Comité de l'évaluation environnementale stratégique sur le gaz de schiste

307 DB90-AN

Les enjeux liés à l'exploration et l'exploitation du gaz de schiste dans le shale d'Utica des basses-terres du Saint-Laurent

6212-09-002

IMPLEMENTATION PLAN FOR THE STRATEGIC ENVIRONMENTAL ASSESSMENT ON SHALE GAS

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Summary

Defining the implementation plan for the strategic environmental assessment (SEA) on shale gas is the first step in the mandate of the expert committee charged with conducting that assessment. Its objective is therefore to define the issues to be considered and to outline a series of studies to:

- Evaluate the environmental risks and impacts associated with this type of exploitation;
- Evaluate the impacts on agriculture, forestry and tourism of eventually developing the shale gas sector;
- Evaluate the socioeconomic desirability of exploiting this resource;
- Define scenarios that would maximize revenue for the government;
- Define the guidelines and parameters of a regulatory framework for the environmental assessment of gas exploration and exploitation projects, and for the execution of such projects, applicable to the St. Lawrence Valley and elsewhere in Québec as the case may be;
- Suggest ways of proceeding to establish guidelines on the role of municipalities and regional representatives in determining policies in the event that the industry is developed in their region;
- Evaluate the desirability of setting up scientific observatories to acquire knowledge on an ongoing basis and to ensure that regulations are kept up to date.

The issues identified and the studies proposed were the subject of many discussions before consensus was reached among the experts named by the Minister of Sustainable Development, Environment and Parks.

The SEA implementation plan begins by explaining the mandate and composition of the expert committee and how its members have agreed to function. Methodological aspects are then presented, defining the analytical approach favoured and describing the research techniques that will be used.

At the heart of the plan is the analysis of issues. However, before tackling the environmental, social and economic issues, the expert committee agreed on the necessity of defining some realistic scenarios for development of the industry that will require consensus.

Environmental issues are grouped under four themes: water; air quality; greenhouse gases; and natural and technological risks.

Social issues are grouped under five main themes: agriculture, forestry and tourism; land use and the compatibility of uses; the social impact of environmental nuisances; health and psychosocial risks; and governance of the industry.

Lastly, economic issues are approached from the perspective of the socioeconomic desirability of gas exploitation, which is examined primarily using the cost-benefit approach and the analysis of economic spin-offs.

For each of these issues, the committee indicates what additional information is needed and proposes studies to be conducted. Potential solutions for impact management are also put forward.

The preliminary version of the SEA implementation plan was presented for public consideration and revised and enhanced in the light of the comments received during four information/discussion sessions and the online consultation. In total, 59 written statements were submitted to the committee through its website.

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Foreword

On March 8, 2011 Pierre Arcand, the Minister of Sustainable Development, Environment and Parks, released the report of the Bureau d'audiences publiques sur l'environnement (BAPE) on sustainable development of the shale gas industry in Québec. At the same time he announced that he would immediately follow its principal recommendation, that a strategic environmental assessment be conducted, by setting up an expert committee to carry out that assessment. Furthermore, on March 16, 2011 the Deputy Premier, Nathalie Normandeau, Minister of Natural Resources and Wildlife and the Minister responsible for Plan Nord, announced that henceforth all oil and gas fracturing activities in Québec would be subject to strategic environmental assessment (SEA).

The first stage in the mandate of the expert committee was to prepare the implementation plan for public consultation, in a spirit of transparency and openness to contributions from stakeholders in all sectors. That stage is now complete, and the present plan incorporates many of the proposals and comments submitted during the consultation held in December 2011 and January 2012.

The plan is divided into three main sections. The introduction explains the mandate and composition of the committee and how it will function. The second section presents methodological aspects, namely the SEA process, the expertise that will be deployed and the tools and techniques that will be used. Lastly, the third section sets out the issues to be considered and the knowledge to be acquired for the purposes of the SEA.

To comment on the implementation plan or any other element concerning the SEA, the public is invited to visit the website of the committee, at: www.ees-gazdeschiste.gouv.qc.ca.

1. Mandate, Composition and Operations of the Committee

On August 31, 2010 the Minister of Sustainable Development, Environment and Parks, Pierre Arcand, asked the Bureau d'audiences publiques sur l'environnement (BAPE) to create a commission of inquiry on the sustainable development of the shale gas industry in Québec, and to hold public hearings in the administrative regions of Centre-du-Québec, Chaudière-Appalaches and Montérégie. The commission's report, which was submitted to the Minister on February 28, 2011, made 43 findings and 101 recommendations primarily directed at the Government of Québec. In response to the need for scientific knowledge and the lack of evidence from which to determine the potential risks of shale gas exploration and exploitation, the commission proposed that a strategic environmental assessment be conducted. According to the commission such an assessment is critical, both for informed decision-making and for the industry to achieve greater social acceptability.

On March 8, 2011 the Minister of Sustainable Development, Environment and Parks, Pierre Arcand, released the BAPE report on sustainable development of the shale gas industry in Québec. He also announced that he would immediately follow its main recommendation, that a strategic environmental assessment (SEA) be conducted, by setting up an expert committee to carry out that assessment.

Since June 2011, transitional measures have been put in place to provide a better framework for all drilling and fracturing activities related to oil and gas in shale.

Thus, an amendment to the Regulation respecting the application of the Environment Quality Act (RRAEQA) and the new Regulation respecting the filing of information on certain drilling and fracturing work on gas or petroleum wells, both of which came into force on June 10, 2011, tightened the environmental regulations for oil and shale gas exploration and exploitation projects. These regulations set out transitional provisions governing this sector throughout the SEA process.

Among other things, the RRAEQA provides for information and public consultation sessions to be held by project promoters in receiving communities. Such consultation would allow municipalities to evaluate the social acceptability of projects and submit their opinion to the Minister.

Furthermore, besides prior public consultation, authorization requests for drilling or fracturing related to oil or shale gas must first be recommended to the Minister by the SEA committee. The committee will only consider projects required for the needs of the SEA.

The BAPE consultation, report and recommendations correspond to the first phases of a strategic environmental assessment. The committee's work is therefore a continuation of that process.

In addition, while preparing the present implementation plan the committee observed that the current economic and social context is unfavourable to the conduct of fracturing activities. Consequently, in carrying out its mandate (which includes the acquisition of new knowledge about hydraulic fracturing), the committee will use alternative methods such as laboratory experiments, and will not recommend authorization of any shale gas fracturing projects for the purpose of knowledge acquisition.

1.1 Mandate of the committee

The general mandate of the committee, to be accomplished over a period of 18 to 30 months, is to define the SEA implementation plan and carry out the work stemming from it so as to achieve the objectives set out by the BAPE, which are to produce:

- An economic assessment of the socioeconomic benefits of exploiting the shale gas resource, and of the conditions that would maximize revenue for the government.
- An assessment of the environmental risks and impacts, the factors influencing social acceptability, and appropriate mitigation measures.
- Guidelines and parameters for a regulatory framework for both the environmental assessment of gas exploration and exploitation projects and the execution of such projects, applicable to the St. Lawrence Valley and if possible elsewhere in Québec.
- An assessment of the need for scientific observatories that would acquire knowledge on a continuous basis and ensure that regulations are kept up to date.

In performing its mandate, and within the established budgets and timelines, the committee may also consider any other relevant questions pertaining to the exploration and exploitation of oil and gas resources, as well as their repercussions.

Territory concerned by the SEA[1]

At present, shale gas interest is focused on a part of the St. Lawrence Lowlands between Québec and Montréal, primarily covering the administrative regions of Chaudière-Appalaches, Centre-du-Québec and Montérégie. The three regions together cover some 33 100 km^2 and include Lévis, Longueuil and 28 regional county municipalities (MRCs) that in turn include 333 municipalities, plus 4 territories not in MRCs. They are home to over 2 million inhabitants.

Most of the territory consists of agricultural land, with no fewer than 16 310 farm operations in 2010 (BAPE report, p. 11).

According to the Ministère des Ressources naturelles et de la Faune (MRNF), Québec has over 200 000 km^2 of sedimentary basins with a potential for the discovery of hydrocarbons. The territory extends from the border of Ontario to that of Newfoundland and Labrador, along the axis of the St. Lawrence River.

In the sedimentary basin of the St. Lawrence Lowlands there is a shale formation that is particularly rich in natural gas: the Utica Shale. The surface and sub-surface area of the formation, which is mostly located in the St. Lawrence Valley between Montréal and Québec, is nearly 10 000 km^2. For the most part its thickness varies between 100 and 250 metres, reaching up to 750 metres in the valley of the Richelieu. The formation outcrops along the north shore of the St. Lawrence, descending gradually to the southeast to a depth of some 2.5 kilometres along the Logan's Line fault. Overlying the Utica Shale is a second shale formation, the Lorraine Group; although this too has gas potential, at present exploration is focused on the underlying Utica Shale.

See map in Appendix 1 (french)

1 Source: Ministère des Ressources naturelles et de la Faune: [http://sigpeg.mrnf.gouv.qc.ca/gpg/classes/ActiviteShale]

1.2 Deliverables

In performing its mandate the committee will produce a number of documents, including:

- The implementation plan for the SEA (the present document), which has been updated after public consultation.
- A report presenting an analysis and synthesis of the studies conducted for the SEA, providing answers to the questions and issues raised.
- A report aimed at strengthening Québec's legislative and regulatory framework for the development of oil and gas resources.

The last two deliverables may be combined in a single report. Finally, progress reports will be submitted by the committee on May 1, 2012 and May 1, 2013. In these reports, the committee will also indicate the amounts committed and spent for its work.

1.3 Composition of the committee

As recommended by the BAPE, the committee charged with conducting the SEA is composed of experts drawn from municipal, governmental, private and university circles. There are also two experts from civil society and a third from an environmental organization. The diversity and complementarity of the skills, experience and expertise of the committee members will contribute directly to the success of the process.

The committee is chaired by Robert Joly, formerly of the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP). He is also the committee spokesperson. The secretary of the committee is Richard Castonguay.

Table 1. Members of the committee

Committee President	Robert Joly
Members	Pierre Boucher
	Sébastien Desrochers
	Corinne Gendron
	Michel Lamontagne
	Michel Malo
	Marianne Molgat
	John Molson
	Jean Perras
	Lucie Ramsay
	François Tanguay

1.4 Operations of the committee

The committee has chosen to operate by consensus. It is organized into five working groups that will focus on different dimensions of the SEA: environmental issues; land use, health and the human environment; the economy; communication; public participation; and the regulatory framework. General orientations are determined in full meetings of the committee, while specialized work is discussed in the working groups.

Figure 1. Organization of the committee

Besides drawing on additional external or governmental resources, the committee has access to a team of experts led by Yvon Maranda in the Bureau de coordination sur les évaluations stratégiques, at the MDDEP.

1.5 Guiding principles

Strategic environmental assessment requires the application of practices and principles that are broadly accepted by those working in the field. In this spirit, the committee has adopted the following guiding principles:

- Be transparent, and publish the results of all studies.
- Exercise scientific rigour.
- Encourage and facilitate contributions from stakeholders of all kinds and from all sectors.
- Focus analysis of the industry on the major environmental, social and economic issues, from a sustainable development perspective.
- Compare the industry to other energy industries, to reveal its advantages and disadvantages in environmental, social and economic terms.
- Consider contextual and institutional factors that could affect the industry or be affected by it.
- Explore different development scenarios, including the "no development" and "alternative energies" scenarios, to inform decision makers and the public about the risks, benefits and cumulative impacts associated with the industry in the short, medium and long terms.

In addition to those principles, and given that the sustainable development perspective is fundamental to this work, the analysis will necessarily take into account all of the principles set out in the Sustainable Development Act and the related government strategy.

1.6 Principal phases of the mandate

The committee's mandate extends over a period of 18 to 30 months, comprising three principal phases:

- Preparation of the SEA implementation plan (the present document);
- Acquisition of the knowledge mentioned in the plan;
- Preparation of the final report, with recommendations.

These phases will be punctuated by consultation and participation activities with the government departments, experts and populations concerned.

The initial SEA implementation plan was prepared over five months, from May to October 2011. Following public consultations in December 2011 and January 2012, it was updated in February and March 2012.

The drawing up of specifications for knowledge acquisition projects began in November 2011 and concluded in April 2012, allowing elements to be incorporated that were raised during the public consultations.

The knowledge acquisition projects will be performed throughout 2012. Details on the studies, mandates and performance schedules will be provided on the committee's website.

The committee intends to conduct studies in the following areas:

- Public participation and consultation in SEA processes;
- Development scenarios and model projects;
- Water quality and availability;
- Atmospheric modeling;
- Analysis of technological and natural risks;
- Cumulative impacts on the environment;
- Social impacts and social perceptions;
- Social acceptability factors;
- Enterprise social responsibility;
- Cost-benefit analysis, economic impact analysis and life-cycle analysis;
- Legislation and regulations applicable in Québec and elsewhere.

A complete list of the studies to be performed is provided in Appendix 2.

While those studies are being carried out, the committee will conduct various consultations to complete its gathering of information and to obtain opinions and expertise. In particular, the committee will meet with representatives from Québec regions and communities where the shale gas industry is already present and wherever exploration and exploitation might occur. Additionally, the committee will conduct visits to provinces and states where shale gas exploration and exploitation activities are underway, such as Pennsylvania, New York, Alberta and British Columbia.

In May 2012, the committee will produce a progress report on its activities and budgetary commitments. At that time, it may announce more precisely when the final report will be submitted. Another progress report will be produced in May 2013.

When the studies are completed, the committee will analyze and synthesize them for the purpose of its reports. A preliminary version will be made public and submitted for consultation. The definitive version of the reports will be delivered to the Minister of Sustainable Development, Environment and Parks no later than November 2013.

1.7 Budget for the SEA

In its 2011-2012 Budget Speech, the Government announced that it would spend $7 million over three years on a strategic environmental assessment on shale gas, conducted by the MDDEP. Of that amount, $2 million will be spent in 2011-2012. The budget for the SEA will cover logistical and scientific support and performance of the assessment itself.

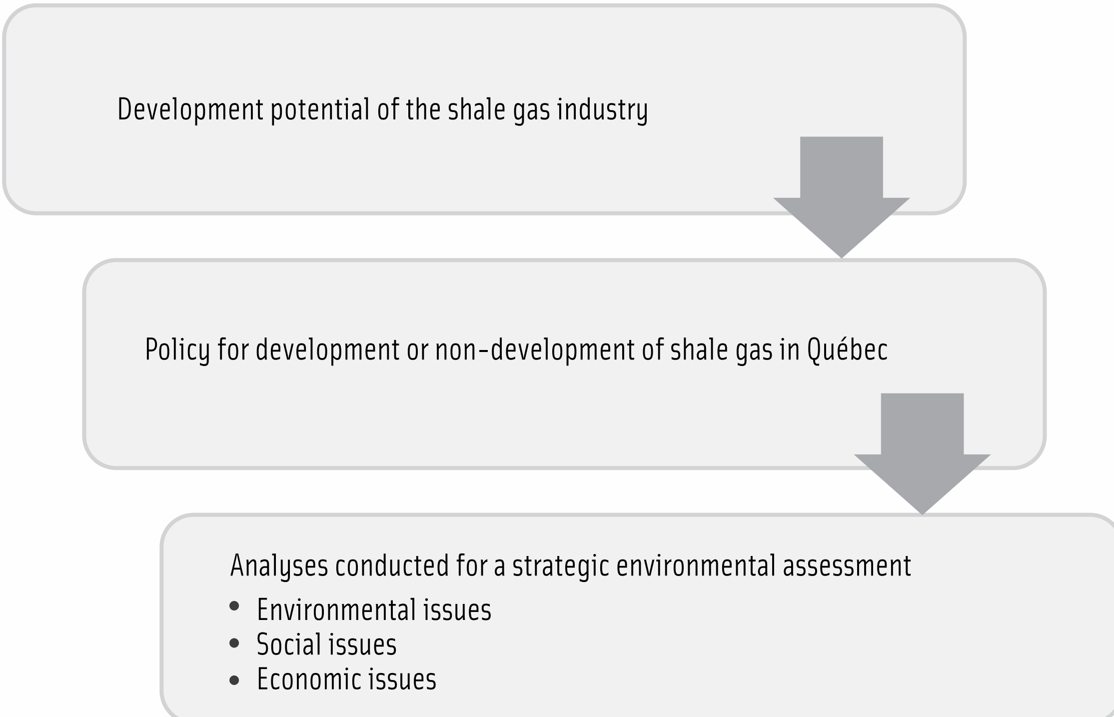
The portion of the budget directly devoted to conducting the studies mentioned in this plan (not including government expertise) comes to $2.5 million.

2. Methodological Aspects

2.1 Strategic environmental assessment

A strategic environmental assessment (SEA) is a systematic, formal, exhaustive and participatory process of analysis focusing on the environmental effects of policies, plans and programs along with alternate solutions. The assessment is called "strategic" because it concerns intervention initiatives upstream of an industry's specific projects. As part of the process of choosing long-term orientations, it provides indications as to how best to achieve those orientations and which types of projects to prefer. By defining and clarifying both individual and cumulative effects, it helps decision makers take into account environmental, economic and social considerations. In this respect it is a privileged tool for sustainable development. Although such assessments are increasingly common, the SEA process is not set in stone, but rather must be adapted and tailored to the context. For its objectives to be achieved, the essence of the approach must be well understood and the basic principles respected.

Figure 2. Decision path based on a SEA



Strategic environmental assessment allows sustainable development considerations to be integrated systematically into every decision. By using various mechanisms for dialogue, its methodology presupposes consultation and participation by the public, including vulnerable groups, in taking strategic decisions. By defining repercussions and determining critical issues, it facilitates the evaluation of projects by sustainable development principles. By adding transparency to decision making processes, it enhances the quality and credibility of decisions, reducing the risk of controversy or confrontation. Finally, the SEA process encourages communication among all stakeholders who may be affected by a decision.

As mentioned above, to be successful a SEA must respect a number of guiding principles[2]. The committee has taken those principles to heart, and will respect them throughout this process.

The objectives of a SEA must be clearly defined, and its results must be explicitly integrated into subsequent decision making. It must be approached as a flexible, iterative process that is adapted to the particularities of the context while being rigorous throughout. The process must be transparent, and its results must be made available to the public in an adequate manner.

2 OECD (2006) and International Association for Impact Assessment (2002)

2.1.1 Objectives of the SEA

The purpose of the SEA is to understand and document the environmental, economic and social repercussions of the potential exploitation of shale gas in Québec. It must contribute to determining the desirability of using or not using this energy source, in terms of both Québec's overall energy policy (and any future revision of the policy) and the principles of sustainable development. Another objective is to clarify the conditions under which development of the industry could be profitable for all Quebecers, conditions such as the techniques and technologies used, governance of the industry, the legislative framework and the fiscal regime.

To achieve those objectives, analyses performed for the SEA will evaluate several options, whose advantages will be weighed in terms of their environmental, social and economic consequences. Thus, the committee will examine the relative benefits of developing or not developing the shale gas industry in Québec, and if appropriate, the manner in which the industry could best be developed (including the pace of development, the locations where development could take place, and the regulatory framework).

2.1.2 Scope of the SEA

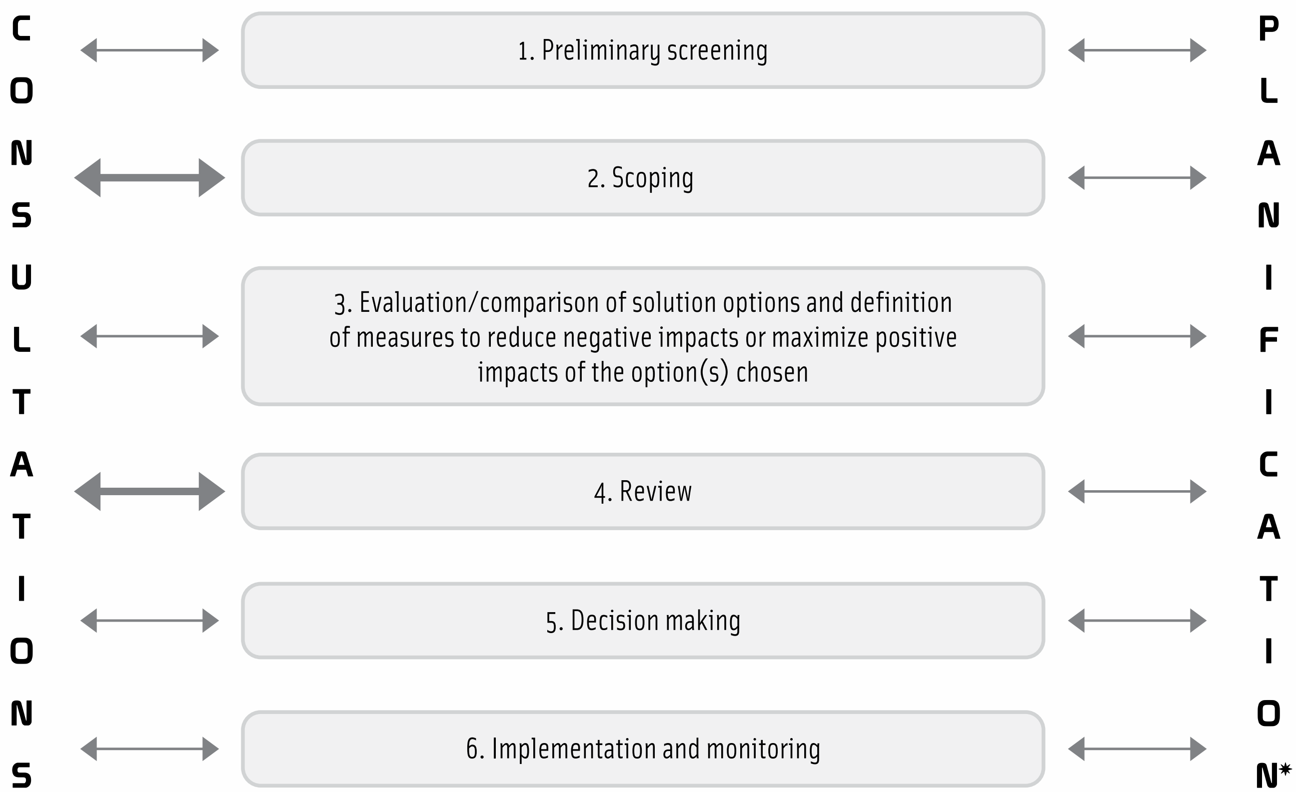
In its analysis, the SEA will take into account a number of contextual documents that, in their objectives and guiding principles, constitute the expression of a social compromise and a collective outlook on development at a given time. These will include formal public policies like the Québec Energy Strategy, the Climate Change Action Plan, the Sustainable Development Act and its application, the Mining Act, the Strategic Plan on Biodiversity, and position papers from other stakeholders (economic actors, interest groups, environmental NGOs, academics, etc.). The Act to ensure the occupancy and vitality of territories and the Sustainable Regional and Local Land Use Planning Act will also be considered. The conclusions and recommendations of the SEA could lead to amendments being made in these contextual documents.

2.1.3 The SEA process

The process of a strategic environmental assessment can be outlined in six general stages[3]:

3 Crowley, M. and N. Risse (2011). "L'évaluation environnementale stratégique: un outil pour aider les administrations publiques à mettre en oeuvre le développement durable", Télescope, 17-2:1-29

Figure 3. Process of an environmental assessment



* By planning, we mean the process of developing a given policy, plan or program.

To some extent, the public consultations conducted by the BAPE completed the first stage of the process, by determining the major issues and controversies surrounding the potential development of the shale gas industry. The BAPE report thus contributed to the preliminary screening and scoping required when launching a strategic environmental assessment. As for the present implementation plan, it sets out not only the objectives and methodology of the SEA, but also the principal issues on which it will focus, the studies the committee intends to conduct and the research and analysis techniques that will be deployed.

The subsequent stages consist of determining scenarios for recoverable gas potential, the potential evolution of supplies, and future prices for natural gas. The analyses will document the potential environmental, social and economic impacts of different scenarios for development of the industry. Based on those analyses, the committee will then be able to formulate a series of recommendations in response to the questions expressed in its mandate.

2.2 The expertise deployed

2.2.1 Committee expertise

As recommended by the BAPE, the committee members embody a wide-ranging and complementary expertise in numerous domains: hydrogeology, ecology, water quality and environmental quality, geology, land use, public policy, regional development, economy, the social sciences, civil engineering, the geology of petroleum systems, techniques of gas and oil exploration, environmental assessment, social responsibility, project management, economic sociology, the economy of environment, law and social ethics, and public participation.

2.2.2 Governmental expertise

The governmental expertise needed for the SEA will be provided by the MDDEP's Bureau de coordination sur les évaluations stratégiques. The Bureau will coordinate departmental and governmental action in the form of strategic and scientific management related to the committee's work, while also providing the SEA with administrative and scientific support.

2.2.3 External expertise

The committee will draw on scientific and technical expertise external to the government, to complete certain studies or meet specific needs in the form of consulting services. It is also counting on scientific and technical collaboration from the industry, which has agreed to provide key information not available to the public sector.

Note that the committee reserves the right, at all times, to seek a second opinion if it deems necessary.

Lastly, consultation mechanisms will be put in place to draw on the expertise of civil society, including non-governmental organizations, the general public and local elected officials, to ensure that both the knowledge and the concerns of civil society are woven into the committee's deliberations.

2.3 Analytical perspective and tools

2.3.1 Sustainable development

In 2006 Québec adopted the Sustainable Development Act, under which the Government must take into account, in its policies, decisions and actions, 16 principles of sustainable development. Subsequently it also adopted the Government Sustainable Development Strategy, with a set of indicators designed to measure Québec's progress in this area.

As stated in the Act and the action plan from which it originated[4], sustainable development means development that meets the needs of the present without compromising the capacity of future generations to meet their own needs. It is based on a long-term approach that takes into account the inextricable nature of the environmental, social and economic dimensions of development activities. Maintaining the quality of the environment is the condition for sustainable development; society and the individuals composing it are its purpose; and economy is the means by which it is achieved. The goal then is to maximize the well-being of individuals and communities while eliminating or minimizing ecological harm by building an efficient, inclusive and equitable economy.

The committee will make these principles an integral part of its analytical approach, paying special attention to those that are most relevant.

The 16 principles of sustainable development (Sustainable Development Act)

- health and quality of life
- social equity and solidarity
- protection of the environment
- economic efficiency
- participation and commitment
- access to knowledge
- subsidiarity
- inter-governmental partnership and cooperation
- prevention
- precaution
- protection of cultural heritage
- preservation of biodiversity
- respect for ecosystem support capacity
- responsible production and consumption
- polluter pays
- internalization of costs

4 Québec Sustainable Development Plan, 2004, available online at: http://www.mddep.gouv.qc.ca/developpement/2004-2007/plan-consultation-en.pdf

Thus, the committee will use every appropriate tool of strategic environmental assessment to carry out its mandate in a sustainable development perspective. This will be reflected in the organization of its work (multidisciplinarity, dialogue and public participation) and in its execution (detailed analysis of the ecological, social and economic dimensions of the potential development of the shale gas industry). The committee will make particular use of life-cycle analysis, cost-benefit analysis and the consideration of environmental externalities.

2.3.2 Public participation

Strategic environmental assessment is a complex exercise in which public involvement is a key component. It expresses a recognition that knowledge is socially anchored. But while the principle of public participation is intrinsic to a SEA by definition, the forms such participation may take are multiple.

In view of the controversy surrounding development of the shale gas industry, public participation will be especially important, for it will help ensure that the work accomplished genuinely contributes to a collective reflection. To that end, a preliminary study on participation practices was launched in the months following the setting up of the committee:

Knowledge to acquire:

- M-1: Document experiences of public participation, with analysis of some key practices to understand their value, operation and risks; prepare possible scenarios for public participation in successive phases of the SEA, detailing the rationale and relevance of each.

From November 2011 to January 2012 the committee held an initial consultation on the implementation plan, with four meetings for information and exchange and online contributions accepted through its website. A report on the results is available on the committee's website.

Taking into account the comments received during the consultation, and the study submitted[5], the committee developed a public participation plan based on the elements presented below. Details on each will be announced as they are implemented, and during the process the committee may add other activities. Such participation activities will provide a forum for the discussion of a range of topics, such as territorial governance and the agricultural question.

Mirror committees

When appropriate, the committee will create mirror committees.

Mirror committees are a means of exchange, reflecting the many different points of view that may exist in a society. They encourage not only the gathering of opinions and information, but interaction among participants.

5 Côté and Waaub (2012), "Mécanismes de participation publique dans les évaluations environnementales stratégiques"

Such mirror committees will be composed of representatives from the principal stakeholders concerned by the themes and subjects at hand. The SEA committee will take part in the work of mirror committees.

Mirror committees will be put together over the course of 2012 to obtain opinions on questions requiring the interaction of stakeholders, beyond whatever scientific studies may be commissioned. Opinions issued by mirror committees will be made public.

Theme forums

Certain themes of interest could also be the subject of forums. These would provide an opportunity to hear from experts, discuss the issues concerned and provide input for the SEA committee. The results of forum discussions will be made public.

Published studies

A number of technical studies will be done for the committee. Over the course of the SEA they will all be made public, either upon delivery or in clusters defined by theme. They will contribute to a broad improvement in knowledge about shale gas.

Aboriginal participation

The implementation plan already includes a commitment to provide a participatory process by which aboriginal populations may examine the repercussions of shale gas development and consider any mitigating measures proposed. The process will be modeled on past practices stemming from constitutional obligations in such matters.

Report consultation

As promised in the implementation plan, the committee will hold a consultation on the preliminary version of its final report, before submitting the final version to the Minister of Sustainable Development, Environment and Parks. Details on the consultation will be made public at the appropriate time.

2.3.3 Communications

Information and communication processes will be essential to the success of the committee's work, and integral to the spirit of transparency. A working group on communications has been created for that reason. The main role of the working group will be to inform the public as to the progress of work in a regular and ongoing manner.

The committee's website is the best channel for conveying and exchanging information about its work. At all times, opinions, documents, comments and questions may be sent to the committee by email at comiteees@cees.gouv.qc.ca.

Additionally, the committee will publish an email newsletter to which people can subscribe via the website. The newsletter will inform subscribers about the committee's schedule, visits, meetings, public activities by its members, studies that have been published, coming events and public participation phases.

Public activities on the committee's schedule will be announced on the website, as well as through press releases or notices in local and regional media, allowing sufficient time for those wishing to participate to read whatever documents will be presented or discussed.

Technical support for this component will be provided by the communications branch of the MDDEP. A communications advisor from the MDDEP is assisting the communications working group.

2.4 Research techniques: a model shale gas project

In carrying out the SEA a variety of methods will be deployed, such as case comparisons, expert opinions, public participation, scenario planning, cost-benefit analysis and multi-criteria analysis. In addition, the committee will make use of four types of procedures to ensure that its work is comprehensive: a review of existing literature, meetings with other provinces and states, field visits and the collection of primary data (geophysical, technical and social).

SEA analyses require agreement on the precise nature of what is being examined, in this case shale gas exploration and exploitation activities. To this end, the committee will prepare a detailed description of a model project, setting out what is commonly understood about the works involved in each of the four phases of a shale gas project (exploration, development, exploitation and abandonment with monitoring). The definition of those phases must be consistent with those generally recognized by other governments, to facilitate the comparison of royalty regimes, tax treatments and other mechanisms for encouraging the gas industry, whether elsewhere in Canada or in the United States. The model project will provide the parameters by which to evaluate the costs, benefits and risk factors (technical, ecological and health) associated with each phase of work and under each scenario.

Knowledge to acquire:

- M-2: Describe a model shale gas project including the phases of exploration, development, exploitation, abandonment and monitoring.

3. Analysis of the Issues

3.1 The pace of development

According to the BAPE report, without an overall development plan it is impossible to get an accurate picture of the environmental impact of the industry's activities (exploration, exploitation, collection and transportation). But the companies involved do not yet have enough exploration data to determine the extent of the gas reservoir and establish its potential, two elements essential to making a development plan for the industry.

Lacking such a plan, the BAPE based its analysis on three development scenarios prepared by three different bodies: the Québec Oil and Gas Association, Mackie Research Capital Corporation and the Government of Québec (the MRNF and the Ministère des Finances).

The resulting estimates are too fragmentary to serve as the basis for a SEA. It is therefore crucial, before anything else, to conduct an appraisal of the recoverable gas potential using a consensual method, and to sketch out potential development scenarios on that basis.

To prepare realistic development scenarios, it is essential to determine:

- the exploitation zones and the gas potential of each;
- gas availability scenarios (the exploitable potential of the resource);
- the foreseeable development of natural gas prices.

3.1.1 Exploitation zones, gas potential and availability of the resource

The potential zones for shale gas exploitation are known. According to the MRNF, Utica Shale Fairway 2 has the best potential (see Appendix 1). According to Mackie Research Capital Corporation, the zone where the Utica Shale is closer to the surface also has potential, though how well it could be exploited is less certain.

3.1.2 Foreseeable development of gas prices

Scenarios for wholesale and retail prices for natural gas delivered in Québec, whether produced in Québec, western Canada or the United States, will need to be worked out by examining the factors that influence those prices. These include the amount of the resource being produced, changes in the level of demand, prices for transporting it from production sites to consumers, substitution effects between different forms of energy, government policies on energy and greenhouse gas reduction, tax and royalty levels, and different regimes of exploration and exploitation rights.

3.1.3 Industry development scenarios

Development scenarios for the shale gas industry will be drawn up on the basis of studies on the availability of the resource, forecasts on the evolution of gas prices and information from companies with exploration permits in the Utica Shale. These scenarios will be used by the committee in performing environmental, social and economic analyses.

Note that, besides those two or three development scenarios, the "no development" scenario will also be examined, as a means of considering the opportunity cost associated with development of the industry.

Knowledge to acquire:

- P-1: Estimate Québec's gas potential, analyze possible developments in natural gas prices, and prepare plausible development scenarios.

3.2 Evaluation of environmental issues

According to the BAPE report, the St. Lawrence Lowlands are home to 65 floral and faunal species that are threatened or vulnerable, of which more than 15 are endemic to the Gulf and Estuary of the St. Lawrence, i.e. unique in the world. The distribution of species in decline has been found to correspond closely to human occupation and its effects on ecosystems and habitats.

It is a region with numerous wetlands, ecosystems that provide important ecological services[6], contributing to our well-being in terms of safety, health and comfort. Like the wetlands, the protected areas of this territory are small and scattered, and are suffering significant anthropic pressure.

In that context, any additional development could threaten the sustainability of what natural environments remain, reducing the biodiversity of this territory.

The BAPE report places considerable emphasis on the environmental concerns raised in the public hearings, and stresses that the main concern of participants was the industry's potential impact on the water supply. But that was not the only concern. Others had to do with the management of wastewater and residual materials, air quality, greenhouse gas emissions, technological and natural risks, and sensitive environments. Additionally, during public consultations on the implementation plan in December 2011 and January 2012 a number of participants expressed concern over the potential repercussions of gas leaks around drilling sites.

6 Ecological services are ecosystem functions that are of benefit to human beings. These services are generally grouped into four categories: regulating services, provisioning services, ontogenic services, and socio-cultural services. See: Limoges, Benoît. 2009. Biodiversité, services écologiques et bien-être humain. Le naturaliste canadien. 133-2:15-19

After studying all the environmental issues raised, the committee has prioritized them by three criteria: the nature of the issue (major or minor), the present level of knowledge (sufficient or insufficient), and the existing regulatory framework (suitable or inadequate). The issues were then grouped into four main themes: water; air; greenhouse gases and climate change; and natural and technological risks. Each of these issues will be further defined, and we will determine the quality of information available, the need for additional information including studies to be conducted, and potential solutions for impact management. The committee will approach these questions from an ecosystemic perspective, so as to have a good grasp of the nature and significance of the issues. Particular attention will be paid to land use and the potential effects of shale gas development on agriculture, forests and tourism.

3.2.1 Issues concerning water

Activities by the oil and shale gas industry require the use of large amounts of water, amounts that vary depending on the industry phase (pre-production or production) and what work is being done (drilling or fracturing). Pre-production corresponds to the exploration phase (searching for the resource) and putting infrastructure in place (boreholes, well completion, other equipment) to prepare for the production to follow.

The development scenarios created in the first stage of the SEA will serve to determine the number of wells that could be drilled under different scenarios, and thus to estimate the industry's potential water needs.

Knowledge to acquire:

- E1-1: Evaluate the water needs of the shale gas industry over the complete arc of development and production, determining the environmental impacts associated with such use and recommending regulatory solutions.

The analysis will deal essentially with three environmental issues related to water: supply, protection of the resource and wastewater management.

The issue of water supply

As mentioned above, water supply was one of the themes of greatest concern at the BAPE hearings and our public consultations. Since considerable quantities of water are used during shale gas development, people are worried that such withdrawals could lead to water shortages, water use conflicts and negative consequences on water quality or levels in surface and groundwater. To people in the regions, especially farmers, the potential long-term effects of such withdrawals are disquieting.

To answer those concerns, the SEA must analyze every possible scenario for the industry's sourcing of water (surface water, groundwater, existing catchment systems and water unfit for consumption or agriculture) as well as the repercussions of those scenarios, and propose mitigation measures in the event that the industry is developed.

Knowledge on available volumes of potential water supply sources

For large watercourses, the volumes of available surface water are very well known. The Centre d'expertise hydrique du Québec maintains a network that monitors the flow of large watercourses, from which the volumes available can be calculated. Furthermore, there are well-known methods of calculating the flow rates that should be maintained to protect wildlife habitats and the quality of the water. However, the flow rates of small watercourses are less well known.

Groundwater volumes are also less well known, and much more difficult to measure. It is known however that groundwater supplies for human and animal consumption are limited. The low flow rates would be insufficient for the heavy demands of shale gas drilling, so using near-surface water for shale gas purposes is not recommended. As for deep saline groundwater, it too has limited flow, making its use unlikely.

However, some bodies of groundwater within 100 m of the surface consist of brackish water (containing over 4000 mg/L of total dissolved solids), which is unfit for human and animal consumption and could therefore be used locally. Projects in the MDDEP's groundwater knowledge acquisition program (PACES) will provide information at the regional level that could guide decisions on the use of such water, though the low flow rates make it unlikely. The information will not be sufficiently detailed to evaluate specific drilling and fracturing sites. Very little is known about groundwater bodies at greater depth (over 100 m).

Existing municipal and industrial water catchment systems often have an authorized limit that is greater than the real volumes withdrawn. They could therefore represent a potential source of supply for the industry, and knowledge about these systems is excellent. For one thing, any groundwater catchment project of more than 75 m^3 per day is governed by the Groundwater Catchment Regulation (GCR), which requires a hydrogeological study to determine its impact on the environment and on other users (sections 31 and 36). As well, the Regulation respecting the declaration of water withdrawals covers all water withdrawals, and the associated database will provide information for analyzing the needs of the industry.

In the event of a lack of available water, or for economic reasons (to minimize transportation distances) the industry could use water that normally would not be withdrawn for common uses (municipal or industrial wastewater, saline or brackish water). However, knowledge about the volumes available from these sources is very fragmentary.

Lack of knowledge about the industry's water needs, and about the availability of water in regions with a potential for shale gas exploration, represents a substantial risk in terms of water use conflicts, the support capacity of ecosystems, and the preservation of biodiversity.

Additional information needs, and studies to conduct on water supply

To determine realistic water supply scenarios (by source of supply and estimated needs based on different development hypotheses), and to evaluate their impacts and draft recommendations, more information is needed about the availability of water resources. This information would primarily include:

Knowledge to acquire:

- E2-1: Hydrogeological data on deep formations (bedrock) and formations deeper than 100 m, from which to develop conceptual and digital models of the hydrogeological systems present; these models could then be used to evaluate the dynamics of fluid circulation at depth (before and after fracturing), and to identify sensitive zones and those for which knowledge is lacking;
- E2-2: Identification of watercourses that could not provide the volumes necessary for the industry;
- E2-3: A classification of Québec aquifers that would identify important aquifers (those whose water is suitable for human or animal consumption) for the purpose of protecting them, specifically by prohibiting gas wells and any other activity that could compromise the resource due to leaks or spills of toxic substances;
- E2-4: A feasibility study on the possibility of mapping usable water, by depth, over the entire region of interest.

The issue of protecting the quality of water resources

Besides concerns around quantitative issues associated with water availability, many concerns were raised by citizens and organizations at the BAPE hearings about protecting the quality of the resource. As with any industrial activity, shale gas exploration and exploitation activities carry risks, including the risk of contaminating surface and groundwater, and risks to health from contaminated water. Examples include spills of chemical products, hydrocarbons like diesel and gasoline, fracturing fluids, wastewater and drilling muds, as well as leaks of methane.

Since correcting a groundwater contamination problem can be long, difficult and costly, strict regulation is necessary for all operations in oil or gas exploration and exploitation: drilling, casing installation, cementing of well casings, well integrity testing, fracturing, and the safe abandonment of wells. Further, having good data on the chemical composition and toxicological characteristics of fracturing fluids and drilling residue will make it possible to identify substances that could contaminate water, and to determine exposure risks in the event of leaks or spills or toxic compounds.

Knowledge about drilling, fracturing and well abandonment procedures

A major study by the State of New York[7] concludes that rigorous application of the proper well casing and cementing techniques provides the best protection for the environment. The study reached that conclusion based on the near total absence of fracturing additives in the water of thousands of domestic wells near sites where hydraulic fracturing had been done. Methane leaks were found to be most often related to flaws in well installation.

All provinces and states that allow the industry to operate on their territory have strict regulations on well installation, along with a great many guides, standards, methods and guidelines. The American Petroleum Institute (API) also publishes an array of standards and methods to promote safe development of the industry. Knowledge about the best drilling techniques is therefore readily available. What is not documented, however, is how applicable that knowledge is to the Utica Shales.

Also, at present there is little information on temporary or definitive well abandonment procedures and the permanence of plugging measures. Under the regulations in force in Québec, authorization must be obtained for well abandonment, and is conditional on definitive plugging; yet there has been little monitoring of abandoned wells in the St. Lawrence Lowlands.

Knowledge about the chemical and toxicological characteristics of fracturing water

Knowledge is available on the chemical composition and toxicological characteristics of fracturing water. Though the industry considers its recipes to be industrial secrets, it must disclose the composition of fracturing fluids to the competent government departments, which in turn can control the release of that information under access to information laws. Lists of the additives used in fracturing water are available on a number of websites.

The recipes for the compounds used depend on the particular characteristics of the well to be drilled. They vary from company to company and from one operation to the next. However, the combinations used are similar for all fracturing operations and include organic and inorganic compounds selected for specific purposes, e.g. to clean the borehole, dissolve clay and certain minerals, prevent corrosion, reduce friction, and prop fissures open to allow gas to escape.

In Québec, 18 fracturing operations have been carried out, and material safety data sheets for the products used have been obtained for 10 of them. Currently there are 45 compounds listed (6 inorganic and 39 organic) that have been used for fracturing in Québec.

Knowledge about drilling and fracturing residues

Oil and gas drilling generates residues that include drill cuttings, drilling muds and the usual residual materials produced by a worksite. The regulations in place treat all such residues as industrial waste that must be analyzed and disposed of in authorized sites depending on composition.

7 NYSDEC, Preliminary revised draft SGEIS, July 2011, p. 10-2

Drill cuttings are fragments of rock brought to the surface during drilling; they must be characterized and sent to an appropriate landfill site. Drilling muds are actually water to which bentonite has been added to control density and viscosity. In some cases polymers may be added. Drilling muds are either recycled or solidified with the addition of sawdust and disposed of in an authorized location. Finally, the typical residues of any industrial site (empty containers, office residues, domestic residual materials) must be transported to recovery and recycling centres or to technical landfill sites.

Additional information needed and studies to be done on drilling and fracturing procedures and temporary or definitive well abandonment

For Québec to put in place a regulatory framework that ensures best practices for shale gas exploration and exploitation, studies must be done on the particular features of Utica Shales and existing standards in other provinces and states.

Knowledge to acquire:

- E3-1: Analyze existing standards in certain provinces and states, from well design to construction, including inspection, fracturing, completion and abandonment.
- E3-2: Document problems with spills and leaks encountered by the shale gas industry in Québec and other jurisdictions, with their causes and consequences and the measures taken to correct them.
- E3-3: Profile a typical well that would be representative of wells drilled in Québec over the last two decades.

Additional information needed and studies to be done on the chemical and toxicological characteristics of water and residues from drilling and hydraulic fracturing

More knowledge is needed about the chemical and toxicological characteristics of fracturing water. It is important to know what kinds of problems could arise in the event of a leak or spill, including environmental contamination and exposure of the public to toxic compounds.

As well, more knowledge is needed about the behaviour of fracturing water that remains at depth. Specifically, (1) could it migrate to the surface through natural faults and fissures in the overlying rocks, or indeed through the well itself and nearby closed wells; (2) could municipal and other high-volume pumping stations modify its circulation; and (3) could such water develop unacceptably high levels of radioactivity by circulating in deep rock formations.

Knowledge to acquire:

- E3-4: Determine the risks of leaks and spills (from retention basins, transportation, fluid injection, reflux water), the potential consequences of such incidents on the environment and health, and mitigation measures that could limit those consequences.
- E3-5: Produce a comprehensive list of substances used (or that could be used) for drilling and fracturing in Québec, with the by-products of their breakdown and reaction, and evaluate their toxicological properties and potential for biodegradation, bioaccumulation, persistence and overall toxicity.
- E3-6: Evaluate contaminants of natural origin in the Utica Shale that could end up in reflux water.
- E3-7: Evaluate the vulnerability of drinking water and other water intakes in terms of the assimilation capacity of watercourse systems for certain toxic substances.
- E3-8: Review the literature on data available in other jurisdictions where drilling has been done in Utica Shale (Pennsylvania and Ohio), concerning the substances used for drilling and fracturing and their degradation and reaction by-products.
- E3-9: Evaluate the natural concentrations of methane present in the groundwater of the St. Lawrence Lowlands; identify the origin of that methane and its mechanisms of preferential migration.
- E3-10: With a digital simulation, model the migration of fracturing water and methane, using physical variables (geological, physicochemical and hydrogeological) corresponding to the geological province of the St. Lawrence Lowlands and its watersheds.

Lastly, since the management of residues from drilling sites is well regulated and characterization data is available, only limited studies need to be performed in this area.

Knowledge to acquire:

- E3-11: Conduct an inventory of standards and regulations in force in Québec that touch on the management of residual materials from drilling sites.
- E3-12: Conduct an inventory of available data on the physico-chemical characteristics of such residues, from existing sites.

Solution options for better protection of the water resource

As mentioned above, the standards in force in other provinces and states have not been applied in the particular context of the Utica Shales. It will therefore be necessary, if the industry is developed, to require mandatory information gathering when environmental permits are issued for drilling and fracturing. In particular, the industry would be required to provide:

- Microseismic studies when hydraulic fracturing is performed;
- Geochemical monitoring of a certain number of fracturing operations, including gaseous compounds on a regional scale;
- Measurement of natural concentrations of methane in wells and aquifers within a specific radius around boreholes.

The issue of wastewater management

The shale gas industry generates wastewater primarily during fracturing activities (in the form of reflux water) as well as from the decanting of drilling muds.

Decantation water must be treated, whereas reflux water may be managed in various ways: reuse in subsequent fracturing, treatment in municipal or private sanitation plants, or storage in deep geological formations.

Reusing reflux water for subsequent fracturing would reduce both the amount of water used and the amount that would have to be treated. However, while reusing such water at the same site could be acceptable, transporting it from one site to another would be of questionable desirability.

One current practice is to truck fracturing wastewater to municipal treatment facilities. But such facilities are designed for the typical load of domestic wastewater, primarily organic matter. They are not designed for wastewater from the shale gas industry, which is loaded with total dissolved solids (especially salts) and substances that can interfere with the treatments used in municipal plants. Furthermore, in the industry's development phase (when drilling and fracturing are done) volumes of wastewater are generated that far exceed the capacity of municipal plants.

In provinces and states with experience in the hydrocarbon industry, disposal of reflux water by injection at depth is an almost universal practice. Injection is used in the United States, British Columbia, Alberta, Saskatchewan and Ontario among others.

In the United States, the Environmental Protection Agency (EPA) regulates injection using a formal classification of the types of injection wells. The system includes the information needed to determine which class applies to any given well, and specifies, for each class of well, the types of fluids that may be injected. The operators of such disposal wells are required to respect detailed construction standards, a regular testing program and an inspection program.

At present, storage of reflux water in deep geological formations is not practised in Québec. Given the little information available on the storage capacity of deep geological formations, the committee considers that a study must be done on this topic.

Knowledge about wastewater management

There is only fragmentary knowledge about the management of wastewater from the shale gas industry, so it is critical that studies be done before establishing a legislative framework, to ensure that such water is managed in an environmentally acceptable manner.

Additional information needed and studies to be done on wastewater management

Two principal needs have been identified: (1) to prepare wastewater treatment scenarios for different hypotheses as to the industry's pace of development; (2) to evaluate the use of wastewater storage in deep geological formations.

Knowledge to acquire:

- E4-1: Prepare different scenarios for reflux water management, including cost estimates, depending on:
  - the production level of reflux water, and its quality;
  - the potential for reuse;
  - handling (onsite retention basins, municipal treatment plants, other types of plants);
  - final disposal.
- E4-2: Review the available wastewater treatment technologies and their effectiveness with regard to risk substances.
- E4-3: Analyze the environmental impacts and induced seismicity risks associated with storing reflux water in deep geological formations. If the practice could be used safely in Québec, determine the regulatory requirements regarding studies, methods and monitoring for such a project to be authorized.

3.2.2 Issues concerning air

Many of the citizens who participated in the BAPE hearings expressed concerns over the consequences for air quality, and potentially their health, that could result from shale gas activities. Others wondered about greenhouse gas emissions if the industry were developed.

The issue of ambient air quality

There is no particular provision in the Clean Air Regulation (CAR) regarding the shale gas industry. However, the general standards apply to some of its activities, examples being the use of stationary internal combustion engines (compressors, generators, etc.) and drill rigs. In addition, the CAR sets out ambient air standards for any new stationary source. Over a hundred parameters are regulated (schedule K of the CAR). Lastly, trucking on a drill site is subject to the Regulation respecting environmental standards for heavy vehicles.

Numerous contaminants are emitted by the various sources, whether mobile (internal combustion engines of heavy machinery), stationary (dewatering units, compressors) or fugitive (defective equipment seals). They include particulate matter, sulfur oxides, nitrogen oxides and various other volatile substances, and could, according to the Institut national de santé publique du Québec[8], have acute and chronic effects on the population as well as on the natural and agricultural environment.

To respond to the worries of concerned citizens and evaluate potential impacts on air quality, the committee will include in its analysis all sources of atmospheric emissions (in both the pre-production and post-production phases), the contaminants emitted, the weather conditions in which they might occur, and the particular features of affected environments. This will serve to quantify the impacts on ambient air and define the level of risk that such activities represent for the population and the environment.

The analysis will be based on the model project prepared for other elements of the SEA, defining parameters to create a representative scenario of the activities and equipment generally used in the development phase. The data employed (physical, natural, human, meteorological) will be representative of the context and the model environments studied, so that cumulative effects can be taken into account.

Contaminants estimated for the study will include nitrogen oxides (NOx), sulfur dioxide (SO2), carbon monoxide (CO), total solid particles (TSP), fine particles (PM2.5), volatile organic compounds (VOCs), hydrogen sulfide (H2S), polycyclic aromatic hydrocarbons (PAHs) and aldehydes (formaldehyde, acetaldehyde, acrolein, etc.).

Methane and ethane will not be considered in the air quality study, since they are not toxic to humans and there are no standards or air quality criteria for them. Both however are simple asphyxiants, meaning that at high concentration in an enclosed space they can displace oxygen and cause asphyxiation. Also, at certain concentrations and in the presence of an ignition source they can explode. Methane and ethane will be considered in the sections on risks and greenhouse gases.

Special attention will be paid to substances with odorant properties.

Results from the model, particularly the estimates for neighbouring populations, will be compared to the Québec air quality criteria to look for anticipated exceedances and to qualify (a) the environmental impact of a model project, and (b) the cumulative impact of different development scenarios. The model will also be used to determine the exposure level of people living nearby, providing data for the analysis of health risks.

8 BAPE report, p. 146

Knowledge to acquire:

- A1-1: Evaluate emission rates for atmospheric contaminants from stationary, mobile and fugitive sources at a model shale gas project, using scenarios that account for simultaneous activities.
- A1-2: Model the atmospheric dispersion of contaminants emitted by stationary and mobile sources, and by a model project in a model environment representative of the St. Lawrence Lowlands, evaluating the impact of these contaminants on ambient air quality. This study will be done in conjunction with S3-1: an estimation of expected impacts on the health of exposed populations and an evaluation of the importance of those impacts for their quality of life.

Solution options for the management of air quality impacts

Attenuation measures adapted to the environment, such as the use of electrical power and piped water, will also be examined in this study. The impact of such attenuation measures on ambient air quality will also be evaluated.

3.2.3 Issues concerning greenhouse gases

In November 2009, the Government of Québec committed to reduce provincial emissions of greenhouse gases (GHGs) to 20% below the 1990 level by 2020. One tool for monitoring such emissions is the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere, which since 2011 has set the threshold for mandatory reporting at 10 000 tonnes of CO2 equivalent per year per establishment. More recently, in December 2011 Québec adopted the Regulation respecting a cap-and-trade system for greenhouse gas emission allowances. The Government considers that this system will play a determining role in achieving its GHG reduction objectives. Starting January 1, 2013, industrial establishments that emit 25 000 tonnes or more of CO_2 equivalent per year will be subject to the capping system as an incentive to reduce their GHG emissions[9].

The committee will estimate the potential GHG emissions of a hypothetical shale gas industry in Québec, and what impact they would have on the Government's GHG reduction objectives.

Knowledge to acquire:

- GES1-1: Evaluate the GHG emissions from stationary, mobile and fugitive sources at a model shale gas project, from the pre-production phase to abandonment.
- GES1-2: Estimate the GHG emissions budget of a model shale gas project based on the prepared scenarios. This study will be done in conjunction with EC2-3: Environmental analysis of the life cycle of a model shale gas project.

9 http://www.canlii.org/en/qc/laws/regu/rrq-c-q-2-r-46.1/latest/rrq-c-q-2-r-46.1.html

Solution options for the management of impacts due to GHG emissions

Attenuation measures adapted to the environment, such as the use of electrical power and piped water, will also be examined in this study. The impact of such attenuation measures on GHG emissions will also be evaluated.

3.2.4 The issue of natural and technological risks

Definition of risk:

The concept of risk includes two elements : the probability of a particular event occurring and the gravity of its consequences. By that definition, risk must be assessed and categorized on a scale from negligible to high, since "zero" risk does not exist. For example, risk is high if an event has a high probability and would have meaningful consequences, but is also high if the event has low probability but would have catastrophic consequences. Conversely, risk is low if an event has a good probability of occurring but with minimal consequences, or if it is extremely improbable and would have consequences of middling importance.

Natural risks

At the BAPE hearings, questions were also raised about natural risks. Thus, some participants wondered about the possibility of fracturing or other activities provoking landslides or earthquakes. Others were more concerned about what impact certain natural phenomena, such as landslides, earthquakes and floods, could have on the safety of drilling and fracturing equipment, and how that in turn could pose risks for people or the environment.

Current knowledge about natural risks

The Ministère des Transports and the Ministère de la Sécurité publique have examined the risk of earthquakes and landslides in the territory concerned. A map of landslide risk zones has also been produced. However, there remains some uncertainty about the potential for landslides.

Additional information needed and studies to be done regarding natural risks

With the collaboration of the Ministère de la Sécurité publique and the Ministère des Transports, the committee will analyze the consequences of natural risks and review existing knowledge about what impact natural phenomena could have on industry facilities, and the implications for the safety of neighbouring communities.

Also to be analyzed is the probability of an earthquake or landslide being provoked by activities of the shale gas industry. The study on earthquake and landslide risks by the Ministère des Transports and the Ministère de la Sécurité publique considered the possibility of induction by seismic surveying, drilling and fracturing.

Knowledge to acquire:

- R1-1: Determine the potential natural risks in the region of interest for shale gas development and their probable repercussions on the facilities of a model project and on public safety.
- R1-2: Analyze the risk of natural phenomena being provoked by activities of the shale gas industry, with their anticipated consequences on property and public safety. This analysis will also contribute to the studies on health risks.

Solution options for the management of impacts related to natural risks

The maps of risk zones created will provide material for reflection on the possibility of excluding the gas industry from, or limiting its access to, particular regions where risks to the health and safety of a nearby community or the environment would be deemed too high.

Technological risks

Every industrial project brings with it certain risks, depending on the nature of the project. It is important to determine potential sources of accidents and incidents at each stage of a model shale gas project, and to evaluate the consequences under different scenarios. Depending on the extent and magnitude of those consequences, measures should be planned for managing or reducing risk at the source, and emergency measures plans could be required. In its analysis of technological risks, the committee will accord particular attention to matters raised during the consultations, including the risks associated with well construction and the integrity of casing and cementing after a well has been abandoned.

Additional information needed and studies to be done regarding technological risks

To measure the potential consequences of an accident involving the shale gas industry, a technological risk analysis will be done using the methodology applied when industrial projects receive an environmental assessment at the MDDEP.

Based on a description of the phases of activity of the model project, including a characterization of dangerous materials used or produced, the analysis will focus on accidents and incidents that could occur in the receiving environment. Along with examining accident and contamination scenarios and their potential dangers, the analysis will identify risk zones and the sensitive elements within them, and will conduct a post-mortem of past accidents and contamination incidents.

Standard and alternative scenarios will be drawn up to define possible consequences (spills, fires, explosions, gas clouds, gas leaks from wells) and to measure their potential repercussions on the sensitive elements of zones at risk. The extent of potential impacts in these various scenarios, combined with their occurrence frequency, will be used in determining the individual and societal risks of such events, weighing their acceptability or unacceptability, defining mitigation and emergency measures, and determining the communication needs of people living in areas at risk.

From that analysis it will also be possible to draw up an emergency measures plan, determine the resources required to respond to emergencies, and distribute responsibilities among stakeholders.

The well-construction techniques and hydraulic fracturing methods used by the shale gas industry in Québec will be evaluated in terms of the standards, technical guides and good practices applied in Québec and elsewhere, to determine the causes of leaks from certain wells and the long-term risk they represent. This analysis will be completed by project EC2-5: Conduct an inventory of technologies and measures that could reduce the risks and externalities associated with development of the shale gas industry.

Knowledge to acquire:

- R2-1: Analyze the technological risks associated with the activities of a model shale gas project.

Solution options for the management of impacts related to technological risks

An examination of the standards and regulations in force in Québec and elsewhere, and of statistics on accidents and incidents in the natural gas industry, will lay the groundwork for determining the normative and regulatory measures needed for technological risk management, as well as the appropriate mitigation measures. Some risk reduction measures have already been identified, notably with regard to land use and emergency measures plans.

3.3 Evaluation of social issues

Shale gas is a natural resource for which, as with mineral resources, the conditions for exploration and exploitation are governed by the Mining Act (R.S.Q., c. M-13.1). As underscored by the BAPE however, shale gas raises new issues due to the location of deposits and their mode of exploitation. That is, mines are generally located on public land, in relatively uninhabited areas that are far from markets, whereas shale gas is found in southern Québec, primarily on private lands in a rural or even agricultural setting, with inhabited areas nearby. Moreover, whereas a mine is usually at a single location, the extraction of shale gas requires the drilling of hundreds of scattered wells linked by a collection network. These fundamental differences play a preponderant role in the industry's effects on the human environment and in its social acceptability.

3.3.1 Land use and compatibility of uses

Governance regime

With a few exceptions, current legislation gives precedence to mining activities in the use of land (section 246 of the Act respecting land use planning and development)[10]. Exploring for and exploiting the resource could therefore conflict with the land use priorities of the nearest community. Indeed, if the resource is located in a populous area, any activity to obtain it would have a direct impact on many people, particularly in terms of water use conflicts and environmental nuisances.

Knowledge to acquire:

- S1-1: Analyze Québec's mining governance regime and its consequences, comparing with other mining regimes around the world.

The BAPE has identified several cases in which the mining sector has precedence. Examples include ecological reserves with no legal status (such as territories recognized by UNESCO as world biosphere reserves, e.g. Lac Saint-Pierre) as well as tourist, vacation and heritage regions. The BAPE concludes that in view of such potential land use conflicts, when defining zones conducive to shale gas development attention should be given to current land use, the status accorded to particular areas, and other planning constraints (BAPE, p. 174). It suggests that development plans and municipal zoning plans for gas development should be made consistent with government orientations, citing the experience with wind power as an example.

Participation of municipal authorities in governance of the industry

Québec's territorial organization involves a host of interacting actors[11] and tools[12], notably in the areas of planning and regulation, that govern the use and development of a given territory. The BAPE report indicates that without clearly defined powers and government orientations, the role of the municipality in the control and development of the shale gas industry remains uncertain, as is the case with other bodies such as the Commissions régionales sur les ressources naturelles et le territoire (CRRNT).

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10 This precedence is still found in the draft bill on land use planning and sustainable development submitted to the National Assembly on December 9, 2010.

11 This could include municipalities, regional county municipalities (MRCs), regional conferences of elected officials (CRÉs), government departments, and organizations like the local development councils (CLDs), etc.

12 Examples of the tools used in Québec for regional and local land use planning and development include: the five-year development plan of a CRÉ; the regional development plan for natural resources and the territory (PRDIRT) of the Commissions régionales sur les ressources naturelles et le territoire (CRRNT); the local action plan for the economy and employment (PALÉE) of a CLD; the diversification and development plan (PDDE); and the general plan and land use and development plan (SAD) of an MRC.

Knowledge to acquire:

- S1-2: Analyze the potential role of municipalities and other relevant bodies in the control and development of the shale gas industry.

This analysis, which will consider the views of the stakeholders concerned, will identify actions that could be taken toward defining government orientations, and will attempt to clarify the powers required by MRCs and municipalities in order to handle the task of making shale gas development consistent with planning at local and regional levels.

Case study of the deployment and governance of Québec's wind power, forestry and pork industries

Three very different case studies will provide comparisons for the committee's consideration of water use conflicts and territorial governance.

Knowledge to acquire:

- S1-3: Conduct three case studies on deployment and governance in the wind power, forestry and pork industries.

Three scenarios of territorial governance

In response to the BAPE's more global suggestion, the SEA committee will also consider three scenarios of territorial governance:

- The status quo scenario, where mining activities (including the gas industry) have precedence everywhere with a few exceptions.
- The zoning plan scenario, applying throughout the province, defining specific areas where that precedence would remain, while outside those areas the industry would have no precedence or would be limited or even prohibited.
- The no-precedence scenario, where the gas industry would have to fit into local development plans.

Each of these scenarios will be explored in terms of benefits, feasibility and social acceptability, as well as how it could be made operational.

Knowledge to acquire:

- S1-4: Define three scenarios of territorial governance based on the degrees of precedence given to gas development, specifying for each a legal framework, development mechanisms, mode of operation, the role of municipalities and other institutions, and the division of responsibilities among levels of authority (local, regional, national). With each scenario, also consider social acceptability, transition from the current regime, feasibility, deterrents, dangers and possible problems as well as benefits.

3.3.2 Social impacts

Activities of the shale gas industry could have multiple effects on communities and individuals, impairing both their health and the quality of their living environment. These effects must be documented for the populations concerned so that measures could be taken to eliminate, attenuate or rectify them.

Current state of receiving communities

The characterization of receiving communities, meaning those that could see the arrival of shale gas facilities, is an essential step in the SEA. Indeed, the Québec Sustainable Development Strategy emphasizes the importance of understanding the current state of the human environment before undertaking any major change (2007: 48), since "urban and rural settings each have conditions, histories and dynamics that are distinct yet related" (2007: 43). Similarly, the Institut national de santé publique du Québec (INSPQ) mentions that for a precise determination and evaluation of the psychosocial effects associated with development of the shale gas industry, a study of the socioeconomic characteristics of local populations is crucial (BAPE, 2011: 229). Furthermore, knowledge of the current state will provide a reference for monitoring the impact of subsequent change.

Knowledge to acquire:

- S2-1: Prepare status reports on potential receiving communities, with details on their social, economic and ecological dimensions as well as their governance.

Agriculture, forestry and tourism

The near totality of the area of interest for shale gas (80%) is zoned for agriculture, whereas that is true for just 2% of the province as a whole. More precisely, "the proportion of land zoned for agriculture in the MRCs is 86% in Montérégie, 66% in Chaudière-Appalaches and 93% in Centre-du-Québec. Furthermore, the average forest cover of municipalities in the St. Lawrence Lowlands is just 28%, below the critical threshold of 30% generally considered necessary to sustain biodiversity" (BAPE 2011).

There is a possibility that exploration, exploitation and distribution pipelines could compromise farm production. Not only would that threaten the quality and quantity of food supplies for Québec's domestic and export markets, it would weaken the region's socioeconomic fabric by putting farmers out of work. The shale gas industry could also have negative impacts on tourism and forestry, compromising communities whose vitality depends on those activities.

At the same time, various regimes regulate the precedence of activities. For example, in agricultural zones authorization is required from the Commission de protection du territoire agricole du Québec (CPTAQ) before site construction can even begin, to avoid any restriction on agricultural practices.

Knowledge to acquire:

- S2-2: Case study on the CPTAQ: history, operations, results.
- S2-3: Analysis of the potential role of the CPTAQ in regulating land use conflicts related to the shale gas industry.

Additionally, the study on land use modifications (S3-5) will document the impact that developing the industry could have on the land.

Heritage, landscape and visual impacts

There are several types of heritage (natural, cultural, agricultural, archaeological) that could be affected by development of the shale gas industry. Elements of interest in receiving communities should therefore be inventoried, to examine how they would be affected and to propose mitigation measures to protect them if necessary.

Knowledge to acquire:

- S2-4: For the regions concerned:
    - Prepare an inventory and cartography of: 1) the network of protected areas; 2) regional areas of historical, cultural, aesthetic and ecological interest; 3) municipal parks and green spaces; 4) conservation plans; 5) active farmland and the potential of arable soils.
    - Evaluate the potential of the regional archaeological heritage.
    - Evaluate the possible cumulative impacts of shale gas activities on heritage elements, and propose mitigation measures.

Landscapes are part of the cultural heritage: they reflect a society's identity. In each region, different types of landscapes have developed through interactions between humans and the environment. The shale gas industry requires facilities that could alter the integrity and features of the landscape, for example through forest clearing. The BAPE observes that impacts would vary with the size of an operation and its complementary infrastructures (storage and sludge basins, compressors, gas treatment units, access roads, gas gathering network). The visual impact would be greater around sites with multiple, closely spaced wells in areas with high visual accessibility. That would apply to much of southern Québec, since according to the MRNF, "the geomorphology of the St. Lawrence Lowlands is characterized by a vast plain of agricultural lands with very low relief" (BAPE, 2011: 174, 175, 186). The BAPE issued two opinions regarding the characterization of landscape units, emphasizing the importance of collaboration with local communities (2011:177).

Knowledge to acquire:

- S2-5: Determine and document the visual, heritage and landscape impacts associated with each phase of the industry, and propose measures that could eliminate, attenuate and rectify them.

Impacts and mitigation measures will be assessed using a participative approach. Tools will include the 3D method (define, develop and deploy), different scenarios (status quo, one well, multiple wells), and a consideration of changes over time through the life cycle of a project. For each region, the assessment will look at the value placed on its characteristic landscapes by the people who live there.

Social impacts of nuisances, risks and environmental problems

Shale gas exploration and exploitation activities, like any industrial activity, have social impacts that must be determined to evaluate their real or potential severity. Social impacts mentioned in the BAPE report include environmental nuisances due to increased noise, trucking and light, as well as increased housing needs.

Increased noise

During the BAPE hearings, a number of citizens shared their concern over the noise pollution that would be generated by shale gas industry activities, and the impact it would have on the quality of life, peace and quiet, well-being, indeed the health of the surrounding population.

Under section 1 of the Environment Quality Act (RSQ, c Q-2), noise is considered as a contaminant, and when caused by stationary sources is governed by precise standards depending on the receiving environment and the time of day. Often, it is municipalities that regulate sound and intervene in cases of noise pollution. The World Health Organization (WHO) has documented the effects of noise on health, providing guidance values for communities based on the type of setting. It recommends that studies be done before permitting any project that would significantly increase the environmental noise level in a community. According to the Québec Oil and Gas Association, the noise from operations on exploration sites can reach over 90 dB(A). Therefore, to respect WHO guidance values, drilling sites must be located at least 1.5 km away from residential zones (BAPE, p. 180).

Increased trucking

According to the Ministère des Transports, increased trucking «would necessarily create more or less significant nuisances for nearby residents in cities, villages and rural areas along trucking routes» (DQ18.1, p. 1). Increased numbers of heavy vehicles could also diminish road safety and impede the free flow of traffic (BAPE, 2011: 184). Some municipalities have already expressed worries about potential damage to roads.

Increased luminosity

Flare stacks and incineration units produce increased luminosity during the testing period. The same is true of site lighting required for worker safety, which can disturb people living nearby. Since there are no regulations on the matter, there is a need to define the magnitude of the nuisance, particularly in terms of the quality of life of nearby residents.

Increased housing needs

An American study on the social impacts of shale gas exploitation[13] cites access to affordable housing and its influence on the cost of living as one of the most significant social concerns, particularly in rural counties. As documented in Sept-Îles by the Canada Mortgage and Housing Corporation (CMHC) and in a number of other studies[14], when an industrial project causes a rapid influx of workers there can be drastic changes in vacancy rates and other indicators of access to housing.

13 http://www.institutepa.org/PDF/Marcellus/MarcellusShaleStudy08312010.pdf

14 http://www.uqac.ca/msiaa/Annexes/Annexe14.pdf

Though the SEA will not look solely at those four factors (noise, trucking, luminosity and housing), they will receive particular attention. We must also emphasize that for all of the studies concerning nuisances, a participative approach will be used to ensure that the communities and social groups concerned have a voice in evaluating consequences and passing judgement on suggested mitigation measures.

Knowledge to acquire:

A theoretical analysis of noise impacts will be done for all sources. The study will evaluate the noise levels of construction and dismantling operations, exploration and exploitation activities, and related road traffic. The results will be interpreted in terms of day and night criteria.

- S2-6: Model the noise impacts associated with shale gas exploration and exploitation activities, based on the model project and development scenarios.
- S2-7: Determine and document the social impacts associated with the different phases of development of the industry, and designate measures to eliminate, attenuate and rectify them, especially but not exclusively with regard to:
  - the intensity and chronicity of environmental noise with different project scenarios (single or multiple wells) and different separating distances;
  - increased trucking and the construction of new access roads.

3.3.3 Health and psychosocial risks

In its memoir to the BAPE, the INSPQ explained the potential risks to health associated with shale gas exploration and exploitation activities. Grouping those risks into five themes (water, air, technological risks, quality of life and nuisances, and psychological and social factors), the INSPQ stressed that there is not enough information currently available to determine the magnitude of those risks.

The technical, environmental and social knowledge acquired for the SEA will partially fill in the gaps, providing health specialists with much more substantial data from which to estimate the potential risks to health. This data acquisition, which will focus largely on populations that would be directly affected by development of the industry, will be all the more valuable in that, according to the INSPQ, perceptions about the risks of shale gas activities, combined with a lack of citizen participation in decision processes, could have psychosocial effects like stress and anxiety on the communities affected, while engendering a general dissatisfaction and loss of confidence in authorities, including the Government (BAPE, p. 229).

The numerous studies mentioned in the preceding sections, on water and air quality, natural and technological risks, and environmental nuisances, will provide public health authorities with the information they need to complete their studies on public health.

Atmospheric emissions

According to the Ministère de la Santé et des Services sociaux (MSSS), air contaminants from emissions are associated with harmful effects on health. While it is impossible to demonstrate all of the direct impacts on health, what can be done is to determine and document the sources of contaminants, the duration of exposure, the concentration of pollutants, and their potential impacts on exposed workers and the population, particularly the most vulnerable: young children and the elderly.

Knowledge to acquire:

- S3-1: Based on the results of air quality studies, estimate the expected impacts on the health of exposed populations, and evaluate the importance of these impacts for their quality of life.

Industrial use of water[15]

The composition of the drilling water, drilling residue and products used by the industry are also matters of concern for public health. Several studies, particularly E3-5 on substances used in drilling and fracturing, and E4-2 on wastewater treatment technologies and their effectiveness with risk substances, will provide public health authorities with information on these topics.

For example, a temporary increase in the turbidity of water in private wells is the most common form of contamination from drilling activities (NYCDEP, 2009). Often accompanied by disagreeable tastes and odours, the increased turbidity can alter the microbiological quality of the water, thereby compromising its safety for drinking.

According to the MSSS (2011), data collected by regional public health offices show that some municipalities are in a vulnerable situation with their drinking water supply, in terms of both quality and quantity. The availability and quality of drinking water, together with wastewater management, are cited by health authorities as important factors for human health.

Knowledge to acquire:

- S3-2: Based on the results of quantitative and qualitative studies on water:
  - Estimate the anticipated impacts on the health of exposed populations, and evaluate the importance of those impacts for quality of life.
  - Evaluate the vulnerability of existing and potential sources of drinking water depending on use (human or animal consumption, agricultural or aquaculture production, etc.), and propose a monitoring model fo the management of drinking water sources, including emergency measures.

15 Infrastructures related to water include drinking water treatment facilities, wastewater treatment facilities, water mains and sewer pipes. (VG, 2009-2010)

Technological risks

While it may seem difficult to evaluate technological risks, nonetheless there are some known dangers related to the technology of shale gas exploitation (BAPE, 2011: 161). As the BAPE makes clear, "An essential component of risk management is the preparation of emergency plans and the training of personnel who are equipped and qualified to handle risks safely and to deal with emergencies. This industry being new in Québec, risk management will demand appropriate methods of communication" (BAPE, 2011: 163). Also, as discussed below, the communication and perception of risks directly influence the level of social acceptability[16].

Knowledge to acquire:

- S3-3: Based on the analyses of the technological and natural risks associated with the activities of a model shale gas project, document risk perception and psychosocial impacts among local populations, using a representative sample of social groups and the development index of each community.
- S3-4: Determine practices (strengths and weaknesses) of risk communication among the industry, municipalities and provincial organizations responsible for public safety. Prepare a model risk communication plan based on the nature of the project, including modes of surveillance and monitoring.

Modifications in land use

The partial or total modification of land uses and functions from those defined in land use and development plans, when found to be incompatible and a possible source of risk, can lead to water use conflicts and disrupt territorial cohesion.

Knowledge to acquire:

- S3-5: Using the different development scenarios, document the impacts of shale gas development on land-use planning, notably with regard to agriculture, forestry and tourism, and define potential land-use conflicts.

Note that for each scenario, the importance of the repercussions on local communities will be evaluated, taking into account their development index and drawing upon Canadian and American experience.

16 For example, the Aarhus Convention (1998) considers transparency of communication as a powerful factor for prevention, protection and democratic management of industrial risks.

Need for new infrastructures

Lastly, the exploitation of shale gas implies a series of connections for gas gathering and the extension of the gas network for transportation. According to Gaz Métro, routes for installing gas pipes would be chosen in consultation with local communities, and efforts would be made to minimize impacts on the environment. Right-of-way widths would be determined by whether the land is used for agriculture, forestry or urban purposes, as well as by the technical characteristics of the gas network. In addition, gas transmission lines would be buried, as would the gas gathering systems of producers, and would respect the construction standards of the Canadian Standards Association (BAPE, p. 170).

Knowledge to acquire:

- S3-6: Evaluate the social impacts that gas infrastructures could have on local communities through the exploitation and transportation of shale gas.

3.3.4 Governance of the industry, its side effects and activities

Once a framework for territorial governance has been determined, the very functioning of the industry (if there is one) should be managed with a view toward the interests, needs and concerns of all stakeholders, to ensure its social acceptability.

Social acceptability of the shale gas Industry: factors and mechanisms

Many factors condition the social acceptability of a given project or industry: its impacts and side effects, the institutional framework, the decision-making process, local control, and so on. There is a need to ascertain which factors determine the social acceptability of the shale gas industry. What characteristics and conditions make this industry acceptable or unacceptable to the population? This information would make it possible to weigh the likelihood of the industry being acceptable to a given community, and to Québec in general; and if might be acceptable, to clarify the conditions under which that would be so. This analysis of acceptability should be applied to both the population as a whole and to particular communities where the industry would be active.

Knowledge to acquire:

- S4-1: Analyze the conditions affecting the social acceptability of the shale gas industry in Québec.

Information, public participation and collaboration mechanisms at the local level

Social acceptability is strongly dependent on the information and consultation mechanisms put in place by the sector's stakeholders, notably industry representatives and government departments and agencies. The BAPE highlighted the inadequacy of the mechanisms currently in place, and suggested exploring the setting up of consultative committees to debate both the overall land-use development plan and specific company projects.

Knowledge to acquire:

- S4-2: Prepare scenarios for public participation and collaboration with local authorities. In terms of specific projects, describe how public participation and local collaboration would happen with each, the duration of the process and the associated costs.

Public representation of issues surrounding the shale gas industry

Since at present there is strong opposition to developing the industry, a better understanding is needed of why that opposition emerged and how the industry's image has contributed to it. This would facilitate assessment of the conditions under which a social consensus might be reached.

This question will be considered during the field visits planned for the committee, allowing a comparison of perceptions about the shale gas industry by the public and elected officials in Québec, France, the United States and other parts of Canada.

Social responsibility of the industry

A fundamental factor in the social acceptability of an industry is its commitment to being socially responsible. In recent years, the movement toward greater social responsibility in enterprise has given rise to a host of practices and guidelines. Adopted in November 2010, International Standard ISO 26000, Guidance on social responsibility, is the fruit of broad international consensus and appears destined to become the central reference on the subject. Besides analyzing the application of this standard to the shale gas industry, it would be useful to make an inventory of best practices in social responsibility in the oil and mining sectors. Such an inventory could inspire companies wishing to do business in Québec, providing the basis for a common framework with which to strive for excellence in social responsibility.

Knowledge to acquire:

- S4-3: Analyze the past and present behaviour of the shale gas industry in Québec and abroad, together with social responsibility practices in the oil and mining sectors (including both a documentation component and an empirical component). Also, study the applicability of the social responsibility framework in ISO 26000 and other international standards, and consider the desirability of applying them to the shale gas industry in Québec.
- S4-4: Study potential mechanisms (certification, disclosure, ecoconditionality) of obliging companies operating in the sector to adopt best practices, to ensure that social responsibility becomes a reality of the industry.

Work, health and safety conditions

In the most conservative development scenarios presented during the work of the BAPE, from 5000 to 7625 direct and indirect jobs could be created by developing the shale gas industry. The most optimistic scenario sets the figure at 19 000.

Currently there are few studies on the control of working conditions in the industry, notably with regard to workplace health and safety. A study is needed on conditions and requirements elsewhere in the world so that guidelines could be proposed in the event of the industry being developed in Québec.

Knowledge to acquire:

- S4-5: Document the control of working conditions in the shale gas industry, notably in terms of workplace health and safety, elsewhere in Canada and in other countries, and propose a framework for Québec.
- S4-6: Document the trades and training associated with the industry, and analyze the possibilities for skills transfer to Québec.

Native populations

In the Statement of Understanding and Mutual Respect, the native community and the Government of Québec agree to favour the route of discussion and negotiation toward developing a harmonious and sustainable relationship. That commitment will guide the SEA committee in studying the potential impacts of the shale gas industry on native populations. To ensure that native communities have a voice in determining those impacts and evaluating proposed mitigation measures, a participative approach will be used.

Knowledge to acquire:

- S4-7: Determine and document the impacts, on native populations, of activities associated with different development phases of the shale gas industry, and identify measures to eliminate, attenuate and rectify them, along with mechanisms for consultation and dialogue with these communities.

Measures to maximize social benefits

Not all economic developments are of equal value in their potential social benefits. From a sustainable development perspective, preference must be given to development and economic activities whose drawbacks are minimal, that maximize the well-being of populations, and that foster an equitable distribution of wealth and social inclusion.

To achieve that objective, it is necessary not only to give preference to the most beneficial economic activities, but also to put in place mechanisms to maximize their social benefits and minimize whatever social problems may be associated with them.

Knowledge to acquire:

- S4-8: Determine factors that could maximize social benefits and minimize social problems associated with development of the shale gas industry, and propose detailed implementation mechanisms.

3.4 Evaluation of the socioeconomic desirability of shale gas exploitation

The socioeconomic analyses will focus on determining whether it would be desirable to proceed with the exploration and exploitation of shale gas in Québec, and if so, what conditions would maximize revenues for the province. This will be done by determining and quantifying the advantages, disadvantages, and environmental, social and economic costs of shale gas development for Québec society, under various scenarios based on realistic development hypotheses, including the "no development" scenario. The analyses will also take into account the broader question of including the gas sector in Québec's energy policy, and whether its development could be sustainable.

3.4.1 Context: the place of the shale gas industry in government orientations

The natural gas industry

In 2009, Québec's consumption of natural gas came to around 5.3 billion cubic metres, accounting for 12.5% of the province's energy consumption. With 85% of the total, the industrial and commercial sectors were the principal consumers. Québec as a whole has some 218 500 residential subscribers, i.e. 180 000 for Gaz Métro[17] and around 38 500 for Gazifère[18] in the Gatineau area. The natural gas distribution networks cover more than 10 000 km, and in the last few years have extended into the National Capital region.

From the early 1980s to the end of the 1990s, natural gas consumption increased steadily. Since the end of the 1990s it has gone up and down, a volatility due in large part to consumption by the industrial sector, which is more sensitive to economic conditions and price fluctuations.

Virtually all natural gas consumed in Québec is imported from western Canada. Since 1987, these imports have ranged between 5 and 6 billion cubic metres per year. The total cost depends on the price, but in recent years has been around $2 billion per year.[19]

Knowledge to acquire:

- EC1-1: Based on a projection of Québec's energy needs, analyze different scenarios for natural gas consumption over a 25-year horizon, taking into account the relevant economic and sociopolitical parameters and what effect local production would have on that consumption.

17 http://www.corporatif.gazmetro.com/corporatif/communique/en/html/2447823_en.aspx?culture=en-ca

18 http://www.gazifere.com/gazifere_reseau_distribution.php

19 http://www.mrnf.gouv.qc.ca/energie/statistiques/statistiques-consommation-gaz.jsp.

Natural gas and energy policy

Following a broad-based consultation process, the Government of Québec published an energy strategy that set out the goals to achieve and actions to undertake between 2006 and 2015.

The strategy is based on six objectives:

1. Québec must strengthen its energy supply security.
2. We must make better use of energy as a lever for economic development. Priority is given to hydroelectricity, wind energy potential, hydrocarbon reserves and the diversification of our natural gas supplies.
3. Local and regional communities and aboriginal nations must be given more say.
4. We must use energy more efficiently.
5. Québec must become a leader in the sustainable development field.
6. Electricity rates must be set at a level that promotes our interests and ensures the proper management of resources, improving price signals while protecting consumers and Québec's industrial structure.

To meet those objectives, the strategy sets out priority actions for each of six orientations, which include "consolidate and diversify sources of oil and gas supply"[20], but also "innovate in the energy field" and "modernize the legislative and regulatory framework".

The SEA committee considers it essential to analyze how the gas industry could fit in with government policies on energy and greenhouse gas reduction. If necessary, modifications could be suggested to allow for the possibility of an interest in shale gas exploration.

Sustainable development

In its 2006-2015 energy strategy, the Government set a course toward sustainable development by promoting potential renewable energies, investing in energy efficiency and increasing the pace of development and implementation of new energy technologies.

More recently, in early 2012 the Government announced its 2013-2020 Government Strategy for Climate Change Adaptation. This document is currently the subject of consultations with the general public and interested groups. Ultimately, the new strategy will provide the framework for Québec's commitments in the fight against climate change.

20 Québec Energy Strategy, p. 74

That the energy strategy is in line with sustainable development confirms the commitments made by the Government when it adopted the Sustainable Development Act. Under the Act, the Administration must exercise its powers and responsibilities in the pursuit of sustainable development. The desirability of exploiting shale gas instead of investing in other industries, and if so doing how best to proceed, must therefore be evaluated according to the principles of sustainable development, as mentioned earlier, and in light of the orientations of the energy strategy, as noted by the Sustainable Development Commissioner (2010-2011 report, pp. 3-14). Studies conducted for the SEA could indicate a need to update the energy strategy, and if appropriate, could contribute to the development of a future version.

Knowledge to acquire:

- EC1-2: Analyze the issues raised by the exploration and exploitation of shale gas, as compared to other industries, in terms of the principles set forth in the Sustainable Development Act, with details on how the industry could align with the orientations of the 2006-2015 Québec Energy Strategy.

3.4.2 Cost-benefit analysis

As emphasized by the Sustainable Development Commissioner in his 2010-2011 report (pp. 3-20, and recommendation p. 72), determining the value of the shale gas industry to Québec society will require a detailed examination of its costs and benefits, an exercise referred to as cost-benefit analysis. Such an analysis cannot be done without knowing the financial structure of a model project. Also needed is an estimate of the environmental externalities, which would emerge from a life-cycle analysis of a model project.

Financial structure of a model project

To properly define the costs, benefits, technical risks and health risks associated with each phase of development work, the committee will start from a detailed description and a broad understanding of all the work involved in the four phases of a model shale gas project (exploration, development, exploitation and abandonment), as previously established for the various studies. The definition and description of those phases must be consistent with those generally recognized by other governments, to facilitate the comparison of royalty regimes, tax treatments and other mechanisms governing the gas industry elsewhere in Canada and in the United States.

For each phase of a project, the allocation and distribution of the industry's direct and indirect costs must be determined, with a breakdown in percentages by resource category. Other costs to be determined are those associated with administering the gas program, managing facilities, issuing authorizations and ensuring the environmental control of operations. To ensure that the model project is valid, it will be developed in collaboration with the principal actors concerned.

Knowledge to acquire:

- EC2-1: Prepare detailed estimates of private and public costs in each development phase, and estimate total costs including the abandonment phase and subsequent monitoring based on the previously defined model shale gas project.

At the same time, based on scenarios for gas prices, the life cycle of a model project and the potential of the resource, pro forma financial projections should be prepared for a model shale gas project.

Knowledge to acquire:

- EC2-2: Prepare pro forma financial projections for a model shale gas project, including abandonment and monitoring. The projections will be based on different development scenarios and on the costs of a single site with multiple wells.

Environmental analysis of the life cycle of a model project

The life-cycle analysis of a model shale gas project will serve to determine and evaluate the environmental impacts of such a project in each phase of execution, including abandonment and monitoring. The analysis will include the impacts on water and air quality of all related activities, "from the well to the consumer". It will also estimate the grey energy associated with the model project, and compare it to the amount of energy made available for consumption after the gas is extracted.

Knowledge to acquire:

- EC2-3: Conduct an environmental analysis of the life cycle of a model shale gas project.

Calculation of the costs and benefits of developing the industry

A cost-benefit analysis will assess to what degree developing the industry would bring a real gain to the economy and to Québec society. Benefits are essentially measured in terms of rent on resources, market conditions and social context. Their calculation takes into account the money invested in promoting and developing the industry, variations in the value of assets, new risk management costs and other responsibilities related to industry activities. Evaluation of the costs for society will take into account all environmental, social and economic impacts, both tangible and intangible. Externalities and rent sharing among economic agents will also be considered. Lastly, development of the shale gas industry could also have positive side effects, e.g. through new workers requiring goods and services and contributing to the occupancy of certain regions.

The cost-benefit analysis will apply to Québec as a whole and will cover a period of at least 25 years.

Knowledge to acquire:

- EC2-4: Conduct a cost-benefit analysis of developing the shale gas industry, based on the development scenarios, rent sharing scenarios and externalities.

Attenuation measures

The costs and benefits of a model project are conditioned by the management of risks and the use of the best technologies available. We will therefore require an inventory not only of codes, standards and technical best practice guides, but also of technologies for attenuating the risks and costs of shale gas exploitation, whether available now or in development. We must also identify technologies and technical standards with significant attenuation potential, and see how they could modify the industry's costs and benefits and the distribution of both among the players of Québec society.

Knowledge to acquire:

- EC2-5: Conduct an inventory of technologies and measures that could reduce risks, and of the externalities associated with development of the shale gas industry.

3.4.3 Economic benefits

Economic impact analysis measures the impacts of an investment, i.e. the increase of economic activities due to making that investment.

Using different development scenarios, the committee will perform an exhaustive analysis of the potential economic benefits of developing the industry. The data produced will be applied to intersectoral models of Québec and Canada, allowing an estimate of the economic impacts of a model shale gas project, and more broadly, of deploying the industry in the Utica Shale based on the scenarios chosen for analysis. Subsequently, independent analysis will provide a more comprehensive evaluation of the results of this exhaustive analysis.

This study will establish the direct, indirect and overall effects on the labour force, on wages, on the industry's potential value added, and on current imports of natural gas. It will also provide an estimate of tax and quasi-tax revenues from the different scenarios.

Also analyzed will be the sensitivity of certain key variables of the development scenarios, including those that influence project costs.

Knowledge to acquire:

- EC3-1: Evaluate the economic benefits of developing the shale gas industry, based on the different development scenarios.

3.4.4 Rent management

The benefits associated with development of the shale gas industry may be measured in terms of the economic rent on the resource. We will therefore estimate the level of that rent, the mechanisms for capturing it and the principles by which it should be shared among the various stakeholders concerned (producers, government, municipalities, citizens, etc.). Subsequently, various scenarios will be evaluated for the distribution of wealth at local and regional levels, with an eye on subregional impacts.

Rent calculation

In simple terms, economic rent is the difference between the sale price of goods or services and their cost of production, including the normal return on capital. Natural resources often generate an economic rent because the prices set internationally for such commodities tend to be higher than the cost of producing and distributing them.

The cost-benefit study will determine the level of rent generated by a model project, which could vary in time depending on different development and production scenarios.

Knowledge to acquire:

- EC4-1: Calculate rent levels under the chosen development scenarios, taking into account environmental externalities and the international context.

Rent capture mechanisms

In situations where a resource is public property, as is the case with shale gas, governments may decide to appropriate, in various ways, part or all of the economic rent. The numerous economic tools for doing so must be inventoried, detailed and analyzed, to determine which ones could apply in the particular context of Québec's shale gas industry in the event that it is developed.

Knowledge to acquire:

- EC4-2: Conduct an inventory and an analysis of economic, fiscal and other tools that could be used to capture gas rent for various beneficiaries.

Rent sharing and rent usage

The sharing of rent obtained from the exploitation of a natural resource raises the question of compensations for the externalities produced by that exploitation. Consequently, for an equitable distribution of the revenues generated, two levels of analysis must be distinguished: 1) the compensation of externalities to the stakeholders who sustain them, and 2) the distribution of the net benefits of exploitation among social and economic stakeholders.

Compensation should be directly correlated to the externalities sustained, and can only be set after a detailed evaluation of the environmental, social and economic costs of developing the industry. As for net rent, its distribution should meet previously established principles, whether in terms of the public nature of the resource, the remuneration granted to operators, the remuneration of workers, etc. Lastly, rent may be allocated to various objectives, be it the funding of public services, debt reduction, and so on. The rationale for any such allocation must be considered carefully.

Knowledge to acquire:

- EC4-3: Rent sharing and rent usage scenarios:
  - Evaluate compensation levels based on the social, environmental and economic externalities revealed by the relevant parts of the SEA and the cost-benefit analysis.
  - Identify the social stakeholders that could receive compensation, mechanisms for managing different means of compensation, and terms for obtaining such compensation (burden of proof, etc.).
  - Analyze principles that could guide the redistribution of natural gas rent, particularly along the lines of observable redistribution models that respect the principles of sustainable development.
  - Prepare rent sharing scenarios, specifying a) compensation levels and the stakeholders concerned, and b) the sharing of net rent (after compensations) among social stakeholders.
  - Determine the possible uses of rent, clarifying their rationale and analyzing their desirability for Québec society.

Green taxation

To enact the principles of sustainable development, governments cannot use regulatory tools alone, but must also harmonize the taxation system with those principles. For this reason, economic tools are increasingly employed not only to maximize the revenues of public administrations, but also to minimize negative externalities (social and environmental risks) and to maximize social benefits. An example of this is "green taxation", the term applied to systems of taxation designed to encourage ecoresponsible behaviour by producers. In the case of the gas industry, the system of royalties and taxes (rights, land rent, royalties, special-purpose funds, etc.) cannot be limited to encouraging production at any cost.

The financial analyses and the cost-benefit analysis will provide results on which to base a determination and justification of the level of royalties to demand from producers. However, since the natural gas market is continental, comparative studies should be done of green taxation systems and royalty regimes in other jurisdictions, to consider their applicability to Québec.

Knowledge to acquire:

- EC4-4: Analyze different scenarios of royalties, taxation and shareholding (such as the Norwegian model) to consider their implications in environmental, social and economic terms.
- EC4-5: Conduct comparative case studies (e.g. with Texas, Alberta, Pennsylvania, the North Sea countries) to consider the relative merits of the different systems.
- EC4-6: Explore economic mechanisms to promote social and environmental responsibility among economic operators.
- EC4-7: Conduct special research on eco-fiscality measures elsewhere in the world, and their applicability to Québec.

3.4.5 Institutional framework and structure of the industry

The potential effects of an industry's development on the economy, the environment and society also depend on the institutional framework in which that industry evolves, as well as its structure.

Institutional framework: international experience

In his 2010-2011 report, the Sustainable Development Commissioner raised numerous concerns about the institutional framework for the shale gas industry in Québec. In particular, the report recommended the rigorous application of regulations during the assessment required for exploration permits; a re-evaluation of the adequacy of regulatory requirements; and, with respect to performance guarantees and liability insurance, improvement in the process for issuing permits.

To provide Québec with an institutional framework consistent with present-day needs, a better understanding is required of the institutional frameworks in other provinces and states, to see whether they might inspire Québec in creating its own.

Knowledge to acquire:

- EC5-1: Describe and analyze how existing regulatory and legislative mechanisms work in other countries, and analyze their applicability to Québec.

Structure of the industry: international experience and parameters

It is also crucial to analyze ways in which the shale gas industry might be structured, so as to identify the most appropriate, effective and advantageous solution for Québec society. Should we opt for nationalization, public participation, complete privatization? Should we limit the number of operators, perhaps even consider the creation of a monopoly, or on the contrary encourage a multiplicity of operators? Should we mutualize certain operations, such as exploration?

A good understanding of industrial structures in other jurisdictions is therefore needed, to weigh the benefits of each in terms of the well-being of the Québec community, the minimizing of ecological impacts, and economic efficiency (sustainable development).

Knowledge to acquire:

- EC5-2: Analyze the industrial structure of the shale gas and related industries in different national contexts, and their environmental, social and economic implications.

Transition measures

Based on the studies to be conducted, the committee will propose a rent capture mechanism, compensatory measures, institutional frameworks and industrial structures. Since those elements could all have significant impacts on every stakeholder concerned, transition measures must be identified that would facilitate change from the present regime to whatever regime is chosen.

Knowledge to acquire:

- EC5-3: Analyze transition measures from the present regime to potential regimes.

3.5 Legislation governing gas exploration and exploitation projects

The opinions expressed in the BAPE report rightly raise the question of the consistency and integration of the legislative framework for the shale gas industry. At present, the industry's activities are governed by several laws and regulations, whether for economic development or the protection of public health and the environment.

The BAPE report also highlights the need for a major updating of the laws and their implementing regulations in every aspect that even remotely concerns development of the gas industry. The techniques used are still so new that the lack of knowledge about real and potential impacts makes an update essential.

Lastly, bearing in mind the principles of sustainable development that should guide governmental action, creating a legislative framework for the industry will require going beyond the sectoral missions of the departments concerned. For example, the principle of subsidiarity, by which powers and responsibilities should be delegated to the appropriate level of authority, requires that coherent institutional arrangements[21] be put in place that include all stakeholders, especially citizens.

Legislative frameworks for gas exploration and exploitation projects elsewhere in the world (subjects, mechanisms, context and efficacy)

Since legislation on gas exploration and exploitation activities has been developed in other provinces and states, a comparative analysis of such legislation will elucidate how it could best be adapted for Québec.

That analysis will take into consideration the sociopolitical context of the provinces and states studied and the various framework mechanisms they have put in place, particularly with regard to authorizations, controls, land use and development work in progress.

Knowledge to acquire:

- L1-1: Conduct a comparative analysis of legislation governing shale gas exploration and exploitation activities in certain other provinces and states.

The state of legislation in Québec

As mentioned previously, gas exploration and exploitation activities are governed in Québec by an array of laws and their implementing regulations. They include:

- Mining Act (currently being amended), and a hydrocarbons act to be announced after the SEA
- Environment Quality Act
- Act to affirm the collective nature of water resources and provide for increased water resource protection
- Sustainable Development Act
- Act respecting land use planning and development (repealed and replaced by the Sustainable Regional and Local Land Use Planning Act)
- Act respecting the preservation of agricultural land and agricultural activities

21 An institutional arrangement can be defined as formal rules produced by a set of stakeholders wishing to produce and consume a public good. Such an arrangement gives rise to political and bureaucratic organizations, policies and legislation, etc., and concerns every aspect of how a society allocates its resources.

For this section, the SEA will first describe the present state of legislation governing the industry, including the areas covered (authorizations, monitoring and control mechanisms, mandatory environmental declarations, funds for post-abandonment monitoring, etc.) and the mechanisms in place for application. The second step will be to evaluate those mechanisms in terms of their efficacy (capacity to produce real and verifiable results), effectiveness and efficiency.

Knowledge to acquire:

- L2-1: Describe the areas of intervention in Québec legislation governing shale gas exploration and exploitation activities, and analyze the implementing mechanisms in force in terms of their efficacy, effectiveness and efficiency.

Regulatory needs for the specific context of Québec

From the study of foreign legislation and the analysis of current Québec legislation governing shale gas exploration and exploitation, it will be possible to determine what new areas of intervention, if any, should be added to the Québec legislation, and to propose intervention mechanisms tailored to the specific features of the territory and sociopolitical structure of Québec.

Any such new legislation should include provisions for participative governance, following the example of Québec's advances in water governance.

Knowledge to acquire:

- L3-1: Prepare proposals for governance and the legislative framework with regard to shale gas exploration and exploitation.

Scientific observatories

Because there are so few shale gas exploration and exploitation sites currently active in Québec, our knowledge about the impacts of such activities on the natural and human environment is at best fragmentary. One of the best ways to increase that knowledge would be to set up scientific observatories, which could function on two levels: 1) at the local level, to examine and monitor individual projects and collect the most relevant data; and 2) over the entire region that is under gas permits in Québec, to compile and interpret all of the data collected. This would expand the scope of the analysis, providing a more accurate portrait of the effects of the industry's development in Québec.

Knowledge to acquire:

- O1-1: Based on the observations and recommendations of the SEA, propose a scenario for putting in place scientific observatories to collect and analyze data on the environmental, social and economic impacts of shale gas exploration and exploitation.

Glossary

Acute toxicity: A deleterious effect resulting from exposure to a single strong dose of a product, or from a single exposure to it.

Anthropic: Of or pertaining to humans. An anthropic impact is one caused directly or indirectly by human action, such as industrial activities or agricultural operations.

Aquifer: Water-saturated geological formation from which a useful quantity of water may be extracted. Aquifers may consist of granular material or fissured rock. Generally, the term is used for formations containing fresh water, as opposed to salt water, which is found at greater depth.

Assimilation capacity: The capacity of a receiving environment to absorb a contaminant load without modification to its ecosystem.

Chronic toxicity: A chronic deleterious effect resulting from repeated doses of a substance, or exposures to it, over a relatively long period.

Completion: All work performed on a well so that it can be evaluated for productivity or brought into service. Completion can include a range of processes, including perforating the casing, stimulating the reservoir by fracturing or acidizing, and installing production casing.

Consumer surplus: Difference between the value of a good to a consumer and what the consumer actually pays for it.

Direct costs: Costs that can be tied to and applied against a product, function or activity, usually including expenses for the purchase of raw materials and the cost of labour.

Environmental costs: Costs related to negative effects on the environment from a particular human activity.

Externalities: Costs or benefits, not transmitted through prices, that are incurred by parties who did not agree to the action causing those costs or benefits. For example, industrial pollution imposes costs on all society that can be referred to as environmental externalities.

Fracturing: Mechanical process of high-pressure injection of fluids or gases into bedrock to generate fractures. In the petroleum industry water is normally used, but other fluids or gases may be injected.

Fugitive emissions: Atmospheric pollutants that enter the air without first passing through a chimney or duct intended to direct or control their flow.

Indirect costs: Charges that cannot be directly tied to a product, operation or cost centre by a simple procedure of cost tracing, e.g. by counting physical consumption units (work time, weight, etc.).

Material safety data sheet: Sheet that must accompany a potentially dangerous product when supplied or sold, indicating the information that should be known and the regulations that must be respected for the product to be used safely and without fear of harm to health.

Microseismics: A particular application of seismics. The geometry of fractures generated in shale may be inferred using a technique that consists of placing a series of geophones in a well adjacent to the well to be fractured, or at shallow depth around the well, to capture the vibrations caused during stimulation by hydraulic fracturing.

Natural radioactivity: Natural radioactivity is due to the presence of naturally occurring radioactive materials (NORM) found in the environment. Long-lived radioactive elements include uranium, thorium, potassium and radioactive carbon, along with their decay products such as radium and radon. These elements have always been present in the Earth's crust and in the tissues of all living beings.

Opportunity costs: Loss of potential earnings from not exploiting a different possibility that would have been better.

Orphan well: Abandoned well for which legal responsibility cannot be established. For example, a well drilled in the past by a company that no longer exists.

Polycyclic aromatic hydrocarbons (PAHs): PAHs are molecules composed of carbon and hydrogen atoms, structured in at least two benzene rings called aromatic cycles. As air pollutants they may be in gaseous or particulate form.

Producer surplus: Difference between the market price obtained for a product and the lowest price at which the producer would be willing to sell it.

Quasi-tax revenue: Earnings obtained by a public administration through contributions, fees, royalties etc.

Reflux water: Water from the hydraulic fracturing process that is recovered from the well.

Resource rent: Economic rent collected in the form of royalties or extraction fees for the extraction of natural resources. Economic rent is payment for goods and services from the surplus value created by a factor of production.

Seismics: Prior to exploratory drilling, geophysical surveys are often done to obtain a geological image of the bedrock. Energy sources (buried dynamite, vibroseismic trucks, air guns) generate acoustic and elastic vibrations that travel through the bedrock. The reflection or refraction of these waves, from the interfaces between the strata of the rock, are captured at the surface using highly sensitive geophones. The recorded results are processed, interpreted and integrated into the geological model to better target conventional oil and gas deposits or avoid undesired (non-conventional) zones.

Shale and schist: A fine-grained, fissile sedimentary rock composed of mud that is a mix of clay minerals and silt-sized particles of other minerals, especially quartz. In Québec, the Utica Shale is the principal geological formation of interest for natural gas exploration. Utica Shale is a sedimentary rock composed primarily of laminated calcareous mud interleaved with shale proper. In French, foliated rocks are commonly called schist, their genesis being specified by the addition of an adjective: argillaceous schist (sedimentary rock) or mica schist (metamorphic rock). In English, the two have different names: a shale is a sedimentary rock, while a schist is a metamorphic rock.

Social costs: All monetary or other costs to a community resulting from a given economic or other activity.

St. Lawrence Lowlands: The geographical region located on either side of the St. Lawrence River, between the Laurentides and the Appalachians, extending south from the city of Québec to the American border. Anticosti Island is part of the St. Lawrence Lowlands.

Tax revenue: All earnings obtained by a public administration through direct and indirect taxes, including income tax and sales tax.

Unconfined groundwater: Aquifer at equilibrium with atmospheric pressure (synonym: free groundwater).

Volatile organic compounds (VOCs): VOCs are compounds of carbon and hydrogen that are normally liquid but can easily enter the atmosphere through evaporation. They may be of anthropic or natural origin.

Well closure: Definitive well closure: cessation of the work of drilling, completion, well modification and production, with the intention of permanently ending all activity; the well is then designated abandoned. Temporary well closure: interruption of the work of drilling, completion, well modification and production, with the intention of resuming work at a later date.

Summary Bibliography

BUREAU D'AUDIENCES PUBLIQUES SUR L'ENVIRONNEMENT. February 2011. Développement durable de l'industrie des gaz de schiste au Québec. Rapport d'enquête et d'audience publique.

CÔTÉ and WAAUB (2012). "Mécanismes de participation publique dans les évaluations environnementales stratégiques". [In preparation]

CROWLEY, M., and N. RISSE. 2011. "L'évaluation environnementale stratégique: un outil pour aider les administrations publiques à mettre en oeuvre le développement durable". Télescope, 17-2:1-29.

DOUCET, Chantale. 2000. Mémoire presenté à l'Université du Québec à Chicoutimi comme exigence partielle de la maîtrise en études et interventions régionales. [Online] [http://www.uqac.ca/msiaa/Annexes/Annexe14.pdf]

GAZIFÈRE. "Le réseau de distribution". [Online] [http://www.gazifere.com/gazifere_reseau_distribution.php]

GAZMÉTRO. 2011. "Gaz Métro parle de solutions énergétiques novatrices lors du colloque 'Vers une prospérité renouvelable'". [Online] [http://www.corporatif.gazmetro.com/corporatif/communique/fr/html/2452411_fr.aspx?culture=fr-ca]

INSTITUT NATIONAL DE SANTÉ PUBLIQUE DU QUÉBEC. 2010. État des connaissances sur la relation entre les activités liées au gaz de schiste et la santé publique. Preliminary report. 74 pp.

LIMOGES, Benoît. 2009. "Biodiversité, services écologiques et bien-être humain". Le naturaliste canadien. 133-2:15-19.

MINISTÈRE DES AFFAIRES MUNICIPALES, DES RÉGIONS ET DE L'OCCUPATION DU TERRITOIRE. 2011. Sustainable Regional and Local Land Use Planning Act. Update of the Act respecting land use planning and development. [Online] [http://www.assnat.qc.ca/en/travaux-parlementaires/projets-loi/projet-loi-47-39-2.html]

MINISTÈRE DES AFFAIRES MUNICIPALES, DES RÉGIONS ET DE L'OCCUPATION DU TERRITOIRE. 2011. «Indice de développement - méthode de calcul». Development index. [Online] [http://www.mamrot.gouv.qc.ca/developpement-regional-et-rural/indice-de-developpement]

MINISTÈRE DES RESSOURCES NATURELLES ET DE LA FAUNE. 2011. «Utica Shale». Oil and gas geoscience information system. [Online] [http://sigpeg.mrnf.gouv.qc.ca/gpg/classes/ActiviteShale]

MINISTÈRE DES RESSOURCES NATURELLES ET DE LA FAUNE. "Consommation de gaz naturel". [Online] [http://www.mrnf.gouv.qc.ca/energie/statistiques/statistiques-consommation-gaz.jsp]

MINISTÈRE DES RESSOURCES NATURELLES ET DE LA FAUNE. Québec Energy Strategy.

MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DES PARCS. 2004. Québec Sustainable Development Plan. [Online] [http://www.mddep.gouv.qc.ca/developpement/2004-2007/plan-consultation-en.pdf]

MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DES PARCS. Regulation respecting a cap-and-trade system for greenhouse gas emission allowances. 2011. [Online] [http://www.canlii.org/en/qc/laws/regu/rrq-c-q-2-r-46.1/latest/rrq-c-q-2-r-46.1.html]

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION. July 2011. Preliminary revised draft SGEIS.

ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (2006) and INTERNATIONAL ASSOCIATION FOR IMPACT ASSESSMENT (2002).

THE INSTITUTE FOR PUBLIC POLICY & ECONOMIC DEVELOPMENT. 2010. Baseline socioeconomic analysis for the Marcellus shale development in Pennsylvania. [Online] [http://www.institutepa.org/PDF/Marcellus/MarcellusShaleStudy08312010.pdf]

VÉRIFICATEUR GÉNÉRAL DU QUÉBEC. 2011. Travaux du Commissaire au développement durable. La gestion gouvernementale de l'exploration et de l'exploitation des gaz de schiste. 2010-2011 report.

Appendix 1. Simplified geological map and location of oil and gas wells

Appendix 2. Knowledge to acquire

Analytical perspective and tools

Public participation

M-1: Document experiences of public participation, with analysis of some key practices to understand their value, operation and risks; prepare possible scenarios for public participation in successive phases of the SEA, detailing the rationale and relevance of each.

Research techniques: a model shale gas project

M-2: Describe a model shale gas project including the phases of exploration, development, exploitation, abandonment and monitoring.

The pace of development

Industry development scenarios

P-1: Estimate Québec's gas potential, analyze possible developments in natural gas prices, and prepare plausible development scenarios.

Evaluation of environmental issues

Issues concerning water

E1-1: Evaluate the water needs of the shale gas industry over the complete arc of development and production, determining the environmental impacts associated with such use and recommending regulatory solutions.

E2-1: Hydrogeological data on deep formations (bedrock) and formations deeper than 100 m, from which to develop conceptual and digital models of the hydrogeological systems present; these models could then be used to evaluate the dynamics of fluid circulation at depth (before and after fracturing), and to identify sensitive zones and those for which knowledge is lacking;

E2-2: Identification of watercourses that could not provide the volumes necessary for the industry;

E2-3: A classification of Québec aquifers that would identify important aquifers (those whose water is suitable for human or animal consumption) for the purpose of protecting them, specifically by prohibiting gas wells and any other activity that could compromise the resource due to leaks or spills of toxic substances;

E2-4: A feasibility study on the possibility of mapping usable water, by depth, over the entire region of interest.

E3-1: Analyze existing standards in certain provinces and states, from well design to construction, including inspection, fracturing, completion and abandonment.

E3-2: Document problems with spills and leaks encountered by the shale gas industry in Québec and other jurisdictions, with their causes and consequences and the measures taken to correct them.

E3-3: Profile a typical well that would be representative of wells drilled in Québec over the last two decades.

E3-4: Determine the risks of leaks and spills (from retention basins, transportation, fluid injection, reflux water), the potential consequences of such incidents on the environment and health, and mitigation measures that could limit those consequences.

E3-5: Produce a comprehensive list of substances used (or that could be used) for drilling and fracturing in Québec, with the by-products of their breakdown and reaction, and evaluate their toxicological properties and potential for biodegradation, bioaccumulation, persistence and overall toxicity.

E3-6: Evaluate contaminants of natural origin in the Utica Shale that could end up in reflux water.

E3-7: Evaluate the vulnerability of drinking water and other water intakes in terms of the assimilation capacity of watercourse systems for certain toxic substances.

E3-8: Review the literature on data available in other jurisdictions where drilling has been done in Utica Shale (Pennsylvania and Ohio), concerning the substances used for drilling and fracturing and their degradation and reaction by-products.

E3-9: Evaluate the natural concentrations of methane present in the groundwater of the St. Lawrence Lowlands; identify the origin of that methane and its mechanisms of preferential migration.

E3-10: With a digital simulation, model the migration of fracturing water and methane, using physical variables (geological, physicochemical and hydrogeological) corresponding to the geological province of the St. Lawrence Lowlands and its watersheds.

E3-11: Conduct an inventory of standards and regulations in force in Québec that touch on the management of residual materials from drilling sites.

E3-12: Conduct an inventory of available data on the physico-chemical characteristics of such residues, from existing sites.

E4-1: Prepare different scenarios for reflux water management, including cost estimates, depending on:

- the production level of reflux water, and its quality;
- the potential for reuse;
- handling (onsite retention basins, municipal treatment plants, other types of plants);
- final disposal.

E4-2: Review the available wastewater treatment technologies and their effectiveness with regard to risk substances.

E4-3: Analyze the environmental impacts and induced seismicity risks associated with storing reflux water in deep geological formations. If the practice could be used safely in Québec, determine the regulatory requirements regarding studies, methods and monitoring for such a project to be authorized.

Issues concerning air

A1-1: Evaluate emission rates for atmospheric contaminants from stationary, mobile and fugitive sources at a model shale gas project, using scenarios that account for simultaneous activities.

A1-2: Model the atmospheric dispersion of contaminants emitted by stationary and mobile sources, and by a model project in a model environment representative of the St. Lawrence Lowlands, evaluating the impact of these contaminants on ambient air quality. This study will be done in conjunction with S3-1: an estimation of expected impacts on the health of exposed populations and an evaluation of the importance of those impacts for their quality of life.

Issues concerning greenhouse gases

GES1-1: Evaluate the GHG emissions from stationary, mobile and fugitive sources at a model shale gas project, from the pre-production phase to abandonment.

GES1-2: Estimate the GHG emissions budget of a model shale gas project based on the prepared scenarios. This study will be done in conjunction with EC2-3: Environmental analysis of the life cycle of a model shale gas project.

The issue of natural and technological risks

R1-1: Determine the potential natural risks in the region of interest for shale gas development and their probable repercussions on the facilities of a model project and on public safety.

R1-2: Analyze the risk of natural phenomena being provoked by activities of the shale gas industry, with their anticipated consequences on property and public safety. This analysis will also contribute to the studies on health risks.

R2-1: Analyze the technological risks associated with the activities of a model shale gas project.

Evaluation of social issues

Land use and compatibility of uses

S1-1: Analyze Québec's mining governance regime and its consequences, comparing with other mining regimes around the world.

S1-2: Analyze the potential role of municipalities and other relevant bodies in the control and development of the shale gas industry.

S1-3: Conduct three case studies on deployment and governance in the wind power, forestry and pork industries.

S1-4: Define three scenarios of territorial governance based on the degrees of precedence given to gas development, specifying for each a legal framework, development mechanisms, mode of operation, the role of municipalities and other institutions, and the division of responsibilities among levels of authority (local, regional, national). With each scenario, also consider social acceptability, transition from the current regime, feasibility, deterrents, dangers and possible problems as well as benefits.

Social impacts

S2-1: Prepare status reports on potential receiving communities, with details on their social, economic and ecological dimensions as well as their governance.

S2-2: Case study on the CPTAQ: history, operations, results.

S2-3: Analysis of the potential role of the CPTAQ in regulating land use conflicts related to the shale gas industry.

S2-4: For the regions concerned:

- Prepare an inventory and cartography of: 1) the network of protected areas; 2) regional areas of historical, cultural, aesthetic and ecological interest; 3) municipal parks and green spaces; 4) conservation plans; 5) active farmland and the potential of arable soils.
- Evaluate the potential of the regional archaeological heritage.
- Evaluate the possible cumulative impacts of shale gas activities on heritage elements, and propose mitigation measures.

S2-5: Determine and document the visual, heritage and landscape impacts associated with each phase of the industry, and propose measures that could eliminate, attenuate and rectify them.

S2-6: Model the noise impacts associated with shale gas exploration and exploitation activities, based on the model project and development scenarios.

S2-7: Determine and document the social impacts associated with the different phases of development of the industry, and designate measures to eliminate, attenuate and rectify them, especially but not exclusively with regard to:

- the intensity and chronicity of environmental noise with different project scenarios (single or multiple wells) and different separating distances;
- increased trucking and the construction of new access roads.

Health and psychosocial risks

S3-1: Based on the results of air quality studies, estimate the expected impacts on the health of exposed populations, and evaluate the importance of these impacts for their quality of life.

S3-2: Based on the results of quantitative and qualitative studies on water:

- Estimate the anticipated impacts on the health of exposed populations, and evaluate the importance of those impacts for quality of life.
- Evaluate the vulnerability of existing and potential sources of drinking water depending on use (human or animal consumption, agricultural or aquaculture production, etc.), and propose a monitoring model for the management of drinking water sources, including emergency measures.

S3-3: Based on the analyses of the technological and natural risks associated with the activities of a model shale gas project, document risk perception and psychosocial impacts among local populations, using a representative sample of social groups and the development index of each community.

S3-4: Determine practices (strengths and weaknesses) of risk communication among the industry, municipalities and provincial organizations responsible for public safety. Prepare a model risk communication plan based on the nature of the project, including modes of surveillance and monitoring.

S3-5: Using the different development scenarios, document the impacts of shale gas development on land-use planning, notably with regard to agriculture, forestry and tourism, and define potential land-use conflicts.

S3-6: Evaluate the social impacts that gas infrastructures could have on local communities through the exploitation and transportation of shale gas.

Governance of the industry, its side effects and activities

S4-1: Analyze the conditions affecting the social acceptability of the shale gas industry in Québec.

S4-2: Prepare scenarios for public participation and collaboration with local authorities. In terms of specific projects, describe how public participation and local collaboration would happen with each, the duration of the process and the associated costs.

S4-3: Analyze the past and present behaviour of the shale gas industry in Québec and abroad, together with social responsibility practices in the oil and mining sectors (including both a documentation component and an empirical component). Also, study the applicability of the social responsibility framework in ISO 26000 and other international standards, and consider the desirability of applying them to the shale gas industry in Québec.

S4-4: Study potential mechanisms (certification, disclosure, ecoconditionality) of obliging companies operating in the sector to adopt best practices, to ensure that social responsibility becomes a reality of the industry.

S4-5: Document the control of working conditions in the shale gas industry, notably in terms of workplace health and safety, elsewhere in Canada and in other countries, and propose a framework for Québec.

S4-6: Document the trades and training associated with the industry, and analyze the possibilities for skills transfer to Québec.

S4-7: Determine and document the impacts, on native populations, of activities associated with different development phases of the shale gas industry, and identify measures to eliminate, attenuate and rectify them, along with mechanisms for consultation and dialogue with these communities.

S4-8: Determine factors that could maximize social benefits and minimize social problems associated with development of the shale gas industry, and propose detailed implementation mechanisms.

Evaluation of the socioeconomic desirability of shale gas exploitation

Context: the place of the shale gas industry in government orientations

EC1-1: Based on a projection of Québec's energy needs, analyze different scenarios for natural gas consumption over a 25-year horizon, taking into account the relevant economic and sociopolitical parameters and what effect local production would have on that consumption.

EC1-2: Analyze the issues raised by the exploration and exploitation of shale gas, as compared to other industries, in terms of the principles set forth in the Sustainable Development Act, with details on how the industry could align with the orientations of the 2006 2015 Québec Energy Strategy.

Cost-benefit analysis

EC2-1: Prepare detailed estimates of private and public costs in each development phase, and estimate total costs including the abandonment phase and subsequent monitoring based on the previously defined model shale gas project.

EC2-2: Prepare pro forma financial projections for a model shale gas project, including abandonment and monitoring. The projections will be based on different development scenarios and on the costs of a single site with multiple wells.

EC2-3: Conduct an environmental analysis of the life cycle of a model shale gas project.

EC2-4: Conduct a cost-benefit analysis of developing the shale gas industry, based on the development scenarios, rent sharing scenarios and externalities.

EC2-5: Conduct an inventory of technologies and measures that could reduce risks, and of the externa¬lities associated with development of the shale gas industry.

Economic benefits

EC3-1: Evaluate the economic benefits of developing the shale gas industry, based on the different development scenarios.

Rent management

EC4-1: Calculate rent levels under the chosen development scenarios, taking into account environmental externalities and the international context.

EC4-2: Conduct an inventory and an analysis of economic, fiscal and other tools that could be used to capture gas rent for various beneficiaries.

EC4-3: Rent sharing and rent usage scenarios:

- Evaluate compensation levels based on the social, environmental and economic externalities revealed by the relevant parts of the SEA and the cost-benefit analysis.
- Identify the social stakeholders that could receive compensation, mechanisms for managing different means of compensation, and terms for obtaining such compensation (burden of proof, etc.).

- Analyze principles that could guide the redistribution of natural gas rent, particularly along the lines of observable redistribution models that respect the principles of sustainable development.
- Prepare rent sharing scenarios, specifying a) compensation levels and the stakeholders concerned, and b) the sharing of net rent (after compensations) among social stakeholders.
- Determine the possible uses of rent, clarifying their rationale and analyzing their desirability for Québec society.

EC4-4: Analyze different scenarios of royalties, taxation and shareholding (such as the Norwegian model) to consider their implications in environmental, social and economic terms.

EC4-5: Conduct comparative case studies (e.g. with Texas, Alberta, Pennsylvania, the North Sea countries) to consider the relative merits of the different systems.

EC4-6: Explore economic mechanisms to promote social and environmental responsibility among economic operators.

EC4-7: Conduct special research on eco-fiscality measures elsewhere in the world, and their applicability to Québec.

Institutional framework and structure of the industry

EC5-1: Describe and analyze how existing regulatory and legislative mechanisms work in other countries, and analyze their applicability to Québec.

EC5-2: Analyze the industrial structure of the shale gas and related industries in different national contexts, and their environmental, social and economic implications.

EC5-3: Analyze transition measures from the present regime to potential regimes.

Legislation governing gas exploration and exploitation projects

L1-1: Conduct a comparative analysis of legislation governing shale gas exploration and exploitation activities in certain other provinces and states.

L2-1: Describe the areas of intervention in Québec legislation governing shale gas exploration and exploitation activities, and analyze the implementing mechanisms in force in terms of their efficacy, effectiveness and efficiency.

L3-1: Prepare proposals for governance and the legislative framework with regard to shale gas exploration and exploitation.

Scientific observatories

O1-1: Based on the observations and recommendations of the SEA, propose a scenario for putting in place scientific observatories to collect and analyze data on the environmental, social and economic impacts of shale gas exploration and exploitation.

Appendix 3. Presentations given at meetings of the SEA committee on shale gas

Meeting of May 30, 2011

- Information session on draft bill 18 limiting oil and gas activities, Sébastien Desrochers.
- Strategic environmental assessment: challenges to implementation, Robert Joly.

Meeting of June 9, 2011

- Introduction to strategic environmental assessment (SEA), Michel Crowley.

Meeting of June 13, 2011

- Introduction to the techniques used for shale gas, Mariane Molgat.
- Taking sustainable development principles into account in the strategic environmental assessment of shale gas, Naomi Verdon, Luc Vézina and Martin Vachon.

Meeting of June 23, 2011

- Québec's oil and gas resources: general context, Sébastien Desrochers.

Meeting of June 28, 20111

- New royalty regime for shale gas and its economic impacts, Luc Monty, Marc Sirois and Marcel Dionne.

Meeting of June 29, 2011

- Exploration of gas shales in the St. Lawrence Lowlands, Sébastien Desrochers.

Meeting of August 17, 2011

- The management of greenhouse gas emissions in Québec, Marie-Ève Boucher.

Meeting of September 13, 2011

- Evaluation of social impacts and social acceptability, Christiane Gagnon.

Meeting of October 7, 2011

- Public participation mechanisms in the strategic environmental assessment, Jean-Philippe Waaub and Gilles Côté.

Meeting of December 6, 2011

- The 2011-2016 strategy to ensure the occupancy and vitality of territories, and its framework act, Yannick Routhier

Meeting of January 12, 2012

- Presentation on isotope reports, Yvon Couture and Charles Lamontagne

Meeting of January 24, 2012

- Consultation of aboriginal communities, Julie Samson and Daniel Berrouard

Meeting of April 3, 2012

- Public participation in the strategic environmental assessment on shale gas, Michel Venne

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