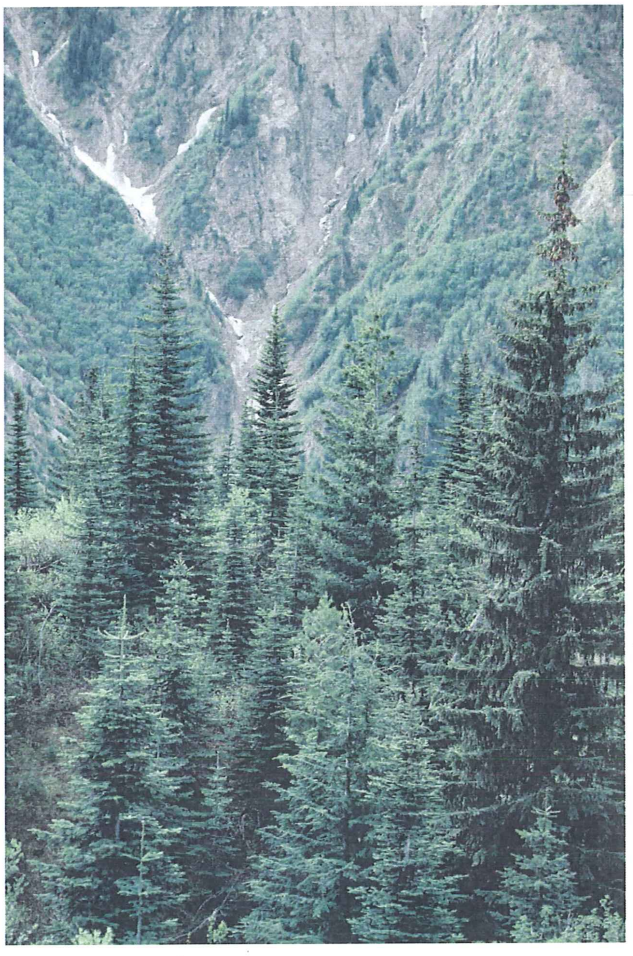
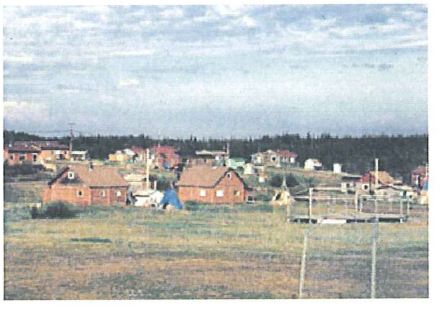
Financial Proposal:

Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity

RFP Number: RFP HL173





Submitted to: BC Ministry of Health

Submitted by: AMEC Environment & Infrastructure

10 August 2012

HTH-2012-00248
Phase 3

August 10, 2012
CC2012_0121

Purchasing Services Branch
c/o 2nd Floor 563 Superior Street
Victoria, B.C. V8V 1T7
Attention: Norman Helewa

Dear Mr. Helewa:

Re: Financial Proposal: Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity BC Ministry of Health RFP: RFP HL173

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC) is pleased to present our financial proposal to provide the required project services in response to British Columbia Ministry of Health Request for Proposal RFP HL173 for the Phase 2 - Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity.

AMEC will confirm that we will use the General Service Agreement with no modifications as included in Appendix I of the RFP.

AMEC trusts that this proposal meets all requirements outlined in the RFP. If you have any questions regarding this request, please feel free to contact the undersigned at 604.295.6110.

Kind regards,

AMEC Environment & Infrastructure
a Division of AMEC Americas Limited

Clifford P.H. Eng, P.Eng., CSAP
Senior Associate, Contaminated Sites
Approved Professional

Leslie A. Panek
Senior Vice President,
Western Canada

AMEC Environment & Infrastructure
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140 Quarry Park Blvd SE
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Financial Proposal:

Human Health Risk Assessment of

Northeastern British Columbia Oil and Gas Activity

BC Ministry of Health Request for Proposal Number: RFP HL173

Submitted to:

Ministry of Health

Purchasing Services Branch

c/o 2nd Floor 563 Superior Street

Victoria, BC V8V 1T7

Attention: Norman Helewa

Submitted by:

AMEC Environment & Infrastructure,

A division of AMEC Americas Limited

140 Quarry Park Blvd SE

Calgary, Alberta T2C 3G3

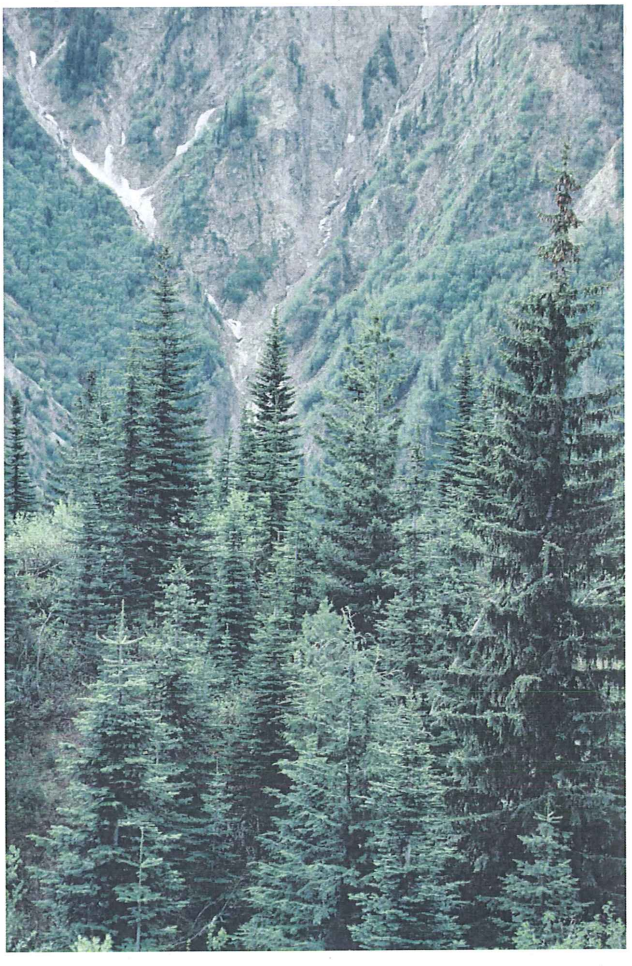
August 2012

BC Ministry of Health - NEBC Human Health Risk Assessment
Phase 2
Budget Summary

TASK	Total Fees and Disbursements
Human Health Risk Assessment	s.21
Community Outreach	
Jurisdictional Scan Report	
Spatial Endabled Data Report	
Regulatory Review Report	
Project Management	
TOTAL	**$894,765**

Pages 5 through 7 redacted for the following reasons:
- -
s.21

AMEC Environment & Infrastructure
a division of AMEC Americas Limited
140 Quarry Park Blvd SE
Calgary, Alberta T2C 3G3



amec.com

HTH-2012-00248
Phase 3

Technical Proposal:

Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity

RFP Number: RFP HL173

Submitted to: BC Ministry of Health

Submitted by: AMEC Environment & Infrastructure

10 August 2012

August 10, 2012
CC2012_0121

Purchasing Services Branch
c/o 2nd Floor 563 Superior Street
Victoria, B.C. V8V 1T7
Attention: Norman Helewa

Dear Mr. Helewa:

Re: Technical Proposal: Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity
BC Ministry of Health RFP: RFP HL173

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC) is pleased to present our technical proposal to provide the required project services in response to British Columbia Ministry of Health Request for Proposal RFP HL173 for the Phase 2 - Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity.

The key highlights of AMEC's technical proposal are our solutions and approach, which builds on an effective communications plans coupled with the qualifications and experience of our team.

While have provided pricing and a detailed cost breakdown under separate cover, AMEC will confirm that we will use the General Service Agreement with no modifications as included in Appendix I of the RFP.

AMEC trusts that this proposal meets all requirements outlined in the RFP. If you have any questions regarding this request, please feel free to contact the undersigned at 604.295.6110.

Kind regards,

AMEC Environment & Infrastructure
a Division of AMEC Americas Limited

Clifford P.H. Eng, P.Eng., CSAP
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Human Health Risk Assessment of

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BC Ministry of Health Request for Proposal Number: RFP HL173

Submitted to:

Ministry of Health

Purchasing Services Branch

c/o 2nd Floor 563 Superior Street

Victoria, BC V8V 1T7

Attention: Norman Helewa

Submitted by:

AMEC Environment & Infrastructure,

A division of AMEC Americas Limited

140 Quarry Park Blvd SE

Calgary, Alberta T2C 3G3

August 2012

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1.0 RFP Cover Page

BRITISH COLUMBIA
The Best Place on Earth

Request for Proposals
Phase 2 – Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity

Ministry of Health Request for Proposals Number: RFP HL173
Issue date: June 28, 2012

Closing Time: Proposal must be received **before** 2:00 PM Pacific Time on: Friday August 10, 2012

GOVERNMENT CONTACT PERSON: All enquiries related to this Request for Proposals (RFP), including any requests for information and clarification, are to be directed, in writing, to the following person who will respond if time permits. Information obtained from any other source is not official and should not be relied upon. Enquiries and any responses will be recorded and may be distributed to all Proponents at the Province's option.

<<Norman Helewa, Project Manager e-mail: norman.helewa@gov.bc.ca>>

DELIVERY OF PROPOSALS:

Proposals must not be sent by mail, facsimile or e-mail. Proposals are to be submitted to the closing location as follows:

A. (8) complete hard-copies(and 1 copy on CD) must be delivered by hand or courier to:

Purchasing Services Branch
c/o 2nd Floor 563 Superior Street
Victoria, B.C. V8V 1T7
Attention: Norman Helewa

Proposal envelopes should be clearly marked with the name and address of the Proponent, the Request for Proposals number, and the project or program title.

PROPONENTS' MEETING:

☐ A Proponents' meeting will be held at:

Auditorium A &B - Basement *1515 Blanshard Street,* *Victoria, BC* *V8W 3C8* *From 1:00 pm – 3:00 pm PST on Friday July 13, 2012.*	Note: A summary of questions and responses will be posted on the BC Bid Website. Attendance is optional. Oral questions will be allowed at the Proponents' meeting. However, questions of a complex nature, or questions where the Proponent requires anonymity, should be forwarded in writing (via email), prior to Noon PST Wednesday, July 11th, 2012, to the Government Contact person designated above. Please note – There will be no video/teleconferencing for this meeting.

PROPONENT SECTION:

For hard-copy proposals, a person authorized to sign on behalf of the Proponent must complete and sign the Proponent Section (below), leaving the rest of this page otherwise unaltered, and include the originally-signed and completed page with the first copy of the proposal. The enclosed proposal is submitted in response to the above-referenced Request for Proposals, including any addenda. Through submission of this proposal we agree to all of the terms and conditions of the Request for Proposals and agree that any inconsistent provisions in our proposal will be as if not written and do not exist. We have carefully read and examined the Request for Proposals, including the Administrative Section, and have conducted such other investigations as were prudent and reasonable in preparing the proposal. We agree to be bound by statements and representations made in our proposal.

Signature of Authorized Representative:	*Legal Name of Proponent (and Doing Business As Name)* AMEC Environment & Infrastructure, a division of AMEC Americas Limited
Printed Name of Authorized Representative: Les Panek, B.Sc., MBA	*Address of Proponent:* 140 Quarry Park Blvd SE Calgary, Alberta T2C 3G3
Title: Senior Vice President, Western Canada/International Environment	
Date: August 7, 2012	*Authorized Representative phone, fax or email address (if available):* (403) 387-1600, les.panek@amec.com

2.0 Executive Summary/Key Features of AMEC's Proposal

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC) is pleased to present our technical proposal to provide the required project services in response to British Columbia (BC) Ministry of Health (MoH) Request for Proposal (RFP) RFP HL173 for the Phase 2 - Human Health Risk Assessment of Northeastern British Columbia Oil and Gas Activity.

The key highlights of AMEC's technical proposal are our solutions and approach, work and communications plans, and our qualifications and experience.

Solutions and Approach

AMEC is presenting a multidisciplinary leadership team with key support personnel who are able to bring added value to the linkages between environmental determinants of health, human health risk assessment, health-based environmental regulation and community health.

The advantage of our approach is to facilitate discussions in the communities about the limitations of the human health risk assessment in terms of scope of the study, and to maximize the reception of the project by stakeholders. AMEC proposes cross-utilization of discipline leads throughout the different tasks to promote continuity and efficiency in project management, execution of tasks and reporting.

Work and Communications Plan

AMEC has developed a sound work plan based on providing efficient and scientifically supported interim and final reports. Our communication plan supports the work plan, and our external communication plan will be based on previously successful models of interaction with the community.

The advantage of our approach and communications plan is to provide continuity to the community throughout the process. We will provide science-based reports based on the communities' reportable areas of concern (within scope).

Qualifications and Experience

AMEC has considerable experience in the upstream and downstream oil and gas industry and experience in completing risk assessments for large contentious projects, for both private and public sector clients. Our experience extends across provincial and territorial boundaries throughout all regions of Canada.

We have assembled a team of highly qualified professionals to lead and complete this project. Each team member is a recognized expert in their field bringing years of experience to the project in disciplines such as community consultation, toxicology and human health risk assessment, community medicine, exposure modeling and risk communication.

The advantage of our qualifications and experience is an established understanding of the approach, methodologies and reasonable expectations of the various stakeholders involved in the development, operations and remediation of oil and gas projects.

AMEC believes that the excellence of our team and our approach will result in the highest quality of service and results for MoH, and other regional agencies with respect to this project. Our goal is to assist MoH complete this evidence based risk assessment and to provide the required communication in the communities of Northeastern BC.

Our financial proposal for this work has been submitted under separate cover.

3.0 Introduction

In response to concerns about the rapid pace of development of the oil and gas industry in Northeastern BC, much of which is driven by unconventional deposits, MoH, in partnership with other ministries, initiated a Human Health Risk Assessment (HHRA) to better understand the specific concerns associated with the industry and the specific health risks associated with those activities. Intended as a planning tool, the risk assessment is to help guide decisions on the need for management strategies for mitigating risk and/or the implementing programs to better understand the sources of risk and their magnitude. As such, the risk assessment needs to include a comprehensive overview of lessons learned from similar studies, a detailed, science-based assessment of health risks associated with all aspects of the industry - from exploration to reclamation, and an understanding of the legislative and policy framework that provides regulatory oversight to the industry in BC.

3.1 Background

This section demonstrates our understanding of the scope of the oil and gas industry's activities in Northeastern BC, concerns related oil and gas industry and the objectives of this phase of the HHRA as they relate to Phase 1 and Phase 3 of the program.

3.1.1 Oil and Gas Activities in Northeastern British Columbia

British Columbia is the second largest producer of natural gas in Canada with much of the region's deposits still under development. While the northeastern region of the province has seen oil and gas development since the early 1950s, this area is the focus of increased interest owing to the ability of newer technologies to exploit both conventional and unconventional deposits.

To date, the vast majority of the natural gas produced in BC has been from conventional deposits (i.e. gas that readily flows from the formation into a well). However, this trend is changing rapidly with the development of unconventional deposits such as shale and tight gas, which are the drivers for activities in the Horn River, Liard and Montney Basins and elsewhere. Indeed, production growth in BC over the last ten years has been almost exclusively due to the development of unconventional deposits[1].

Horizontal/directional drilling and multi-stage hydraulic fracturing have allowed for the commercial development of shale and tight gas deposits previously considered uneconomic. While the use of horizontal drilling on its own has not introduced any unique environmental concerns, a number of concerns have been identified with hydraulic fracturing including water usage, contamination of ground water supplies, return water treatment and disposal etc. Beyond the concerns associated with the technology employed, the high level of activity in the sector has brought exploration, drilling and production activities to areas with little, if any industrial presence. Communities have understandable concerns about potential health impacts associated with airborne emissions, discharges to surface water, ground water contamination, impacts on wildlife and physical disturbances. As discussed in the following sections, these as well as broader social determinants of health were identified as concerns in a number of studies including Phase 1 of the Human Health Risk Assessment Study.

[1] BC MEM/NEB, 2011

3.1.2 Concerns About Oil and Gas Activities in Northeastern British Columbia

Oil and gas activities in Northeastern BC have been a focus of population health concern for the past 10 years. In March 2005, the BC Northern Health Authority initiated a preliminary study to identify potential community health and safety impacts. This study included a comprehensive description of the significantly increasing oil and gas development in the region, a literature review of population health studies and chronic low-level exposures from sour gas activities, and a regulatory review of setbacks and emergency response planning. The relevant health issues identified that were linked with oil and gas development in the Northeastern BC area were:

- emergency response planning;
- First Nations community and ecosystem health;
- air quality and human exposure to emissions;
- stress and quality of life;
- health and social impacts on communities: drugs & alcohol, prostitution, sexually transmitted disease, crime and violence; and
- utilization of health care and social services.

This study was published by the Medical Health Officer (MHO) to the Board of Northern Health in 2007. In 2011, in response to the frequently asked question, **"Is it still safe to live in Northeast BC among so many oil and gas wells?"** Medical Health Officers in the region asked the BC Minister of Health to develop a health plan to address the health concerns directly and indirectly associated with the oil and gas industry. The MHO asked that the following questions be addressed:

- One well may be safe – but so many in same area – are they still safe?
- Can it be measured and monitored?
- How can we involve GP's in surveillance programs?
- Where is health data published?
- Who is responsible for monitoring health effects?
- Do we need targeted health legislation?

In follow-up, the Government of British Columbia initiated the three-phase HHRA project. Funded and led by the MoH, Phase 1, which was completed in March of this year, involved a comprehensive public engagement program to identify concerns related to oil and gas development and inform the scope of the Phase 2 study.

3.1.3 Phase I Outcomes – Identifying Health Concerns Relating to Oil and Gas Development

Phase 1 of the three-phase HHRA project collected input from a wide spectrum of people and organizations regarding their health concerns related to oil and gas activities in Northeastern BC, the location of the majority of oil and gas activities in the province. The focus of the Phase 1 engagement was to inform interested parties and people about the HHRA project, to encourage contributions of health concerns, and to inform potential participants how their comments could be submitted.

Information about Phase 1 was delivered by news releases, newspaper ads, a project-specific website, email notifications, and mass mailings to residences in Northeastern BC. Input was received through one-on-one meetings (over 200 participants), online through the project website (41 submissions), via email (over 200 submissions), and through the project toll-free telephone line (16 comments). Phase 1 engaged with the public, municipal and regional governments, First Nations, non-government organizations, regulators (BC Oil and Gas Commission), provincial ministry representatives, Northern Health Authority, and the oil and gas industry.

The Phase 1 report, titled *Identifying Health Concerns Relating to Oil and Gas Development in Northeastern BC* includes a summary of the types of concerns identified and the recommendations made during the engagement activities. The Phase 1 report noted the appreciation of the participants to express their concerns in the assessment although the time available was short. The participants also expressed a desire for continued transparency and involvement in subsequent assessment phases. The contributions to Phase 1 covered a wide range of concerns and suggestions for regulating and monitoring oil and gas development in the province. Concerns that were voiced included disease outcomes, exposure pathways, environmental issues, provision of health services.

Reported concerns are general in nature, including:

- negative impacts on water quality and human health from construction associated with oil and gas resource development;
- prevalence of chronic disease; and
- additional traffic on public roads, including oversized and hazardous material loads.

Suggestions were also reported and included increased monitoring methods and framework, scientific research and tracking of health data:

- examining the impact of oil spills in water bodies;
- health records review of oil and gas-related social issues; and
- keeping roads that are near fields and residences sprayed with dust retardants to reduce negative effects on crops.

As can be seen above, many issues lie outside the scope of a traditional human health risk assessment and it will be important to describe which concerns and suggestions documented within the Phase 1 reports are within the scope of the Phase 2 work. It will also be important to describe why others are not within the Phase 2 study and not appropriate for evaluation using the human health risk assessment tool,

The *Phase 1 compendium of submissions* contains detailed requests submitted in Phase 1 from individuals, organizations and local governments. These concerns include specific oil and gas industry scenarios (e.g. low levels H_2S in air; chemicals used in fracturing shale; and flaring), governmental policies (e.g. setbacks) and health sensitivities (e.g. child health).

3.1.4 Overview of Similar Studies

In 2008, a study addressing public concerns regarding the impacts of oil and gas activity was published by health officials in Garfield Country, Colorado. The *Community Health Risk Assessment of Oil and Gas*

Impacts in Garfield County had similar goals as the one described in the RFP. The health authority in Garfield Country completed a human health risk assessment which was complemented with a health study to describe population health and sensitivities in the community.

In addition, human health risk assessments of oil and gas activities have been completed in application for environmental assessment in British Columbia and Alberta. These include:

- MacKenzie green energy facility in 2006-7 located on the western edge of the study area as well as some older gas plants in the area (Cariboo 1996, Jedney 1995, Ring Border 1998, Taylor 1997, W Stoddard 1997).
- Wolverine Coal Mine (near Tumbler Ridge) in 2005.
- Willow Creek coal (Chetwynd) amendment completed in 2010.

Other studies that are currently out of scope but which may be published in time for inclusion in the proposed project include environmental applications for:

- Roman Coal Mine (S of Tumbler Ridge) that started in 2007 and is ongoing.
- Cabin Gas plant near Ft Nelson that started in 2008 and is ongoing.
- Farrell Creek gas plant (N of Hudsons Hope) that was initiated last month.

The health science literature is sparse and varied. There are few studies within the PubMed health science database that relate directly to oil and gas. Studies appear to focus primarily on (a) drilling fluids (with some discussion over the oil mist and vapour levels that are produced); (b) radioactive substances; (c) methane, ethane and propane entering drinking water; and (d) ozone.

In terms of gray literature, there are some health impact assessment publications available online that focus on oil and gas activities. This literature from US, Canada and Europe acknowledges difficulty in assessing health impacts from shale gas operations owing the site specific nature of exposure conditions. While this literature is likely to provide descriptions of potential exposure scenarios and the risks attributable to those conditions, it is unclear how directly attributable it will be to the oil and gas industry in Northeastern BC.

3.1.5 Objectives and Challenges

It is understood that the primary objective of the HHRA is to evaluate the risk to human health associated with the oil and gas industry and, where significant risks are identified, provide recommendations by which these risks can be managed. This objective is to be realized through: a review and evaluation of similar studies completed in other jurisdictions; an evaluation of human exposure pathways related to different oil and gas activities; an evaluation of health risk associated with those pathways; and a regulatory review to understand if, and how, the exposure pathways that contribute to risk are monitored or otherwise controlled.

Understandably, there are a number of challenges associated with this undertaking. The first, and perhaps most significant challenge is effectively managing stakeholder expectations. This challenge arises from the fact that Phase 1 of the Study identified many concerns that, while valid from a community health perspective, fall outside of the formal quantitative risk assessment framework - one

where the risk attributable to an environmental stressor is quantified through knowledge about exposure and dose/response relationships. Certain issues identified by stakeholders dealt with broader determinants of community health, many of which are indirect consequences of economic development and not necessarily unique to the oil and gas sector. If these broader issues are not dealt with effectively, then stakeholders may feel that the human health risk assessment is not effectively addressing valid concerns that have been raised.

A second challenge arises from breadth of the oil and gas industry in Northeastern BC in terms of industrial activities and geographical extent. The budget that has been established for this project will not allow for an evaluation of all oil and gas activities on a site-by-site basis meaning assumptions will need to be made regarding different scenarios and locations. These scenarios and assumptions will need to be generic so they can conservatively apply to the majority of cases that can be anticipated to occur. Communities and/or individuals may feel their situation is unique and therefore not representative of the specific conditions evaluated in the human health risk assessment. This will likely be exacerbated by the relative lack of ambient monitoring data which precludes an evaluation of direct exposure in individual communities.

AMEC understands that for the human health risk assessment to be viewed as a valid planning tool these challenges will need to be addressed convincingly during the execution of Phase 2 of the Study. AMEC's proposed methodology, which is discussed more fully below, addresses these challenges through an effective community outreach and consultation program that is intended to build on the results of the Phase 1 study while focusing on those concerns that are amenable to a formal risk assessment framework. As an integral part of project planning and execution, stakeholder engagement will be a critical element to ensure there is a common understanding of project scope, data availability and methodology ensuring the process used for identifying and evaluating health risk is effective and transparent.

4.0 Solution and Approach

This section describes AMEC's understanding of deliverables and the tasks involved in reaching these deliverables. An overview of our proposed solution and approach is presented in Figure 1.

AMEC is presenting a multidisciplinary leadership team with key support personnel who are able to talk to the linkages between environmental determinants of health, human health risk assessment, health-based environmental regulation and community health. This will facilitate discussions in the communities about the limitations of the human health risk assessment in terms of scope in order to maximize the reception of the project by stakeholders. AMEC proposes cross-utilization of discipline leads throughout the different tasks to promote continuity and efficiency in project management, execution of tasks and reporting.

4.1 Jurisdictional Scan of Human Health Risk Related to Oil and Gas Activities

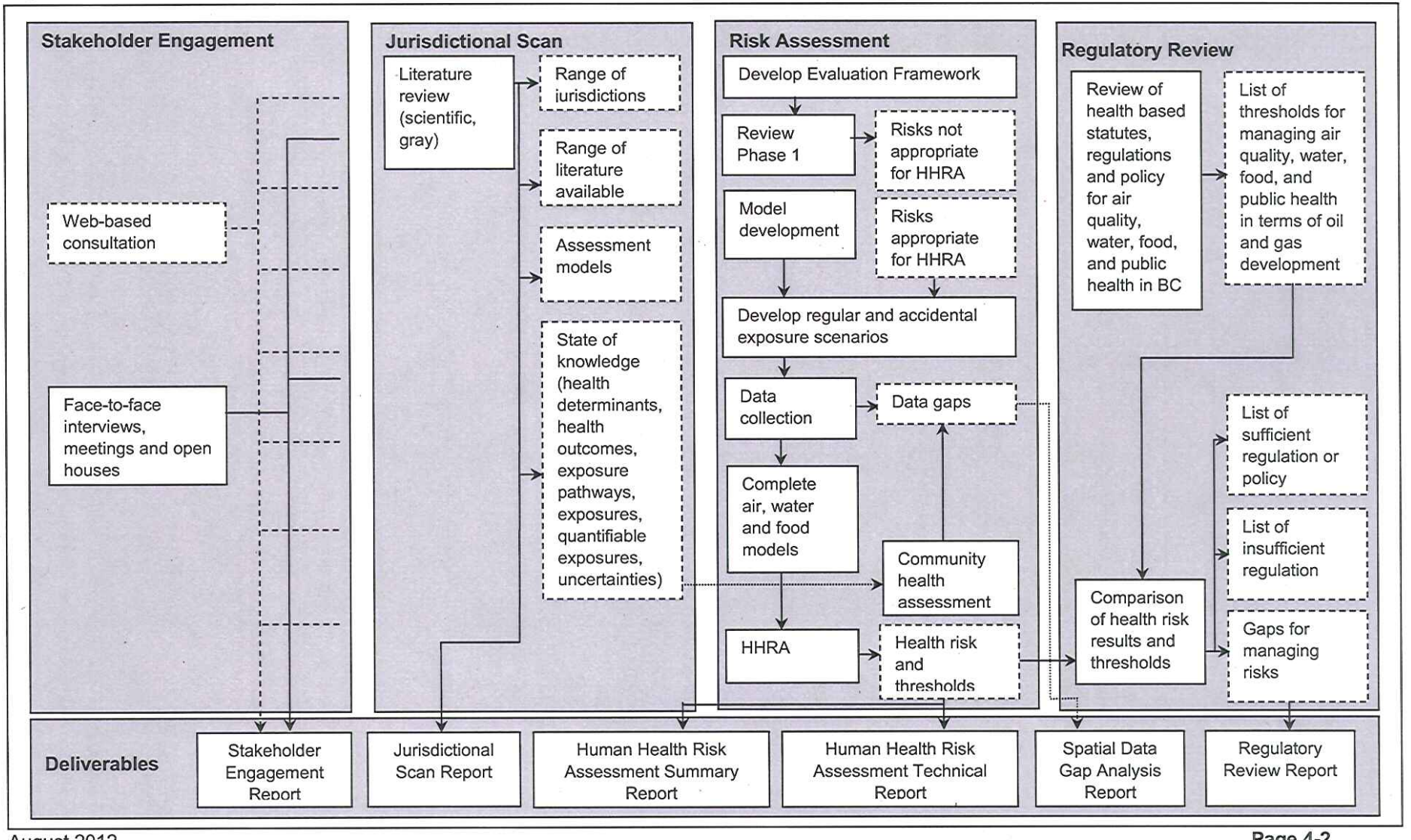
The jurisdictional scan of human health risk related to oil and gas will entail a systematic review on-line of peer reviewed scientific studies available in health science, risk assessment and environmental health databases. This will be supplemented with a systematic on-line review of gray literature available from health and oil and gas organizations and agencies in jurisdictions with a predominant oil and gas industry presence. Select telephone interviews with governmental health agencies and oil and gas associations throughout Canada might produce information related to studies and publications in progress and any locally available gray literature that is not available online. A systematic review of human health risk assessments published in environmental assessments in oil and gas producing provinces and territories in Canada will also be completed (see 3.1.4).

The literature searches will use key words and be limited to oil and gas activities and the following categories of issues, as described in Section 3.3.1 of the RFP): Environmental pathways of exposure (air quality, water quality, land and food quality) and hazards to human health posed through environmental issues and events such as incidents, fluid releases and increased traffic.

Documents will be reviewed to identify their scope; specific concerns that were addressed; chemicals of potential concern; evaluation framework used; major findings and any regulatory and/or policy changes that arose from the study. Site specific factors that may have influenced the outcome of the individual studies will be evaluated for their applicability to conditions in Northeastern BC.

AMEC views the Jurisdictional Scan as a critical early deliverable as it serves to identify what has been done elsewhere, what those findings were and how applicable those findings are to the situation in BC.

Figure 1. Snapshot of Proposed Project Solution and Approach



4.2 Human Health Risk Assessment

4.2.1 Framework Development

Critical to the successful outcome of the risk assessment as an effective planning tool is the development of a conceptual framework that effectively captures the issues of concern such that they can be evaluated in a qualitative or quantitative manner. In the broadest sense, risk assessment is a formal evaluation of the potential consequences of an action (or inaction). For risks to be realized, something or someone must be exposed to a stressor, and the stressor must result in some consequence on the individual or thing exposed. Risk is therefore the product of exposure and the likelihood of harm that may result from that exposure. Once risks that are deemed "unacceptable" are identified, means by which those risks can be managed are often evaluated to identify those that can mitigate the risk most effectively. Effective risk management frameworks[2] recognize that as individuals or communities must bear the risk, the development and implementation of effective management strategies must involve meaningful input from those affected as well as follow-up to ensure that any management strategies that are implemented have an impact on the stressor or stressors that were identified as the initial concern.

At the heart of any risk assessment/risk management framework is an evaluation of consequence (hazard) and probability (exposure). Applied in the environmental field, risk assessment is most often used to quantify the health risk associated with exposure to chemical agents based on an understanding of the dose/response relationship in a population of interest. The framework used by Health Canada (2000), the United States Environmental Protection Agency (2012) and others typically progress through a process of: 1) **planning and scoping** (often termed "*Problem Formulation*") which defines the issue(s) and the scope of the evaluation; 2) **hazard identification**, that identifies the nature of the hazard, its source and the possible means of exposure; 3) a **dose-response assessment** that quantifies the relationship between exposure, dose and response in different individuals and age groups; 4) an **exposure assessment** that attempts to quantify exposure via different pathways (e.g. air, food soil etc) based on available information; and 5) **risk characterization** that integrates information regarding exposure and dose-response in order to arrive at conclusions regarding risk. As risk assessments are predicated on the availability of data and often employ assumptions regarding the applicability of those data to individual circumstances, the risk characterization also needs to evaluate the quality of data supporting the evaluation of risk. The outcome of a risk characterization could be that the risk associated with a given set of circumstances is or is not "acceptable" based on a pre-defined metric that defines acceptable. Alternatively, the risk characterization could conclude that given the uncertainty in the available information, additional information is required to make definitive conclusions regarding risk. Given the importance of developing management strategies that effectively target risk-reduction, an understanding the uncertainty associated with any assessment is critical to making efficient management decisions.

---

[2] NERAM *Basic Frameworks for Risk Management* March 2003; Health Canada, D*ecision-Making Framework for Identifying, Assessing, and Managing Health Risks* - August, 2000; U.S. EPA, *Framework for Human Health Risk Assessment to Inform Decision Making* - External Review Draft 2012

Applied to understanding the health risks associated with the Oil and Gas industry in Northeastern BC, Phase 1 of the project indentified a number of concerns related to chemical exposure which lend themselves to the application of a formal, quantitative risk assessment framework. Issues that are more difficult to address using such a framework are those broader social determinants of health. As discussed above, critical to the success of the project will be bridging the gap between a quantitative risk assessment framework that focuses on chemical exposure and community expectations.

In conjunction with the community outreach activities described under Section 4.8, AMEC will develop a conceptual framework for addressing the health risk associated with the Oil and Gas Industry. As an initial step, this will be based on a distillation of the concerns identified in the Phase 1 report identifying those that are: 1) directly attributable to the industry; and 2) that can be addressed using a quantitative risk assessment framework. This framework will then be validated through targeted discussions with key stakeholders to ensure that there is a common understanding of the concerns that will be addressed in the risk assessment, the source(s) of those concerns and the information that is available to evaluate the health risk associated with those concerns. Once this process is complete, it is anticipated that the risk assessment process will follow a standard evaluation framework as described in the following sections.

4.2.2 Problem Formulation

The problem formulation step in any risk assessment describes the overall process by which the risk assessment will be executed identifying the stressor(s) to be evaluated, the sources of those stressors, the receptor populations to be evaluated, and the means by which those populations are potentially exposed. In the present case, the risk assessment needs to address the full range of potential health risks associated with the oil and gas industry in Northeastern BC. This encompasses activities such as exploration, drilling and production, processing, transportation and ancillary supporting activities covering both normal operating conditions and upsets.

Based on the available information, it is anticipated that the risk assessment framework will follow the process depicted by Figure 2. As an initial step, the industry will be divided into specific sub-sectors so that the concerns associated with each can be better indentified and addressed. Depending on the extent of industrial activity associated with each major process and data availability, it is anticipated that both qualitative and quantitative assessments will be undertaken. As an example, it may be possible to address the human health risks associated with exploration qualitatively through a comparison to the health risks associated with a much more intensive activity such as well drilling and development.

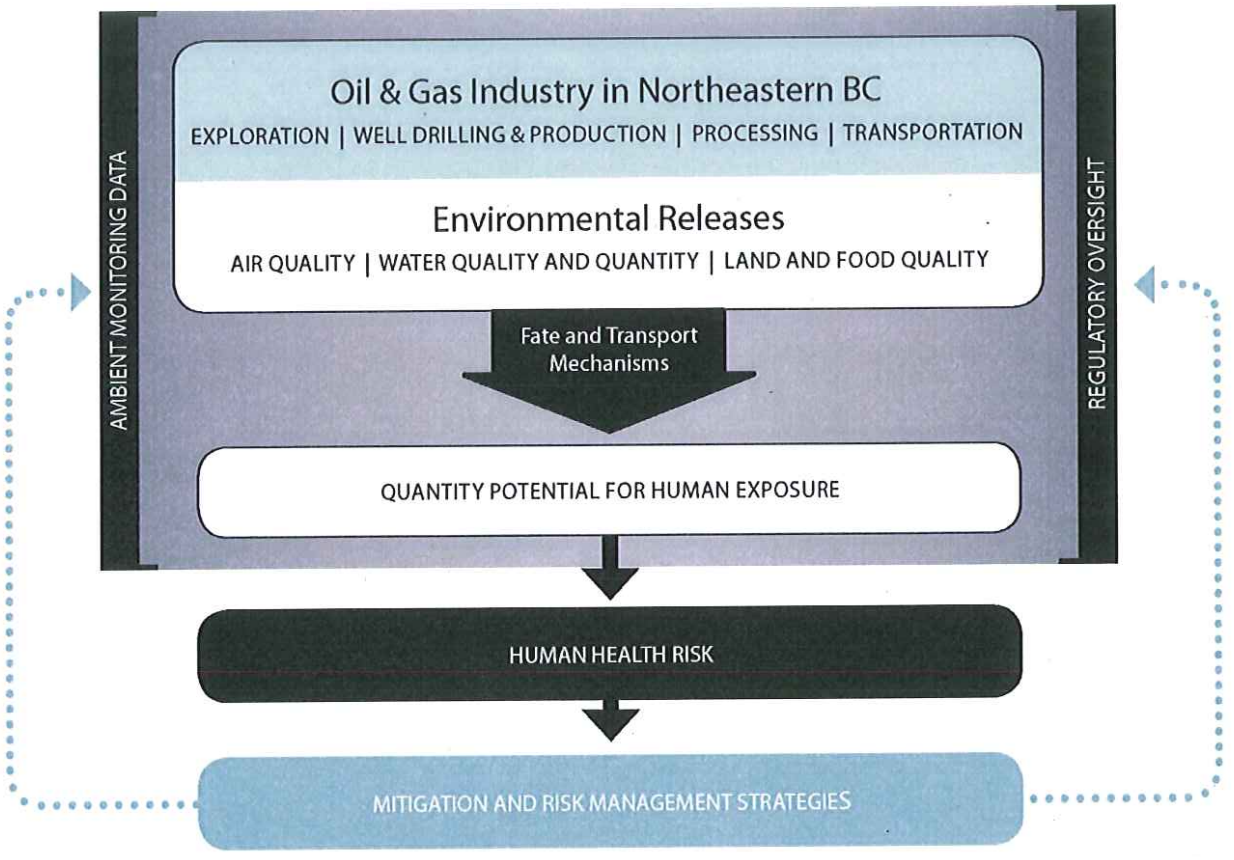


Figure 2. Conceptual Framework for HHRA

As an initial critical step at the Problem Formulation stage, the individual activities associated with the Oil and Gas industry will be reviewed to obtain an understanding of the range of environmental releases associated with those activities, the availability of information to evaluate those releases and whether the data support a qualitative vs. quantitative assessment. For each major activity, an evaluation framework will be developed such that the specific issues associated with the activity can be identified and deconstructed into those component parts that contribute to releases to the different environmental media (i.e. air, water, land etc). This will serve to frame an understanding of the populations who might be exposed and the pathways of exposure.

4.2.3 Exposure Assessment

The exposure assessment typically identifies the different pathways by which the various receptor populations can be exposed to individual contaminants of concern taking into considering release mechanisms as well as transport and transformation mechanisms operational in the receiving environment. The exposure assessment typically examines direct exposure pathways such as ingestion or inhalation as well as indirect pathways such as uptake in the food chain with subsequent ingestion in the diet.

An exposure assessment is reliant on data that quantifies the presence of a contaminant in the environmental medium of interest. Estimates of exposure are usually obtained from ambient monitoring data (where available) and/or levels estimated using fate and transport models, which in turn, are based on an understanding of the emission rates and dispersion characteristics from a particular source.

In terms of available data for the oil and gas industry in BC, there is a considerable wealth of information available from Environmental Impact Assessments (EIAs) completed for various types of undertakings, government databases, permitting information etc. As described more fully under Section 4.3 (Information Gathering), as the initial step in the exposure assessment, AMEC will review and evaluate information available from a variety of sources to assess relevancy for assessing the receptor populations and exposure pathways identified as requiring evaluation in the problem formulation step. This information will be used directly to evaluate potential exposure or will be used as input to fate and transport models depending on quality and relevance. This information will be supplemented through ambient monitoring data and data from environmental permits where available.

At a minimum, those exposure pathways evaluated will include direct inhalation to airborne emissions, direct exposure to ground water and surface water, uptake in the food chain with subsequent ingestion through a traditional diet. As indicated above, the exposure pathways and receptor populations assessed will be very much dependent on the particular scenario modeled which will be confirmed as part of the initial scoping exercise and the problem formulation step described above.

One issue that received considerable attention in the Phase 1 portion of the study was the development of unconventional deposits involving hydraulic fracturing of the gas bearing formation. Concerns identified with this practice indentified during Phase 1 and elsewhere include impacts on drinking water supplies and the treatment/disposal or return fluids containing a wide range of potential contaminants. As potential impacts associated with this practice are very much dependent on site specific factors (i.e. the depth to the formation; the presence of aquifers capable of supplying potable water, the drilling methods and drilling fluids used), it will be important to ensure that the evaluation framework used for evaluating this aspect of the oil and gas industry is applicable to the range of exposure conditions likely to be experienced in Northeastern BC. Considering the degree of concern expressed around hydraulic fracturing, potential risks associated with this process will be evaluated in depth using a number of complementary approaches. These will include reviewing available studies on hydraulic fracturing (e.g. McKenzie et al, (*Human health risk assessment of air emissions from development of unconventional natural gas resources*. Sci Total Environ (2012), doi:10.1016/j.scitotenv.2012.02.018) as part of the jurisdictional review, completing a toxicological evaluation of the major components of the fluids used in hydraulic fracturing, reviewing the procedures used for preventing uncontrolled releases during hydraulic fracturing and reviewing available monitoring data associated with this activity in BC and elsewhere. Considering the site specific nature of hydraulic fracturing and the complexity of modeling, it is unlikely that a quantitative risk assessment can be completed for this activity. However, the compilation and detailed review of available information should provide a sufficient scientific basis for a qualitative assessment of human health risk.

4.2.4 Dose Response Assessment

The dose response assessment describes the development of toxicological reference values (TRVs) that describe the relationship between dose and response. For the vast majority of risk assessments, a

variety of authoritative sources of toxicity information are consulted to indentify available TRVs when assessing environmental exposures. These include, but are not restricted to:

- Health Canada;
- U.S. Environmental Protection Agency (EPA);
- Agency for Toxic Substances Disease Registry (ATSDR);
- CALEPA; and
- The World Health Organization (WHO).

The toxicity criteria selected for each contaminant of interest are typically selected on the basis of a detailed evaluation of the rationale underpinning each agency's reference value, taking into consideration the currency and rigor of the scientific studies used, the relevance of the studies to the population of interest, the duration of exposure (acute, sub-chronic and chronic) and the degree of uncertainty inherent in the assessment. As the most conservative TRV may not always be the most scientifically valid, when selecting a particular TRV for use in assessing toxicity, it is critical that the basis be thoroughly documented to aid in transparently of decision making.

Considering the populations at risk, a critical issue that needs to be addressed in selecting toxicological reference values is one of potentially sensitive receptors. As an example, it is increasingly recognized that children may be more sensitive to environmental stressors owing to the fact that many of their bodily systems are still developing and, in proportion to body size, they have greater potential for exposure to contaminants present air, soil, water and food. For contaminants like methyl mercury, lead and vinyl chloride, while it is well recognized that there is early life sensitivity, it is equally recognized that for common air pollutants such as SO_2, particulate matter and NO_x, that the elderly and individuals with pre-existing cardio-pulmonary conditions can be particularly sensitive. As part of the toxicological evaluation, AMEC will ensure that the TRVs selected are based on the best available science, reflecting the range of individual sensitivities anticipated in the communities of interest. The selection process will be thoroughly documented to ensure there is a clear understanding of the rationale used for selecting a particular value and its basis.

It can be anticipated that the fluids used in hydraulic fracturing will contain chemicals for which toxicological reference values have not been developed. In such circumstances, AMEC will review the primary toxicological literature and structure activity relationships to indentify suitable studies on which to establish exposure limits protective of human health. AMEC has considerable experience in developing health-based exposure limits having developed hundreds for use in environmental permitting.

4.2.5 Risk Characterization

Risk characterization refers to the integration of quantitative information on exposure with the dose-response relationship for the contaminants and population of interest. Applied to quantitative assessments, the risk characterization component of the HHRA directly compares predicted exposures via different routes of intake to the toxicological criteria that define an "allowable", "acceptable" or "safe" level of exposure. For chemicals that operate via a threshold-type of dose response, the comparison most often used is termed a hazard quotient (HQ) or exposure ratio (ER). Where predicted levels of exposure are less than the allowable limit no adverse health outcomes would be expected in the study

population. The converse is not automatically true, however. That is, when levels of exposure exceed the allowable exposure limit, adverse health outcomes are not necessarily expected. Rather, there is erosion in the margin of safety between the level of exposure and that known to cause adverse effects. Under such a situation, it is prudent to re-examine the basis of all of the assumptions used to generate the estimates of risk and exposure prior to identifying possible risk management measures. This analysis could conclude that given the conservatism of the assessment, no adverse health outcomes are expected or alternatively, that some form of follow-up action is required to reduce the uncertainty in the assessment.

For carcinogens that are assumed to operate via a non-threshold mechanism of action, the risk characterization identifies the incremental cancer risk associated with a particular exposure pathway. Incremental lifetime cancer risks are a unitless value that expresses the probability of developing cancer for a specified level of exposure averaged over a lifetime. Typically, incremental cancer risks of one in one hundred thousand to one in one million are considered *de minimus*, which means they are below a level that would be of concern.

For qualitative assessments, the risk characterization typically involves a comparison of exposure conditions with those where the risk is well understood. In cases where there is no potential for exposure, risks are discussed relative to a qualitative discussion of exposure conditions. However, regardless of whether a contaminant is addressed quantitatively or qualitatively, it is critical that the risk characterization documents in a transparent manner, those factors that were considered in the determination of risk and those factors that contribute to risk.

Finally, an important issue that needs to be addressed in the risk assessment is the concept of cumulative effects. This is defined as the combined effect of simultaneous exposure to more than one environmental stressor (U.S. EPA, *Framework for Cumulative Risk Assessment*, May 2003). As part of the risk characterization, AMEC will address the issue of cumulative effects through a variety of means. Exposure to multiple chemicals is typically addressed through the assumption of additivity for those contaminants that operate through a common mechanism of action, although it is becoming increasingly recognized that environmental factors can potentiate the effects of certain contaminants (e.g. alcohol use and exposure to the industrial degreaser trichloroethene). While the issue of additivity and potentiation will be addressed at the risk characterization stage, cumulative effects resulting from multiple sources will be addressed at the exposure assessment stage through reference to ambient background data where available, or through the use of assumptions that account for multiple sources of pollutants.

4.2.6 Uncertainty Analysis

Critical to evaluating the outcome of a the risk characterization and the development of management options to address any risks that are indentified as being unacceptable is an understanding of uncertainty in the assessment and the source(s) of that uncertainty. In those cases where there is significant uncertainty, either as a result of lack of data or lack of information concerning actual exposure conditions in a particular community, uncertainty can drive recommendations for additional information gathering (e.g. monitoring data). As a component of the risk characterization AMEC will provide a clear description of the uncertainties inherent in the assessment, the sources of that uncertainty and the consequences of those uncertainties. This will be a critical input to the assessment of spatially enabled data.

4.3 Data Collection & Review

Central to a robust assessment of human risk is information on the levels of contaminants in the media to which humans can be exposed. Measured or predicted concentrations in a particular medium (e.g. ambient air) are used directly to assess potential exposure or are used as input parameters in fate and transport models to assess indirect pathways of exposure (e.g. aerial deposition with subsequent uptake in the food chain). The following section describes AMEC's approach to collecting the data needed for completing the human health risk assessment.

4.3.1 Hydrogeology

Background Data Review

A literature review and data mining for geological and hydrogeological data will be undertaken covering the Northeast region of BC particularly from areas that are representative of reasonable maximum concentrations of the oil & gas site-related chemicals in groundwater near residential areas.

Required reports and data will be compiled from the following sources:

- Oil & Gas Projects related Environmental Site Assessments & Baseline Groundwater Studies;
- Federal, Provincial and Local Governments, Groundwater related Databases and Reports;
- Oil and gas producers including Horn River Basin Producers Group (HRBPG);
- B.C. Oil and Gas Commission;
- Consultants such as Canadian Discovery Ltd;
- Scientific databases such as Knovel, USEPA; and
- Universities (Thesis and published papers).

Data mining will concentrate on chemical properties of oil and gas field chemical and effluents, location and vulnerability of groundwater resources, groundwater-surface water hydraulic connectivity and potential effect on human health. As appropriate, resulting groundwater and selected model input parameters will be incorporated into a one dimensional F&T model to assess potential exposure via this pathway.

Data Gap Analysis

The hydrogeological, geological, toxicological data gaps analysis will spatially identify regions where data do not exist or data are incomplete. Recommendation to address and mitigate data gaps will be identified if applicable, including the need for future groundwater monitoring.

Data Processing & Reporting

Using data from all sources listed above, a summary of literature reviewed as well as data gap analysis will be provided as part of the exposure assessment discussed above. Sources of groundwater contamination, exposure pathways and hazards, will be analyzed using available data.

A report, which will be included as an Appendix to the HHRA will include:

- estimation of annual groundwater quantity required by O&G sectors in Northeastern BC;
- list of existing aquifers and their vulnerability;

- potential risk to groundwater resources,
- location of potential groundwater-surface water interaction;
- identification of major contaminants and their mobility, dispersion, fate and transport in porous media and their associated risk to human health;
- list of hydraulic fracture fluids and their composition;
- a summary of baseline groundwater quality for the NE BC; and
- recommendation for groundwater monitoring program for selected aquifers.

Contaminants & Pathway Analysis

Contaminants originating from oil industry operation include naturally occurring contaminants in oil bearing formation water such as arsenic, nickel and mercury as well as naturally occurring radioactive material (NORM). Contaminants from oil and oily effluents include both dense and light non-aqueous phase liquids (DNAPL & LNAPL). LNAPLs are highly mobile, dispersible and soluble in underground saturated medium and can travel to downgradient receptors possibly reaching surface water features. For example; benzene, toluene, and m,p-xylenes (BTEX) are hydrocarbons that are prominent environmental pollutants associated with oil and natural gas operations.

Contaminants originating from natural gas exploration and production activities such as hydraulic fracturing fluids, flowback effluent and gas condensate are very complicated. The chemical composition of hydraulic fracturing fluids recently published by the U.S. EPA and other sources will be used to identify chemicals of interest.

Fate and Transport Modeling (F&T)

Two type contaminant migration pathways includes, surface release and subsurface migration of oil and effluent (upward migration). It is anticipated that a one dimensional simplified fate and transport modeling using selected hazardous chemicals and aquifer parameters will be developed for oil and gas sectors separately assuming surface release from oil and gas operations is a source of contaminants.

Model Input parameters can be summarized as follows:

1. Hydrogeology Parameters
   - Hydraulic Conductivity (m day)
   - Hydraulic Gradient (m/m)
   - Average Groundwater Velocity (m/day); and
   - Aquifer porosity (%).

2. Model Input Hazardous Chemical of Interest Parameters
   - Dispersivity (Longitudinal and Transversal (m))
   - Adsorption (Bulk density (g/m3), Partition Coefficient (Kd), Fraction of organic Carbon

3. Biodegradation

- Solute half life (year);
- Source half life (year); and
- Initial Source concentration (mg/L).

4.3.2 Surface Water

Background Data Review

The northeastern region of BC is characterized by multiple watercourses and waterbodies throughout the region. A literature review and search for historical water quality and sediment data will be undertaken with information being compiled from the following sources:

- Environmental Impact Assessments;
- Watershed Stewardship and Interest Groups (such as the BC Lake Stewardship Society);
- Government Monitoring Programs (such as the CABIN program);
- Government Reports;
- Water Survey of Canada Website;
- Environment Canada;
- BC Government Website;
- Current Projects within the Region; and
- Published Scientific Literature.

Data compilation will concentrate on surface water chemistry, sediment chemistry and biota monitoring programs where available.

Data Gap Analysis

Once data from all sources has been compiled, a gap analysis will spatially identify regions where data is sparse or non-existent. Recommendations to address and mitigate data gaps will be specified as warranted.

Data Processing and Reporting

Using data from the sources listed above, trends in surface water quality will also be provided for major water bodies and water courses using summary statistical calculations. Summary statistic results will be compared to drinking water guidelines as applicable. A baseline assessment of turbidity and TSS will also be conducted for the major water courses in the region. The findings from these evaluations will provide a baseline description of water quality, as well as a benchmark for further monitoring initiatives and mitigation strategies. Where data allows, relevant information in biota monitoring programs will also be summarized.

Exposure Evaluation

To provide input into the human exposure assessment, the following parameters will be evaluated and summarized both as they relate to direct exposure (i.e. direct ingestion and dermal contact) and indirect exposure via uptake in the food chain):

- Baseline water quality for the Northeastern region of BC;
- Potential risks to water quality in surface water bodies used for drinking water due to industrial activity;
- Potential increases to sedimentation and turbidity in water sources due to industrial activity;
- Potential effects from waste water on human health;
- Potential effects from the release of water recovered from industrial process; and
- Potential risk to surface water quality and sediment quality from effluent releases and spills.

Fate and Transport Modeling (F&T)

Contaminant fate and transport modeling will be conducted where data and circumstances allow. For surface water quality, a conceptual model will be constructed to identify the possible point-sources of contamination that may affect drinking water reservoirs taking into consideration the results of the hydrogeology fate and transport modelling.

4.3.3 Air

Background Data Review

There is limited air quality information readily available for the northeastern region of BC. A number of gas processing facilities have conducted limited monitoring related to their activities but there is no broad airshed-type monitoring system in place. Therefore information pertaining to air emissions related to the oil and gas industry will be compiled from the following sources:

- Environmental Assessments;
- Ambient air monitoring data;
- Issue specific monitoring data (e.g. flaring, traffic etc);
- Permit applications (e.g. air reports supporting flaring permits and waste discharge authorizations);
- Government reports; and
- Published Scientific Literature.

Data compilation will concentrate on information pertaining to ambient air quality and aerial deposition associated with the different oil and gas activities including traffic related emissions.

Data Gap Analysis

Once information from the various sources has been compiled a gap analysis will be completed to identify areas and activities where data is sparse or non-existent.

Data Processing and Reporting

The data collected above will be reviewed for relevance in assessing human exposure associated with emissions from the oil and gas industry. The information will be compiled regionally as appropriate and reported in an appendix to the HHRA report.

Exposure Evaluation

To provide input into the human exposure assessment, the following parameters will be evaluated:

- Background air quality statistics for the Northeastern region of BC;
- Modeled and/or measured facility specific data on air quality;
- Modeled and/or measured facility specific data on aerial deposition;
- Soil quality data in relation to aerial deposition; and
- Information on traffic density and traffic type.

Fate and Transport Modeling (F&T)

On the understanding that information on dispersion modeling will be available in various EIAs and permit applications, it is not anticipated that little dispersion modeling will be undertaken as part of the HHRA. However, limited modelling may be done for certain release events like pipeline breaks to estimate transient exposures. In addition, traffic emissions may be estimated using US EPA emission models like MOVES or NONROAD that are widely used for this kind of purpose.

4.4 Regulatory Review

Overall, the regulatory review will:

- Identify what aspects of oversight are covered by each agency?
- Ask if the right information being collected to assess compliance?
- Ask if the right information being collected to evaluate exposure and potential health risk?
- Produce recommendations that arise from any identified risk and information gaps that would help reduce uncertainty of better understand the source of risk and how to manage effectively.

Population health and health-based components of environmental regulations and policies will be compiled, interpreted and synthesized in a summary document. Some of these tasks will already have been completed during the HHRA data collection and the gap analysis of spatially enabled data, which will promote efficiencies. Once complete, the risk assessment and community medicine/epidemiology team will come together in a half day workshop to discuss the regulations and policies in terms of the results of the jurisdictional scan, the results of the HHRA (whether exposures are acceptable or not) and the gaps identified in the gap analysis of spatially enabled data. Recommendations will be developed and prioritized for later action.

4.5 Gap analysis of spatially enabled data

Lessons learned from the human health risk assessment will inform the report with recommendations concerning the types of spatially enabled data that would improve efforts to monitor and manage the health of the population in Northeastern BC. A systematic literature review of spatially enabled environmental and population health data will establish availability of data sets in this area. The review of spatially enabled environmental data will have been completed during the HHRA data collection task and will be integrated within this task. The discipline leads from the data collect and exposure assessment modelling tasks will meet with the community medicine/epidemiology team for a half day workshop to discuss linkages in the datasets and establish well reasoned data gaps in currently available spatially

enabled data for the purpose of identifying those parameters that are 1) linked to the oil and gas industry; 2) reasonable metrics for evaluating population health; and 3) are measurable. The report will identify how spatially enabled data is being used to inform community health monitoring in other jurisdictions with the aim of providing recommendations on how it can be applied in Northeastern BC. .

4.6 Stakeholder Engagement

Phase 1 of the three-phase HHRA collected input from a wide spectrum of people and organizations regarding their concerns regarding human health effects related to oil and gas activities in Northeastern BC. The focus of the Phase 1 engagement was to inform interested parties and people about the HHRA, to encourage contributions about health concerns, and to inform potential participants how their comments could be submitted.

Phase 1 engaged with the public, municipal and regional governments, First Nations, non-government organizations, regulators (BC Oil and Gas Commission), provincial ministry representatives, the Northern Health Authority, and the oil and gas industry.

As discussed above, the Phase 1 report, titled *Identifying Health Concerns Relating to Oil and Gas Development in Northeastern BC,* includes a summary of the types of concerns identified and the recommendations made during the engagement activities. The contributions to Phase 1 covered a wide range of concerns including personal health, exposure pathways, environmental issues, and affects on communities and community services. Concerns were also expressed regarding a variety of aspects of the oil and gas industry and the oil and gas institutional framework.

Phase 2 stakeholder engagement will have a very different objective than that of Phase 1. The purpose of the Phase 2 engagement will be to inform interested parties about the scope and process of the human health risk assessment and the regulatory review and to gain the stakeholders validation of the Phase scope and process. Phase 1 emphasized the collection of concerns from stakeholders. Phase 2 will emphasize the communication of information to stakeholders

Phase 2 of the assessment is focused and will not address all of the topics of concern expressed in Phase 1. Phase 2 will examine identified environmental pathways of exposure (air quality, water quality and quantity, food quality) and the human health risks as the result of accidents, spills, explosions and increased traffic related to oil and gas activities. Phase 2 also recognizes that different oil and gas activities could present different human health risks and will examine those different activities. Also, Phase 2 will include a review of the BC statutory, regulatory, and policy framework that protects the health of the population and will develop recommendations for changes.

The Phase 2 stakeholder engagement will be conducted through a variety of means over the period of the assessment as described below. The means of external communications, including that with stakeholders, are discussed in Section 5.2. Proposed Communication Plan.

4.6.1 Stakeholder Engagement Steps

Step 1: After consultation and confirmation with the client and review of stakeholder input from Phase 1, AMEC will engage all Phase 1 participants from the 15 (nine non-Aboriginal, five Aboriginal and the Treaty 8 Tribal Association) communities throughout Phase 2. Given the small community size and potential sensitivity of the subject matter being studied, we will use multiple engagement strategies in

order to promote the maximum participation rate. There may be individuals who are hesitant about speaking out about this subject matter in a public forum given their ongoing involvement with industrial activities and concern about backlash.

The first step will be to communicate to stakeholders regarding the commencement of Phase 2. During this step, AMEC will also outline future communication strategies and planned activities for Phase 2. This is discussed in more detail in Section 5.2 Proposed Communication Plan.

Step 2: AMEC will conduct a series of community visits during which we will hold participant workshops, and conduct face-to-face or telephone interviews with those that would prefer to contribute confidentially or who are unable to attend the workshops. The first set of workshops are anticipated to commence in Q1 2013. The objectives of the first set of community workshops will be to:

- Provide an introduction of the new Project team.
- Provide an overview of the team's intended activities and research as well as a description of what will be produced during Phase 2.
- Present preliminary findings from the jurisdictional scan of studies and reports related to human health risk in relation to oil and gas activity and facilitate stakeholder input into other data sources, research or reports.
- Present the health risk indices that will be evaluated in Phase 2 through a PowerPoint presentation and informational posters. We will then validate the proposed measurement indicators our team intends to use with key stakeholders. The PowerPoint presentation will be videotaped and posted on the website for future access and referral. The posters and all handed out materials will also be posted on the website for future access and referral.

To gain input from stakeholders, AMEC will use a Focused Conversation methodology. Focused Conversations are an IAP2 ("International Association for Public Participation") recommended technique to introduce people to new information and gain insight into complex issues. This provides stakeholders with a structured approach to exploring challenging issues by using a series of questions arranged in four stages. Stage 1 is the Objective Stage whereby the purpose is to review the facts (why and how the health risk indices were selected) as well as the proposed methodology. Stage 2 is the Reflective Stage which is where the team facilitates the safe input and management of emotional responses. Stage 3 is the Interpretative Stage where the input is reviewed collectively. The final stage is the Decisional Stage whereby the group considers additional indices and next steps.

For the face-to-face and telephone interviews, we will follow the same approach, employing a Focused Conversation methodology.

Step 3: AMEC will conduct a second set of meetings/interviews after the HHRA has begun and some modelling and other related activities have occurred. The second set of meetings/interviews are anticipated to commence in Q4 2013. The objectives of the second round of meetings/interviews are to inform key stakeholders about the status of the modelling, for example, scenario and exposure pathway mapping, input data from air and water quality models, food intake data to be used. This will allow our team to verify inputs to the HHRA model.

We would again propose using a Focused Conversation methodology. This approach provides a consistent (and familiar to those who participated in the first workshop) means of offering stakeholders a structured approach to exploring challenging issues by using a series of questions arranged in four

stages. For those that were not able to participate in the first workshop, they will have access to minutes, presentation material and videos and notes from the website.

Two AMEC staff will participate in all stakeholder workshops. One person will be from AMEC's office in Burnaby who is a certified Public Participation Practitioner and experienced in public engagement. The other person will be an expert in human health issues and experienced in discussing those types of issues in public forums.

In addition, meetings will be conducted with representatives from the BC ministries that participated in Phase 1. These ministries will be suppliers of information that will be used in the risk assessment and the regulatory framework review as well as contributors to the validation of the Phase 2 scope, process, and technical assessment.

AMEC will document all stakeholder contacts and comments received in its proprietary Stakeholder and Issues Information Management System (SIIMS). This is a web-based, searchable database that will be customized for Phase 2 of the human health risk assessment. SIIMS will maintain contact information about stakeholders and records of communications and will facilitate compilation and categorization of all stakeholder comments and completion of the required stakeholder engagement report.

All stakeholder activities and the results of those activities will be documented in a Phase 2 stakeholder engagement report.

This proposed stakeholder engagement will provide the transparency and continued involvement of stakeholders that was requested by participants in Phase 1. Early and on-going communications about the assessment will contribute to the acceptance of the stakeholders of the selected scope for Phase 2 and reduce the risk that study will be deemed unsuitable.

Table 1. Public Consultation Process

Description	Personnel	Timing
Confirm the communities for engagement activities throughout Phase 2.	Janine Bedford Karen McCaig	8 hours
Conduct first Set of Community Meetings	Karen McCaig Janine Bedford Logistics Materials Production Team	460 hours
Second Set of Meetings	Karen McCaig Janine Bedford Logistics Materials Production Team	450 hours
Stakeholder Engagement Report	Lindsey McDonald Karen McCaig Janine Bedford	70 hours

4.7 Project Deliverables

AMEC expects to provide the following deliverables:

- A Jurisdictional Scan report describing the scope, search methods and results, including chemicals of potential concern; evaluation frameworks; major findings and any regulatory and/or policy changes that arose from the study; and any site specific factors that may have influenced the outcome of the individual studies in Northeastern BC.
- The development and validation of an evaluation framework for assessing health risk associated with the oil and gas industry based on those concerns identified in Phase 1 of the study.
- A detailed human health risk assessment addressing the full range of oil and gas related activities in Northeastern BC. The human health risk assessment will include a plain language summary that can serve as a stand-alone document.
- Regulatory Review report focussing on what aspects of the industry are regulated as they relate to understanding health risk, who collects and analyzes information, and what is done with that information once analysed.
- Based on the outcome of the human health risk assessment, the Jurisdictional Scan and the Regulatory Review, a report with recommendations regarding spatially enabled data collection needs to better understand and monitor public health outcomes as they relate to the oil and gas industry.
- Undertaking effective engagement of key stakeholders to validate the approach being used and providing a summary report documenting the nature and outcome of such consultations.

The anticipated delivery dates for these work products and other milestones are provided in Table 5.

4.8 Proposed Team

Members of project team, while described more fully in Section 6.2 are introduced below with respect to their proposed roles and responsibilities.

Table 2. Proposed Team

Name	Role	Responsibilities
Cliff Eng, P.Eng., CSAP	Project Manager	• Liaison with MoH client contact and other government personnel as necessary • Working with the project leads to ensure project schedule and deliverables adhered to • Reviewing project deliverables for quality • Managing project change during the duration of the project • Attending/participating in regular update meetings with steering committee
Stuart Bailey, Ph.D.	Human Health Risk Assessment/Toxicology Lead	• With the project team, leading the development of the conceptual framework for HHRA • Oversee food-web modeling and contaminant uptake pathways • Overseeing the exposure assessment for different receptor groups and exposure scenarios • Conducing the toxicological assessment for identified contaminants of concern • Completing the risk characterization • Risk communication
John Mick, B.Sc., M.E.Des.	Upstream Oil & Gas Lead	• Identification of oil and gas related activities in Northeastern BC • Identification and evaluation of emission sources associated with individual oil and gas activity in Northeastern BC
Rob Kemp, B.Sc., M.Eng., P.Eng.	Emissions/Dispersion Modeling Lead	• Identification and evaluation of information related to airborne emissions from oil and gas related activities • Evaluation of information related to dispersion/deposition modelling under different scenarios to identify exposure related information • Identification and evaluation of ambient air monitoring data to aid in developing point estimates of exposure

Name	Role	Responsibilities
Scott King, M.Sc., P.Geol., PG	Hydrogeology and Contaminant Transport Lead	• Identification and evaluation of information related to surface water and ground water discharges from oil and gas related activities • Evaluating the relationship between surface/sub-surface disposal and impacts to surface water and ground water • Provide input parameters for the use in food-web modelling
Janine Bedford, M.Res, BA	Stakeholder Engagement Lead	• Developing and implementing an effective community engagement strategy
Marla Orenstein, M.Sc.	Community Health/Epidemiology Lead	• Completing a jurisdictional scan report to identify reports, papers and studies that have assessed the human health risks associated with the oil and gas industry. • Oversee evaluation of availability of spatially enabled data for monitoring and managing public health and providing recommendations for additional data collection to address risks and/or uncertainties indentified in the human health risk assessment. • Integration of community health linkages and approaches throughout project. • Oversee evaluation of Phase I related information to identify/prioritize oil and gas activities and associated concerns • Support engagement of key stakeholders in discussion of HHRA and the broader health concerns in relation to the risk assessment framework
Karen McCaig, B.Eng., M.Sc., ACSM	Oil & Gas Regulatory Framework Lead	• Reviewing and evaluating the regulatory and policy framework governing the oil and gas industry in BC as it relates to the protection of public health • In conjunction with the project team, developing recommendations regarding measures that can be taken to mitigate or otherwise manage unacceptable risks identified in the human health risk assessment • Identifying measures that are, or should be taken for information gathering to address uncertainties in understanding the risk to public health from the oil and gas industry.

4.9 Project Risk Management

AMEC considers risk management to be an integral part of any project. As described under Section 3.1.5, external risk factors centre on the expectations in the community regarding the scope of the study and whether it can realistically address the range of concerns indentified in Phase 1. AMEC is addressing this risk through an active stakeholder engagement strategy whereby communities will be consulted on the evaluation framework and the scope of the assessment. The success of this process will be dependent on the skill of the communications team as well as how information is conveyed regarding how concerns that fall outside of the scope of the HHRA will be addressed in the longer term.

Internal risk factors relate to data availability and quality, which affects the ability to make quantitative estimates of risk; resource limitations which can limit the scope of the assessment; staffing changes which may affect project schedule; and the ability to obtain critical information in a timely manner. The consequence of these risk factors and the strategies employed to mitigate these risks are outlined in the following table.

Table 3. Risk Factors and Mitigation Strategies

Risk Factor	Potential Consequences	Mitigation Strategies
Data Availability and/or Quality	Lack of quality data prevents or limits the ability to make quantitative or qualitative estimates of health risk for certain activities and/or locations	• Use surrogate information to the extent possible; • Predictions of risk will be qualified through a robust discussion of uncertainty • Lack of quantitative information can lead to recommendations for data collection as part of the spatially enabled data review
Resource limitations - External	Project will be partially reliant on government agencies to source and supply information from government sources. Delays caused by resource limitations may affect project schedule.	• Work with project partners at the outset so there is a clear understanding of expectations • Identify data needs and requests at an early stage such that delays in delivery have less of an impact on overall schedule • Rely on on-line sources of information to the extent available
Resource limitations - Internal	The overall project budget places a limit on the scope of the assessment. Unanticipated changes in scope introduced through community consultation, discussions with the MoH and/or the data review phase will place pressures on project budget and schedule.	• While AMEC has a relatively good understanding of information sources and the overall scope of the assessment, this is to be verified at the project initiation phase and confirmed during public consultation activities. • Changes in scope are to be documented such that potential implications on project delivery and schedule can be indentified and agreed to.

Risk Factor	Potential Consequences	Mitigation Strategies
Staffing Changes	Staffing changes due to illness or change in circumstance have the potential to affect project schedule and the quality of deliverables	• AMEC has considerable redundancy in all disciplines represented on this proposal. Should there be a need to substitute critical staff, AMEC will ensure that staff with equivalent skill sets are added to the project and are available for its duration so as not affect schedule.
Adverse Weather Conditions	Adverse weather may affect the ability to travel as part of the community consultation activities thus affecting project schedule.	• To the extent possible travel will be scheduled around those periods less affected by weather disruptions. • Overall project schedule sufficiently flexible to accommodate delays of a few weeks. Any delays beyond this will be discussed with project team and MoH to understand consequences.

4.10 MoH Project Commitment Requirements

AMEC is satisfied with the approach and commitment level proposed in page 13 of the RFP. Specifically, MoH would be expected to participate in bi-weekly meetings (approximately 30-40 meetings) via telephone conference or in person at 1515 Blanshard Street, Victoria, BC. AMEC will provide bi-weekly progress reports via email to the MoH project manager prior to the bi-weekly meetings (covering progress, timelines, issues, concerns, and risks).

In addition, it is anticipated that that MoH will have some form of steering committee involving other Ministries and agencies. As such, resource requirements and estimated time commitments for each are described below. These estimates are subject to change based on the executed project scope.

Table 4. Anticipated Resource Requirements

Ministry/Agency	Resource Needs	Estimated Resource Requirements
Ministry of Health	• Participate in bi-weekly project management meetings • Participate in technical meetings as required • Participate in community consultation meetings • Source/provide information related to community census information and health status indicators for the Study Area • Review draft reports	• 40 bi-weekly meetings of 1-hour each • Assume 20 technical meetings of 2-hours each • Two separate trips to 15 communities • Dependent on data needs • Dependent on the number of reviewers
Ministry of Environment	• Participate in technical meetings as required; • Source/provide information related to ambient air quality; targeting air monitoring; ground water quality and quantity; surface water quality and quantity; biota monitoring; permitting and effluent quality monitoring. • Provide information on regulatory oversight of the	• Assume 20 technical meetings of 2-hours each • Dependent on data needs and the data sources accessed

Ministry/Agency	Resource Needs	Estimated Resource Requirements
	industry.	
Ministry of Energy and Mines	• Participate in technical meetings as required; • Source/provide information related to oil and gas industry in Northeastern BC (e.g. the facilities, location, activities etc) • Source/provide information on technologies employed and additives used in all aspects of industry • Provide information on regulatory oversight of the industry.	• Assume 20 technical meetings of 2-hours each • Dependent on data needs and the data sources accessed
Ministry of Forest Lands and Natural Resources	• Participate in technical meetings as required; • Source/provide information related to angling, hunting and trapping as they relate to sustenance and non-sustenance lifestyles • Provide information on regulatory oversight of the industry.	• Assume 20 technical meetings of 2-hours each • Dependent on data needs and the data sources accessed
Ministry of Transportation and Infrastructure	• Participate in technical meetings as required; • Source/provide information related to road transportation in direct support of the oil and gas industry • Provide information on regulatory oversight of on-road and off-road diesel powered equipment.	• Assume 20 technical meetings of 2-hours each • Dependent on data needs and the data sources accessed
The Ministry of Aboriginal Relations and Reconciliation	• Participate in technical meetings as required; • Provide guidance and/or participate directly in stakeholder sessions with First Nations	• Assume 20 technical meetings of 2-hours each • Dependent on project needs

5.0 Work and Communications Plan

The sections below provide an overview of the proposed work plan and communications strategy. While the work plan provides an overview of the key personnel involved as well as the overall level of effort for each major task, a detailed breakdown is provided in the financial proposal.

5.1 Proposed Work Plan

Table 5. Project Work Plan

Description	Personnel	Hours per Task	Milestones and Deliverables
Task 1. Community Outreach			
(see table 6)	Bruce Vincent	(see table 6)	(see table 6)
Task 2. Jurisdictional scan report (Literature review)			
Define literature review methodology	Marla Orenstein Karen McCaig Judi Krzyzanowski	10	Identify sources and search strategies - *anticipated delivery Q4 2012*
Execute literature review	Marla Orenstein Karen McCaig Judi Krzyzanowski	65	Complete literature review and interviews *anticipated delivery Q4 2012*
Interpretation and synthesis of studies and information	Marla Orenstein Karen McCaig	65	Complete analysis of reports - *anticipated delivery Q4 2012*
Reporting	Marla Orenstein Karen McCaig	72	Complete draft report - *anticipated delivery Q4 2012/Q1 2013*
Task 3. Human Health Risk Assessment			
Framework Development	Stuart Bailey Jon Mick Trevor Newton	130	Conceptual framework for addressing the health risk associated with the Oil and Gas Industry- *anticipated delivery Q4 2012/Q1 2013*
Conceptual Exposure Model	Stuart Bailey Francois Dion Joel Nichols	80	Develop conceptual model for assessing exposure identifying activities/facilities to be addressed and relevant exposure pathways - *anticipated delivery Q4 2012*
Data Collection & Review – Hydrogeology, Surface water, air	Rob Kent Trevor Newton Sergei Touchinski Allison Routledge Marco Disertori Bing Han	408	Data compilations for relevant exposure pathways - *anticipated delivery Q1 2013* Appendices for HHRA - *anticipated delivery Q4 2013*
Exposure Assessment	Stuart Bailey Francois Dion Joel Nichols	324	Complete qualitative and or quantitative exposure assessment for all major oil and gas activities and exposure pathways – *anticipated delivery Q2/Q3 2013*
Does Response Assessment	Stuart Bailey James Kiryakos	116	Toxicological evaluation of COCs and hydraulic fracking fluids - anticipated delivery Q2/Q3 2013

Risk Characterization and Uncertainty Assessment	Stuart Bailey Francois Dion James Kiryakos Joel Nichols	520	Complete risk characterization of major activities and exposure pathways and indentify need for risk management - *anticipated delivery Q4 2013*
Reporting	Stuart Bailey Francois Dion James Kiryakos Joel Nichols	650	Draft HHRA Report - *anticipated delivery Q1 2014* Final HHRA Report - *anticipated delivery Q1 2014*
Task 4. Regulatory Review			
Review environmental and human health regulations and policies for health-based components	Karen McCaig Marla Orenstein	30	Source and review legislation and policies - *anticipated delivery Q1 2013*
Synthesize information collected during review	Karen McCaig Marla Orenstein	30	Review legislation and policies to identify scope - *anticipated delivery Q1 2013*
Assess and develop regulatory and information gathering recommendations	Karen McCaig Marla Orenstein Stuart Bailey Rob Kemp Sergei Touchinski	28	Identify how information is used to address emissions and potential health risks Develop recommendations as appropriate - - *anticipated delivery Q2 2013*
Reporting	Karen McCaig Marla Orenstein	70	Draft Regulatory Review Report - *anticipated delivery Q1 2013*
Task 5. Spatially enabled data gap analysis			
Review risk assessment results and identify data gaps	Marla Orenstein Karen McCaig	32	Review preliminary results of HHRA as they related to data availability - *anticipated delivery Q3 2013*
Review spatially available environmental data	Karen McCaig Judi Krzyzanowski GIS professional	25	Document sources of spatially enabled data and utility for monitoring health outcomes - *anticipated delivery Q2/Q3 2013*
Review spatially available population data	Marla Orenstein GIS professional	20	Document spatially enabled population data in relation to monitoring data - *anticipated delivery Q2/Q3 2013*
Analysis of linkages and future requirements	Marla Orenstein Karen McCaig	42	Identify linkages and develop recommendations as appropriate - outcomes - *anticipated delivery Q3 2013*
Reporting	Marla Orenstein Karen McCaig	58	Draft Spatially Enabled Data Report - *anticipated delivery Q32013/Q4 2014*
Task 6. Project Management and project controls			
Project management and tracking	Cliff Eng	200	Bi-weekly updates Invoicing

5.2 Proposed Communication Plan

Effective communications must be maintained between the AMEC project team and the BC MoH, among the project team members, and with the project stakeholders. The three elements of communication are discussed separately.

5.2.1 Communication with BC Ministry of Health

AMEC's project manager will maintain regular communication with the BC MoH, the client, to regularly inform the client of the progress of the risk assessment and regulatory framework review. These communications will consist of weekly in-person meeting or teleconferences and monthly written progress reports.

The project manager, and an alternate, will be the primary contacts for the client and will coordinate requests for information from the project team to the client and other BC Ministries and will convey requests and instructions from the client to the project team.

In addition, or as a supplement to the regular bi-weekly meetings it is anticipated that there will be the need for technical meetings with key staff from other ministries to discuss information needs, overall strategy and technical matters. These will be scheduled on an ad-hoc basis during the regular bi-weekly meetings or via email correspondence.

5.2.2 Project Team Communications

AMEC will provide expertise from a number of disciplines and from a number of different offices. Regular communication among the project team members is critical to the coordinated and timely execution of the risk assessment and regulatory framework review.

The AMEC project manager will conduct regular teleconference project team meetings. At the beginning of Phase 2, the meetings will be held weekly to coordinate the initiation of tasks and information requests. During most of 2013, the meetings will be held on a monthly basis as the technical work is being conducted. During the finalization of the study, meetings will become more frequent to ensure timely completion of tasks and coordinated report preparation.

AMEC will establish a project SharePoint site on which all project related information and reports will be stored. This vehicle has proven to be an effective means of sharing information among geographically dispersed project teams.

5.2.3 External Communications

External communications will be primarily with stakeholders who wish to participate in Phase 2. A description of the stakeholder engagement is presented in section 4.4 of this proposal. In addition, AMEC will work with the BC MoH to prepare and issue any public information releases about the risk assessment.

Members of AMEC's Human Environment Group will be responsible for all aspects of external communications including the planning, execution, and documentation. Team members with extensive stakeholder engagement experience will manage the engagement. Discussions with stakeholders will include a project team member with both human health expertise and consultation experience.

The communication of information and the collection of stakeholder input will be completed through a variety of means to facilitate appropriate stakeholder engagement. These will include one or more of:

- Project website.
- Project toll-free telephone line and the project-specific email address
- E-mails to all participants of Phase 1 and Phase 2 participants
- Media releases
- Quarterly newsletters

The following steps will be taken for external communications and in conjunction with the stakeholder engagement.

Step 1: Notify stakeholders (from Phase 1) through emails, mail or telephone that Phase 2 is commencing. In completing this step, AMEC will conduct an in depth review of Phase 1 outputs including communications and stakeholder databases. We will then review our assumptions, approach and forthcoming communications activities with the Client.

This step will include the development of material to provide stakeholders with an overview of planned study activities and timelines. This communication is important in demonstrating to stakeholders our commitment to ongoing and transparent communication. The communication will be through an updated Project website and would include content such as team information, overview of planned activities and goals, and updated contact information. In addition, a variety of other mediums to notify the key stakeholders including emails, telephone calls, and mail will be used.

Step 2: Develop and issue a media release to inform the general public that Phase 2 has commenced. The release will also provide an overview of Phase two activities, timelines and goals. We would also suggest informing the public about Phase 3 given that it will be the Phase when the public is able to participate. We will use the same media channels as used in Phase 1.

Step 3: Maintain current information on the project website regarding the study plans and progress.

Step 4: Issue Quarterly Newsletters to all participating stakeholders. This will be used to inform stakeholders of project activities and progress.

Step 5: To promote stakeholder engagement and study transparency, all verbal or electronic messages sent by e-mail or to the project telephone number will be reviews and responses will be sent. Records of all communications will be documented and stored in SIIMS.

Table 6. Project Communication Plan

Description / personnel	Timing	Resources
1. Communication with client		
- Bi- weekly meetings at project initiation - Bi-weekly progress reports - Project Manager	Throughout Phase 2	
2. Project team communications		
- Weekly meetings at project initiation - All team discipline leads		
3. External communications		
Step 1: Notify stakeholders (from Phase 1) that Phase 2 is commencing - in depth review of Phase 1 outputs including communications, stakeholder databases - 1-2 Client meetings/discussions - Develop notification material and provide stakeholders with an overview of planned activities and timelines - Record in SIIMS - Production editing and design	Q4 2012	80-100 hours
Step 2: Develop and issue a media release to inform the general public that Phase 2 has commenced - Identify/confirm media outlets to utilize - Develop media release - Client review and feedback - Production editing and design	Q1 2013	32-40 hours
Step 3. Update website and toll-free number with Phase 2 activities - Develop content around engagement - Review discipline specific content and ensure language is accessible	Q4 2012- Ongoing	80 hours
Step 4. Newsletters - Develop and issue quarterly newsletters - Review and gather input from project team - Client review and feedback - Production editing and design	Q4 2012- Ongoing	96 hours
Step 5. Review and respond to messages from emails, website input and toll-free telephone number - Respond to queries as required - Liaise between stakeholders and DLs/project team as required - Record all communications in SIIMS	Q4 2012- Ongoing	150 hours

6.0 Qualifications and Experience

6.1 Corporate Profile

AMEC (LSE: AMEC) is a focused supplier of consultancy, engineering and project management services to its customers in the world's Oil and Gas, Minerals and Metals, Clean Energy, Environment & Infrastructure markets. With annual revenues of over Cdn$5.1 billion, AMEC designs, delivers and maintains strategic and complex assets and employs some 27,000 people in around 40 countries worldwide. See www.amec.com.

AMEC's Environment & Infrastructure business is a leading environment and infrastructure, engineering, consulting and project management organization with more than 240 offices and over 7,500 employees worldwide. Our team of professionals provides a full range of services to clients in a wide range of sectors including government, industrial & commercial, water, transportation, minerals & metals, oil & gas clients and clean energy.

AMEC Environment & Infrastructure employs a permanent staff in each region of Canada, including hydrogeologists, environmental, geological, civil, and geotechnical engineers, and environmental scientists and technician/technologist support personnel. Each of our regional teams is supported by local AMEC offices and national AMEC professional practice networks.

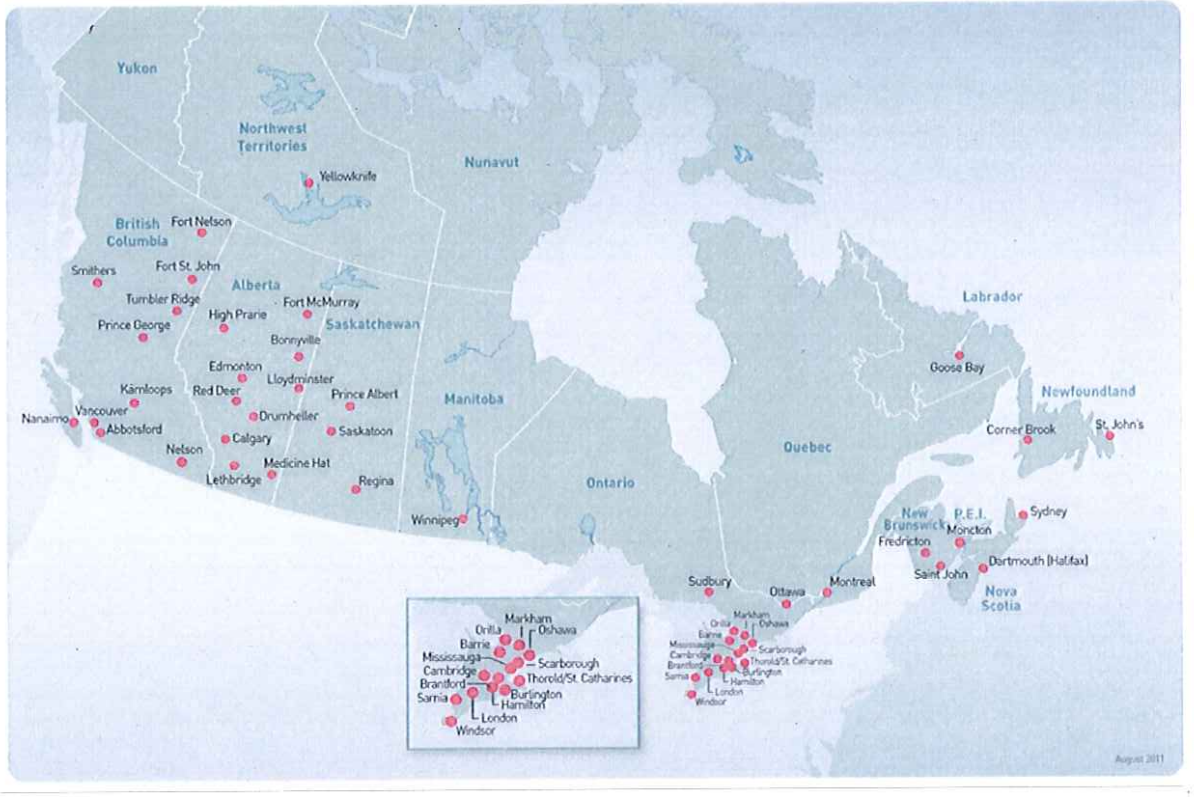


Figure 3. AMEC Environment & Infrastructure, Canadian Locations

AMEC has considerable experience in the upstream and downstream oil and gas industry as evidenced by the project descriptions provided in Section 6.3. In addition, AMEC has extensive experience in completing risk assessments for large contentious projects, for both private and public sector clients. AMEC's project team and related experience are discussed more fully below.

6.2 Project Team and Experience

AMEC has assembled a team of highly qualified professionals to lead this project. Each team member is a recognized expert in their field bringing years of experience to the project in disciplines such as community consultation, toxicology and human health risk assessment, community medicine, exposure modeling and risk communication. The project team is depicted in Figure 4 while bios of project leads are provided below.

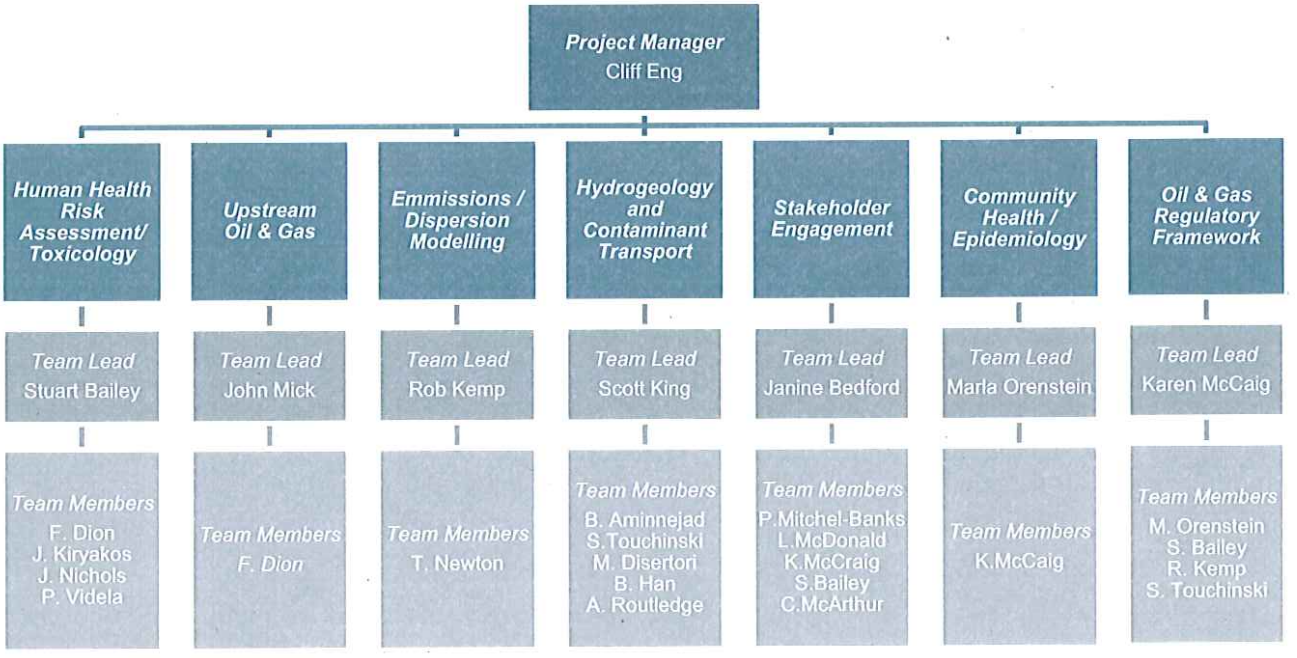


Figure 4. Organizational Chart

6.2.1 Project Manager – Cliff Eng, P.Eng., CSAP

Mr. Clifford Eng will serve as project manager. He is a senior professional with 28 years of experience and that encompasses due diligence, contaminated sites redevelopment, risk assessment, treatment systems design, remediation management, and regulatory strategy.

He has successfully managed multi-disciplinary programs with project durations of up to 10 years and, on behalf of PRPs, has directed the efforts of multiple consultants and contractors on US Superfund sites. Mr. Eng has been the project principal for remediation projects with capital costs in excess of $15M US and consulting fees greater than $2M US. His Canadian federal program experience includes assignments with DCC, PWGSC, RCMP, Transport Canada, and NavCan.

As the contaminants practice lead in BC, he is responsible for senior review and critical decisions in conducting Preliminary Site Investigations (PSIs), Detailed Site Investigations (DSIs), risk assessments, and remedial planning/implementation. He provides strategic advice on obtaining contaminated sites regulatory instruments such as determinations, AiPs, and CoCs. Mr. Eng also provides contaminated sites expertise in support of environmental impact assessment applications for infrastructure and energy projects.

Mr. Eng has past clients who are involved in the development and/or remediation of oil and gas sites. Similar to any project in which he, or any other AMEC or AMEC affiliate is involved, AMEC's Code of Business Conduct prohibits the release of information considered business confidential or where such information could lead to an unfair advantage. Like all AMEC employees, Mr. Eng has signed the Code of Business conduct signifying he understands and is bound by its content.

6.2.2 Team Lead – Toxicology and Human Health Risk Assessment – Stuart Bailey, Ph.D.

Dr. Stuart Bailey will serve as the team lead for the human health risk assessment and toxicity assessment. Dr. Bailey, who holds his PhD in biochemistry, has 22 years of experience conducting risk assessments under a variety of regulatory frameworks. Recent experience includes providing risk assessment and risk communication support on a large scale vapour intrusion project involving over 650 homes and businesses affected by the industrial degreaser, trichloroethylene. In this role, Dr. Bailey has worked closely with the Medical Officer of Health, the Ministry of the Environment and the local municipality to deliver risk-related information to the community.

For the current undertaking, Dr. Bailey will be responsible for leading the development of the conceptual framework for evaluating health risks associated with the oil and gas industry; working with the project team to ensure that all contaminants of concern and potential exposure pathways are identified and evaluated and participating in public consultation activities as a technical resource. Dr. Bailey will be responsible for ensuring the technical accuracy of all elements of the human health risk assessment.

In terms of client base, over the past several years Dr. Bailey has worked equally with private and public sector clients. Public sector clients include Health Canada, the Ontario Ministry of the Environment, Canada Post, the Ministry of Transportation and a variety of municipal governments. Private sector clients include General Motors of Canada Limited, Toyota Motor Manufacturing, Honda of Canada, and Northstar Aerospace Canada Inc.

With respect to potential for conflict of interest, while none of Dr. Bailey's clients are involved in the upstream or downstream oil and gas business, he does have family members with financial interest in oil and gas development in Northeastern BC. Similar to any project in which he, or any other AMEC or AMEC affiliate is involved, AMEC's Code of Business Conduct prohibits the release of information considered business confidential or where such information could lead to an unfair advantage. Like all AMEC employees, Dr. Bailey has signed the Code of Business conduct signifying he understands and is bound by its content.

6.2.3 Team Lead – Upstream Oil & Gas / Petroleum Engineering – John Mick, B.Sc., M.E.Des.

Mr. John Mick will serve as the Upstream Oil & Gas Lead. He has over 30 years professional consulting experience with domestic and international projects dealing with site decommissioning, environmental audits, remediation projects, waste disposal projects and risk assessment studies for a wide variety of industrial sectors. Mr. Mick has also managed the design of on-site treatment programs for bio-piles, air

sparging systems and soil landfarming. He has worked on a number of environmental assessment projects, including the assessment of military and industrial sites in the Canadian Arctic.

Mr. Mick has also managed several characterization studies at gas plants in Alberta and Northeastern B.C. to identify the extent and degree of contamination and for the evaluation of potential site remediation and risk management options. He has also managed several risk assessment studies for the evaluation of human health and ecological risk associated with contaminated sites. He has also been responsible for the development of site specific criteria and risk management options to reduce exposure risk to human and ecological receptors.

As previously identified, Mr. Mick has past clients who are involved in the upstream or downstream oil and gas business. Similar to any project in which he, or any other AMEC or AMEC affiliate is involved, AMEC's Code of Business Conduct prohibits the release of information considered business confidential or where such information could lead to an unfair advantage. Like all AMEC employees, Mr. Mick has signed the Code of Business conduct signifying he understands and is bound by its content.

6.2.4 Team Lead – Emissions/Dispersion Modeling – Rob Kemp, B.Sc., M.Eng., P.Eng.

Rob is a senior engineer and air quality specialist and will lead the air quality data collection and review task. This will include the collection of air exposure data to support the various risk scenarios and identification where data gaps exist. Exposure from mobile sources such as O&G related traffic will be estimated using emission and dispersion models and provide to the team for appropriate risk scenarios. He will ensure that the team is provided with appropriate air concentration data to support the risk assessment.

He has over 20 years of experience in the environmental field including environmental regulatory processes and approvals; environmental impact assessments; air quality impacts; air pollution control systems; emission inventories and greenhouse gas emission management. Rob has led the air quality components of 8 major EAs since 2008 that included a HHRA component and is familiar with the air data required by the HHRA team. He has led over 50 air quality assessment such as flaring permits and waste discharge applications for the oil & gas and other industries in B.C. since 2006 and was the lead author for the Flaring Reduction Strategy for BC in 2005.

Conflict of interest is not foreseen. Rob has an extensive history with the oil and gas industry in BC but has no current projects with the industry in NE BC.

6.2.5 Team Lead – Hydrogeology and Contaminant Transport – Scott King, M.Sc., P.Geol., PG

Mr. King has 29 years of professional experience as a hydrogeologist and will serve as Hydrogeology Discipline Lead for this work. He will be responsible for coordination and completion of the technical content and review of the hydrogeology component. Mr. King will ensure that there is appropriate interdisciplinary communication and sharing of information related to human health risks from groundwater.

Previous experience includes a wide variety of hydrogeologic and hydrogeochemical work in Canada and the United States related to site characterization and remedial investigations of contaminated sites. Mr. King has performed wellhead protection studies and used models to understand groundwater flow and the fate and transport of contaminants. In recent years he has provided expert technical review services and litigation support, has conducted training workshops in contaminant hydrogeology, and been an adjunct instructor in hydrology.

Key experience since 2006 has included extensive involvement with hydrogeological studies at three oil sands projects in northern Alberta (2009-present) involving aquifer characterization, tailings hydrology, groundwater management programs, interpretation of data, and design of dewatering schemes. This work has been exclusively for private sector oil and gas clients. Prior to joining AMEC in 2009, Mr. King consulted for both private and public sector clients in Canada and the United States, including Environment Canada in BC as part of their contaminated sites program.

While a conflict of interest is not foreseen, Mr. King is currently working with Imperial Oil on an oil sands project and this client may have interests in the study area. Similar to all AMEC employees, Mr. Scott is bound by the company's Code of Business Conduct.

6.2.6 Team Lead – Stakeholder Engagement – Janine Bedford, M.Res, BA

Janine Bedford is a certified Public Participation Practitioner and is Aboriginal. She will be responsible for coordinating and implementing the engagement, participation and consultation of key stakeholders. Janine will advise the team on public participation and stakeholder engagement practices.

Janine has a Masters of Research and over seven years of experience working with Aboriginal and non Aboriginal stakeholders on research projects ranging from participation in the skilled trades, impact benefit negotiation and mining to topics as sensitive as sexual exploitation of Aboriginal youth and access to victim support. She has also worked on various health evaluations including a review of the Communicable Disease Control Cluster within the First Nations and Inuit Health Branch, the BC Medical Association's Specialists Services Initiatives, the Screening Mammography Program in BC and an evaluation of the National Collaborating Center for Environmental Health. Each of these included engagement, focus groups and other research with various stakeholders.

She has extensive experience in working closely with communities to facilitate their input into the design, implementation, and engagement of various research projects.

A Conflict of Interest is not foreseen. Janine is not currently working with oil and gas companies who are active in North Eastern BC.

6.2.7 Team Lead – Community Medicine/Epidemiology – Marla Orenstein, M.Sc.

Marla Orenstein, M.Sc., is an epidemiologist who specializes in environmental and behavioural risk factors for chronic disease. She will be responsible for coordination and completion of the jurisdictional scan report of past and current studies and reports related to human health risk in relation to oil and gas activity and the public health review of the Phase 1 report. Marla will advise the team on community medicine/epidemiology science. This will ensure such linkages are scoped within the HHRA and that a community health approach is integrated throughout communications, stakeholder engagement and reports related to the project.

Marla founded Habitat Health Impact Consulting in 2006 and since then has led over a dozen health impact assessments (HIAs) related to oil & gas developments, mining projects, and sustainable energy. Marla has developed training courses for HIA that have been offered in Brazil, Mexico, the US, Portugal and Canada, and has provided mentoring and assistance to public sector agencies to help them complete their own HIAs. In 2010, Marla co-authored a guidance tool that describes the health effects commonly associated with resource development projects. Marla is currently co-authoring a textbook on HIA that will be published by Springer later this year.

A Conflict of Interest is not foreseen. Marla is not currently working with oil and gas companies who are active in North Eastern BC.

6.2.8 Team Lead – Oil & Gas Regulatory Framework – Karen McCaig, B.Eng., M.Sc., ACSM

Karen McCaig, M.Sc., is an occupational and environmental hygienist who specializes in the health impact assessment of natural resource projects. She will be responsible for coordination and completion of the regulatory review report. Karen will coordinate the collection and synthesis of the multidisciplinary information collected during the jurisdictional scan, HHRA and gap analysis of spatially enabled data. Karen will ensure linkages to community medicine are integrated throughout the review, including the interpretation of regulations and development of recommendations.

Karen has a balanced perspective due to her varied experience working in near equal proportions for industry, consultancy, nongovernmental organizations and academia. Since 2006, Karen has worked on environmental policy analysis projects including several regulatory analysis projects and environmental assessment applications for natural resource and infrastructure projects. Over the past year, Karen has attended many open houses discussing electrical engineering concepts and associated human health issues with concerned citizens.

A Conflict of Interest is not foreseen. Karen is not currently working with oil and gas companies who are active in North Eastern BC.

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