-round, you could have an explosion of work in 12 to 18 months. That can't happen in the same way in the Yukon, because the Crown controls all of the land and the Crown controls the distribution of that land to the companies to drill and explore.

So let me give you my perfect example of that, which is Offshore Norway. Offshore Norway has a proven track record of putting out lands only when they choose to put additional lands out. It started in very southern Norway, just down 62 to

63 degrees. Today, north of Hammerfest at 68 degrees north, they are issuing that land. They did not issue all of those licences in the first year. They have been exploring for more than 35 years and what they did is they continued to allow for a slow and ensured pace of development.

Now, they go one step further. They pick the companies that get the land. The companies don't get to bid on land and the high bid wins. The government says, you receive this land, because they all have to go in and prove to them how they are going to work that land responsibly and what technical ideas they have.

So there are many tenure systems. That is one of the best. I think that many of the places in the U.S. are far from being perfect and I think you have an opportunity, because this is a new entry for you, to design that tenure system in a way that can do a slow-paced development.

In terms of *Gasland* and *Gasland 2*, I could spend a lot of time on that. I think *Gasland* is about industrial activity. It is not about fracking. It is about industrial activity. I think that a lot of it is misleading. I think that a lot of it has been disproven and I know that many people may not agree with me, but this is my opinion and I would be happy to talk more about it at another time.

Finally, what would I say to your people? It is the same thing I say to the peoples in the communities in the central Mackenzie. They all have access to the Internet. They all hear these bad things, but what we did and what ConocoPhillips did and what Husky has done, is we take the young people out and we show them the lease. We take the young people out and we show them the roads.

We take the young people out and we show them what we're doing and, all of a sudden, this big, scary picture that they're showing on TV or on the Internet doesn't look the same when they get to go and drive an ice road out to a lease and walk around that lease and see it. We have monitors there who are normally their friends. Their community people are there. They're there when they have lunch and they get to talk to them when they're on the rigs.

I think one of the challenges you have is, if your people were working on the rigs and being able to talk to the young people, it would be easier. Without it, I agree with you — there is a level of concern by all.

Unidentified speaker: (inaudible)

Mr. Hogg: You are going to get all the answers. In my opinion, the Canol shale, although we drill it between 1,800 and 2,000 metres, you're right — you're probably around 3,000 metres, but unfortunately, the depth today isn't as relevant as the depth in the past. Our shales at 1,800 to 2,000 metres weren't buried so deep that they're not still in the oil window, so what we flowed was liquids out of the formation. Until somebody drills a well and does some geological work on that formation, it could be either oil or gas, or it could be both. That would be my best guess.

Ms. Moorcroft: Thank you, Mr. Hogg, for coming and for your presentation. I have a number of questions. I know I won't have time to get to all of them. As we've seen in northeastern B.C. and other jurisdictions across North America, the pace and scale of fracking development is very intense — more so than for conventional oil and gas.

Industry is following market pressures to make a profit and, of course, they want to get a return on infrastructure and other investments. My question is: Would industry make these investments here in the Yukon if the production was limited to supplying domestic demand for gas in the Yukon, or would the emphasis be on exporting gas from fracking?

To put that another way, if oil and gas development were to go ahead, which would require hydraulic fracturing as you've said, how much LNG production would be used locally and how much would be transported out of the Yukon to southern and overseas markets?

Mr. Hogg: In terms of pace and scale of development, what I would say to that is you have every ability to control the pace and scale. You have the ability to put out one licence and wait five years — 20,000, or 30,000 or 40,000 hectares. You have one company in and they're going to do the work. You have a choice to decide if you want one basin to start, two basins to start. You are at the beginning, and it's yours to decide. If I were you, I would be excited to have this ability. You have basins that have yet to be explored. You have the ability to put the procedures in place to ensure that it's done safely, that it's monitored and it's reported.

In terms of — would the industry come to explore if they couldn't export? It depends on how that gas is used or oil is used, and what the domestic supply is. I think you had an LNG guy in here — and I'm sorry I was flying yesterday — who was talking about world prices. I would argue that world prices don't mean anything for a made-in-Yukon solution. The price for the made-in-Yukon solution is, what's the price to pay to get your diesel from Vancouver or Edmonton transported up here and bought by the people when you could explore for your own natural gas.

I'm guessing that that price is probably upwards of $15 per million cubic feet, whereas in the Alberta hub right now, AECO might be selling at $4. It has nothing to do with the worldwide price if what you are doing is displacing another product that is dirtier than natural gas and, if you are going to bring that party in and if you set the tenements of how you want them to come in, I think you could have those companies come in with the expectation of knowing what they are going to be able to do.

One of the challenges I had listening to New Brunswick today was, in my professional opinion, they did it backwards. They invited all the companies in, they gave them all the land, and then they went, "Oh, we're not sure we want fracking." Well, that's not the best way to start an industry in New Brunswick. I think the way you are doing it is exactly the way to start an industry, or not start an industry, if that's your choice. But nobody is in here starting to do the work and then deciding not to do it. I hope I answered your question.

Finally, on local LNG versus — I'm not an LNG expert. I'm an explorer. I would suggest that if the field was good enough, there would be a want to export that gas. Clearly, if it

was in Liard, it would make sense to tie into the B.C. infrastructure and get that gas to market more efficiently. If it was in the north — I think in Eagle Plains — it's probably a potential to use it internally and also to help your friends out in the Northwest Territories. There is a town closer to the fields up there — Inuvik — that is in desperate need of natural gas. You see their trucks go by here every day, carrying LNG or propane up there on your highways. You could actually be an exporter to your friends in the Northwest Territories.

Ms. Moorcroft: I would ask, though, when you speak about the market for Yukon and Inuvik, that the population would be probably less than one percent of the production value, and I would want to know what price you would pay to transport LNG from Eagle Plains, in particular, or from Liard. To transport the oil or gas south would be quite a lot.

MGM drilled a vertical oil well near Norman Wells in 2012-13 in partnership with Royal Dutch Shell, and on April 15, 2014, an article in the *Calgary Herald* reported that MGM and Royal Dutch Shell withdrew their application for a horizontal well licence in the territory, which would involve fracking, when the application was referred for environmental assessment because it was feared to drive up costs and cause major delays.

The question is: Do you believe that strong environmental regulations and assessment of fracking can affect the financial viability of fracking?

Mr. Hogg: I'll go back to the first part. The reason we withdrew the application for the horizontal well was because we've continued to say, as have others who explore in the central Mackenzie, that the time for an environmental assessment is when you know you have a project. If I go to a mining analogy, you don't do an environmental assessment when miners are drilling diamond drill cores. You do an environmental assessment when miners are building a mine.

Well, in shale gas exploration, until you actually know the gas or oil will flow out of the shale formation, it's the wrong time to do an environmental assessment, because the questions that are going to be asked in the environmental assessment assume that you have a development when you don't know anything about a development because you've yet to drill — in this case, we had yet to drill a single exploratory well within the Canol shale before they asked for an environmental assessment. We fundamentally believe that is wrong and, if you went that way, I would fundamentally believe that was wrong. The time for environmental assessments is when you know you have a project, not when you're exploring to develop a project.

In the second part of your question, I think you were asking about the market for one percent of production. I guess I don't know how you established it's one percent.

Unidentified Speaker: (inaudible)

Mr. Hogg: Again, this is exactly why environmental assessments don't work. Until I know what a well will flow at and until I know what my cost for the well is, until I know how close my well is to infrastructure — if my well is a mile off the Dempster Highway or my well is 100 kilometres off the Dempster Highway, it's a very different answer. What I would say to you is, if you put the parameters out there where people can explore and what they can do with those lands — so if you decide to put all the blocks — let's say for example — close to the Dempster Highway, there is a much greater potential that it's economic than putting them 100 kilometres from the Dempster Highway up in Old Crow — not that we're going to explore in Old Crow, but it's just an example.

What I'm saying is, how can I answer a question like that when I have no other parameter than that?

I fundamentally believe that if you can flow wells at five to 10 million cubic feet a day — let's remember that if I take 30 million cubic feet of gas a day, roughly, that would make 1,500 barrels a day of syn-diesel. Does made-in-the-Yukon diesel make sense for the Yukon? I actually think it does. If I can make money doing that and I can sell diesel that is made in the Yukon cheaper than bringing it from the south, I think that is a good business model for the Yukon government.

Mr. Silver: Thank you, Mr. Hogg, for your time here today.

A lot of the questions from the gallery are going to be on the environmental-risk side, so I am going to stick with the economic risks — comparatively, the Northwest Territories here.

Your president, Henry Sykes, was quoted in the *Northern Journal* in April 2014, saying: "We are sitting on" — and this is about the Sahtu region — "billions of barrels of oil in the Sahtu, but there is no way to take any of it, and nobody can tell you when there might be a way to get any of it out of there."

He also went to comment, and I quote: "Almost everybody involved in the Sahtu is looking for partners to spread their risk around because it is too much money with no imminent prospect of return."

There is also an article in the CBC in May this year about Husky Energy withdrawing their application to drill, as well, and this shocked the mayor of Norman Wells. The decision was made a week after the Sahtu Land and Water Board delayed making a decision on that project.

The question, as we go into the Yukon, is: What are the economic risks to companies wanting to invest here in the Yukon — the Northwest Territories being quite different, because of the existing pipelines that connect the territory to northern Alberta? Also, what would be the industry's asks, as far as government involvement, to getting the resource down to market. You did talk about how we would be able to control the pace and the scale, but what are the thresholds for a company like yours, as far as numbers? Would they be able to sustain themselves with a local market, or would it have to have certain volume thresholds to even consider coming in here that maybe a domestic market wouldn't even come close to hitting?

Mr. Hogg: Thanks for the question, Mr. Silver.

On MGM and the comments of my president, I think there's a level of frustration that he has relative to the lack of movement on infrastructure in the Northwest Territories. As I

said to you earlier, we were formed in 2007. The reason we were formed is because, by 2010, we were going to have the Mackenzie gas pipeline. That infrastructure would have allowed for continual exploration on the Mackenzie Delta, where we started exploring initially, and we would be able to have an off-take solution for our gas.

When that pipeline continued to be stalled by regulatory conditions, we then decided to go to the central Mackenzie corridor and look closely at the oil play in the central Mackenzie. Now we've been in that play for four years, coming up to five years, and we see no ability currently to easily get the product out. Unlike the Yukon, we don't have a road to move product. It's an oil-rich shale but, unfortunately, all oil-rich shales have associated natural gas with them — and natural gas liquids — so the three are slightly different.

I could easily put my oil into the Enbridge line, but then what do I do with my natural gas? So there isn't a natural gas solution that we could be able to move that natural gas in any way out of the area, even if we were putting it into trucks and moving it. There is no solution, and I think the frustration is that we see a regulatory process in the Northwest Territories of five to seven years before we could have a pipeline built. As a junior explorer, what we try to do is we try to explore and put that product onstream because that's actually where we make the money. Without the ability to produce that product for another seven years, it has really been very detrimental to MGM and that is why we are being merged with Paramount in the next few weeks, because Paramount, which we spun out of, has the ability to hold the assets until there is a pipeline solution in the Northwest Territories.

In terms of your question about scale and pace, I would think that all explorers are trying to maximize their profit — absolutely. We are trying to get as much gas out of the ground as we can, and we are trying to move that gas to market. But there is a very big difference between having ExxonMobil decide to come in and explore and having a junior company come in and explore. A junior company doesn't need to have — I'll give you an example in the Mackenzie Delta. We started exploring in the Mackenzie Delta to look for conventional prospects that would be 200 billion cubic feet. It seems like a lot of gas, but to an ExxonMobil, there is no interest in exploring for something that small.

What I would say is, if you open it up, don't expect to have ExxonMobil and Shell come knocking at your door, but I think you could expect to see smaller companies come in and knock at your door who know that the amount of local supply plus a future of being able to export that gas out of the territory would bring them a rate of return that was a reasonable business rate of return of 12 to 15 percent. It will depend on how you set it up and what the conditions are that you put in place. All that front-end cost — whether we're drilling wells and we're drilling monitoring wells — all of that and the time value of money are important to everybody. Clearly, the exploration phase would be two, three or four years. But then what happened in the territories is that now we've stalled. We've done the exploration. We know where the shale is. Now we realize that we can't get a pipeline solution for seven years, so everybody will probably slow down a little bit until we can get the infrastructure to catch up with what we understand about the shale.

In Liard, I think it's fairly easy for you. In the Eagle Plain area, I think you're in a very similar situation except you have a road. If you wanted to build an export pipeline — it's always easier to build an export pipeline beside a road than it is beside a river like the Mackenzie. Those would be my comments.

Hon. Mr. Dixon: Could you explain a little bit about the process behind the determination of where you would put those water wells and how the community was involved in that process and how they remain involved in that process?

Mr. Hogg: Each of the parties who have drilled up there — ConocoPhillips, Husky and ourselves — have all drilled water wells and we've all had a slightly different approach to doing it.

The reason we put those water wells in was that, when we first put our vertical well in for submission to the Sahtu Land and Water Board, we had questions from the community and we had questions from the GNWT Department of Environment about our understanding of groundwater. We really didn't understand the groundwater. As I said, there is no groundwater usage so very little was understood. I went back to my management and I said, "Look, we don't understand groundwater. We need to drill wells." It was that simple.

I won't speak for the other two companies, but they did the same thing. We decided to put our wells on the corners. We decided to put ours on the corners of the lease because we felt that, as the very first well to fracture stimulate, if there was going to be a leak, we felt that the communities would like to know that we weren't leaking up through the well into the groundwater nearby. We chose to do that.

Now Husky had built some permanent roads, so they drilled a number of water wells along their roads and they drilled wells on their lease. ConocoPhillips, from my memory, did the same thing. They drilled some water wells along their roads and they drilled some groundwater wells on their lease. Each of the companies decided, with consultation with the communities and the GNWT, to ensure that they had put the wells in areas that were appropriate. Do we have enough wells? No, we probably don't. Do we need more wells? Yes, we would and if we had committed to drilling more exploratory wells, we would. We would also commit to drilling more water wells, because I truly believe it's important for us to prove to the communities in the Northwest Territories that the groundwater is safe and that we have not caused any problems to the surface water.

I think I caught your whole question — thank you.

Mr. Tredger: Thank you, Mr. Hogg, for your presentation. As we've seen across North America, the pace and scale of fracking industrialization is intense, more so than for conventional oil and gas. Industry is following market pressures to make a profit, wanting to get a return on

infrastructure and other investments, which we know are significant for fracking.

You were speaking of one well and the measures taken there using less water, fewer roads and a lot less truck traffic in that area. We do need to contemplate the end result, so I wonder if you could estimate how many wells and how much production would it take to make a play in the Yukon viable. What would the infrastructure needs be — the water needs, an estimate of the roads and trucking needed to get supplies in and waste materials out? You had mentioned that, in your estimation, the natural gas would end up being some of the most expensive in North America. Can you give an estimate as to how much an MCF would have to be to make it viable in the Yukon?

My final concern is that, if we do indeed have some of the most expensive gas in North America, I'm not sure we want to use it locally. It leaves us very vulnerable to a boom-bust cycle because we would be on the extreme edge of production — so very vulnerable to market pressures. Government would be under severe pressure to reduce royalties and to make concessions to make the industry more viable.

If you could comment on those, I thank you.

Mr. Hogg: Thank you very much, Mr. Tredger. Like Ms. Moorcroft's question, because it's basin-dependent and it's area dependent, it's very difficult for me to tell you how many wells without knowing which basin I'm in, without knowing which shale it is, not knowing what depth it is. To be able to answer your question on how many wells I would need, what would the well production look like, what would the truck traffic be and what would the estimated expense of the natural gas be at an Mcf — that's impossible.

What I can give you is a sense for what it would cost to do exploration. Maybe that's a better way to do it. I would think, if you were exploring in the northern basins of the Yukon, your exploration well cost would be in the $10 million to $15 million per well. Again, we tend to start exploring with much smaller wells, so instead of drilling a 1,500-, 2,000- or 2,500-metre horizontal in the central Mackenzie last winter, I believe Conoco Phillips drilled 1,000-metre horizontal wells with a 10-stage frack. You are taking these production wells and maybe reducing them to a third or a quarter of the volumes, and thus a third or a quarter of the truck traffic, a third or a quarter of the sand that's coming in.

All of those numbers would be smaller. When you move to development, you have to remember that it is very expensive gas, so only the best, the sweetest spots, the most economic spots, will be developed initially.

If I go into northeast B.C. into the Horn River Basin, the very large fracks — the very best shales that have been found; some of them potentially the best in the world — people are experimenting with how much gas could I literally get out of these wells. I think you hear numbers from companies like Apache Publishing that one of their wells was capable of production at 100 million cubic feet a day.

Coincidentally, in the Mackenzie Delta, that is kind of a fairly average well for a conventional gas play, but in a shale well, that is pretty impressive. So it's very difficult for me to answer that question with any sense other than, in the exploration phase, it would be smaller. Depending on what they find, I would assume that they would want to be able to export that gas in some way, but also I think there is the opportunity — as I said previously — for a local supply and a local business to be able to offset some of your carbon that all comes from the south as diesel.

Finally, when I say it is the most expensive gas in North America, I mean it from the point of view of how much it costs us to explore for it. Let me just give you one quick example of that for the central Mackenzie. The wells in the central Mackenzie are the most expensive wells. Why? Because I have to rent a rig for an entire year to use it for four weeks, so because I am bringing a rig up from Alberta or B.C., I am going to barge it in and I am going to put it on the land, I'm going to let it sit there, and then I'm going to use it for my period to drill and then it's going to sit on the land again.

The drilling company seems to want to be paid for the whole year. I'm not sure why. But they just seem to want to get their money out of us. It's not as much about the cost of drilling a single well; it's about all the field services that — if their equipment could be working in the south, it would be. I'm not using it in the north, but I'm paying for it. The difference for you is I can move that rig down the Dempster year-round. I don't have to have that rig sit there on the wrong side of the Mackenzie River for a whole year before I can use it again.

So even though that gas is expensive, once you find it, the costs come down dramatically, but the initial expense for any work in either territory is very high. I hope I answered your question.

Chair: Thank you very much. We're going to proceed with a few questions from the gallery. We don't have much time. Mr. Elias, will you start us off please?

Mr. Elias: This question is from Kevin Alexandrovich; the community is MGM, I believe.

Unidentified Speaker: (inaudible)

Mr. Elias: Oh, it says community. I thought it was an acronym for marsh something or other.

Anyway, the question is: Would you publicly release MSDS — material safety data sheets — of all chemicals and materials prior to beginning any operation?

Mr. Hogg: As I stated in my discussion, all of that material is published for our wells. If that's the question, which I think it is. All of the MSDS data sheets are released. All of the ways we are using the chemicals is in the discussion. I would refer you to our 1,200-page project description. Every piece, every chemical used in fracture stimulation in the Northwest Territories, is released to the public. I don't know if I can say it any clearer than that.

Chair: I have a question from Don Roberts. What steps has MGM taken to inform all N.W.T. residents of the long-term benefits and consequences of fracking?

Mr. Hogg: Part of the process for working with the First Nations in the Sahtu district and Tulita district in general is to have regular consultation with the communities. Before even starting to work on a project description to drill a well, we're in the communities, we're talking to the communities about the project, we're talking to the elders, we're doing traditional knowledge, we're going out on the land with both people for traditional knowledge and we're going out on the land with other community members who have knowledge in those areas, to ensure we understand that. Before we submit our application, we go back to the communities and talk to them about the project and inform them about the project. The project goes into the Sahtu Land and Water Board. When it's in there, the communities all have the right — the game councils and everybody else — to comment on the process that MGM is following. The communities are involved in ensuring that we're employing the people in the community. The communities look to us to try to employ as many young people as we can.

We do trips to the lease for the communities. We will take them out to the well site if we're drilling. We took them out to the fracture stimulation operation so they could see it. Subsequent to all of that, we go and meet with them again. We tell them how the project went. We tell them how we spent the money. All the way through this, we're also talking about the water. We take them and show them the water wells. We explain as much as we can the water data to the community members. We also believe there is an onus on the government to do the same things we're doing — to reinterpret that data to ensure that what we're saying as industry is what the government thinks as well. I think we do our best to talk to the communities to make them informed of what we're doing.

Ms. Moorcroft: This question has no name. It's anonymous. For how many generations would you guarantee the integrity of your well casings to be absolutely leak-proof as far as water contamination?

Mr. Hogg: I guess that's a difficult question, because most wellbores are abandoned after production. I'm going to assume a generation is about 20 years, give or take a couple of years. If a well was put on in generation one and sometime during generation two, it no longer was producing, that well would be abandoned in accordance with any directive from the agency that was working on well abandonments. I guess if we're talking about how many generations — two — because I don't know of a wellbore that's still producing more — in Canada — there might be — let's say three.

I don't know of many wellbores that are producing more than two generations — 40 years. For most wellbores, that would be more than the reserve life.

Mr. Silver: Thank you, Madam Chair. This also is an anonymous question. How much water was consumed to date by MGM in its operations? How much waste water has MGM disposed of since commencing its activities?

Mr. Hogg: That's a great question. As you saw in my summary, I had quantified that we had used — do you mind if I go back because the numbers aren't perfect — 40,000 cubic metres of water on the project and I think 80 percent of that water was used for roads; 15 percent of that was used for lease staging an area; and five percent was used for the camp. Now the interesting part is the question, which I'll expand upon is: We didn't frack this well with water; we fracked this well with mineral oil — a hydrocarbon oil. We used about 1,300 cubic metres of that, of which we have recovered 80 percent. The reasons for doing that were twofold: we were the very first well drilled. The communities were concerned with us using water and we were trying to do this project in one season. As a geologist, there is always a challenge with rocks. When the rocks are free of water for hundreds of millions of years and you put water into them, clays can expand and things can change. The characteristics of the rock will change. When the communities didn't want us to use water for the first well, using a mineral oil allowed us to know that we would not cause something called "hysteresis." We would not change the characteristics of the rock. The rock is filled with hydrocarbon. We put hydrocarbon in and we took hydrocarbon out, so there was no water used. Subsequent to that, ConocoPhillips has used water to fracture stimulate, but in our case we did not use water to fracture stimulate, we used a mineral oil.

Chair: We will allow one last question, even though we are down to a minute.

Hon. Mr. Dixon: This is an anonymous question. Do you need to fracture to explore shale gas or oil?

Mr. Hogg: The short answer is yes. Shale does not have porosity and permeability, so porosity being holes and permeability being the connection of those holes. Think of a sugar cube. For those of you who are old enough to remember when sugar came in cubes, a sugar cube has about 30-percent porosity and it has almost infinite permeability, 10 to 15 darcys of permeability. Shale rock has three- to five-percent porosity, but microdarcys — a thousandth of a millidarcy of permeability. It has no ability — it has gas or oil trapped in it and it is in the holes, but the holes are not connected. Without the ability to fracture the rock in the subsurface, we cannot get the hydrocarbon out.

Chair: The time for questions has elapsed and I want to thank Mr. Hogg and thank all the visitors in the gallery who submitted questions.

The committee will review the remaining questions and we will do our best to follow up and ensure that they are answered. These proceedings are now adjourned. Thank you very much.

The Committee adjourned at 5:00 p.m.