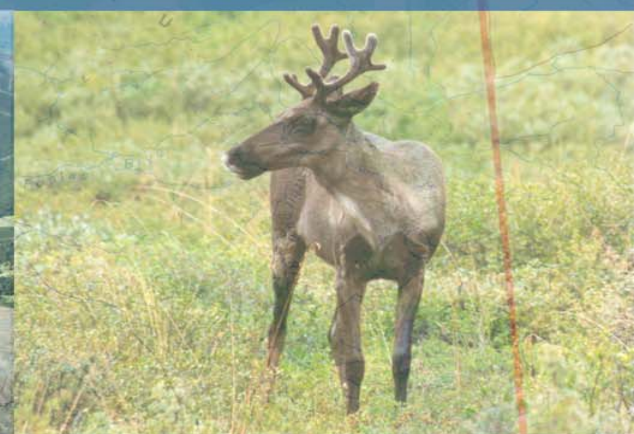
CEAMF STUDY: VOLUME 1

A Cumulative Effects Assessment and Management Framework (CEAMF) for Northeast British Columbia

Final





Prepared by AXYS Environmental Consulting Ltd.

In Association With:
Salmo Consulting Inc., Diversified Environmental Services, Paragon Environmental Consultants,
Limnotek Research and Development, RWDI West Inc.,
There's More to Forests Policy Advisory and Ecological Services

March 2003

Prepared For: The BC Oil and Gas Commission - The Muskwa-Kechika Advisory Board

A CUMULATIVE EFFECTS ASSESSMENT AND MANAGEMENT FRAMEWORK (CEAMF) FOR NORTHEAST BRITISH COLUMBIA

FINAL REPORT

Prepared for:
The BC Oil and Gas Commission
The Muskwa-Kechika Advisory Board

Prepared by:
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Diversified Environmental Services
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SP319

Executive Summary

Report Design and History

What is the purpose of this report?

The purpose of this report is to describe a framework to both assess and manage cumulative effects in the study area. The product of this is referred to as a Cumulative Effects Assessment and Management Framework (CEAMF).

What is the study area?

The study area is the portion of northeast BC that is bordered by the Peace River to the south, the Muskwa-Kechika Management Area (MKMA) to the west, the Alberta provincial border to the east, and the NWT territorial border to the north.

Why was this report done?

This report was done as a response to concerns in the region about the possibility of worsening environmental effects due to multiple land and resource use activities. Some mechanism was needed to address these concerns; (specifically, those related to the potential contributions of oil and gas projects to the cumulative effects), and the Oil and Gas Commission's (OGC) process that reviews project applications.

Objectives of this Report

The objectives of the report are to:

1. define a CEAMF, describe its attributes, and explain how it may be implemented;
2. assist project reviewers, specifically the OGC, in addressing cumulative effects as part of their regulatory mandate; and
3. assist land and resource managers in addressing cumulative effects throughout the study area.

For whom was this report written?

This report was written for the OGC and the Muskwa-Kechika Advisory Board (MKAB).

For whom is the framework intended?

The framework is designed, principally, to meet the needs of the OGC. The framework is also intended to meet the needs of advisory and administrative bodies that are responsible for managing the MKMA; specifically, the MKAB and the provincial government. However, all or many aspects of the framework may also be adopted by government ministries that are responsible for lands outside of the MKMA, by First Nations, and by other organizations and public groups in the region.

Who funded this report?

The report was funded by the OGC's Environmental Fund, with partial contributing funding from the Muskwa-Kechika Trust Fund.

Who did the report?

Development and production of this volume of the study was led by AXYS Environmental Consulting Ltd., located in Sidney, BC. Other consultants contributed specific material within the report.

Who else has been consulted?

Team members have consulted with representatives of the OGC, MKAB, and various government ministries. Furthermore, a two-day workshop was held in Fort St. John in January 2002, in which the aforementioned representatives and First Nations were invited to discuss the proposed work.

How is this report organized?

This report represents Volume 1 of a two-volume set. Volume 1 *A Cumulative Effects Assessment and Management Framework (CEAMF) for Northeast British Columbia*, is organized into the following main sections:

- Introduction (describes the purpose, scope and context for the work);
- Land Administration (describes government land and resource use management in the region);
- Regional Assessment (describes the land use setting and the state of selected environmental features);
- Regional Framework (describes the framework); and
- Summary and Recommendations (outlines key finding, contributions to science and decision making, and a series of recommendations).

What are the other volumes in this report series?

There is one other volume in this series: Volume 2 *Cumulative Effects Indicators, Thresholds, and Case Studies,* which proposes cumulative effects indicators and thresholds for the region based on the detailed analysis of cumulative effects in two case study areas. Volumes 1 and 2 are inter-connected, and each provides a specific contribution to the framework.

Report Discussion and Results

What are cumulative effects?

Cumulative effects are changes to the environment that are caused by an action in combination with other past, present, and future human actions. These changes are typically evaluated under some form of regulatory requirement for specific project applications through a Cumulative Effects Assessment (CEA).

What is a framework?

A Regional Cumulative Effects Assessment and Management Framework (CEAMF) is an administrative structure that combines various initiatives that assist decision makers in assessing and managing the effects of human use on the land.

What types of effects does the framework address?

The report focuses on cumulative effects on the natural environment; however, the framework may readily be expanded to include effects on wilderness values, First Nations traditional values, and other social, cultural, economic and land use issues.

What are the parts of the framework?

The framework comprises the following main parts:

- Regional assessment;
- Regional planning and research studies;
- Effects management;
- Project assessment matrices;
- Project screener;
- Thresholds; and
- Monitoring.

This are tied together by what is referred to here as the Sustainable Resource Management Strategy (SRMS), which is a CEAMF customized for Northeast BC.

What is the regional assessment?

The regional assessment is a characterization of the state of land and resource use and various environmental features (air quality, soils and terrain, aquatic resources, vegetation and wildlife) in the study area. A description of each environmental feature includes a discussion of issues, effects, valued components, and specific areas of possible concern (referred to as hot spots). The regional assessment provides, at a coarse scale over a large geographic area, information of use to both project-specific reviewers and regional planners. This section includes a series of 30 maps illustrating key concepts.

What are the regional planning and research studies?

The regional planning and research studies are various initiatives that improve and add to existing information that is useful and necessary to decision makers. These studies focus on applied landscape ecology, ecological response studies, future scenario forecasting, and effects monitoring.

What is effects management?

Effects management includes any measures needed to minimize or eliminate effects from human disturbances. These measures may be the responsibility of a single project proponent, of multiple project proponents, or of government. As such, these measures are either project-specific or regional in nature. The report describes 29 measures, and recognizes those already being implemented or considered in northeast BC and elsewhere.

What are the project assessment matrices?

The project assessment matrices provide generic and specific information that is useful in the review of individual oil and gas project applications. The information provided in the matrices is based on the five conventional steps in project assessment, including scoping, analysis, mitigation, significance evaluation, and follow-up.

What is the project screener?

The project screener is a step-by-step process for OGC staff to follow when reviewing project applications for possible cumulative effects issues. The process has two options: one is a simple series of questions that can readily be answered with available information; and the other is based on thresholds to be used when they become available. An expanded review process is also described for situations warranting more detailed review of an application as a result of certain environmental concerns. This OGC-customized screening tool is called the Application Cumulative Effects Screener, or ACES.

What are thresholds?

Thresholds are measures of limits of acceptable change. Four types of thresholds are proposed based on access density in broad landscapes, access density within watersheds, core habitat security, and species-specific thresholds. In the framework, contribution to the threshold by each project is compared to three levels of thresholds (cautionary, target, and critical). The thresholds are introduced and summarized in this report, and are fully detailed in Volume 2.

What is monitoring?

Monitoring is the on-going determination of environmental conditions, the verification of predicted effects, and the verification of the effectiveness of applied effects management measures. It is a critical aspect of the framework – one that is directly linked to the principles of adaptive management.

What is the fundamental approach on which the framework is based?

The framework is based on the following principles:

- a response to assessing and managing cumulative effects within a regulatory review process for individual project applications must not be onerous to the majority of applicants or to the reviewers;

- in the absence of thresholds, cumulative effects can only reasonably and practically be addressed through the implementation of measures that successfully reduce environmental effects. Some of these measures may be specific to individual projects, while others require joint coordination and involvement among the various parties involved. The result of these efforts is to slow down the pace of negative environmental change, not necessarily to eliminate cumulative effects;
- cumulative effects, ultimately, can only be managed through the implementation of thresholds. The collective contributions of human activities are compared to thresholds, which if exceeded, result in adjustments to projects, implementation of regional initiatives, and possibly, the temporary or indefinite rejection of projects;
- with or without thresholds, various regional initiatives should be implemented that provide the necessary information to land and resource managers to assist their decision-making. These initiatives may be supported either by government or jointly with industry; and
- in recognition of the above, a 'dual-track' approach is proposed that includes addressing cumulative effects at the project level while at the same time addressing cumulative effects at the regional level.

How would the framework be implemented?

The framework is practically implemented in a process referred to as the Sustainable Resource Management Strategy (SRMS). Based on the 'dual-track' approach, it includes parts that are immediately implementable and some parts that may be incorporated as administrative resources, information, and financial support become available. The SRMS introduces the concept of a Steering Committee to advise on regional initiatives and to assist in the review of contentious project applications. A regional database of information is also introduced as part of the SRMS, based on the lead of the Regional Assessment in this report, and on existing provincial data sources.

Who would be involved in the implementation?

The report describes the roles and responsibilities of government, land and resource managers and planners, regulatory reviewers, project proponents, the proposed Steering Committee, the MKAB, the Oil and Gas Advisory Committee, First Nations, the public, and non-government organizations.

How would thresholds be implemented?

In Volume 2, thresholds were developed and demonstrated within two case study areas, one being a sub-set of this report's study area. To implement these thresholds broadly throughout northeast BC, initiation of a pilot program is recommended. The program would be used to demonstrate practical application of thresholds within a regulatory review and provincial planning process. Following a successful pilot, thresholds would be incorporated within the OGC's and other review processes.

Are there priorities for implementation of the framework?

It is expected that the OGC and MKAB, in consultation with other ministries and stakeholders, and in consideration of available resources and current priorities, would determine which of this report's recommendations they have the capacity to immediately implement. Notwithstanding this expectation, four of the recommendations are key: adopting a 'dual-track' approach to assessing and managing cumulative effects; creating a SRMS Steering Committee; maintaining a regional database; and implementing ACES.

Does the framework solve all cumulative effects problems?

Theoretically, implementation of any framework would solve all cumulative effects problems, as by definition a framework is an all-encompassing approach to addressing cumulative effects through the use of a complete and inter-related set of initiatives. In practice, however, any framework is subject to various real-world limitations that are common to matters affecting regulatory process, public land administration, and industry and public interest. As such, the framework, as proposed in this report in the form of the SRMS, recognizes a phased and modular approach (i.e., users of the framework select appropriate initiatives over time, as required), and the need for time and broad participation to develop the various initiatives as described. Only in this way can a framework be accommodating, rather than intrusive.

Where does the framework start and end?

The framework, as described in this report, is a beginning, that with the involvement and support of the various parties recognized, would assist decision-makers in best fulfilling their mandates, and assisting the public and industry in becoming effectively involved in the decision-making process. With the incorporation of monitoring and adaptive, on-going evaluation of framework objectives and procedures, the framework can continually evolve to meet the mandate of government, and the interests of northern BC communities and resource users.

Contributions to Science and Decision-making

Overall, what does the framework contribute to science and decision-making?

Although other regions have attempted to develop and implement frameworks for addressing cumulative effects, the proposed SRMS for northeast BC is unique in comparison to many other frameworks as listed below.

- It could be immediately and practically applied as it builds on existing tools and requires limited changes to the current administrative and management structures in place for the region (the only change being the addition of the proposed SRMS Steering Committee).
- It recognizes and is consistent with both local and strategic level planning for the region and its implementation does not require that land use objectives be re-visited in the short term – it provides a 'bridge' between various levels of planning and on-the-ground project operations.
- It builds on and supports scientific research and provides a mechanism (in the form of the regional, publicly-accessible database) that can be used to continually update the state of knowledge for the region and feed that information back into decision-making processes.
- While focused on the environmental effects of oil and gas activities, the concepts presented here are readily adaptable for use by other land management agencies and for use in the assessment and management of social, cultural, recreational and economic effects.
- It provides realistic options for assessing, managing, and mitigating cumulative effects resulting from oil and gas activities, at both the local and regional scale, based on knowledge of what is appropriate to the region and what has been proven successful elsewhere.

- It breaks new ground in its identification of scientifically-based indicators and thresholds, which are customized for use in the region to which they would be applied, and which are implementable at a pilot scale in the short term (in conjunction with the recommended project screener).
- It recommends a workable and non-onerous approach to incorporating cumulative effects into the day-to-day application review procedures currently in place by the OGC, while requiring only minimal changes to those procedures for the majority of application reviews;
- It relies not on one management agency to solve the problems of cumulative effects but rather provides an 'umbrella' under which all cumulative effects management decisions could be made, by any agency or organisation, at any time – the concept of a multi-sector steering committee devoted to addressing cumulative effects issues is unique within the region.
- In generally, it provides reference points, guidance and options which support decision-making, which are adaptable to a variety of situations, and which are linked to other planning and management processes at the local, sub-regional, and regional scales.

Acknowledgements

The authors of this report would like to thank the BC Oil and Gas Commission (OGC) and the Muskwa-Kechika Advisory Board for funding this important project. In particular, we are grateful to Derek Doyle, OGC Commissioner, and Howard Madill, Muskwa-Kechika Management Area Program Manager and his predecessor Paul Mitchell-Banks, for their direction and input throughout the course of this work.

During various stages of the project, we were assisted by members of the Muskwa-Kechika Advisory Board, and by representatives from the provincial government, First Nations, industry, and non-government organizations. Specifically, we would like to acknowledge the contributions of:

- Muskwa-Kechika Advisory Board members: Tom Briggs, Barry Holland, David Luff, Bill Lux, Bruce McKnight, Neil Meagher, Kathleen O'Neill (Coordinator), Ross Peck (Chair), Dave Porter, Dennis Porter, Wayne Sawchuck, Jack Sime, George Smith, Peter Stone, Jim Stephenson, and Brian Wolf; and
- Workshop participants: Andy Ackerman (Ministry of Water, Land and Air Protection), Nick Baccante (Ministry of Water, Land and Air Protection), Rod Backmeyer (Ministry of Water, Land and Air Protection), Bill Bayrak (BC Oil and Gas Commission), Brian Churchill (Peace Habitat and Conservation Endowment Trust), Grant Fox (BC Oil and Gas Commission), Kimberly Hawkins (Westcoast Energy Inc.), Kim Heinemeyer (Round River Consulting), Pierre Johnstone (Ministry of Water, Land and Air Protection), Kevin Kuhn (Slocan, Fort Nelson), Bill Lux (Kaska Dene Council), Howard Madill (formerly of Ministry of Forests), Colin Magee (Ministry of Energy and Mines), Loretta McAllister (Prophet First Nations), Paul Mitchell-Banks (formerly Muskwa-Kechika Program Manager), Shira Mulloy (Canadian Association of Petroleum Producers), Anne Murphy (Ministry of Sustainable Resource Management), Kathy Parker (University of Northern BC), Colin Rankin (Salasan Associates), Carl Reimer (Westcoast Energy Inc.), Shirley Ross (Fort Nelson First Nation), Ron Rutledge (Ministry of Sustainable Resource Management), Wayne Sawchuk (Muskwa-Kechika Advisory Board), Graham Suther (Ministry of Sustainable Resource Management), Mary Viszlai-Beale (Ministry of Forests), and Dwayne Werle (Canadian Natural Resources Ltd.).

The availability of spatial data enabled us to conduct mapping and GIS analysis which is an integral component of the Cumulative Effects Assessment and Management Framework. We thank Anne Murphy (Ministry of Sustainable Resource Management) and Grant Fox (Oil and Gas Commission) for making data available to us.

In addition, we would like to thank the following people for meeting with project team members and/or for providing information in support of the study: Andy Ackerman (Ministry of Water, Land and Air Protection), Darral Alexander (Ministry of Forests), Rod Backmeyer (Ministry of Water, Land and Air Protection), Bill Bayrak (BC Oil and Gas Commission), Annette Block (BC Oil and Gas Commission), Kelly deCaux (Oil and Gas Commission), Derek Doyle (Oil and Gas Commission), Elvin Gowman (Land and Water BC), Kelly Harrison (Oil and Gas Commission), Gordon Humphrey (Oil and Gas Commission), Carl Jahn (Ministry of Forests), Ron Kronlachner (Ministry of Forests), Sharon Rosee (Oil and Gas Commission), Devin Scheck (Oil and Gas Commission), Graham Suther (Ministry of Sustainable Resource Management), Steve Warrington

(Ministry of Sustainable Resource Management), and Michael Wood (Oil and Gas Commission).

This report is the product of a team of researchers and authors including:

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- Lee Waterman, Paragon Environmental Consulting – Soils and terrain

Volumes

Volume 1: A Cumulative Effects Assessment and Management Framework (CEAMF) for Northeast British Columbia

Volume 2: Cumulative Effects Indicators, Thresholds, and Case Studies

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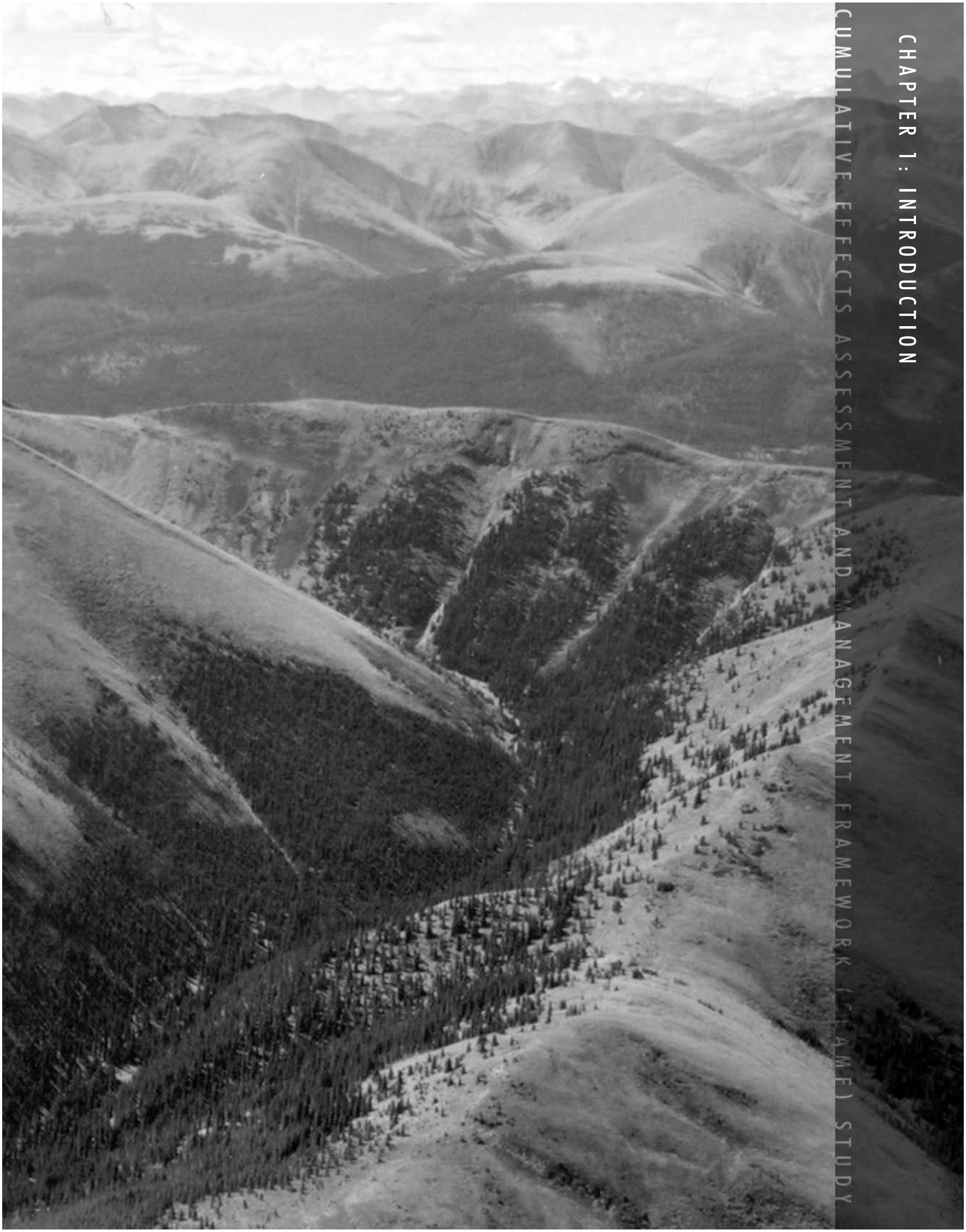
List of Abbreviations

AAC	Annual Allowable Cut
ACES	Application Cumulative Effects Screener
ALCES	A Landscape Cumulative Effects Simulator
ALR	Agricultural Land Reserve
AMA	Access Management Area
ATV	All-terrain Vehicle
AXYS	AXYS Environmental Consulting Ltd.
BC	British Columbia
BCEAA	BC Environmental Assessment Act
BEC	Biogeoclimatic Classification
BEI	Broad Ecosystem Inventory
BEU	Broad Ecosystem Unit
BPPTP	Besa-Prophet Pre-Tenure Plan
BTM	Baseline Thematic Mapping
BWBS	Boreal White and Black Spruce
CAD	Conservation Area Design
CAPP	Canadian Association of Petroleum Producers
CCME	Canadian Council of Ministers of Environment
CEA	Cumulative Effects Assessment
CEAA	Canadian Environmental Assessment Act
CEAMF	Cumulative Effects Assessment and Management Framework
CEC	Cation Exchange Capacity
CEMA	Cumulative Effects Management Association
CWS	Canadian Wildlife Service
DEM	Digital Elevation Model
DFO	Fisheries and Oceans Canada
DIAND	Department of Indian Affairs and Northern Development (Federal)
DOE	Department of the Environment (Federal)
EEP	Environmental Protection Plan
EFP	Environmental Field Report
EFR	Environmental Field Report
EIA	Environmental Impact Assessment
ELC	Ecological Land Classification
EMM	Effects Management Measures
ER	Ecological Reserve
ERDZ	Enhanced Resource Development Zone
ESSF	Engelman Spruce- Subalpine Fir
EUB	Energy and Utility Board

FRBC	Forest Renewal BC
GDP	General Development Permit
GIS	Geographic Information System
GLOBIO	Global Methodology for Mapping Human Impacts on the Biosphere
GOAT	GIS Oracle Access Tool
IL	Information Letter
ILM	Integrated Landscape Management
IMP	Integrity Management Plan
LIS	Low Impact Seismic
LRMP	Land and Resource Management Plan
LWBC	Land and Water BC Inc.
MDRC	Maximum Dissturbance Review Criteria
MEM	Ministry of Energy and Mines
MKAB	Muskwa-Kechika Advisory Board
MKMA	Muskwa-Kechika Management Area
MOE	Ministry of Environment
MOF	Ministry of Forests
MSRM	Ministry of Sustainable Resource Management
MWLAP	Ministry of Water, Land and Air Protection
NEB	National Energy Board
NES	Northern East Slopes
Nox	Nitrous Oxides
NWT	Northwest Territories
OGC	Oil and Gas Commission
PAI	Potential Acid Input
PAS	Protected Areas Strategy
PM	Particulate Matter
PTP	Pre-tenure Plans
RDP	Resource Development Permit
RLUP	Regional Land Use Plan
RMZ	Resource Management Zone
RoW	Right-of-Way
SMZ	Special Management Zone
SOE	State of the Environment
SO_x	Sulphur Oxides
SRMP	Sustainable Resource Management Plan
SRMS	Sustainable Resource Management Strategy
SWB	Spruce-Willow-Birch
TCU	True Colours Unit
TEK	Traditional Ecological Knowledge (or Indigenous Knowledge)
TIS	Threshold Implementation Strategy

TP	Total Phosphorous
TRIM	Terrain Resource Inventory Mapping
TSA	Timber Supply Area
UNBC	University of Northern British Columbia
USEPA	United States Environmental Protection Agency
VEC	Valued Ecosystem Component
VSC	Valued Social Component
WMA	Wildlife Management Area
ZOI	Zone of Influence

CHAPTER 1: INTRODUCTION



1 Introduction

1.1 Background

As part of the British Columbia (BC) Oil and Gas Commission's (OGC) initiative to address environmental effects associated with oil and gas development, an environmental fund was established in 1998 to support research projects over a five-year period. During 2001, three research areas were considered: air emissions; cumulative effects; and ecosystem health and integrity. With regard to cumulative effects, AXYS Environmental Consulting Ltd., Diversified Environmental Services, and Salmo Consulting Inc. proposed to develop a Cumulative Effects Assessment and Management Framework (CEAMF) for northeast British Columbia, including the Muskwa-Kechika Management Area (MKMA). The proposal was accepted by the OGC, and complementary funding was provided through the Muskwa-Kechika Trust Fund, a fund created through the *Muskwa-Kechika Management Area Act* to promote research aimed at addressing ecological sustainability and maintenance of wilderness characteristics in the MKMA by providing information to support planning processes.

Cumulative effects are changes to the environment that are caused by an action in combination with other past, present, and future human actions (Hegmann *et al.* 1999). These environmental changes are typically evaluated under some form of regulatory requirement for specific project applications through a Cumulative Effects Assessment (CEA). CEAs build on what has been learned and applied in Environmental Impact Assessments (EIA); however, CEAs display some marked differences to EIAs that must be clearly understood by assessment practitioners and project proponents. To achieve the overall objective of mitigating and addressing environmental effects of oil and gas activities, it is necessary to have agreed-upon standards and guidelines for assessing and managing the cumulative impacts of these activities – i.e., a 'framework' (defined in more detail in Section 1.4).

The CEAMF presented in this report describes a practical approach, specific to northeast BC, for assessing and managing project-specific and regional cumulative effects. The framework includes and is supported by a database of regional information and a baseline assessment that identifies cumulative effects issues and 'hot spots' in the region. The framework also provides direction for other research on cumulative effects that will be undertaken under the OGC Environmental Fund or the Muskwa-Kechika Trust Fund, or by academia and industry. Finally, the framework provides an 'umbrella' under which environmental and cumulative effects assessment and management tools (e.g., application screening, modelling, land use planning, etc.) can be employed and updated.

The CEAMF is the overarching component of a broader body of work that will assist the OGC and Muskwa-Kechika Advisory Board (MKAB) in proactively addressing land use and resource management issues in northeast BC. The key elements of the CEAMF, including the regional assessment and a proposed application screening tool, are described in detail in this volume (Volume 1). Cumulative effects indicators, thresholds, and case studies are described in Volume 2.

While the proposed framework focuses on cumulative effects associated with oil and gas activities, and what can be done by the OGC to assess and manage such effects, it is recognized that you cannot manage cumulative effects for one sector in isolation of other influences. In the case of northeast BC, various land use activities will potentially contribute to cumulative effects. These activities include, but are not limited to, forestry, mining, hunting, trapping, fishing, hydroelectric development, transportation and utility development, agriculture, recreation, and human settlement. As a result, although the recommendations presented in both volumes of this study are aimed at the OGC and MKAB, specific components of the framework rely heavily on the involvement of other ministries, First Nations, industry, and stakeholders.

The development of a CEAMF for northeast BC is an ambitious and complex undertaking requiring broad-level support from regulators, resource users, and other stakeholders. To ensure that the CEAMF meets the needs of the OGC, the MKAB, and other stakeholders in northeast BC, input was received from government ministries, First Nations, the oil and gas industry, non-government organizations, and other interest groups through a series of meetings, workshops, and presentations. The CEAMF also recognizes and builds upon other planning activities in the region, including Land and Resource Management Plans (LRMPs), Sustainable Resource Management Plans (SRMP), local-level plans, and other initiatives that set land management objectives. As such, it provides a 'bridge' between regional-scale land planning and management and site-specific (i.e., project-level) activities.

1.2 Study Area

The CEAMF and baseline regional assessment presented in this report are specific to the northeast British Columbia region (Figure 1-1). The study area includes the Fort Nelson and Fort St. John Forest Districts, a portion of the Mackenzie Forest District, and the whole of the Muskwa-Kechika Management Area (MKMA). The study area covers approximately 16.4 million hectares.

The Fort Nelson, Fort St. John and Mackenzie LRMPs guide land use activities in the study area (see also Section 2.3). Sixty per cent of the study area falls within the Fort Nelson LRMP area, 28.5% falls within the Fort St. John LRMP area, and 11.5% falls within the Mackenzie LRMP area. About 9% of the study area is classified as protected area, and is managed as part of the BC Protected Areas System.

The MKMA covers approximately 6.3 million hectares of the study area, and encompasses the eastern foothills of the Muskwa range of the Rocky Mountains (north of the Peace River), the Kechika range of the Cassiar Mountains, and the northern portion of the northern Rocky Mountain Trench. The MKMA comprises one of the largest remnants of untouched wilderness in North America, south of 60° latitude. As such, it provides critical habitat and movement corridors for an abundant and diverse group of large mammals, and supports the continent's largest intact predator-prey system (Gailus 2000). Although the MKMA contains numerous provincial parks and protected areas, it is neither a park nor an ecological reserve.

Figure 1-1. Study Area

The MKMA is a unique management concept, envisioned and designed as a special management area that will allow resource development to continue while the principles of conservation biology are applied to protect important wildlife and wilderness values. Within the MKMA, 11 protected areas have been established where resource extraction activities are not permitted. These core protected areas are connected by transition areas and buffer zones that allow for a number of sustainable human activities. Elsewhere in the MKMA, extractive resource development is permitted where it is consistent with local level plans and zoning[1] (e.g., pre-tenure plans and wildlife management plans – see also Section 2.4.2).

Northeast BC contains some of the richest oil and gas reserves in the province. In recent years, total oil and gas revenues have exceeded $200 million annually, and permanent employment in the oil and gas sector has accounted for almost 20% of the local economy (Gailus 2000). Other industries important to the region's economy include forestry, mining of metallic and non-metallic resources, tourism, and localized agriculture.

The rapid rate of growth of oil and gas exploration and development in northeast BC has raised concerns about cumulative impacts from oil and gas-related activities alone, and in combination with other land uses. Further, the region, and the MKMA in particular, contains considerable non-industry values such as wilderness, public and commercial recreation, hunting, trapping, fishing, and First Nations' traditional and cultural values. Thus, this area is a good candidate for the development of a regional CEAMF.

Land use and administration in the study area are discussed in more detail in Section 2.

1.3 Objectives

The principal objective of Volume 1 is to present a CEAMF for conducting single-project assessments and managing regional cumulative effects in northeast BC. This objective will be achieved by:

- identifying preferred tools and approaches for cumulative effects assessment and management at the project-specific (i.e., local) and regional levels. This will help the OGC, proponents, and other stakeholders to better understand cumulative effects and to develop and implement methods to minimize these effects before they occur;

- initiating the development of a regional, spatially-referenced database and map series which contain information on biophysical attributes and development disturbances. The database and maps provide an overview of existing cumulative effects in the region so that potential areas of concern (i.e., hot spots) can be identified and significant data gaps noted. This will support project-specific assessments and will aid in applying proactive effects management; and

[1] For example, Special Wildland Zones are included in the Mackenzie LRMP portion of the MKMA. In these zones, forestry is excluded by other development activities are permitted.

- guiding future research priorities by identifying important data gaps regarding analytical methods, mitigation activities, and significance determinations. This will help with incorporating results from other research projects into practical applications for analyzing, evaluating, and managing cumulative effects (e.g., the development of new mitigation measures).

The framework can eventually be used by the OGC and industry as:

- a baseline for future assessments;
- a means of flagging regional hot spots and areas that require management or remedial action;
- a project screening tool to aid in the review of future applications and management initiatives;
- a guide to available effects assessment and management tools;
- a practical application for incorporating results from other research projects; and
- a means of identifying important data gaps and setting priorities for follow-up and monitoring.

Although the CEAMF was developed for the OGC and MKAB, it will have direct application to, and broad implications for, the oil and gas industry in the region. The CEAMF will aid the industry by raising awareness of cumulative impacts; providing increased understanding of how CEAs can be conducted as part of standard EIA processes; presenting a means for the consistent application of CEA methods; and providing greater consideration of cumulative effects and mitigation measures as part of oil and gas activities in the region.

While the proposed CEAMF presently focuses on assessing and managing cumulative effects relating to oil and gas activities, the framework has been developed with future expansion in mind. For example, the framework can be adapted to address other industrial impacts (e.g., forestry and mining), as well as non-industrial values (e.g., wilderness recreation). This future expansion of the framework will be particularly important within the context of the MKMA, in which only a small portion of the area has high oil and gas potential.

The Terms of Reference for this project are provided in Appendix A.

1.4 Definition of a Framework

Traditionally, cumulative effects have been assessed and managed on a project-by-project basis. Cumulative effects, however, can also be assessed and managed on a regional basis through a jointly coordinated and jointly funded approach that involves governments, proponents, and the public. A regional CEAMF is an administrative structure that can help decision makers assess and manage the effects of human use of the land.

A CEAMF, typically, is developed when concerns are raised about the long-term environmental effects of many land uses over a large geographic region (usually defined by jurisdictional, ecological, physiographic, or resource borders). This is especially true for relatively undisturbed areas facing rapid and extensive resource development from known and potential future projects.

A CEAMF is useful because it provides a 'one-window' approach to addressing cumulative effects over large geographic areas. As such, the various elements of the framework (discussed below) are coordinated to complement each other, and to ensure that effects of concern are identified, addressed, and monitored. Information on environmental and land use conditions is shared, stakeholders become involved, and a useful product is developed that can be used either to assist in the review of individual project applications, or to understand longer-term trends at a regional scale. Without a coordinated approach, information would likely remain unavailable or would not focus on regional issues of greatest concern. Project proponents, regulatory reviewers, and land administrators would likely be hampered by inadequate information, and would continue to make decisions in isolation.

A CEAMF, therefore, ties together the various initiatives that individually or collectively provide the information on which decisions are based. The CEAMF may also provide a means of interpreting information that will help land managers answer fundamental questions such as:

- Could a single proposed project cause a problem? If so, what can be done to mitigate that problem?

- Is there an environmental problem now as the result of many human disturbances? If so, what can be done to mitigate that problem?

- Could there be an environmental problem sometime in the future? If so, how soon, and what can be done to avoid that problem?

A CEAMF may include any combination of the following basic elements (Figure 1-2):

- ecological monitoring (e.g., of water quality; movements of far-ranging species);

- ecological research (e.g., on species responses to human disturbances);

- assessment methods (e.g., for quantitative assessment of sediment loading on streams);

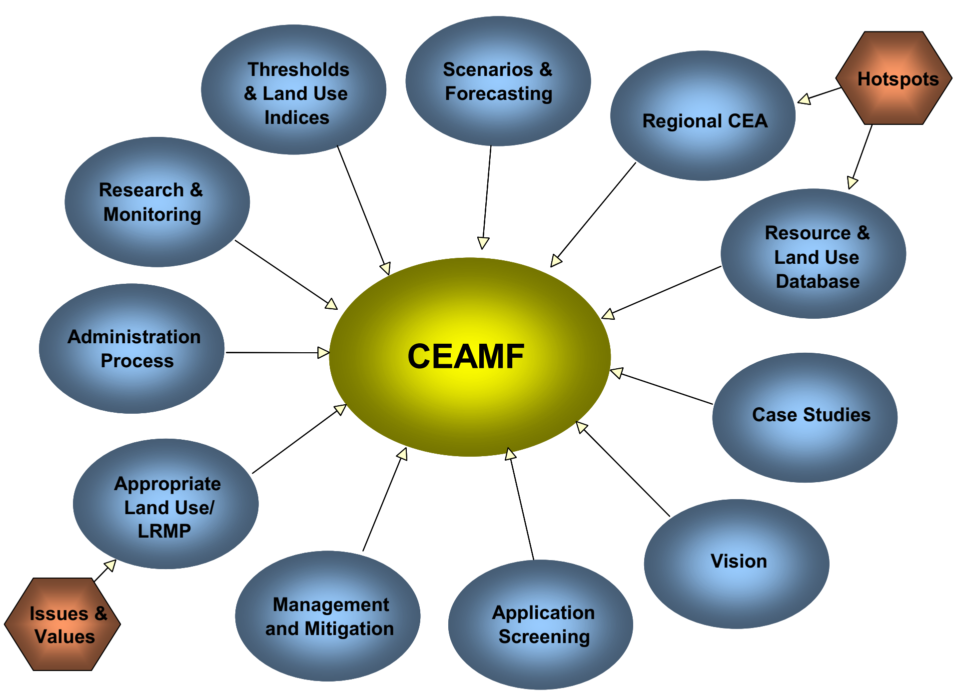
- administrative review process (e.g., incorporating information for consideration during review of project applications);

- administrative coordination (e.g., a central body to coordinate information and initiatives relevant to cumulative effects);

- mechanisms of administrative compliance (e.g., enforcement or voluntary compliance);

- databases and mapping (e.g., mapping of existing ecological features through use of a Geographic Information System (GIS));
- land use plans (e.g., zonation of a region to various levels of allowable land use);
- protected area planning (e.g., exclusion of human disturbances from certain areas);
- management techniques (e.g., definition of best practices for mitigating industrial projects; identification of opportunities for regionally coordinated mitigation);
- stakeholder consultations (e.g., ongoing involvement of affected communities);
- scoping (e.g., establishment of a vision for desired land use; identification of issues of concern, or environmental and land use features of importance);
- limits to growth (e.g., identification of ecological and land use thresholds);
- application review (e.g., implementation of a project application screening process);
- future scenario forecasting (e.g., predicted effects for different levels of future development);
- project-specific cumulative effects assessments (i.e., assessment of the contribution of a specific project to overall cumulative effects); and
- regional cumulative effects assessment (i.e., assessment of the effects of all land uses).

Figure 1-2. Elements of a CEAMF



Typically, a jointly-funded, independent group of government, industry, non-government, and First Nations representatives is formed and called upon to define issues of concern (e.g., increased hunting pressure due to increased access; degraded air and water quality; loss of wildlife habitat), and to identify initiatives that may be implemented to solve those problems. These initiatives are then incorporated into the CEAMF.

Usually, the next step involves collecting and mapping information that describes existing conditions. This is normally based on the monitoring of certain ecological indicators. The results are then used to identify priority areas that require management of existing and potential future effects. Individual projects submitted to authorities for approval may then be reviewed in the context of the CEAMF. Land use planners and other decision-makers may then develop policies or other administrative mechanisms to manage land use so as to best meet identified objectives. Finally, and over time, new information and data are added to the CEAMF so that decisions can be made in an adaptive management fashion.

Many of these components and steps are described in more detail and with specific reference to northeast BC in subsequent sections of this report. Cumulative effects frameworks in place in other areas are described in Appendix B.

1.5 Associated Project Components

This project includes a number of separate but integrated components (described below), which, when combined, will provide an approach for identifying, scoping, assessing, and managing cumulative effects in northeast BC. This approach will help the OGC and industry ensure that cumulative effects are addressed in the project approval process. It will also provide a basis for which the MKAB, First Nations, and stakeholders can participate in and monitor progress towards managing regional cumulative effects.

1.5.1 Cumulative Effects Assessment and Management Framework

This report (Volume 1) describes an overall approach, specific to northeast BC, for conducting project-specific assessments and for managing cumulative effects on a regional scale. Volume 1 describes:

- land use setting and planning context in northeast BC;
- identification of important regional issues;
- selection of indicators for assessing ecosystem and socio-economic effects (i.e., Valued Ecosystem Components (VEC) and Valued Social Components (VSC));
- identification of hot spots or areas of potential concerns for specific VECs or VSCs;
- a dual-track approach (project-specific or regional) for addressing cumulative effects;
- effects management measures (e.g., thresholds, modelling, coordinated land planning); and
- recommendations for implementing the CEAMF and its components, including roles and responsibilities of key players.

1.5.2 Project Screener

Imbedding within the CEAMF are recommendations to implement an OGC Application Cumulative Effects Screener (ACES), a key component of the overall CEAMF. Section 4.2.3 of Volume 1 outlines the development and testing of an application screening process to assist the OGC in making decisions on petroleum exploration, development, and production proposals, and in managing cumulative effects. The screener provides a systematic method for reviewing project applications, and allows for consistent and accountable decision-making. The screener is designed to fit within the existing OGC application review process. Implementation of the screener would require processes for establishing, managing, and updating regional databases, as well as staff training, all of which are discussed in Section 4.2.3.

1.5.3 Indicators, Thresholds and Case Studies

Volume 2: Indicators, Thresholds and Case Studies describes candidate cumulative effects thresholds and a scheme for implementing those thresholds. Candidate thresholds are based on a literature review and specific evaluations of cumulative effects on fish and wildlife in two representative areas of northeast British Columbia. The case studies test and develop approaches for assessing and managing cumulative effects on fish and wildlife resources, and evaluate the suitability of available data. Volume 2 includes:

- a literature review on appropriate ecological indicators and thresholds for fish and wildlife management;
- a spatial database of existing biophysical and land use features for each representative area;
- a review of development and renewable resource trends for each representative area;
- the application of various methods and indicators to assess cumulative effects;
- the identification of candidate thresholds for northeast British Columbia;
- recommendations on the use of these thresholds for cumulative effects assessment and management; and
- the identification of implementation and data needs.

1.6 Use and Structure of the Report

This report should be used as a guide for assessing and managing cumulative effects at the project-specific and regional scales. The main audience for the CEAMF is the OGC; however, this report will also be of interest to other land management agencies, the MKAB, First Nations, proponents of industrial activities, residents of local communities, and other stakeholders.

This report consists of the following sections:

- **Section 1: Introduction** – provides a background to the history and structure of the report, defines the meaning of Cumulative Effects Assessment and Management Framework, and introduces the companion parts of the framework;

- **Section 2: Land Administration** – describes the administrative context for land management in British Columbia, and the study area, specifically;

- **Section 3: Regional Assessment –** describes the development of a database of environmental and land use information for the study area, summarizes existing environmental and land use features, identifies cumulative effects issues, and provides examples of how the database can be used to identify potential cumulative effects hot spots;

- **Section 4: Regional Framework** – describes a process for assessing and managing cumulative effects at the project-specific and regional level, and presents an approach for implementing the CEAMF, including respective roles and responsibilities of various players;

- **Section 5: Summary and Recommendations** – presents a set of broad recommendations for using the CEAMF and integrating it with existing plans and tools, and for monitoring and managing cumulative effects; and

- **Section 6: References** – documents information sources used during the preparation of the report.

Volume 1 also includes a number of appendices that provide background and technical information on the CEAMF and its components.

1.7 Evolving Nature of the CEAMF

The CEAMF presented in this Volume has evolved using input from various stakeholders. Consultations took place at interim stages of the project. In August 2002, a series of meetings with government ministry staff were held in Fort St. John. These meetings provided opportunities for discussing ministry-specific issues and matters of regional cumulative effects management that are outside the jurisdiction of any one ministry. In October 2002, a presentation was made to the MKAB in Mackenzie. The purpose of the presentation was to update board members on progress in the development of the CEAMF, and to seek feedback on the framework and its use.

During the project scoping stage, a two-day workshop was held in Fort St. John, at the end of January 2002. The workshop was attended by representatives from government ministries, industry, First Nations, academia, and non-government organizations, and was used to introduce the project and the concept of the CEAMF. Preliminary issues, valued ecosystem and social components, and methodologies for deriving environmental and land use hot spots were presented. A summary of this workshop is provided in Appendix C.

Preceding the workshop, a one-day facilitated session was held with First Nations groups, which have traditional territories in northeast BC. The purpose of the session was to identify cumulative effects issues associated with First Nations use of the land, and to discuss referrals to First Nations regarding project applications for proposed oil and gas development.

It is fully anticipated that this work will continue to evolve, especially through implementation of the CEAMF and its components. Ultimately, Volume 1 does not represent the final solution to cumulative effect management. Rather, it presents a framework within which various effects assessment and management strategies may coexist in a complementary and adaptive manner. To be effective, the CEAMF should have the support of all stakeholders who have an interest in managing cumulative effects in the region.

CHAPTER 2: LAND ADMINISTRATION

2 Land Administration

2.1 Regulatory Framework for Land Management

2.1.1 Roles and Responsibilities

The regulatory environment in British Columbia is complex. Provincial legislation related to administration of the land base includes, but is not limited to, the *Land Act, Water Act*, *Oil and Gas Commission Act, Forest and Range Practices Act, Wildlife Act, Heritage Conservation Act,* and the *British Columbia Environmental Assessment Act* (see Section 2.2). Pertinent federal legislation includes the *Fisheries Act, Waste Management Act,* and *Canadian Environmental Assessment Act* (see Section 2.2), among others.

Several provincial government ministries are responsible for management of Crown land. The Ministry of Sustainable Resource Management (MSRM) takes a coordinating role in land management, and is directly responsible for regional and sub-regional scale land and resource management planning, and finer scale sustainable resource management planning. The Ministry of Water, Land and Air Protection (MWLAP) is responsible for managing water, air, and wildlife habitat (although the permitting of water use is the responsibility of Land and Water BC Inc.). Provincial parks are administered under the Protected Areas Branch of MWLAP's Environmental Stewardship Division.

Land and Water BC Inc. is responsible for issuing tenures (including leases and licenses of occupation) for the use of Crown land for activities other than those related to oil and gas exploration or development. The Ministry of Forests (MOF) is responsible for forest tenure administration, determination of Annual Allowable Cuts (AAC), forest planning, and the management of timber harvesting, grazing, and recreational uses occurring on forest land. Land administration objectives used to manage forests in BC must also comply with the *Forest and Range Practices Act* (Government of BC 2002).

Throughout the province, oil and gas activities are regulated through the BC Oil and Gas Commission (OGC). Oil and gas pre-tenure planning is currently occurring in the MKMA[1]. The pre-tenure planning process (discussed further in Section 2.4.2) is being led by MSRM but involves various other regulatory agencies including the Ministry of Energy and Mines (MEM), MWLAP, and MOF as well as industry and other stakeholders.

2.1.2 Oil and Gas Commission

The Oil and Gas Commission is a regulatory agency that reports to the Minister of Energy and Mines. The OGC is responsible for overseeing oil and gas operations including exploration, development, reclamation, and pipeline transportation. The OGC regulates all oil and gas activity in BC by operating under a number of acts, including the

1 At present, pre-tenure planning is only a legislative requirement in the MKMA and the plans apply only to oil and gas tenures.

Oil and Gas Commission Act, Petroleum and Natural Gas Act, Pipeline Act, and all acts that govern the provincial land base in BC (OGC 2002a). Recent changes to the *Oil and Gas Commission Act* and the *Petroleum and Natural Gas Act* have resulted in greater streamlining of the permitting and application review process, which is intended to reduce the regulatory burden on clients and stakeholders (OGC 2002a). Some of these changes include the elimination of pipeline and access road questionnaires, duplicated information in the Operations Engineering Technical Review package for pipeline and facility applications, and of unnecessary information on Crown land applications and campsite questionnaires (OGC 2002a).

A recent addition to the responsibilities of the OGC is the creation of the General Development Permit (GDP). This may provide a means of managing cumulative impacts since a company must now submit an application based on the entire development plan. Previously, each proposed activity (e.g., well, road, pipeline) was reviewed as a stand-alone application, and project effects were assessed for separate activities. Other changes include the transferring of responsibilities and authorities under the *Waste Management Act* and the *Water Act* to the OGC, enabling provisions of the *Forest and Range Practices Act* to be enforced by the OGC, and establishing requirements for wells and test holes on private land (OGC 2002a).

In addition to reviewing project applications (see Section 4.2.2), the OGC requires companies to abide by certain standards and regulations. For example, companies are expected to complete an Integrity Management Plan (IMP) to ensure pipelines are safe from both a human health and an environmental perspective (OGC 2002b). Additionally, the OGC has specific guidelines for wells, well access, borrow pits, remote sumps, campsites, decking sites, pipelines, permanent access, stream crossings, and water removal (OGC 2002b). Guidelines for minimum construction setbacks have been established for specific fish and wildlife habitat values such as nesting sites, mineral licks, bear dens, beaver dams, and bull trout streams (OGC 2002c).

The OGC also operates under the following three fundamental standards:

- an open, accountable, and neutral process for assessing the environmental, economic, social, heritage, and health effects of projects;
- a co-operative review procedure with federal authorities; and
- meaningful participation by the public, proponents, First Nations, local governments, provincial, and federal agencies.

The OGC involves stakeholders in the regulatory process through the use of guidelines that require proponents to complete a consultation/notification process prior to submitting an application (OGC 2001). Additionally, the OGC has recently developed an application review process that will allow First Nations to review applications for potential infringement of Treaty rights (OGC 2002b).

2.2 Regulatory Requirements for Cumulative Effects Assessment

The *BC Environmental Assessment Act* (BCEAA) requires an assessment of environmental effects for all major provincial projects. The intent of the Act is to identify any foreseeable adverse impacts throughout the life of a project (including construction, start up, operation, and shut-down), and to determine ways to eliminate, minimize, mitigate, or compensate those impacts (Government of BC 2001). The Act, reformed in the spring of 2002 through Bill 38, forms a single review procedure for environmental assessments of projects that are subject to the Act. The purpose of Bill 38 was to provide greater flexibility in customizing review procedures on a project-by-project basis. This increased flexibility is intended to contribute to the government's strategic priorities for improving the investment climate in BC while preserving high environmental standards (Environmental Assessment Office 2002). Some specific changes to the Act that may have consequences for how EIAs are conducted in BC include the waiving of EIAs for projects that do not raise strategic impact concerns, and providing Ministers with the ability to make early decisions to terminate a review and reject a project where it is clear that the project does not satisfy government requirements.

The National Energy Board (NEB) is a federal agency that requires an assessment of environmental effects on all major federal projects. Projects within northeast BC that would require an assessment include inter-provincial pipelines or powerlines (NEB 2001). The NEB operates under the *National Energy Board Act* and has responsibility for applying related regulations, rules, guidelines, guidance notes, and memoranda of guidance (NEB 2001). For example, Section 28.2 of the *National Energy Board Act* directs oil and gas interests to adhere to Section 28 of the *Canada Petroleum Resources Act*, which states that the NEB may revoke a permit for a claimed "significant discovery" if further drilling proves it to be not significant.

The *Canadian Environmental Assessment Act* (CEAA) came into effect in 1995 as a tool for federal decision makers to assess the environmental effects of projects being conducted or funded federally, or which fall under federal regulatory approval (CEAA 2001). Under section 11(1) of the CEAA, a federal environmental assessment is to be conducted as early as is practical in the planning stages of the project. Part II of the CEAA summarizes what projects require a federal cumulative effects assessment. Some of the projects which may be applicable in northeast BC include prospecting for mines or minerals, inter-provincial pipelines or powerlines, and physical activities related to the approval of an oil and gas development plan (CEAA 2001).

A cumulative effects assessment may also be required for projects that may affect navigable watercourses (under the *Navigable Waters Protection Act* 1985), and projects that may affect migratory birds (under the *Migratory Birds Convention Act* 1994).

2.3 Land Use Planning

Issues such as cumulative effects, that require coordinated, strategic-level approaches across a vast geographic area, are best addressed through regional or sub-regional planning processes. In BC, Land and Resource Management Plans (LRMP) form an important tool within the broader framework of cumulative effects assessment and management.

The land and resource management planning process is an important component of British Columbia's land use strategy. LRMPs are strategic planning documents that are used to provide broad resource management direction for all Crown land, including provincial forests and aquatic areas, for a period of approximately ten years. Planning strategies and objectives are meant to combine environmental, social, economic, and resource values while embracing the principles of sustainable development and providing a forum for discussing resource management issues. Input from industry, interest groups, the public, and government agency representatives is an important component of the planning process. Within the study area, the Fort St. John, Fort Nelson and Mackenzie

LRMPs (which include the MKMA) are the principal planning documents used to guide strategic land use decisions.

LRMPs provide recommendations for managing Crown land and resources. These recommendations generally address protected areas within the plan area, general management directions for the entire area, and boundaries, objectives, and strategies for Resource Management Zones (RMZs) and Special Management Zones (SMZs). Resource management in any area, outside of protected areas, is defined by the general management direction, plus relevant RMZ, SMZ, or sub-zone level direction. Management direction for protected areas is generally defined through separate, local-level, protected area management plans (see below).

Industrial activity is permitted in all RMZs, except for protected areas, although resource development and access may be limited or restricted in some zones. RMZs are defined based on resource values, existing economic activity, environmentally important areas, and agricultural land reserve boundaries. Each RMZ contains specific resource values, and includes management objectives and strategies which define the type of activities and level of intensity permitted. SMZs are similar to RMZs but are defined planning areas where the conservation of one or more resource values, such as wildlife habitat, recreation, or community watersheds, is to be emphasized in resource management decisions (Government of BC 2002). In addition to determining locations and intensity of land use activities, LRMPs provide strategic direction for mitigating impacts so that responsible resource development can occur within the planning area. Resource developers and users are required to manage their activities using a range of management tools and strategies, and to operate within the constraints of the regulatory framework.

Lower-level planning within a specific RMZ and SMZ may occur at both the local and landscape level. Local level plans may include park management plans, forest development plans, wildlife management plans, or pre-tenure plans. Local level plans must be within specified boundaries, and must be consistent with the strategic objectives of each LRMP. Landscape level plans are defined under a process called Sustainable Resource Management Planning and through the creation of Sustainable Resource Management Plans (SRMP). SRMPs are meant to provide guidance to operational planning for provincial objectives such as maintenance of biodiversity, economic development, and environmental values. Landscape level planning is designed to meet the objectives of the *Forest and Range Practices Act* of the results-based code, and may complement biodiversity conservation measures being delivered through the BC Protected Areas Strategy (PAS) (BC Ministry of Forests 1999).

Also under the results-based code is a government-sponsored program for creating results-based pilot projects that explore more efficient and less costly ways to combine forest management with the protection of social and environmental values (BC Ministry of Forests 2002). A results-based pilot project is underway for the Fort St. John Timber Supply Area (TSA). Under this project, major forest operators in the Fort St. John TSA are using a coordinated planning process which will incorporate landscape level planning into forestry plans, combine individual forest development plans into one consolidated plan, eliminate the need for individual approval of most site level plans, establish a process for ongoing public involvement, and test certification processes as a means of maintaining or improving environmental performance. The core of the pilot project is a new document called the Sustainable Forest Management Plan.

2.4 Muskwa-Kechika Management Area

The Muskwa-Kechika Management Area (MKMA) is a Special Management Zone. The MKMA spans three LRMP plan areas: Fort St. John, Fort Nelson and MacKenzie.

2.4.1 Muskwa-Kechika Advisory Board

The *Muskwa-Kechika Management Area Act* created the MKMA and a Premier-appointed advisory board to advise on natural resource management in the MKMA. The Muskwa-Kechika Advisory Board (MKAB) is comprised of individuals with a broad range of interests, including, but not limited to, First Nations, conservation organizations, business, labour, and local government. The principal role of the MKAB is to ensure that activities within the MKMA are consistent with the objectives of various management plans. Board members also review Trust Fund proposals (see Section 2.4.3).

2.4.2 Local Level Planning in the MKMA

Local level planning is based on local level strategic plans which are consistent with the MKMA and LRMP objectives and are legislated under the *Muskwa-Kechika Management Area Act*. As stated above (Section 2.3), local level planning provides guidelines for recreation, wildlife management, industrial activity, and protected areas. Some of the local level planning activities in the MKMA are described below.

Prior to the creation of the MKMA, the Muskwa-Kechika Access Management Area had been designated under the *Wildlife Act* (BC Reg. 218/94). Local level planning within the access management area restricted public off-road vehicle access to designated roads in order to protect wildlife and habitat. Additional access management provisions in the MKMA have more recently been associated with LRMPs and pre-tenure plans (see below).

The MKMA Recreation Management Plan was completed in 1997. The plan provides an overview of recreation resources in the MKMA, general management direction for recreation access and use, guidelines for commercial recreation, and specific management direction for five defined recreation categories. A Wildlife Management Plan for the MKMA is currently being developed. This plan is meant to ensure that the MKMA's wilderness characteristics, wildlife, and habitat are maintained over time. The plan will provide resource managers, users, tenure-holders, and the general public with guidelines for wildlife management in the MKMA. Another major type of local plan is the park management plan. There are presently 17 protected areas within the MKMA. Each is subject to management direction provided through a park plan or other strategic plan documents. Presently, recreation, wildlife, and other local level strategic plans do not provide specific direction for industrial activities like oil and gas development.

Oil and gas development in the MKMA falls under a separate planning process. According to the *Muskwa-Kechika Management Area Act,* a pre-tenure plan (PTP) is required before oil and gas tenures can be issued in the MKMA (*MKMA Act* 1998). Oil and gas PTPs promote environmentally responsible development of oil and gas resources (within discrete planning areas) by identifying objectives and strategies for development activities that are consistent with the *MKMA Act*. PTPs must be compatible with other existing or evolving local level or strategic plans. Presently, pre-tenure planning is underway for specific sub-areas of the MKMA. Phase 1 of the Besa-Prophet Pre-tenure Plan (BPPTP) has recently been completed (BC MSRM 2002). The BPPTP provides goals for oil and gas activities in portions of two RMZs - the Prophet RMZ and the Besa-Halfway-Chowade RMZ of the Fort Nelson and Fort St. John LRMPs. Another PTP is in place for the Sikanni drainage within the Besa-Halfway-Chowade RMZ. Additional PTPs that are underway in the MKMA include Suphur/8 Mile, Churchill, Muskwa West, and Halfway-Graham (scheduled for completion in March 2003); Upper Gataga, and Upper Akie/McKuster (scheduled for completion in December 2003); and Besa-Prophet Phase II (scheduled for completion in March 2003). The only PTP that is fully completed is the Upper Sikanni Management Plan (BC MSRM 1995), which was completed in 1995, and which preceded the *Muskwa-Kechika Management Act*.

2.4.3 Research and Projects in the MKMA

One of the roles of the MKMA is to support research activities that have direct links to the mandate and objectives of the MKMA, as outlined in the *Muskwa-Kechika Management Area Act.* To fulfill this role, a trust fund was established between the MKAB and the provincial government (BC Ministry of Sustainable Resource Management 2001). The Muskwa-Kechika Trust Fund receives donations from industry, regulators, the provincial government, and non-government organizations. The research projects funded by the Trust must contribute towards wildlife and wilderness resource management objectives, and integrated management of natural resource development. Projects must also contribute towards maintaining the diversity and abundance of wildlife species and the ecosystems on which they depend.

During the 2001-2002 fiscal year, the trust fund received 91 applications, 35 of which were funded. Projects have been separated into five themes: building an information base; planning support; improving management; advancing applied science; and promoting awareness, involvement, and capacity building. In addition to the CEAMF, which was partially funded under the Trust, some of the major projects that received funding include:

<u>An Ecosystem Approach to Habitat Capability Modelling and Cumulative Effects Management:</u> This project involves developing an information database of the MKMA by defining processes, core areas, typical movements, and specific habitat requirements of ungulates and large carnivores. From a management perspective, the information can be used to identify the best scenarios for accommodating changes associated with increased access (Parker 2002).

<u>MKMA Park Management Planning:</u> Funded projects include continuing public involvement processes for park management planning, conducting inventories and surveys, assembling data, and performing other functions required to support management and planning for protected areas within the MKMA.

<u>Conservation Areas Design (CAD):</u> The CAD will provide a framework for linking landscape level objectives and zoning, including maintaining ecological sustainability with local-level decision-making plans (e.g., pre-tenure plans, park management plans). This may be achieved by developing habitat connectivity models for the Besa-Prophet area that are based upon habitat suitability models developed in other research projects (e.g., Parker 2002).

The role of research in the context of the proposed CEAMF is discussed further in Section 4.4.

CHAPTER 3: REGIONAL ASSESSMENT

3 Regional Assessment

3.1 Overview

3.1.1 Products

The Regional Assessment (RA) provides a broad-scale overview of the state of the environment, and of land and resource uses in the northeast BC study area. The RA summarizes contributors to cumulative effects and those environmental components that are potentially affected. It therefore serves as an information basis for application within the CEAMF (as described full detail in Section 4).

The RA focuses on, and presents a description of land and resource use, and five environmental components: air quality; soils and terrain; aquatic ecosystems; vegetation; and wildlife (Sections 3.2 to 3.7). For each section, information is provided on the following topics to the extent and level of detail that is appropriate and useful:

- baseline setting (i.e., current conditions of environmental features and human use);
- issues of concern (i.e., issues regarding regional matters of concern and potential cumulative effects);
- valued ecosystem components or VECs (i.e., potentially affected environmental components that are of value to people or which have intrinsic value); and
- hot spots (i.e., specific geographic areas of potential concern based on potential conflict between human use and the valued ecosystem component; see Appendix E for a detailed explanation of what the hot spots represent and how they were derived).

The RA also includes 29 maps (listed in Table 3-1), which include baseline and hot spot maps for each discipline. Due to their large size and number, all of these maps are provided together in Appendix H, but are referred to throughout Section 3.

It should be emphasized that the hot spot maps are not limited to disturbances caused by oil and gas activities. As discussed in Appendix E (Hot Spot Map Derivation), many of the hot spot maps relied on a disturbance coverage that was generated for the study area and which overlay 17 themes representing different types of land uses including, by not limited to, oil and gas, forestry, agriculture, mining, urban settlement, recreation, transportation, and access[1]. Many of these activities overlap in the southern part of the study area and have collectively contributed to land clearing and associated habitat loss, and to impacts associated with the proliferation of access (e.g., increased hunting and fishing pressure). These and other impacts are discussed in more detail below, and later in relation to each environmental component.

[1] Seismic line data was excluded as many of the seismic lines are known to be 25-30+ years old, and therefore, will have revegetated naturally.

3.1.2 Types of Effects

Cumulative effects issues in northeast BC result from various human activities. Effects that are generally cross-disciplinary (i.e., they are not focused on any one environmental component) include the following, based on type of activity:

- **urban and rural settlement**: habitat loss and fragmentation; altered hydrology; air and water pollution;
- **transportation corridors**: habitat fragmentation and barriers to wildlife movement; run-off of oils and chemicals from roads; exotic and invasive species introduction;
- **oil and gas exploration and development**: increased access to remote areas; sensory disturbance of wildlife; habitat loss and fragmentation; impacts from stream crossings;
- **forestry**: vegetation and habitat loss; disruption of natural forest processes such as fire; loss of old growth-dependent species; soil erosion;
- **mining**: acid mine drainage; increased access to remote areas;
- **hydro-electric development**: habitat loss; barriers to wildlife movements; changes to aquatic environments;
- **agriculture and livestock grazing**: habitat loss; run-off of pesticides and herbicides; soil erosion; exotic and invasive species introduction;
- **recreation and tourism**: disturbances to wildlife; vegetation trampling; exotic and invasive species introduction; and
- **fish and wildlife harvest (including hunting, trapping and fishing)**: wildlife mortality; disturbance to wildlife; illegal harvesting.

3.1.3 Mapping

The maps collectively form a database of spatially referenced information. The maps consist of spatial coverages and related attribute tables at a variety of scales that were assembled from files available mainly from the MSRM, MOF, and OGC. The database only includes data that are available for the majority of the study area and that are available free of charge. Full details about the types of data available, sources of data, scale of data, and specific file names are presented in Appendix D[2]. A summary of baseline and hot spot maps is provided in Table 3-1.

In summary, the contents of the database represent an assembly of data including:

- topographic data (at scales of 1:1,000,000; 1:250,000; and 1:20,000) and air photos;
- place names and management boundaries, including protected areas;
- land use and disturbances (human activities and industrial development);
- terrestrial ecosystem mapping, biogeoclimatic data, and watersheds; and
- wildlife habitat and rare and endangered species, fish distribution, soils and terrain.

[2] All data used for the study (Volumes 1 and 2), including maps, have been provided on CD-Rom.

Table 3-1. List of Baseline and Hot Spot Maps

Figure Title		Fig. #
Component	**Description**[1]	
Land and Resource Use	Generalized Land Use	3-1
	Residential Settlement and Transportation	3-2
	Pipelines and Wellpads	3-3
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[1] Shaded cells indicate hot spot maps; remaining cells are baseline maps.

In addition to these data types, a number of derivative datasets were developed to generate seamless coverages for a specific theme for the study area, and for data analysis and summary purposes (e.g., the hot spot maps and density maps). These coverages and their attribute tables have been incorporated into the regional database provided. Methodologies for deriving individual hot spot maps are described in Appendix E, while other derivative maps are described in Appendix D in relation to the database.

The database represents the most current digital information base for the study area; however, users of the data should be aware of the following limitations:

- the purpose of the database is to provide a regional overview of both the data available and the environmental characteristics of the study area. If a detailed assessment is being conducted, users should verify that the data is the most current, and determine if more detailed information is available for their specific area of interest; and
- as mentioned above, the data have been provided at a variety of scales. Users should be aware of the consequences of mixing data at different scales, and should select a working scale that is appropriate for the spatial extents of their particular development.

3.2 Land and Resource Use

Section 3.2 describes the types of land uses occurring in northeast BC (Figure 3-1 provides a general overview). All of the activities, with the exception of residential settlements and agriculture, occur to varying degrees in both the Interior Plateau and MKMA sub-regions of the study area. Activities with special significance or management regimes that are specific to the MKMA are described separately.

3.2.1 Setting

3.2.1.1 Residential Settlement

The regional population in northeast BC has been slowly increasing, a trend that is expected to continue. Population growth projections for this region are strongly linked to the intensity of development activity in key resource sectors. Fort Nelson and Fort St. John are the largest urban centres in the study area (Figure 3-2). Outside of these cities, smaller settlements and rural areas are located along major travel corridors. In the Fort Nelson planning area, smaller residential communities are predominately located along the Alaska Highway, including Summit Lake, Toad River, Muncho Lake, Liard River, Coal River, Fireside, Lower Post, and Watson Lake. In the Fort St. John planning area, smaller residential communities include Taylor, Clayhurse, Cecil Lake, Goodlow, Rose Prairie, Montney, Wonowon and Pink Mountain. First Nations communities within the study area include Halfway River, Blueberry and Doig.

3.2.1.2 Transportation

The study area is traversed by a number of transportation corridors (Figure 3-2), which link residential communities, service centers, and industrial areas. The major transportation corridor in the region is Highway 97 (Alaska Highway). In more remote areas of the region, various forms of RoWs (e.g., seismic lines, pipelines, cutlines, well access roads, logging access roads, and transmission lines) provide access and potential access for road and off-road vehicles.

3.2.1.3 Industrial Activities

Oil and gas exploration and forestry are the dominant industrial land uses, regionally; however, some active mineral extraction and exploration also occurs. Other forms of industrial land use include agriculture, hydroelectric, transportation, communication, and utility corridors.

Oil and Gas

The Peace-Liard region is the only part of the province where large commercial quantities of natural gas, and more limited amounts of oil are produced. Approximately 2,600 oil and gas pools have been identified in northeast BC and about 12,000 wells have already been drilled. The development of several large gas fields in the region has resulted in the creation of seismic lines, pipelines and associated facilities, access roads, and well sites (Figures 3-3 and 3-4).

Over 250 oil and gas companies operate in northeast BC and the industry is one of the region's largest employers. The level of development activity associated with this industry is projected to increase. It is estimated that at the 1994 rate of production, more than 50 years of proven plus potential natural gas reserves remain in northeast BC, exclusive of any impacts resulting from the creation of new protected areas or the implementation of forest practices code requirements (ARA et al. 1996). Provincially, the sales value of oil and gas production was estimated at $5.6 billion in 2001 and recent statistics indicate oil & gas crown revenue will exceed forestry crown revenue as the largest source of revenue from British Columbia's natural resource sector.

The study area also includes reserves of coal bed methane. Although production has yet to be initiated in British Columbia, the Ministry of Energy and Mines is in the process of implementing a strategy to establish coal bed methane as a clean, environmentally safe energy source that can be developed to service local, domestic and export markets.

In May 1998, the provincial government introduced the Oil and Gas Initiative (OGI) to encourage British Columbia's oil and gas sector to expand and make it easier for oil and gas firms to do business in British Columbia (BC Ministry of Energy and Mines 2003). The Oil and Gas Initiative will provide regulatory efficiencies, tax efficiencies, and investments in infrastructure. The government aims with the support of the Oil and Gas Initiative to double oil and gas production in the province.

Forestry

Active timber harvesting and processing presently occurs in various locations throughout the study area. Spruce, pine, aspen, and cottonwood are the principle merchantable species. The study area encompasses all of the Fort Nelson and Fort St. John Timber Supply Areas (TSA) and parts of the Mackenzie and Cassiar TSAs. It is expected that forest harvesting will be sustained or enhanced to provide new opportunities in the region. LRMP objectives regarding forestry are to minimize timber losses, manage forests at the landscape unit level, and increase the area and productivity of the forest land base.

Mining

The potential for long-term extraction of coal from the Peace River coal field is moderate to high in some places, although there are only a few places in the Dawson Creek area where there is active coal mining. There are no major operating coal mines in either the Fort St. John or Fort Nelson areas. There are potential metallic mineral reserves in the western mountains, and coal and industrial minerals in the foothills. Additionally, there are areas (usually near industrial or residential areas) of active aggregate mining (sand and gravel) for road construction, industrial developments, and building structures.

Agriculture

Agricultural has a long history in the North Peace and Fort St. John areas. The Peace River region accounts for over one third of the province's Agricultural Land Reserve (ALR). The industry has been, and continues to be, dominated by the production of grain and oilseed crops. Additionally, the Peace River area is one of North America's highest capability areas for cow/calf production. The ranching sector has grown considerably over the past few years, and there has been recent growth in beef and forage crop production, and expansion of grazing and agricultural leases on Crown land. Slow, steady growth is expected, along with expansion into more specialized activities.

Hydroelectric Projects, Communications, and Utilities

Several large and small hydroelectric projects occur within the region. Larger projects include the Gordon M. Shrum Generating Station at the W.A.C. Bennett Dam at the head of the Peace River Canyon, and the Peace Canyon Dam and Powerhouse located near the town of Hudson Hope. No potential micro hydro sites have been identified in the region. Although demand for electricity in BC is increasing, it is unlikely that the potential Liard River resource will be developed in the foreseeable future. There are also numerous communication, transportation, and utility corridors throughout the region, and additional structures of this nature will likely be required.

3.2.1.4 Non-industrial Activities

Outside of residential areas and transportation corridors, the principle land uses for non-industrial purposes within the study area include public access, recreation, tourism, and First Nations traditional uses. Public access occurs along all accessible RoWs. Public use is permitted on most industry roads on Crown land. Off-road use by ATVs or snowmobiles also occurs on seismic lines, pipelines, and inactive roads, and is prevalent year-round, but particularly during the hunting season. De-activation of roads and roll-back of access corridors following industrial use has become the norm; however, ATVs and snowmobiles can still access such corridors long after they have been de-activated. There are no data to quantify levels or frequency of pubic use of RoWs. Under the Access Management Area Regulations of the *Wildlife Act,* ATV use (excluding snowmobile use) is restricted in officially-designated Access Management Areas. The MKMA is a designated Access Management Area as are smaller areas within Northeast BC, including the Mount Klingzut closure area just outside the MKMA's eastern border.

Outdoor recreation and tourism account for a small but growing portion of the regional economy. Northeast BC has always had a high international profile for backcountry hunting and fishing opportunities. Guided hunting and fishing trips account for most of the region's tourism revenue, but other backcountry pursuits such as wildlife viewing, photography, and adventure tourism are gaining in popularity due to the natural beauty of the region, and to its abundance and diversity of wildlife. All flowing waters and most lakes in the region are open year-round for sport fishing within provincial seasons and regulations. Most lakes and waterways are accessible by road, and many offer world-class fishing experiences for species such as lake char, northern pike, walleye, arctic grayling, bull trout, rainbow trout, and mountain whitefish.

Non-consumptive recreational pursuits are less common than hunting and sport fishing, but they do occur at a number of designated and informal recreation sites throughout the region. Most activities are highly dependent on the region's wilderness recreation values such as its scenic quality, and its diversity and abundance of fish and wildlife. Popular recreation activities in the region include hunting, hiking, camping, scenic and wildlife viewing, cave exploring, kayaking, canoeing, fishing, jet-boating, mountain-biking, cross-country skiing, snowmobiling, and use of all-terrain vehicles (ATVs). All-season highways, logging roads, and seismic lines comprise the principal access corridors for recreational users. Recreational activities occur by regional residents and tourists. Non-resident recreational activities occur primarily as part of commercially-guided excursions.

The demand for wilderness tourism is expected to increase with the anticipated growth of commercial recreation opportunities (Dawson Creek LRMP 1999). Additionally, highway and community tourism has been increasing. The Northern Rocky Mountain and Alaska Highway Tourism Association has attempted, in recent years, to encourage tourists to travel off the Alaska Highway into wilderness areas of the northeast. By working with guide outfitters, the Tourism Association is hoping to increase the profile of wilderness eco-adventure tourism in the northeast, as a whole, and in the MKMA protected areas, in particular. The maintenance of pristine or natural settings and the availability of a variety of outdoor recreation opportunities are critical to sustaining the viability of the wilderness recreation and tourism sectors.

First Nations traditional activities on the land include consumptive uses such as hunting, trapping, fishing, and berry-picking; non-consumptive uses focus on spiritual and ceremonial practices.

Hunting and Trapping

Hunting is the most common non-commercial resource use. Quality hunting and guide outfitting experiences exist in the study area due to the diversity of landscapes and wildlife. Hunting occurs year-round by local First Nations communities, and by other local residents and guide outfitters during hunting seasons. Guide outfitting is an important revenue-generating business which serves a varied clientele from provincial, national, and international locations. Private hunting occurs in season on Crown land throughout the study area. The most commonly hunted species are moose and elk. Other animals hunted less frequently include caribou, deer (white-tailed and mule), black bears, grizzly bears, sheep, goats, and wolves. Groundbirds (e.g., grouse) and waterbirds are also hunted. Existing access roads are used extensively by hunters as the jumping-off point for single and multi-day trips. Many areas are accessible by standard trucks and vehicles. Hunters mainly use ATVs and snowmobiles for off-highway use.

Trapping is socially and economically important to both local and regional economies. Trapping occurs throughout the study area, and is an important traditional use, although it is diminishing in commercial importance. The diverse landscapes and habitats of the region are home to a variety of commercially harvested furbearers including marten, fisher, lynx, coyote, wolf, fox, beaver, and squirrel. The most commonly harvested of these are marten, beaver, and squirrel. The trapping sector, however, is experiencing an economic decline due to a deteriorating fur market.

3.2.1.5 Protected Areas

Provincial parks and protected areas (referred to collectively, as protected areas for simplicity) comprise about 9% of the study area (Figure 3-5). These protected areas are legally defined areas that have been set aside to protect representative ecosystems or special biophysical or cultural heritage features, and/or to provide recreation opportunities (where appropriate) related to the area's natural and cultural setting. In general, resource extractive activities are prohibited within protected areas in northeast BC, with the exception of First Nations traditional activities, grazing, and guide outfitting. Directional drilling for oil and gas is permitted beneath some protected areas.

The largest protected areas are found within the MKMA, namely the Northern Rocky Mountains, Kwadacha Wilderness, Muncho Lake, Graham-Laurier, Denetiah, Redfern-Keily and Liard River Protected Areas. Outside the MKMA, Klua Lakes, Maxhamish Lake, and Thinatea are the largest protected areas. Several of the MKMA protected areas are considered to have the best representation of significant landform features in the province. These include the Grand Canyon of the Liard, the hoodoos along Wokkpash Creek, and the rugged alpine features of the Denetiah, Northern Rocky Mountains, and Redfern-Keily Protected Areas (BC Parks 1999).

There are several ecological reserves (ER) within the study area, including Smith River ER just south of the 60^{th} parallel; Portage Brule Rapids ER just outside the MKMA northern border near Highway 97; Grayling River Hot Springs ER north of the Liard River; Fort Nelson River ER just north of Fort Nelson; Kotcho Lake Islands ER northeast of Fort Nelson; Parker Lake ER just west of Fort Nelson; Cecil Lake ER northeast of Fort St. John; Clayhurst ER near the BC-Alberta Border in the southern part of the region; and Sikanni Chief River ER within the MKMA. Other than scientific research and some types of low-impact recreation (in select ERs only), human use and resource development activities are excluded from ecological reserves.

3.2.1.6 Muskwa-Kechika Management Area

The MKMA has been identified as having significant resource and wilderness values. Approximately 25% of the Management Area consists of parks and protected areas; 75% is comprised of Special Management Zones (SMZs). Recreation and tourism are permitted throughout the area, while economic and industrial development such as mining, oil and gas, and logging are permitted only within the SMZs and Special Wildland Zones (where all activities other than logging are permitted). Access routes to the MKMA include roads (to some protected areas) and seismic lines, and access is achieved either on foot, horseback, or skis, or by aircraft, snowmobile or dogsled. As previously noted, ATV access other than by snowmobile is restricted within the MKMA under the Access Management Area Regulations.

Although there are few producing or proven oil or gas reserves within the MKMA (the only known past production area was just inside the MKMA within the Sikanni drainage), exploration drilling has been done in the area. There are also reserves immediately adjacent to the MKMA. The Ministry of Energy and Mines has estimated that the MKMA contains 8 trillion cubic feet of gas, with the highest concentration located in the eastern portion of the Management Area. Since about 1993, oil and gas tenure applications for the MKMA have been deferred pending pre-tenure planning. In 2002, the first pre-tenure plan for oil and gas was completed for the Besa-Prophet area of the MKMA.

Three mineral formations overlay the MKMA: the Gataga Kechika lead and zinc belt; the Eastern Foothills lead and zinc belt; and the Churchill copper belt (ARA et al. 1996); however, little mineral exploration activity has occurred even though the Ministry of Energy and Mines states that significant potential for mineral resource development exists. Some mining occurred previously in the MKMA as part of the Churchill Copper Project, which has since been closed. The remoteness of the area has been the main factor that has limited exploration and production activities.

Opportunities for wilderness tourism and background recreation in the MKMA are considered to be significant. The main features and attractions in the area are closely linked to hunting and fishing, but increasingly, emphasis is being placed on visual quality and adventure tourism (BC Parks 1999). There are an estimated 17 to 20 guide outfitting territories in the MKMA. Backcountry recreation activities include hiking, fishing, horseback riding, wildlife viewing, nature appreciation, river boating, and snowmobiling.

With regards to forestry, there has been limited interest in the area's forest resources due primarily to difficult access and low volumes combine to limit interest. Trapping is another land use activity that occurs in the MKMA. There are approximately 35 traplines, many of which are owned and operated by First Nations (ARA et al. 1996).

3.2.1.7 Land Use Plans

Three LRMPs (Figure 3-6) cover the study area: Fort Nelson (Figure 3-7), Fort St. John (Figure 3-8), and Mackenzie (Figure 3-9). These LRMPs provide general and specific management directives to guide all uses on Crown land in the region.

3.2.2 Issues

As described above, the primary land uses in northeast BC include energy and mineral exploration and development, aggregate extraction, timber harvesting, hunting and outfitting, trapping, agriculture, residential occupancy, and summer and winter recreational activities. In general, the only facilities to be found in the MKMA are guide outfitting and fishing camps, trapper cabins, and trails. Use is primarily by guided hunting and fishing trips, but private recreational users are prominent in more accessible places. Each of these activities, individually or in combination, can result in specific and cumulative impacts to the biophysical environment or to socio-cultural values. The discussion below focuses on the issues resulting from oil and gas activities in relation to their effects on other land uses in the region. Issues are summarized below for the Interior Plateau (i.e., the lands generally outside and east of the MKMA) and MKMA sub-regions.

3.2.2.1 Interior Plateau

Access Management

Considerable access to the Interior Plateau exists, mainly in the form of seismic lines, which are used by off-road vehicles. Some graded roads and utility corridors (i.e., pipelines, transmission lines) provide further access. Increased access into previously inaccessible or difficult to reach hinterland areas is one of the major issues of concern in the region, and has been raised by government agents and stakeholders. More access increases the opportunity for recreationists and commercial resource users to hunt, fish, trap, and travel throughout a larger area. Although corridors provide a source of forage for wildlife and domestic stock, and a means for recreation and motorized access, they can fragment habitats. It is generally recognized that resource roads have increased public access to this area, and that the restrictions will be required in important wildlife areas.

LRMPs provide some direction for access management, and in recent years there has been more co-operation between resource management agencies and industry in planning, developing, and in some cases, rehabilitating access corridors. While the LRMPs provide opportunities to create communication, transportation, and utility corridors outside of protected areas to support resource development in the region, an objective of the plans is to ensure that future development utilizes existing corridors and sites, wherever possible. Additionally, the development, maintenance and/or upgrade of utility corridors must be done with sensitivity to high capability wildlife habitat, recreational values, and visual quality objectives. Unused corridors are to be rehabilitated where feasible.

Impacts to Forest Operations

Oil and gas activities may result in impacts to forest operations, thus leading to conflicts between these two major resource use sectors. Development of oil and gas-related facilities, including RoWs in areas with harvestable timber, may result in a temporary or permanent loss of forest production through reduction in the harvestable land base. Additionally, a major concern of timber operators is the continued and safe access to their sites, which may sometimes be impeded in active oil and gas operating areas.

Impacts to Trappers

Decreased opportunity and success for trapping are the most significant issues for the trapping sector. The specific concern for trapping is that construction of oil and gas-related facilities and infrastructure can have a negative effect on furbearer habitat that, in turn, would lead to a decrease in populations, and thus, lower trapping success in the area. Another important concern is the need to manage motorized access to previously inaccessible areas that may be used by trappers. Disruption or destruction of traplines and trapper cabins are also issues of concern for trappers. Cumulative impacts may result from the incremental introduction of industrial facilities into hinterland areas, which typically occurs after access is opened up by one developer. Access control and co-ordinated access management among industrial users is an issue for trappers.

As stated in the LRMPs for the Interior Plateau, a major concern for many trappers is the need for adequate notification of impending land and resource developments that could detrimentally affect their interests. In an attempt to provide appropriate notification, the provincial Ministries of Water, Land and Air Protection; Forests; and Energy and Mines (Energy and Minerals Division), in conjunction with the BC Trappers Association, have implemented a program to ensure that trappers are adequately notified of impending developments, provided that the trapper has authorized the release of personal information.

Impacts to Sport Fishers, Hunters, and Guide Outfitters

Decreased opportunity and success for hunting and fishing are the most significant issues for the hunting and fishing sectors. A concern is that construction and operation of industrial facilities will have a negative effect on habitat, which in turn, would lead to a decrease in populations, and thus, lower success of hunting and sport fishing in the area. Another concern is that public access will be impeded due to the active use of RoWs for industrial activities, particularly after ground freeze-up (i.e., late fall and winter), which is the prime period for industrial construction in the northeast. Private hunters and fishers generally view increased access via new or improved industrial RoWs favourably; however, guide outfitters, in general, are concerned that increased access to wilderness areas will lead to losses and damages at outfitter camps; increased traffic that disturbs game species and changes their movement patterns; increased competition for wildlife; the need to alter scheduled outfitting trips or move camps to avoid construction periods or locations; and, importantly, the diminishment of the wilderness experience they are selling to their clients.

Impacts to Non-industrial Uses

Effects of oil and gas activities on non-industrial users (namely First Nations and other public users of the land), include loss or degradation of traditional hunting, trapping, fishing, and gathering areas; degradation or intrusion into culturally or spiritually important areas; sensory disturbances to recreational users due to noise or dust caused by construction; impediments to access to certain areas during active construction periods; and degradation of the visual quality of the region. Additionally, unmanaged access may have negative effects on users who are looking for a wilderness experience (e.g., those taking horse packing trips).

3.2.2.2 Muskwa-Kechika Management Area

The above issues apply, to lesser or greater degrees, in the MKMA. Issues relating to competing uses by industrial sectors occur in some areas, but typically, the limited use of the area for forestry, and the presence of access management protocols help minimize these issues. Access is one of the greatest threats to wildlife and wilderness, and is a major issue for users of the wilderness features in the MKMA. Note that the MKMA Act requires land managers to manage the MKMA for a lesser level of impact than may occur in other areas.

3.2.3 Hot Spots

Areas that are intensely developed are more likely to result in conflicts and other types of cumulative effects among land users. While areas of greater potential conflict among users may be considered as a type of hot spot, a hot spot map was not developed for land and resource use components.

The types and intensity of land use activities across a region or sub-region are generally defined through planning processes, such as LRMPs, which are intended to provide strategic level management direction, thus balancing lower and higher intensity use areas across vast land bases. Because LRMPs have defined, through multi-stakeholder processes, areas where oil and gas activities can occur in relation to other types of land use, it is inappropriate to define such areas a hot spots for cumulative effects for land use.

For similar reasons, and due to sensitivity of information, hot spot maps were not developed for First Nations traditional uses; however, those who wish to map areas of concern for their own purposes could use methods similar to those for identifying regional hot spots which would include selecting spatially-explicit areas of traditional use and interest (e.g., hunting/fishing camps, historical hunting grounds, spiritual sites), a process that would include indigenous knowledge.

3.3 Air Quality

Air quality is, by definition, a cumulative effects issue, as each new development will incrementally add to the overall air pollutant levels of a region. Air quality is affected not only by local pollution sources, but also by long-range transport of pollutants from distant sources. Potential sources of both air and noise emissions from oil and gas activities include:

- vehicles and equipment used for seismic exploration equipment;
- well test flaring for exploration drilling;
- production and processing facilities; and
- transmission pipelines, including compressor stations.

The Fort St John/Taylor region has heavy industry present in its airshed (e.g., pulp mills, sawmills, and other wood products plants) in addition to oil and gas activities. Because of the cumulative effects of these activities and the desire to mitigate potential detrimental increases in air pollution, the region has initiated the development of an air quality management plan.

Oil and gas well densities in several regions of the Interior Plateau are quite high, particularly around Fort St. John and around the Kwokullie Lake on the Eisho Plateau (Figure 3-10). The southern region of the Interior Plateau also has the highest human population density in the study area. Because of the high density of oil and gas development and the relatively high human population density, cumulative effects of air emissions are potentially of concern and need to be addressed for proposed new facilities in these areas. Factors other than well density, which influence the potential for cumulative effects include sulphur content and expected well throughput. Sulphur content is known and reported to the OGC, and is, therefore, available for use in assessing potential impacts.

Sulphur dioxide (SO_2) is considered to be the key air pollutant associated with oil and gas activities, and so, can be used as the indicator pollutant to assess the potential cumulative air quality impact of proposed developments. The acceptability of the resulting ambient SO_2 concentrations can be judged by comparing the expected maximum SO_2

concentrations to ambient air quality criteria. These criteria can be either regulatory or receptor based.

Previous modelling of well test flaring with H_2S concentration in the 30% range in the Interior Plateau region has shown concentration values of 900 μg/m^3 SO_2 to distances of 10 to 20 km. Although maximum H_2S concentrations tend to be lower in this region (in the range of 4–6%, with a significant portion of the natural gas being 'sweet,' or low in sulphur content), these findings indicate that areas with several air emission sources can experience cumulative effects on air pollutant concentrations.

Little to no oil and gas development has occurred in the MKMA to date. The area is also very sparsely populated, with few communities. Air quality associated with industrial activities, therefore, is not yet of concern.

Areas of continuous sulphur emissions activity, based on sulphur emission density (i.e., volume emission/land area), are indicated as potential hot spots in Figure 3-11. As would be expected, clusters of high densities are correlated with certain areas of oil and gas activity in the Interior Plateau, particularly in the southern portion of the region. The most intense 'hot spots' on the SO_2 emission intensity map do not necessarily imply that BC Ambient Air Quality Objectives are exceeded. Rather, the hot spots indicate areas where objectives may potentially be exceeded. Regarding the MKMA, if monitoring (or multiple-source dispersion modelling) of some of the areas that appear on the emission intensity map as the most intense shows non-compliance with BC Ambient Air Quality Objectives, then similar areas in the MKMA would also be expected to do so. Conversely, if non-compliance is uncommon in the most intense areas at present, then similar areas in the MKMA would also be expected to be compliant. The topography in the MKMA, however, might be expected to be more conducive to potential exceedances than the flatter terrain in the eastern part of the study area, for example, as occurs in the foothills development regions in Alberta.

3.4 Soils and Terrain

3.4.1 Setting and Issues

Continued development in the Interior Plateau and MKMA poses several challenges to quantifying cumulative effects from a soils and terrain perspective (see Figure 3-12 for soils classification). Main impacts of concern, discussed below, are soil acidification, changes to overall soil quality/capability, and long-term effects on sensitive permafrost areas.

3.4.1.1 Soil Acidification

Soil acidification impacts are typically measured in relation to the Potential Acid Input (PAI) from industrial or other sources. While a large impact from PAI is not expected in either the MKMA or the Interior Plateau, confidence in predicting the impact of acid deposition is low due to the lack of research and the lack of regional objectives for acceptable PAI levels.

Interior Plateau

Luvisolic and Cryosolic soils are dominant in the Interior Plateau, and are considered to have low sensitivity to PAI. Minor areas of Dystric Brunisols have been identified, including areas east of Highway 97 from Pink Mountain north to Trutch, and along the Fort Nelson River valley. Areas of sandy Luvisols may also occur throughout the Interior Plateau, but this needs to be verified through improved baseline information gathering. With the concentration of oil and gas development occurring in the Interior Plateau, acid deposition monitoring remains important, but impacts are expected to be low given the buffering capacities of the soils.

Muskwa-Kechika Management Area

Acidification effects on regional soils are assessed based on the extent of sensitive soils, and the degree of impact that PAI have on these soils. Based on available soils information, there is a limited area of highly sensitive soils in the MKMA. The primary concentrations are at higher elevations in the Rocky Mountain Foothills, and in proximity to many rivers and streams in the area surrounding the Cassiar Mountains, including the Kechika River and its tributaries. These areas have sandy soils with acidic conditions and low Cation Exchange Capacities (CEC). Sensitivity ratings are based on an assessment of the pH decrease that the addition of acidifying inputs is likely to have on the buffering capacity of a soil. Specifically, areas with Dystric and Sombric Brunisolic soils are considered to be highly sensitive to acid inputs. Moderately sensitive soils include Eutric and Melanic Brunisols; however, it is also possible that areas with sandy Luvisolic soils would be considered sensitive. Baseline mapping information will need to be improved in order to make such an assessment.

3.4.1.2 Soil Quality/Capability

Interior Plateau

The Interior Plateau shares many of the same concerns with the MKMA, with the exception of two factors. Relatively level topography and lower elevation eases concerns about erosion on steep and/or unstable slopes, but raises issues of its own. Agricultural activity in the Fort St. John area is particularly sensitive to improper soil management practices and maintenance of soil quality/capability; moreover, given the minor extent of suitable agricultural land, any area that is taken out of production will have a greater relative effect than the same disturbance in a forested area.

Muskwa-Kechika Management Area

Effects on soil quality/capability are more readily quantifiable. As with acidification, the cumulative effects of loss of soil quality/capability are assessed by the extent and degree of impact. Particular attention should be given to highly productive soils (high capability), riparian soils, and to soils that present reclamation challenges (e.g., soils that are highly erodible, or on steep or unstable slopes).

Loss of soil productivity is a concern for a variety of land uses, including agriculture, forestry, First Nations traditional use, conservation, and hunting.

3.4.1.3 Permafrost Areas

Interior Plateau

Concerns about disturbances in permafrost areas have recently been identified. Much of the Interior Plateau area has permanently frozen, primarily Organic Cryosolic soils. In fact, most of the land east of the Fort Nelson River is permafrost. Vegetation displaced by disturbance takes significantly longer to re-establish during the short growing season here. Additionally, deleterious effects are being noted along pipeline RoWs. The heat generated by pipelines during operation thaws the area immediately surrounding the pipe. When combined with removal of tree cover this contributes to pronounced subsidence across the entire RoW over the years to come; however, even without pipeline impacts, tree removal and activity along cutlines increase the risk of subsidence. This situation introduces significant concerns, including the following:

- ponded water in the subsided trench alters natural drainage patterns, and may be an obstacle for wildlife crossing;
- in mineral Cryosolic soils, subsidence contributes to erosion by the alteration of natural drainage. As water runs down the newly created trench, mineral material is carried with it. Since it will be carried until reaching a low area, commonly a crossing drainage channel, sedimentation of waterways is likely;
- in either case, the depth of cover material over the pipeline is reduced, creating safety and contamination concerns surrounding pipeline integrity; and
- ATV traffic has a high impact on vegetative cover in permafrost areas.

Muskwa-Kechika Management Area

Only one small area of Cryosolic soils has been identified in the MKMA, northwest of Trutch, on the north side of the Prophet River.

3.4.2 Hot Spots

3.4.2.1 Acid Sensitivity

Risk ratings for sensitivity to PAI have been assigned based on the ability of the regional soils to buffer the impacts of soil acidification (Figure 3-13). Only a few relatively small and isolated areas occur as soil acid sensitivity hot spots.

High risk soils have low buffering capacities due to low pH levels, low CECs, and relatively low calcium reserves. They are primarily derived from coarse textured fluvial or glaciofluvial parent materials, and are classified as Dystric or Sombric Brunisols. Eutric and Melanic Brunisols are considered to be moderately sensitive to PAI, and are also developed on glaciofluvial material. The majority of soils in the region have low sensitivity; these soils fall into two categories. Upland mineral soils are mostly Luvisolic, with higher pH, an increased cation exchange capacity, and higher calcium reserves. Organic soils and Gleysolic mineral soils are also rated as low risk due to a number of factors.

These soils are influenced by seepage and/or shallow water tables. The influence of water moving through these coils complicates the interpretation, in that it is considered to provide a buffering effect, even though absolute levels of calcium are often similar to those found in moderately sensitive soils. While bogs and nutrient-poor fens would be rated as moderately sensitive, these wetland classifications will need to be established on a project-specific basis, as they cannot be identified solely through soil classification (i.e., Mesisol).

3.4.2.2 Erosion Risk

Erosion risk categories have been established using different criteria for agricultural and forestry land (Figure 3-14). Erosion risk is minimal for all but numerous small and isolated areas.

With no litter layer and an absence of well-established vegetation rooting, agricultural soils are at greater risk of significant erosion on gentler slopes than are forest soils. For agricultural areas, high risk areas are those with slopes greater than 10% (5°), moderate risk slopes are between 6 and 9% (>3-5°), and low risk areas have slopes of less than 6% (0-3°). In forested areas, however, high risk slopes are those greater than 45% (>24°), moderate risk slopes are 30-45% (16.5-24°), and any areas with slopes less than 30% (<16.5°) are considered to be low risk. Erosion control measures are essential for any moderate or high risk areas. Loss of topsoil degrades soil quality, can compromise slope stability, and often leads to sedimentation within the affected watershed.

3.5 Aquatic Ecosystems

3.5.1 Setting

3.5.1.1 Physical Environment

Geomorphological and biogeochemical characteristics largely determine structure and function of aquatic communities in the study area. The area designated as the Interior Plateau for this project roughly corresponds to the Alberta Plateau and Liard Plateau physiographic regions (Holland 1976). The northern portion is part of the Taiga Plains Aquatic Ecoprovince (Perrin and Blyth 1998), the oldest landmass in British Columbia. This area is a remnant of a large inland sea that was situated at an elevation of approximately 450 m above present mean sea level. The bedrock of this area is shale, which is largely unmodified since last glaciation. That parent material weathers rapidly, producing naturally turbid surface waters and deep river channels that cut into the plains.

The geologic history of this area has produced an undulating topography that is dominated by extensive wetlands, poorly drained soils, and slow, meandering rivers. There are no large lakes in the Interior Plateau, but small lakes are abundant. The wetlands include black spruce bogs that are characterized by acidic conditions, slow decomposition of organic matter, expanses of peat, and tea-stained colour of water due to leaching of tannins and lignin's from surrounding organic matter. Streams typically originate on the organic peat lands, and are characterized by meandering large-channel morphology and average gradients less than 0.5%. Typical streambed material is composed of organic fines. Sand, gravel, and cobble substrates are typically absent.

The southern portion of the Interior Plateau area rises to elevations of 1500 m on the Halfway Plateau Terrestrial Ecosection, and declines to the lowlands of the Peace River watershed. Soft shale is the typical bedrock, and weathering produces deeply-incised river channels and naturally turbid mid-order rivers and streams. Suspended sediment levels in headwater streams are relatively low. Soils are poorly drained, resulting in large expanses of bog and wetland. There is an absence of large lakes. Colour associated with leachates from bogs is moderate (e.g., 30 TCU) in high-order reaches of the lower Beatton River, but at higher elevations, less staining of water occurs.

Drainages in the western MKMA portion of the study area are mountainous, resulting in abundant, high-gradient, headwater streams, and small lakes that originate in the alpine and flow into large river basins including the Kechika, Liard, Muskwa, Prophet, Sikanni and Halfway Rivers. Erodability is low to moderate at high elevations, producing relatively clear streams with abundant riffle and pool sequences. At lower elevations, turbidity increases as the larger streams join to form large rivers. Wetlands are not extensive in these western portions of the study area, although they are locally present near slow-flowing streams that characterize valley bottoms formed by past glaciation. Trees are often absent at lowest elevations in these valleys due to cold air drainage.

Phosphorus concentration in surface waters, particularly in spring, is a key indicator of potential biological production in aquatic systems. In a review of very limited chemical data from the Taiga Plains and Peace Plains Aquatic Ecoprovinces (Interior Plateau in this study), Perrin and Blyth (1998) found most total phosphorus (TP) concentrations were high compared to many other aquatic ecoprovinces of British Columbia. While the available data reviewed by Perrin and Blyth (1998) was sparse and cannot be considered representative of the complete Interior Plateau study area, reported phosphorus concentrations of 30 μg/L to 240 μg/L does indicate a potential for highly productive lakes and streams, particularly in the Peace River Valley. These data are supported by the presence of high concentrations of total dissolved solids (100–400 mg/L), also indicating potential for high biological production. In high order river reaches, the pH is moderately alkaline (7.7 to 8.3) due to alkaline carbonate leachates derived from shale parent materials, thus indicating high acid neutralizing capacity. Although data are lacking for most bog areas, localized acidity associated with acid bog conditions is expected.

In the MKMA, only incidental chemical data were found in the databases received by Perrin and Blyth (1998). The data indicated that high TDS concentrations (up to 300 mg/L) occur mainly in the Muskwa Ranges and Liard Plateau where there has been a long history of fire. In other areas of the MKMA, TDS concentrations are extremely variable, with relatively high concentrations found in the east, and lower concentrations found at higher elevations in the west. These observations may indicate that nutrient deficiency increases with rising elevation to the west, and lower nutrient deficiency is associated with lower elevations to the east. When coupled with spatial distribution of turbidity associated with erosion, areas of high-elevation, clear, nutrient-deficient headwaters are found to the west grading to more nutrient-rich, higher order, turbid, low-elevation rivers to the east.

3.5.1.2 Fisheries Resources

Approximately 40 fish species occur within the study area. The majority of these have “downstream” or “intermediate” distributions within the drainage systems they inhabit, and are typically found in the lower and middle reaches of mainstem rivers and larger tributary streams and lakes. Many of these species, including white sucker *(Catostomus commersoni)*, lake chub (*Coeusius plumbeus*), finescale dace (*Phoxinus neogaeus*), and brook stickleback *(Culaea inconstans)* have broad tolerances, and are able to complete their life cycles in habitats of relatively low sensitivity. Two notable exceptions to this general distribution pattern are bull trout (*Salvelinus confluentus*) and Arctic grayling (*Thymallus arcticus*). These species occur in both migratory and stream resident forms, and occupy a variety of habitats based on season and life phase, including habitats of high sensitivity to human disturbance.

Several fish species that are of special concern provincially occur within the study area (British Columbia Conservation Data Centre 2002). In the Fort St. John Forest District, goldeye (*Hiodon alosoides*) and bull trout are blue-listed (vulnerable), and the spottail shiner (*Notropis hudsonius*) is red-listed (threatened). In the Fort Nelson Forest District, goldeye, bull trout, Dolly Varden (*Salvelinus malma*), and inconnu (*Stenodus leucichthys*) are blue-listed, and cisco (*Coregonis artedi*), Arctic cisco (*Coregonis autumnalis*), emerald shiner *(Notropis atherinoides)*, spottail shiner, and ninespine stickleback (*Pungitius pungitius*) are red-listed. In the Mackenzie Forest District, bull trout and Dolly Varden are blue-listed, and the Williston Watershed population of Arctic grayling is red-listed. In addition, Haas (1998) compiled a list of indigenous fish species or individual populations that did not hold any provincial conservation status, but were possible candidates for "regional and/or future conservation consideration". Arctic lamprey (*Lamptera japonica*), chum salmon, pygmy whitefish (*Prosopium coulteri*), round whitefish (*Prosopium cylindraceum*), northern pike (*Esox lucius*), trout-perch (*Percopsis omiscomaycus*), the Liard Hotsprings population of lake chub, flathead chub (*Platygobio gracilis*), walleye (*Stizostedion vitreum*), and brook stickleback were among the species identified for the Peace and Liard drainages. While pearl dace (*Margariscus margarita*) and spoonhead sculpin (*Cottus ricei*) were previously proposed as "regionally significant species" under the British Columbia Forest Practices Code, the classification was never formalized.

3.5.2 Issues

3.5.2.1 Overview

Issues with aquatic resources are associated with water quality and quantity for both human and aquatic communities, loss or alteration of fish habitat, and increased human access to lakes and streams via roads or trails constructed for seismic activity, exploration drilling, and other more permanent industrial infrastructures.

Water quality can be affected by soil disturbance at industrial sites, leading to release of sediment into surface waters. While Arctic grayling may be adapted to the naturally turbid streams in the eastern portion of the study area, changes in the size distribution of particles or increased concentration of particles caused by industrial disturbance may result in reduced feeding efficiency, decreasing spawning success, and gill abrasion. In reaches of small streams or bog lakes that are not turbid, episodic introduction of suspended solids may substantially reduce survival of fish age classes, and attenuate irradiance, causing a general decline in biological production.

Water quality may also be affected by episodic or more chronic discharge of industrial wastewater. This wastewater may include sewage which can introduce pathogens and nutrients to surface water, which in turn, can lead to, localized eutrophication (excessive biological production caused by high nutrient loading that can be harmful to aquatic communities, including fish). Other chemicals may be released or discharged, and may produce toxic effects in aquatic biota. While it is anticipated that waste is treated before discharge or is contained for disposal at other sites, complete containment and treatment may not always occur. For example, infiltration of contaminated fluids from containment pits or lagoons may flow through porous soils to groundwater, and eventually, to surface waters where anomalous mortalities in critical food webs may occur.

Water quantity may be affected by demand for water for industrial use. For example, water used for hydrostatic testing may lower surface stream flow, and modify wetted usable habitat in downstream reaches, particularly in winter.

Both fisheries habitat and aquatic resources are protected under the *Fisheries Act of Canada* and the *Water Act of British Columbia*. While all industrial activities affecting water quality, fish, and fish habitat are subject to regulation to avoid habitat degradation, multiple small-scale human disturbances can erode habitat and water quality. Interactions between small developments, such as a proliferation of access in adjacent gas fields, may result in synergistic effects. Increased traffic can cause increased soil compaction and associated increases in sediment run-off and impacts to water quality.

The issue of developing access into previously intact wilderness areas is of increasing concern. A prime example of that involves fluvial migratory bull trout during both the pre-spawn staging and spawning periods. In mid- to late-summer and early fall, mature adult bull trout migrate long distances to congregate at selected sites in foothills drainages. During this time, they are particularly vulnerable to exploitation, as many large fish, often in excess of 800 mm in length, may assemble in shallow streams. Under these conditions, even limited illegal angling effort could result in significant impacts to the annual recruitment within a bull trout subpopulation. While aggregations of large, slow-growing bull trout provide a dramatic example of the potential effects of access development, many other fish species are similarly susceptible to over-exploitation of previously remote populations.

In many cases, impacts associated with increased access are not solely derived from industrial actions, but through related activities. For example, closely aligned and linked industrial roads can provide increased access to an area by ATVs or snowmobiles. This can lead to dramatically increased interest in formerly inaccessible areas, which in turn can result in increased pressure on environmental resources, such as local fish populations.

3.5.2.2 Interior Plateau

The issue of particular concern in the Interior Plateau is the sustainability of Arctic grayling. Bull trout distribution is generally restricted to over-wintering of adults in large mainstem rivers.

Numerous sub-populations of Arctic grayling occur throughout the eastern portion of the study area in apparent geographic and genetic isolation from each other and from foothills populations. Grayling populations can occur in accessible tributary drainages that originate on well-drained uplands and provide riffle-pool habitat configurations with gravel/cobble substrates. Portions of the upper Beatton, upper Milligan, upper Chinchaga, upper Kahntah, Trutch, and Klua drainages support such populations. Streams in this portion of the study area have low-to-moderate average gradients, and relatively high concentrations of suspended sediment caused by fast weathering of sedimentary parent materials. Yearling and post-yearling juvenile grayling in plains populations generally make significant upstream feeding movements during the summer, and can be found in abundance at the headwaters of suitable tributary drainages upstream of the distribution limits of other species.

Plateau wetland and muskeg complexes dominate much of the northeast portion of the Interior Plateau. Streams occurring in these areas typically originate on organic peat lands, and are characterized by meandering large-channel morphologies, average gradients less than 0.5%, and substrates composed of fines and organic accumulation. Beaver activity is extensive, with large segments of stream modified into series of dams and impoundments that are interrupted by sections of muskeg seepage and discontinuous channel. These habitats typically have low sensitivity to disturbance due to the dominance of sediment and organic substrates, and extremely low potential for erosion due to low gradient and discharge velocity. Suitability for most fish species is restricted by low habitat diversity, high summer temperatures, low dissolved oxygen levels, absence of winter discharge, and lack of seasonal access. Drainage systems within these muskeg complexes often support resident populations of brook stickleback and finescale dace. Due to their tolerance of high water temperatures and low dissolved oxygen levels, these two species are often extremely abundant and widespread in low-sensitivity, marsh-like habitats where no other fish species are able to survive. They successfully over-winter in beaver impoundments and other small bodies of water where little or no flow is present.

3.5.2.3 Muskwa-Kechika Management Area

Within the MKMA, the issue of particular concern is the sustainability of bull trout. While Arctic grayling distribution spans the width of the entire study area, their presence in the more mountainous MKMA section, including the areas typically occupied by bull trout, is largely restricted to the post-spawning, over-summering of mature adults. Current and historical sampling data and limited radio-telemetry data suggest that adult Arctic grayling in the MKMA portion of the study area spawn in the warmer, more turbid tributaries along the eastern boundary before moving farther west into clearer, cooler, mountain-fed streams and rivers for the summer (T. Euchner, pers. comm.). Rearing juvenile grayling are rarely found in the low-turbidity systems of the mountains and foothills that are frequented by juvenile bull trout.

Bull trout are largely confined to the low-turbidity, moderate-gradient systems that flow east from the Rocky Mountains and Rocky Mountain Foothills to meet the Halfway, Prophet, Muskwa, and Liard Rivers. Streams in this zone typically originate in mountainous areas where comparatively high landform stability and low soil erodability result in low suspended solids concentrations. This relatively clear water provides mature bull trout with the silt-free, gravel substrates required for successful fall spawning and winter incubation.

Following spawning, bull trout eggs incubate in gravel substrates for up to eight months (September-April) before hatching. During this period, redd sites must remain silt-free and receive a constant supply of oxygenated water, regardless of flow conditions. Ground water upwelling within the stream channel may be an important factor in maintaining this consistency. Since these conditions are closely associated with the geology of more mountainous terrain, bull trout distribution does not extend into the eastern portion of the management area, except in the case of adult mainstem over-wintering habitat. Critical spawning habitat for migratory bull trout populations is known to occur in the Graham, Cypress, Chowade, upper Halfway, Besa, Prophet, Muskwa, Gathto, and Tuchodi drainages. Juvenile bull trout (yearling to three-year age classes) appear to disperse widely into small tributary and headwaters habitats within these natal watersheds.

In contrast to portions of the Interior Plateau section of the study area, the exceptionally high recreational values in the MKMA may intensify pressure on local fisheries resources as visitors drawn to the area for hiking and hunting pursue angling as a secondary activity.

Within the study area, the MKMA is of particular value as a recreational area. Activities including hiking, angling, camping, and backcountry cycling may be pursued in a pristine setting. Part of the backcountry experience is the appreciation of clear, cool streams and lakes that are not affected by disturbance. Glacial turbidity is recognized as part of high water quality in the alpine, but turbidity produced from land or industrial disturbance can greatly reduce the aesthetic characteristics of mountainous settings. Hence, an important issue specific to the MKMA is the maintenance of high-quality steams and lakes that are not disturbed by bank or soil instability resulting from industrial activity. The issue here is recognition of high aesthetic values of aquatic systems that inherently demand no effects of land disturbance or industrial wastewater discharge.

3.5.3 Valued Components

During the process of defining issues associated with cumulative impacts to aquatic ecosystems in the study area, several valued ecosystem components were identified (Table 3-2). A number of common themes are evident in the VECs associated with fish. Limiting human access to streams and lakes is a recurring issue in terms of its effect on over-exploitation of bull trout and grayling. Maintenance of physical habitat structure and presence of stable flow of high quality water is also important. While there is an issue of maintaining rearing and spawning habitat, protecting migration routes used by bull trout is of equal importance. Protecting riparian zones along streams and littoral zones around lakes is an issue because of the risk of disturbance to these sites, particularly during oil and gas exploration activity, and forest harvesting.

In selecting specific VECs for the study area, the appropriateness of an individual fish species was determined by identifying the priority of cumulative effects issues, identifying good indicators for these effects, and determining how these effects can be estimated or measured.

Therefore, while a species may be considered regionally significant, if it occurs at low densities or has a restricted distribution, it may not be an appropriate VEC. An example of this selection criterion is chum salmon (*Oncorhynchus keta)*, which only occurs at low densities in the Liard River system within the study area (Haas 1998). Without negating the need for conservation measures to protect chum, the species would not meet the criteria of being a readily measurable VEC. McLaren et al. (1998) list several conditions that must be met in selecting wildlife indicator species, including cost-effectiveness in monitoring, and a “reasonable degree of success” in locating the species when sampling.

Table 3-2. Attributes of Aquatic VECs

Issue/VEC	Attributes
Water Quality/Quantity for Human Consumption	• uncontaminated surface and groundwater • stable water supply
Habitat Quality for All Indigenous Fish Species	• unimpeded access for seasonal movements for foraging, overwintering, and spawning • preservation of habitats important to all life-history stages, including upper-reach, juvenile rearing habitats, and mainstem and large-channel over-wintering habitats (e.g., beaver impounded channels that support over-wintering populations of brook stickleback and finescale dace) • maintenance of riparian, instream, and littoral vegetation • maintenance of habitat structure and complexity to meet cover, foraging, and spawning requirements (e.g., large woody debris, boulders, and bedrock) • preservation of stable stream flow regimes, including avoidance of activities that lead to altered hydrology and stream channel
Bull Trout Distribution and Abundance	• unimpeded access for seasonal movements for foraging, overwintering, and spawning • habitat structure to meet cover, foraging, and spawning requirements (e.g., large woody debris, boulders, and bedrock) • stable upper-reach rearing habitats • isolated resident populations in upper portions of watershed • protection from exploitation during vulnerable periods • water quality and quantity to support over-wintering eggs • cold-water species (maintenance of cooler stream temperatures reduces competition with warmer water species (e.g., rainbow trout (*Oncorhynchus mykiss*))
Arctic Grayling Distribution and Abundance	• unimpeded access for seasonal movements for foraging, overwintering, and spawning • habitat structure to meet cover, foraging, and spawning requirements (e.g., large woody debris, boulders, and bedrock) • upper-reach rearing habitats • protection from over-exploitation, particularly during vulnerable periods • sensitivity to water quality (e.g., visual foraging, incubation of eggs)
Critical Habitat Areas	• critical spawning areas for both fluvial and lacustrine spawners • holding areas where aggregations of fish species are found on a seasonal basis
Intact Riparian Communities	• riparian vegetation important for regulating stream temperature, flow regimes, and sediment input, also a source of nutrients • habitat structure and complexity • stable aquatic and terrestrial invertebrate community

The same principle was applied to the selection of representative fish species for this project; those species that occur in sufficient numbers over a large portion of the study area were chosen over species with restricted or localized distribution. This criterion eliminated numerous species, including chum salmon, as potential VECs. In also identifying "habitat quality for all indigenous fish species" as a VEC, it was assumed that the life requisites of other species would be addressed.

Bull trout and Arctic grayling were recognized as VECs in the study area (Figure 3-15 provides observations). While these two species are important sport fish, protection of their habitat indirectly assists in protecting many other indigenous species. Mature fish of both species commonly over-winter in the mainstems of large rivers and the lower reaches of significant tributaries, and they undertake upstream movements to spawning or summering habitats. While both the spring-spawning grayling and fall-spawning bull trout have stringent requirements for water quality, bull trout eggs require stable high quality water flow for a prolonged winter period. Rearing juvenile bull trout and grayling may penetrate the extreme headwaters of their natal tributary systems during summer feeding movements, and are typically present in small streams upstream of the distribution limits of other fish species. Young-of-the-year and yearling bull trout and Arctic grayling may successfully over-winter in relatively small tributary streams where they often survive despite marginal discharge and apparent "frozen down" conditions. These upper-reach, juvenile rearing habitats generally have high potential to be affected by industrial activity, including petroleum exploration and production, forest harvesting, and associated access development.

Cannings and Ptolemy (1998) note that newly emerged grayling fry are susceptible to high stream discharge, therefore, side channel and stream margin habitats are important until the fry have attained sufficient size and strength to move into faster-flowing water. Adults of both species are vulnerable to sudden increases in exploitation as a result of improved human access to summer rearing habitats, in the case of Arctic grayling, and fall staging and spawning habitat, in the case of bull trout. The migratory behaviour of both species demands maintenance of stream networks and access, which also benefits the movements of other species.

As well as being blue-listed by the BC Conservation Data Centre, bull trout are classified as an "identified wildlife species" (IWMS 1999). While only the isolated Williston Watershed population of Arctic grayling is red-listed, on a regional scale, the species is identified by Haas (1998) as requiring "special forestry consideration" since they are highly sensitive to angling pressure and water quality. The Fort St. John LRMP makes specific reference to grayling and bull trout, suggesting they "appear to be diminishing in presence and population size in many watersheds" (Fort St. John LRMP 1997).

3.5.4 Hot Spots

Hot spot polygons represent areas that currently have increased potential for conflict between industrial development and sensitive aquatic resources (Figure 3-16), and do not assume the absence of concern elsewhere. Hot spots derived from Arctic grayling distribution dominate upland portions of the Interior Plateau, while hot spots associated with bull trout presence occur in mountain and foothills terrain in the southwest portion of the study area.

3.6 Vegetation

3.6.1 Setting

The Interior Plateau is almost exclusively covered by the Boreal White and Black Spruce (BWBS) biogeoclimatic (BEC) zone (Meidinger and Pojar 1991), with the Spruce-Willow-Birch (SWB) and Engelmann Spruce-Subalpine Fir (ESSF) BEC zones found at elevations above 1300 m (Delong, Annas and Stewart 1991) (Figure 3-17). Extensive, well-drained forests of the plateau are characterized by frequent fires that result in a matrix of mixed coniferous and deciduous species at various successional stages. Dense black spruce dominates the poorly-drained muskeg-like portions of the BWBS zone. The southern portion of the region has well-drained alluvial sites that are productive from a forest or agriculture perspective. Extensive networks of wetlands and shallow lakes connected by riparian areas and floodplains are common high-value components of the landscape. Engelmann spruce and subalpine fir forests are found at higher elevations (up to 1700 m) in the southern portion of the plateau, but are replaced by the Spruce-Willow-Birch zone at similar elevations in northern regions of the plateau.

Due to its topography, the MKMA is dominated by the Spruce-Willow-Birch (SWB) BEC zone. White spruce and subalpine fir are the dominant species of this zone. The Boreal White and Black Spruce BEC zone is found in the lower elevation valleys, while the Alpine Tundra zone occurs at higher elevations of the management area.

Boreal White and Black Spruce zone

Major trees species in the BWBS include white spruce, trembling aspen, lodgepole pine, black spruce, balsam poplar, larch, tamarack, subalpine fir, common paper birch and Alaska paper birch (Delong, Annas and Stewart 1991).

Dry sites (BWBS dk) are dominated by white spruce and lodgepole pine with soopolallie or soapberry in the shrub layer, and bastard toad-flax in the herb layer. The moister subzone (BWBS mw) commonly has white spruce, trembling aspen and lodgepole pine in the overstory. Understory species which distinguish this subzone from others include creamy peavine, tall bluebells, northern bedstraw and common miterwort. The wet, cool BWBS wk subzone is differentiated from the other subzones by the presence of subalpine fir and black huckleberry (Delong, Annas and Stewart 1991).

Spruce-Willow-Birch zone

White spruce and subalpine fir dominate lower elevations of this poorly studied zone. No subzones are distinguished. Pine and aspen occur in valley bottoms and on lower slopes, while scrub birch and several willow species dominate poor nutrient and moderate nutrient upper elevation sites, respectively (Pojar and Stewart 1991).

Engelmann Spruce-Subalpine Fir zone

The provincial extent and regional diversity of the ESSF zone, which is comprised of fifteen forested and fifteen parkland subzones, makes it impossible to easily summarize its characteristic vegetation. In general, ESSF forests are dominated by Engelmann spruce and subalpine fir except where lodgepole pine has established after fire. ESSF parkland can be comprised mainly of heathers in the high elevations with late snow melt, while more sheltered, moist subalpine meadows can be dominated by herbaceous species such as sitka valerian, Indian hellebore, arrow-leaved groundsel, subalpine daisy and arctic lupine (Coupe, Stewart and Wikeem 1991).

3.6.2 Issues

Oil and Gas

In general, oil and gas development may have substantial effects on vegetation in the region. Direct effects occur in the form of plant structural and successional changes due to clearing, and to topography changes associated with the construction of seismic lines, well pads, production facilities, infrastructures, and pipelines. Indirect effects can include successional changes, or reduced plant health due to increased soil acidity, drainage pattern changes, and industry-related air emissions.

Seismic lines are long, linear disturbances that affect plant communities due to clearing and habitat fragmentation. Severe damage to soils and vegetation allows for the introduction of alien or noxious species as the plant community is shifted to an earlier successional stage. If seismic lines are put in through wetlands, hydrological changes may occur, and the ratio of wetlands to uplands may be altered due to vegetation clearing.

Road construction, site clearing, camp construction, and well site flaring are the primary activities undertaken during exploration drilling. Their effects on vegetation are similar to those of seismic line development except for the linear nature of seismic lines. Additional impacts on vegetation from exploration drilling includes deteriorating plant health from air-borne pollution, road salting during the winter, and dust deposits from road traffic.

Hydro-electric

Vegetation can be severely affected by hydro developments, particularly dam-associated flooding. Additional effects are incurred through the construction of roads and infrastructures needed to maintain hydro facilities, and through changes in water levels and flows due to reservoir operations. Changes in the timing and availability of water can affect plant community composition, or cause shifts to a different site-series association.

Mining

Development of access routes to large mining operations can have considerable impacts on vegetation due to clearing and habitat fragmentation. Open pit mining tailing depositions can have severe impacts on vegetation in the development footprint, but will have a relatively minor effect compared to strip-mining operations.

Forestry

The forest industry has a major influence over the land-base of the region, hence the impacts of forestry operations can be severe, especially if there is little or no co-ordination among tenure holders. Forestry-related impacts on vegetation include habitat fragmentation, the creation of edge-effects due to cutblock development, and the creation of patch sizes that are inconsistent with the natural disturbance patterns of the region. Additionally, vegetation structure, function, and composition are affected by harvesting activities, while early successional vegetation patterns dominate in cut-overs.

Transportation Development, Repair, and Maintenance

Roads can effectively be hard boundaries to plant distributions, which can lead to potential isolation of populations. Long, linear, main roads, and resource trunk roads and spurs are ubiquitous fragmenting agents on the landscape. Roads increasingly isolate patches of remaining forests, and can cause changes in forest vegetation due to increased light intrusion, increased ruderal species presence, and reduced microsite effects that extend into nearby forests (i.e., cause edge effects). Additionally, grading, dust deposition and salt application commensurate with road maintenance and repair can affect roadside vegetation by reducing photosynthetic capability or by removing salt-intolerant species. These effects can also facilitate the incursion of noxious weeds and alien species into previously pristine areas. Herbicide and agro-seed applications on road and rail RoWs are particularly damaging to vegetation.

Agricultural Land Conversion and Urban Sprawl

Agriculture and urban development have severe and often permanent effects on vegetation as land conversion removes all or most of the existing natural vegetation. Agriculture fields and urban landscaping projects can also be sources of escaped plant species that result in noxious weed invasions of nearby areas. Additionally, agricultural crop and residential yard management can have downstream effects on water and soil due to water use, and herbicide and fertilizer applications.

Tourism and Recreational Activities

The current effects of tourism and recreational development in the region are low, but have potential to become greater in the future. New roads and infrastructures are normal precursors to the development of facilities such as fishing or ski lodges, and can cause losses of native vegetation due to clearing. Additional and increasing impacts from ATV or other off-road use can inhibit natural vegetation regeneration, and can keep RoWs open rather than allowing them to re-vegetate over time. Increased access to remote areas can also increase the risk of human-caused forest fires.

3.6.3 Valued Components

The identification of vegetation VECs (Figure 3-18) was based on Broad Ecosystem Unit (BEU) types and structural stage values from the 1:250,000 Broad Ecosystem Inventory (BEI) (RIC 1998). There are 33 BEU types within the study area. To simplify VEC selection at this scale, these BEU types were grouped into six vegetation types: forests greater than 140 years old (‘old-growth’); forests 140 years old or less; alpine; wetlands; parkland; and non-vegetated (e.g., cultivated field, rock, gravel bar).

Old-growth forests, wetlands[3], and any regionally rare BEU types were considered to be VECs because they may be susceptible to fragmentation or complete removal, and may contain regionally unique plants species. Additionally, old-growth forests were considered to be a VEC because they are comprised of unique, late succession plant community types, and typically provide high value wildlife habitat and timber harvesting

3 Although, large areas of wetlands occur east of the Alaska Highway, wetlands are sensitive ecosystems that are highly susceptible to disturbance. The presence of large wetland areas in some parts of the region does not negate this sensitivity.

opportunities. Old-growth boreal forests are also considered to be important carbon sinks. Wetland plant communities were considered to be a VEC because they may contain rare plant species, and are highly sensitive and susceptible to disturbance due to recreational and resource use activities.

3.6.4 Hot Spots

Vegetation hot spots (Figure 3-19) tend to be concentrated along linear developments such as highways and rail lines. Most of these hot spots occur within the Interior Plateau; the greatest concentration of those in the Taiga Plains. The hot spots here tend to be concentrated along Highways 77 and 97, and along the rail line that follows the Fort Nelson River. A large hot spot area on the Etsho Plateau is associated with concentrated block developments (i.e., well sites). Within the Northern Boreal Mountains, hot spots occur mainly around the Liard River and on the southern portion of the Liard Plateau. In the southern portion of the Interior Plateau, hot spots tend to be concentrated along the eastern and western portions of the Boreal Plains. Both of these areas are highly disturbed. The lack of hot spots in the Fort St. John region is likely a result of conversion of native vegetation to agricultural crop development.

3.7 Wildlife

3.7.1 Setting

The study area supports a large number of resident wildlife species, and includes the migratory routes of numerous bird species. The large mammals of the region have received considerable attention with respect to inventory, and in more recent years, research efforts have been initiated on topics such as habitat use patterns and predator-prey dynamics. The large size and general remoteness of the study area, however, means that for many species, in particular those that are cryptic or of low economic profile, data on distribution, abundance, and ecology are limited.

Issues for key wildlife that are considered to be of concern with respect to cumulative effects in the study area are provided in Tables 3-3 (mammals) and 3-4 (birds). Selection of these species is based on federal (COSEWIC) or provincial status designations, or economic and/or public profile value. Information on conservation status, study area distribution and abundance, and socio-economic value is also provided. The key bird species group was further defined by including only species known to breed in the study area. No amphibians or reptiles met the criteria for key species in this region. Not included for consideration as key species were insects, although it is important to note that there are many blue-listed species and some red-listed species in the study area.

Table 3-3. Key Wildlife (Mammals)

Key Species	Conservation Status	Study Area Distribution and Abundance	Socio-economic Values
Woodland Caribou	Provincial: blue (boreal and northern mountain populations) Federal: boreal population – threatened; mountain population – special concern	Found throughout the study area at low densities, or in small isolated herds[1]	Hunting, wildlife viewing
Wood Bison	Provincial: red Federal: threatened	MKMA: not present Interior Plateau: small reintroduced populations found: a) on west side of the Liard River near the NWT border south toward the confluence of the Liard and Crow Rivers; b) on north side of Liard River; c) in the Etthithun Lake-Kahntah River headwaters area; and d) extending into BC from a herd in the Hay-Zama region of northwestern Alberta[2]	Wildlife viewing
Plains Bison[3]	Provincial: blue Federal: not listed	One population on the boundary of the MKMA and the Interior Plateau. Found west of Sikanni Chief and Pink Mountain, in an area extending from the south side of the Halfway River to just north of Trimble Lake and the Sikanni Chief River[4]	Hunting, wildlife viewing
Moose	Provincial: yellow	MKMA: generally low to moderate densities[5] Interior Plateau: generally low density in extreme northeast, moderate to high densities elsewhere[2]	Hunting, wildlife viewing
Stone's Sheep	Provincial: yellow	MKMA: throughout Interior Plateau: small herds found along cliff banks of lower sections of the Buckinghorse and Sikanni Chief Rivers and adjacent tributaries.[6] Also found in similar habitats in the Liard drainage[2]	Hunting, wildlife viewing

[1] Shackleton 1999, Dzus 2001
[2] Shackleton 1999, Harper et al. 2000
[3] Introduced
[4] Shackleton 1999
[5] Shackleton 1999
[6] MacGregor 1977, Hebert and Smith 1986, Poole and Fear 1998

Key Species	Conservation Status	Study Area Distribution and Abundance	Socio-economic Values
Mountain Goat	Provincial: yellow	MKMA: throughout Interior Plateau: small herds found along cliff banks of lower sections of the Buckinghorse, Sikanni Chief and Boat Rivers and adjacent tributaries[2]	Hunting, wildlife viewing
Rocky Mountain Elk	Provincial: yellow	Widely distributed in Peace River area – as far north as the Liard Plateau and south along the Kechika valley and west to headwaters of the Major Hart and Turnagain Rivers[2] Densities generally sparse throughout, but there are a few high density areas near Fort St. John and in the Prophet River vicinity[2]	Hunting, wildlife viewing
White-tailed Deer	Provincial: yellow	MKMA: marginal along eastern boundary; low density[2] Interior Plateau: low density along Fort Nelson and Peace Rivers and their tributaries to as far north as the Liard River[2]	Hunting, wildlife viewing
Rocky Mountain Mule Deer	Provincial: yellow	Sparsely distributed up into the Liard River area and east through the Peace area to the Alberta border[2]	Hunting, wildlife viewing
Grizzly Bear	Provincial: blue Federal: special concern	MKMA: throughout; low density Interior Plateau: sparsely distributed in the foothills and across the border into Alberta. Densities in this zone range from 104 to 420 km^2 per bear [7]	Hunting, wildlife viewing
Black Bear	Provincial: yellow Federal: not at risk	Throughout; low to moderate abundance	Hunting, trapping, wildlife viewing
Wolf	Provincial: yellow	Throughout	Trapping, hunting, wildlife viewing
Wolverine	Provincial: blue Federal: special concern (western population)	Throughout; low density	Trapping, hunting
Lynx	Provincial: yellow Federal: not at risk	Throughout; abundance variable	Trapping, hunting
Fisher	Provincial: blue	Throughout; uncommon	Trapping
Marten	Provincial: yellow	Throughout	Trapping

[7] Banci 1991

Key Species	Conservation Status	Study Area Distribution and Abundance	Socio-economic Values
Aquatic Furbearers (beaver, muskrat)	Provincial: yellow	Throughout; abundance variable	Trapping
Red Squirrel	Provincial: yellow	Throughout; abundance variable	Trapping
Snowshoe Hare	Provincial: yellow	Throughout; abundance variable	Trapping, hunting,
Northern Long-eared Bat	Provincial: blue	Western extreme of range. Found at sites in the Prophet, Peace and Liard River areas[8]. More common in northern BC than previously thought[9]	

[8] Nagorsen and Brigham 1993, Crampton et al. 1997, Cannings et al. 1999
[9] Wilkinson et al. 1999, Vonhof and Wilkinson 1999

Table 3-4. Key Wildlife (Breeding Birds)

Key Species	Conservation Status	Study Area Breeding Distribution and Abundance[10]	Socio-economic Values
Short-eared Owl	Provincial: blue Federal: special concern	MKMA: unlikely Interior Plateau: possible	Wildlife viewing
Peregrine Falcon (*anatum* subspecies)	Provincial: red Federal: threatened	MKMA: unknown Interior Plateau: little information; a few breeding records exist	Wildlife viewing
Bald Eagle	Provincial: yellow Federal: not at risk	Local breeder throughout	Wildlife viewing
Ruffed Grouse	Provincial: yellow	Throughout	Hunting, wildlife viewing
LeConte's Sparrow	Provincial: blue	MKMA: unlikely Interior Plateau: small numbers – most common in Boreal Plains; few breeding records	Wildlife viewing
Nelson's Sharp-tailed Sparrow	Provincial: blue Federal: not at risk	MKMA: unlikely Interior Plateau: little known, most common in Boreal Plains; few breeding records	Wildlife viewing
Bay-breasted Warbler	Provincial: red	MKMA: possibly in foothills Interior Plateau: small numbers – most common in Boreal Plains; few breeding records	Wildlife viewing
Cape May Warbler	Provincial: red	MKMA: possibly in foothills Interior Plateau: throughout; most common in Taiga Plains; few breeding records	Wildlife viewing
Black-throated Green Warbler	Provincial: blue	MKMA: possibly along eastern slope Interior Plateau: likely throughout, most common in Boreal Plains; few breeding records	Wildlife viewing
Canada Warbler	Provincial: blue	MKMA: unlikely Interior Plateau: may be more abundant than thought, most common in Boreal Plains; few breeding records	Wildlife viewing

[10] Campbell et al. 1990a, Campbell et al. 1990b, Campbell et al. 1997, Campbell et al. 2001

Key Species	Conservation Status	Study Area Breeding Distribution and Abundance[10]	Socio-economic Values
Connecticut Warbler	Provincial: red	MKMA: unlikely Interior Plateau: small and localized populations, most common in Boreal Plains; few breeding records	Wildlife viewing
Philadelphia Vireo	Provincial: blue	MKMA: unlikely Interior Plateau: likely more widespread than is known, most common in Boreal Plains; few breeding records	Wildlife viewing
Sandhill Crane	Provincial: blue Federal: not at risk	MKMA: does not breed here Interior Plateau: small numbers breed near Fort Nelson	Wildlife viewing
Upland Sandpiper	Provincial: red	MKMA: unlikely Interior Plateau: two breeding records in fallow agricultural fields in the Fort St. John area	Wildlife viewing
Trumpeter Swan	Provincial: blue Federal: not at risk	MKMA: unlikely Interior Plateau: local but widespread breeder	Wildlife viewing
Canada Goose	Provincial: yellow	Throughout	Hunting, wildlife viewing
Mallard	Provincial: yellow	Throughout	Hunting, wildlife viewing
Surf Scoter	Provincial: blue	MKMA: unlikely Interior Plateau: occasional	Wildlife viewing

3.7.2 Issues

The oil and gas exploration and development activities which are generally considered to have the most significant effects on wildlife are: seismic line development; temporary and permanent access road construction; camp construction and operation; drill site activity and operation; well site and production plant activity and operation; and pipeline construction and operation. The primary cumulative effects issues for wildlife associated with these activities are:

- habitat loss and fragmentation due to vegetation clearing and alteration of seral structure (post-reclamation or site decommissioning);
- reduced effectiveness of available habitat due to sensory disturbance (e.g., vehicle traffic, helicopter overflights, production plant operation);
- increased direct mortality due to increased human (hunters and poachers) and predator access; destruction of nests, dens or hibernacula (during construction phase); potential health impacts associated with project-related contaminants; collisions with vehicles; and problem wildlife incidents (associated with camps); and
- disruption of movements due to vegetation clearing and increased human and predator access.

Additionally, activities in other sectors may contribute to the cumulative effects from oil and gas exploration and development. These activities may include hydroelectric development; mining; forestry; transportation corridor development, repair and maintenance; agricultural land development; hunting; urban sprawl; and tourism and recreation. Of these, forestry and hunting are the most likely activities to result in impacts that contribute to those from the oil and gas sector due to the nature of their effects and the overlapping geographic areas of interest.

Species-specific effects of oil and gas exploration and development are described below for key species. In general, for all these species, there is a lack of information on the impacts of oil and gas exploration and development as it occurs in the study area.

3.7.2.1 Ungulates

Woodland Caribou (*Rangifer tarandus caribou*): Woodland caribou may be exposed to increased wolf predation as a result of industry-related disturbances, not only because of facilitated predator access along linear corridors, but also because an increase in early successional habitats supports higher densities of moose and deer, which in turn, support an increased density of wolves (Rettie and Messier 1998, Rettie 1998). Caribou tend to avoid roads and seismic lines (Jalkotzy et al. 1997, Dyer 1999). This avoidance seems to be greatest in late winter (Dyer 1999). Buried pipeline RoWs did not appear to be a barrier to caribou movements, although some avoidance was observed (Jalkotzy et al. 1997). Caribou avoided recently fragmented (by logging) areas in west central Alberta by average distances of 1.2 km (Smith et al. 2000). Much of the work examining the impacts of oil and gas development on barren-ground caribou may also have application to the woodland caribou.

Wood Bison (*Bison bison athabascae*): Wood bison are known to congregate along RoWs that are seeded with sedges (Gates et al. 2001). Oil and gas development can increase meadow and grassland habitat, and it has been suggested that the recovery of bison populations may be facilitated by these activities (Gates et al. 2001). There does not yet appear to be any studies that have specifically addressed the impacts of oil and gas exploration and production on this species (Carbyn et al. 1998), although disturbance effects may be similar to those noted for other ungulates. A trial project is underway to establish a population of wood bison on an oil sands lease area north of Fort McMurray (Gates et al. 2001).

Plains Bison (*Bison bison bison*): The plains bison population was introduced to the study area when individuals escaped from a farm in the Pink Mountain area in the early 1970s (Shackleton 1999, MELP 2000). This population is a potential threat to the genetic integrity of wood bison in the region (Shackleton 1999). There is no information available on the impacts of oil and gas development on this species, although disturbance effects are likely similar to those observed for wood bison and other ungulates. For example, the risk of wolf predation and unregulated harvest may increase with increased road access into the bison's range.

Moose (*Alces alces*): Moose habitat use near roads associated with oil and gas development may be significantly reduced (Jalkotzy et al. 1997). In central Alberta, moose were located farther from roads than expected between November and January, and they avoided well-traveled roads approximately one-third more often than less-traveled roads (Rolley and Keith 1980). Linear corridors have also been shown to increase wolf predation on moose (James 1999). Alternately, these developments may sometimes enhance moose habitat as linear corridors through a closed forest will open the canopy, create edges, encourage shrub growth, and facilitate moose movements (Jalkotzy et al. 1997). Several studies have found that pipelines affect moose movement patterns. Buried pipelines without berms were not a barrier; however, elevated pipelines or berms did result in deflection or avoidance (Jalkotzy et al. 1997). Other factors that might influence moose crossings of pipelines include snow accumulation and clearing; human activity; and sex and reproductive status (Fraker and Green 1994).

Stone's Sheep (*Ovis dalli stonei*): Habitat fragmentation and increased road access might affect Stone's sheep, but there is little specific information available for this species[1] (Paquet and Demarchi 1999). The small riverside populations outside the MKMA are potentially vulnerable to habitat disturbance and hunting pressure because of limited escape terrain and ease of human access (Poole and Fear 1998). Studies of disturbance effects on Dall's sheep, mountain goats, and bighorn sheep may be applicable to Stone's sheep (Paquet and Demarchi 1999).

Mountain Goat (*Oreamnos americanus*): Mountain goats seem to be particularly susceptible to disturbance by irregular loud noises, industrial activities, road construction and traffic, snowmobiles, and low-flying aircraft, particularly helicopters (Pendergast and Bindernagel 1977, Foster and Rahs 1983, Nietfeld et al. 1984, Singer and Doherty 1985, Penner 1988, Côté 1996). Adverse reactions to helicopters can affect a goat's

1 Anecdotal information provided by guide outfitters at pre-tenure plan workshops for the MKMA have suggested that Stone's sheep are very susceptible to disturbance from access and human activity in a manner similar to mountain goats.

physiological condition (Côté 1996), and may indirectly affect survival and reproduction (Joslin 1986). Close approaches by a helicopter can also result in injury or death on steep terrain (Côté 1996). Habituation to disturbance appears most likely when the sources of disturbance are localized and highly predictable (Penner 1988). Goats may show greater tolerance to road traffic and humans on foot during summer than in winter (Benzon and Rice 1987). Seismic lines running along the top of cliffs occupied by goats could facilitate access by wolves, and thus, increase predation rates (Seip and Cichowski 1996). As noted for Stone's sheep, small riverside populations outside the MKMA may be vulnerable to habitat disturbance and hunting pressure because of limited escape terrain and ease of human access (Poole and Fear 1998).

Rocky Mountain Elk (*Cervus elaphus nelsoni*): Elk have been shown to avoid roads in many areas (Ferguson and Keith 1982). A study of the effects of an oil well on elk in Montana suggested that the animals compensated for site-specific environmental disturbance by shifting their range use, activity centres, and habitat use, rather than by abandoning their range (Van Dyke and Klein 1996). Behavioural changes designed to avoid disturbance may continue even after the disturbance has been terminated (Van Dyke and Klein 1996).

White-tailed Deer *(Odocoileus virginianus)*: Although there does not appear to be any specific information on the effects of oil and gas exploration and development on the white-tailed deer, it is likely that wolf predation risk would increase. The white-tailed deer may adapt to roads by avoiding nearby habitats where traffic noise inhibits predator detection, and by selecting advantageous routes and times to cross roads (Forman and Deblinger 2000). This species may accommodate some level of human disturbance on the ground (e.g., Kernohan et al. 1996); however, physiological disturbance effects of snowmobiles have been demonstrated for this species (Moen et al. 1982), but the impacts of this activity on habitat use can be variable (Richens and Lavigne 1978). The white-tailed deer is expanding its range into the northeast perhaps partly as a result of increased deforestation and agricultural development (Shackleton 1999).

Rocky Mountain Mule Deer (*Odocoileus hemionus hemionus*): Roads generally decrease mule deer habitat value and can disrupt their normal migratory and daily travel routes (Wallmo 1978, Towry 1984). Foraging opportunities along roadsides, and salt on highways often attract deer, and may result in increased mortality (Wallmo 1978). Mule deer reproduction decreased significantly in the year following an experiment on ATV harassment (Yarmoloy 1983). Habituation to some industrial developments may occur. For example, mule deer passed under a coal conveyor when adequate clearance was available, regardless of whether the belt was active or not (Greenwood and Dalton 1984).

3.7.2.2 Large Carnivores

Grizzly Bear (*Ursus arctos*): Grizzly bears are known to be affected by human and industrial activities. High levels of human activity may lead to abandonment of prime habitat, or alteration of behaviour (e.g., increased nocturnal activity), or may act as a movement barrier (Hamer et al. 1977, McLellan and Shackleton 1989, Gibeau and Herrero 1998). Females with young may be particularly susceptible (Interagency Grizzly Bear Committee 1987). Grizzly bears avoided habitats within 100 m of roads, regardless of traffic volume, in a region of southern BC that was under oil development (McLellan and Shacketon 1989). In contrast, some bears were attracted to linear corridors in the Bow River valley, apparently because of the abundance of berry-producing shrubs along the RoWs (Gibeau and Herrero 1998). The location and protection of denning sites has been noted as a primary concern with respect to oil and gas development in grizzly bear habitat (Antoniuk 1994). Helicopter overflights may be a significant problem during den entrance and exit periods (fall and spring, respectively) when bears are in relatively exposed habitats. Oil and gas activities can also lead to direct bear-human interactions. The problems that arise when bears become habituated to human food sources, such as camp garbage, are well-documented (Carr 1989, Herrero 1989, 1985, Craighead and Craighead 1970, Dalle-Molle and Van Horn 1989). Additionally, roads facilitate access by poachers and hunters, the grizzly bear's only predators.

Black Bear (*Ursus americanus*): Generally, black bears show greater adaptability to, and tolerance for, human activities than the grizzly bear, although industrial development can still result in the direct loss or alteration of black bear habitat. Roads and trails associated with resource development activities may be avoided by black bears because of sensory disturbance or increased hunting pressure. Their home ranges have been known to conform to the artificial boundaries imposed by roads and highways (Manville 1983), although bears may also readily cross these same features. Black bears appear to be sensitive to disturbance during the pre-denning phase (Tietje and Ruff 1980, Manville 1983, Horejsi and Raine 1983). This species can also become a serious management problem if it becomes habituated to human food sources (e.g., camp garbage).

Wolf (*Canis lupus*): Wolves generally avoid areas with high road densities, and high levels of human activity (e.g., traffic) and related disturbances (Mech et al. 1988, Thurber et al. 1994, Jalkotzy et al. 1997, Westworth Environmental Associates Ltd. 1998, James and Stuart-Smith 2000). Increased wolf mortality due to vehicle collisions and poaching occurs in areas with high road densities (Mech et al. 1988, Thurber et al. 1994, Jalkotzy et al. 1997, James and Stuart-Smith 2000). Human disturbance (foot traffic, aircraft, vehicles) may result in abandonment of natal dens (Ballard et al. 1987, Jalkotzy et al. 1997). People on foot can disturb wolves up to a distance of 0.8 km, although tolerance varies among packs (Thiel et al. 1998). Unused or rarely used linear corridors (e.g., pipelines, roads, powerlines) provide easy travel routes for wolves and access to ungulate prey (Jalkotzy et al. 1997, Westworth Environmental Associates Ltd. 1998, James and Stuart-Smith 2000).

Wolverine (*Gulo gulo*): Wolverines appear to avoid human settlements (Banci 1994); however, they have been observed feeding in garbage dumps, and are known to occur in the logged forests of the sub-boreal interior of B.C., and in habitats where seismic lines are common (Banci 1994). Wolverines may be particularly sensitive to human disturbance when they have kits. Females have been known to move their young to less secure dens to avoid human contact (Banci 1994, Pulliainen 1968). Human development and major access routes (highways) may function as dispersal barriers (Krebs and Lewis 1999; Kyle and Strobeck 2001). Determining the impacts of agriculture, forestry, and energy development on wolverines is confounded by the effects of mortality from hunting, trapping, and poisoning (Dauphiné 1989), and by the lack of information on the species habitat requirements (Banci 1994). The persistence of wolverine populations appears to depend on the existence of large, unroaded, wilderness refugia (e.g., National Parks) where human activity is limited (Hornocker and Hash 1981, Hatler 1989, Banci 1994, Krebs and Lewis 1999).

3.7.2.3 Furbearers

Lynx (*Lynx canadensis*): There is some evidence that roads may influence lynx movements (Clayton 2000), but there is also evidence that they will cross highways and openings (Mowat et al. 2000), perhaps depending on width and availability of cover (Todd 1985). Lynx occasionally hunt or travel along seismic lines (Riewe 1980), and have been reported to follow road edges and forest trails for considerable distances (Parker 1981). In northern Canada and Alaska, anecdotal evidence suggests that lynx will tolerate moderate levels of snowmobile traffic through their home ranges (Mowat et al. 2000). In western Alberta, lynx frequently crossed a pipeline RoW prior to construction, but almost completely avoided the area during the construction period (Morgantini 1984). Lynx have been found to persist mainly in isolated, untrapped refugia during low points in the population cycle, and increased access or other disturbances to such areas could negatively affect subsequent population recovery (Todd 1983, 1985). Habitat fragmentation tends to increase competition between lynx and generalist predators, such as coyotes and cougars (Buskirk et al. 2000).

Fisher (*Martes pennanti*): Fishers have been shown to seldom travel along roads or powerline RoWs (Johnson and Todd 1985). While they apparently avoid linear corridors during construction activities, they may not significantly shift their territories in response to post-construction levels of activity (Morgantini 1984, Eccles and Duncan 1987). Fishers are considered curious by nature, but their usual reaction to the presence of humans seems to be avoidance (Jalkotzy et al. 1997). However, Johnson and Todd (1985) suggest that the rarity of sightings may actually be the result of their relative scarcity rather than actual avoidance behaviour. Little is known about the impacts of forest removal activities, such as seismic clearings, on the fisher's use of forest edges (Fenske-Crawford and Niemi 1997).

Marten (*Martes americana*): Marten are known to be sensitive to intense human disturbance, but they may be able to adapt to less intense disturbances (e.g., selective logging) (Koehler et al. 1975, Soutière 1979). Many studies, including one in the Prophet River area (Poole and Stanley 1998), have reported that marten respond negatively to habitat fragmentation (e.g., Steventon and Major 1982, Hargis et al. 1999, Potvin et al. 1999). No consistent response to linear development has been demonstrated, but there is some evidence that crossings are generally avoided or attempted unsuccessfully (Eccles and Duncan 1986, Jalkotzy et al. 1997, Robitaille and Aubry 1999). Several studies have reported that marten occasionally cross large openings (e.g., 50 to 200 m), although they generally will stop only in areas with cover (Koehler et al. 1975, Soutière 1979, Hargis and McCullough 1984).

Aquatic Furbearers: There has been little study of the impacts of oil and gas exploration and production on the beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*). Potential impacts on these species might be expected if there were localized hydrological regimes alterations (e.g., artificial damming). Research on the Mackenzie Delta found that seismic activity resulted in short term reductions in muskrat activity levels, but apparently did not affect daily activity patterns, number of daily movements, or use of houses (Westworth 1980). Habitat alterations that result in deciduous regeneration can produce high quality beaver habitat (Slough and Sadleir 1977, Poole 1998, Slough 1988, Barnes and Mallik 2001).

Red Squirrel (*Tamiasciurus hudsonicus*): The red squirrel does not seem particularly sensitive to disturbance. The species did not avoid forested habitats adjacent to the Norman Wells-Zama pipeline in the NWT (Eccles and Duncan 1987), and it was found to be abundant in forests fragmented by agriculture in north central Saskatchewan, although it was less abundant in small fragments (Bayne and Hobson 2000). Any potential impacts would be most severe during periods of poor cone production.

Snowshoe Hare (*Lepus americanus*): Snowshoe hares do not appear to be particularly sensitive to disturbance, provided their requirement for dense cover is met (e.g., Thompson et al. 1989). Studies in Alberta (Windberg and Keith 1978) and Wisconsin (Keith et al. 1993) suggest that hares persist in fragmented habitats, although survival may be lower in very small patches (e.g., 5-15 ha). In a study along the Norman Wells-Zama pipeline in the NWT, there was less use of the pipeline clearing, but no consistent use pattern (less or more) for the undisturbed habitat adjacent to the clearing (Eccles and Duncan 1987). Since predation is the most important source of mortality among snowshoe hares (Hodges 2000), and predation risk may have indirect effects on hare reproduction and survival (Hik 1995, Boonstra et al. 1998), any development activities that increase predator numbers or access may have important consequences for hare populations.

3.7.2.4 Small Mammals

Northern Long-Eared Myotis (*Myotis septentrionalis*): This bat is known to be particularly vulnerable to disturbance at the juvenile stage and during the winter (Caceres and Pybus 1997). During hibernation, disturbance effects may deplete this species' limited energy stores (Speakman et al. 1991, Thomas 1995, Caceres and Pybus 1997), and any changes to the internal environment of a hibernaculum may result in its abandonment (Caceres and Pybus 1997). The ecology of this species is little known (Caceres and Pybus 1997), and there is no research available regarding potential impacts of oil and gas exploration and development.

3.7.2.5 Birds

Raptors and Owls

Three key species were identified for this group: Short-eared Owl (*Asio flammeus*), Peregrine Falcon (*Falco peregrinus anatum*), and Bald Eagle (*Haliaeetus leucocephalus*). Development activities such as agriculture (e.g., wetland drainage), urban expansion, forestry, and mining have eliminated or alienated important habitat for these species throughout their ranges (Brownell and Oldham 1985, Holt and Leasure 1993, Cadman 1994, Rowell and Stepinsky 1997, Buehler 2000, Clayton 2000). Linear developments may negatively impact raptors through the loss and fragmentation of habitat, collisions with overhead wires and vehicles, and direct human disturbance (Postovit and Postovit 1987, Williams and Colson 1987, Watson 1993), but for most species, the effects of oil and gas exploration and development are little known and poorly understood.

Game Birds

The Ruffed Grouse (*Bonasa umbellus*) was the only key species selected for this group. This species tends to avoid homogenous habitats and areas inhabited by humans (Campbell et al. 1990b). There appears to be little information available on the effects of oil and gas exploration and development on this species, although there may be health risks associated with ingestion of, and dermal contact, with contaminated soils. Similar species are known to be vulnerable to disturbance. For example, human presence may displace Sharp-tailed Grouse (*Tympanuchus phasianellus*) from lek sites, although they are also known to habituate to various activities (e.g., road construction) (Baydack and Hein 1987, Connelly et al. 1998).

Passerines

Eight key passerine species were identified: Philadelphia Vireo (*Vireo philadelphicus*), Cape May Warbler (*Dendroica tigrina*), Black-throated Green Warbler (*Dendroica virens*), Bay-breasted Warbler (*Dendroica castanea*), Canada Warbler (*Wilsonia canadensis*), Connecticut Warbler (*Oporornis agilis*), LeConte's Sparrow (*Ammospiza leconteii*), and Nelson's Sharp-tailed Sparrow (*Ammodramus caudacutus nelsoni*). Unlike forestry-related activities, the impacts of oil and gas development on passerines have not been widely studied (William 1996, Cooper et al. 1997b, Norton 2001).

Obviously, habitat loss is a potential problem for any of these species. Habitat fragmentation is also a concern for many species. For example, the occurrence of the Connecticut Warbler in the aspen-parkland of Saskatchewan was positively related to aspen grove size and negatively related to grove isolation (Johns 1993, Bayne and Hobson 2000). Forest fragmentation (and resultant increase in edge habitat) can result in an increase in predation and nest parasitism (Bull and Jackson 1995, Moskoff and Robinson 1996, Cooper et al. 1997a). There was, however, apparently no effect of increasing seismic line development in Alberta's boreal forest on the Bay-breasted Warbler, despite the increase in habitat fragmentation (Cooper et al. 1997b, Norton 2001b). Air pollution from sour gas plants can affect the growth of deciduous trees by increasing disease frequency, and thus, indirectly reduce nesting habitat suitability for some passerines (Cooper et al. 1997b). There are also apparent mortality risks for Bay-breasted Warbler populations that are in the immediate vicinity of oil and gas plants that are producing SO_2 emissions (Cooper et al. 1997b).

Shorebirds

Two shorebirds were identified as key species: Upland Sandpiper (*Bartamia longicauda*) and Sandhill Crane (*Grus canadensis*). The major concern for shorebirds is the loss or alteration of wetland habitats that are critical to breeding and migration. The effects of oil and gas exploration and development on shorebirds are essentially unknown. Some shorebirds (e.g., Lesser Yellowlegs (*Tringa flavipes*)) have been observed to nest on roadsides, seismic lines, and agricultural fields (Campbell *et al*. 1990b).

Waterfowl

Four key waterfowl species were identified: Trumpeter Swan (*Cygnus buccinator*), Canada Goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*), and Surf Scoter (*Melanitta perspicillata*). Considerable research has been conducted on the effects of development on geese and swans in northern Canada and Alaska. For example, Canada Geese were found to exhibit varying flight and alert responses to aircraft overflights according to aircraft type, altitude, and lateral distance (Ward *et al*. 1999). Construction of features such as gravel roads, pads, and quarries can result in loss of Tundra Swan (*Cygnus columbianus*) nesting habitat. Human activity (e.g., traffic) can lead to avoidance of areas within 100-200 m of roads, and may cause nest abandonment and increased predation risk (Ritchie and King 2000). Similar information for the Trumpeter Swan is not available, although human disturbances (e.g., boating, bird watching, floatplane use) can cause nest failure and loss of young (Mitchell 1994). There also appears to be no information on the effects of oil and gas exploration and development on Mallards and Surf Scoters, although habitat loss and alteration are a concern, particularly on wintering grounds and more southerly breeding areas (Savard et al. 1998, Government of Northwest Territories 2000).

3.7.3 Valued Components

A subset of the key species described above were selected as VECs for hot spot mapping. The primary criterion for selection was that an appropriate scale (regional) and format (digital map) of habitat value information was available. This criterion was met by 16 of the key species (Table 3-5). The habitat value database used was the BEI-based Wildlife Habitat Capability ratings product from MSRM.

A VEC representative of each of the regionally important wildlife groups (large carnivores, ungulates, furbearers, and birds) was also required. Within the wildlife groups, VEC selection was based on the regional profile of the species, the state of knowledge regarding oil and gas development and exploration impacts (species with a better knowledge base were given priority, whenever possible), and the severity of known impacts.

The VECs selected for hot spot mapping were grizzly bear, moose, marten, warblers, and caribou. Habitat capability mapping for each of these is provided in Figures 3-20 to 3-24 respectively. Habitat value information for the caribou was derived using BEU types and structural stage values (RIC 1998) that characterize their winter habitat.

Table 3-5. Selection of Wildlife VECs

Key Species	Availability of Information	Effects	Mapping	VEC
Woodland Caribou	Yes	Known – avoidance, increased mortality	Yes	Yes
Wood Bison	Very limited	Unknown		
Plains Bison	None	Unknown		
Moose	Yes	Known – avoidance, increased mortality	Yes	Yes
Stone Sheep	Very limited	Unknown – likely sensitive to disturbance	Yes	
Mountain Goat	Some indirectly	Probable – sensitive to disturbance	Yes	
Rocky Mountain Elk	Some	Known - avoidance	Yes	
White-tailed Deer	Very limited	Probable - avoidance, increased mortality	Yes	
Rocky Mountain Mule Deer	Yes	Known - some habituation	Yes	
Grizzly Bear	Yes	Known - avoidance, increased mortality	Yes	Yes
Black Bear	Some	Known - avoidance, increased mortality, some habituation		

Key Species	Availability of Information	Effects	Mapping	VEC
Wolf	Yes	Known – avoidance, predation facilitated		
Wolverine	Very limited	Probable – sensitive to disturbance		
Lynx	Yes	Known – some avoidance		
Fisher	Limited	Known – some avoidance	Yes	
Marten	Limited	Known – some avoidance	Yes	Yes
Aquatic Furbearers (beaver, muskrat)	Very limited	Unknown – likely minimal	Yes (beaver)	
Red Squirrel	Limited	Known – generally minimal		
Snowshoe Hare	Some	Known – increased mortality possible, generally minimal		
Northern Long-eared Myotis	None	Unknown – sensitive to disturbance		
Short-eared Owl	Limited	Probable – sensitive to disturbance		
Peregrine Falcon (*anatum* subspecies)	Limited	Probable – sensitive to disturbance		
Bald Eagle	Limited	Probable – sensitive to disturbance		
Ruffed Grouse	Very limited	Probable – increased mortality		
LeConte's Sparrow	Very limited	Unknown		
Nelson's Sharp-tailed Sparrow	Very limited	Unknown		
Bay-breasted Warbler	Very limited	Unknown	Yes	Yes[2]
Cape May Warbler	Very limited	Unknown	Yes	
Black-throated Green Warbler	Very limited	Unknown	Yes	
Canada Warbler	Very limited	Unknown	Yes	
Connecticut Warbler	Very limited	Unknown	Yes	
Philadelphia Vireo	Very limited	Unknown	Yes	
Sandhill Crane	Very limited	Unknown		
Upland Sandpiper	Very limited	Unknown		
Trumpeter Swan	Limited	Probable – sensitive to disturbance		
Canada Goose	Limited	Probable – sensitive to disturbance, some habituation		
Mallard	Very limited	Unknown		
Surf Scoter	Very limited	Unknown		

[2] Generalized warbler habitat capability data were used rather than species-specific habitat capability data

3.7.4 Hot Spots

3.7.4.1 Grizzly Bear

The greatest grizzly bear hot spot concentration is in the southwest section of the Taiga Plains, east of Highway 97 and north of Beatton River (Figure 3-25). This area also corresponds to hot spot concentrations identified for marten and moose. There are some localized grizzly bear hot spots within the MKMA in the upper Muskwa River watershed and along the Kechika River between Turnagain River and Denetiah Creek. The majority of the Boreal Plains around and north of Fort St. John, much of the MKMA (in particular along the Rocky Mountain Foothills) and parts of the Liard Plateau are of some concern regarding cumulative effects impacts on grizzly bears. The remainder of the Interior Plateau is essentially of negligible concern, as expected, given that grizzly bear habitat capability in this region is predominantly rated nil.

3.7.4.2 Moose and Marten

The greatest hot spot concentration for both moose and marten is in the southern third of the Interior Plateau (Figures 3-26 and 3-27, respectively). There is also a smaller hot spot concentration for these species around Fort Nelson. Areas of some concern regarding cumulative effects impacts on marten are common and present throughout the study area. Areas of some concern for moose are concentrated along the Rocky Mountain Foothills and in the Kechika watershed, with some areas scattered at moderate density throughout the Interior Plateau.

3.7.4.3 Warbler

There are no significant concentrations of warbler hot spots in the study area (Figure 3-28). This reflects the apparent lack of high capability warbler habitat in the region, and a limited understanding of this group's habitat requirements in the northeast. There are areas of some concern regarding cumulative effects outside of the MKMA, particularly in the Boreal Plains and scattered throughout the Taiga Plains.

3.7.4.4 Caribou

The greatest caribou winter habitat hot spot concentration is in the southern third of the Interior Plateau (Figure 3-29). This area corresponds to hot spot concentrations identified for marten and moose. There are also smaller hot spot concentrations around Fort Nelson, along the Liard River and onto the Liard Plateau, and south of Kotcho Lake. There are almost no hot spot areas in the MKMA, although there are areas of some concern along the Rocky Mountain Trench and parts of the Rocky Mountain Foothills.

3.8 Summary

Table 3-6 provides a summary of key hot spot map attributes for each environmental component, including issues, VECs, what was mapped, and general observations about the nature of the hot spots.

Table 3-6. Hot Spot Map Summary

Discipline	Issues	VECs	Mapped Theme[1]	Categories	Observation[2]
Air Quality	Possible exceedance of air quality thresholds	Air quality in local and regional airsheds	Well SO_2 emission-density (Figure 3-11)	0-15,000 m^3 SO_2/km^2	Concentrated emissions clusters occur throughout Interior Plateau; negligible emissions occur in MKMA
Soils and Terrain	Reduction in soil quality	Soil types sensitive to acid input	Soil acid sensitivity (Figure 3-13)	Hot spot	One large hot spot cluster located northeast of Headwaters Ranch; a few small hot spot clusters occur in the Interior Plateau and MKMA
	Soil loss	Soil quantity	Erosion risk (Figure 3-14)	Negligible concern Some concern Moderately disturbed Highly disturbed	Majority of study area of negligible concern; numerous very small moderately and highly disturbed areas clustered around Fort St. John and scattered throughout MKMA
Aquatic Ecosystems	Reduction of water quality Degradation of fish habitat	Bull trout Arctic grayling Water quality	Important habitat (drainages) for fish VECs (Figure 3-16)	Areal coverage for each species	*Bull trout*: two hot spot areas, one associated with upper Prophet River watershed and the other with Halfway River watershed *Arctic grayling*: large hot spot patch extending through the eastern slopes and across the mid-region of Interior Plateau[3]
Vegetation	Removal or damage to vegetation	Old growth forests Wetlands Rare plants	Sensitive features (Figure 3-18)	Negligible concern Some concern Moderately disturbed Highly disturbed	Majority of hot spots occur in Interior Plateau; clusters of highly disturbed areas throughout southern portion of study area; numerous patches of moderately disturbed areas throughout the remainder of the Interior Plateau[4]

<table>
<tr><th>Discipline</th><th>Issues</th><th>VECs</th><th>Mapped Theme[1]</th><th>Categories</th><th>Observation[2]</th></tr>
<tr><td rowspan="2">Wildlife</td><td rowspan="2">Loss or reduction in capability and effectiveness of habitat
Habitat fragmentation
Direct mortality
Disruption of movements</td><td>Grizzly Bear
Moose
Marten
Warbler</td><td>Habitat capability (Figures 3-25, 3-26, 3-27, 3-28)</td><td rowspan="2">Negligible concern
Some concern
Moderately disturbed
Highly disturbed</td><td>Grizzly bear: highly disturbed patches northeast of Headwaters Ranch; areas of some concern occur throughout the southern Interior Plateau and along the MKMA foothills and Rocky Mountain Trench
Moose: large patch of highly disturbed area located in the southern Interior Plateau; some areas of moderate concern and of some concern occur in the eastern portion of MKMA
Marten: highly disturbed clusters occur in the southern Interior Plateau; extensive patches and clusters of some concern occur in remainder of the study area
Warbler: majority of hot spots occur in Interior Plateau, very small patches of highly disturbed and moderately disturbed areas, a few patches of some concern</td></tr>
<tr><td>Caribou</td><td>Winter habitat (Figure 3-29)</td><td>Large clusters of highly disturbed, moderately disturbed areas in southern Interior Plateau; clusters of some concern throughout the study area</td></tr>
</table>

1. The theme is what the map was based on. Not included here is, common to all hot spot maps, inclusion of the correlation with areas of human use.
2. A patch is a contiguous geographic area of coverage for a given category that is isolated from other patches. A cluster is a pattern of many patches.
3. Areas of water quality concern are directly correlated with fish habitat categories.
4. Hot spot theme does not distinguish between each of the three VECs. It reflects areas of concern for the three VECs combined.

CHAPTER 4: REGIONAL FRAMEWORK

CUMULATIVE EFFECTS ASSESSMENT AND MANAGEMENT FRAMEWORK (CEAMF) STUDY

4 Regional Framework

4.1 Solving the Cumulative Effects Problem

4.1.1 What is the Problem?

The problem is that things we value in the natural environment may be harmed or lost if human disturbances happen too often and too quickly for us to take appropriate action. The response of the environment is called a cumulative effect, an effect that considers all manner of influences by humans. Over time, an observer of changes to a landscape – a landscape where people are building, working, living, and traveling – will notice that the more we do, the less we see of the landscape that we are building, working, living, and traveling on. An observer would also note that many of these human actions just happen, and while some happen as a result of government decisions, in most cases, actions are driven by commerce or personal wish.

Although there are administrative processes in place to govern many such actions, the decisions to do so often are made in consideration of each individual action at a time. Eventually, this independence of decision-making becomes apparent when an environmental effect on something we value becomes unacceptable, by whatever definition — this is the problem of addressing cumulative effects. That is, decisions made in isolation produce environmental results that appear collectively.

From the point of view of regulatory decision-makers, particularly those responsible for processing numerous applications (such as OGC staff, including resource officers and managers), addressing cumulative effects in any practical and meaningful fashion immediately becomes a problem of administrative resources and logistics. From the point of view of land and resource decision-makers, such as government planners, and those with overarching mandates (such as regional boards and committees), addressing cumulative effects becomes a problem of prioritization and having a clear and definable objective. For these decision-makers, the problem is not having the information and tools they need to help them make better decisions.

Cumulative effects are often 'made real' for decision-makers or advisory bodies when they are faced with various situations suggesting a cumulative effects problem; for example:

- A proponent wishes to construct another well in a certain area (e.g., a valley, a new natural gas pool) that is currently occupied by a number of other resource users. The question arises: will this additional application compromise something of environmental importance?
- A proponent wishes to construct a resource access road in a topographically constrained area, such as a valley, that is currently inaccessible except by an ATV trail. The question arises: what are the future implications of more use once the road is built?[1]

[1] Such possible future actions are typically referred to as 'induced' projects or activities, which in its general meaning refers to any human action that may occur as a consequence of an earlier action.

- An area of well-defined boundaries is already experiencing ‘boom’ conditions and applications for project approvals are coming in faster than due process allows time to investigate some matters of environmental concern (unless substantial delay occurs in the reviews). The question arises: what is the most effective way in such situations to not compromise on environmental responsibilities?
- An area of generally understood boundaries, currently experiencing minor human use, is expected to substantially ‘pick up’ in the future in regards to resource extraction (e.g., coal bed methane, natural gas or timber harvesting). The question arises: what can be done now to prepare for this eventuality?

4.1.2 What is the Solution?

It would seem at first that the only solution to the problem of cumulative effects, or at least a principle contributor to a solution, is to fully coordinate the pace and type of all human uses so as to ensure the environmental features we value are not harmed or lost. This approach, reflecting the desire to replace independent decision-making on each action with a coordinated and informed process for all projects, is called a framework - in this case, a Cumulative Effects Assessment and Management Framework (CEAMF), a term that says we both assess what is important to us and manage what we are assessing. The concept of such frameworks has been both studied (AXYS 2000, Macleod Institute 2000, Pollution Probe 2001) and already implemented in other regions (Appendix B).

The term “framework” implies the collection of many pieces, tied together. It also implies an approach that moves beyond individual project decision-making to a process that relies on more broad approaches, of which such decision-making is only one part. It is also an attempt to overcome the weaknesses of individual project decision-making; namely, the isolation of decisions and the failure to incorporate measures and means of determining if now, soon, or some time much later the environmental feature we wish to manage remains as we want it. But to do this, we must already know what we want and, by default, know when something that we value is no longer as we want it. The point when the condition of the environmental feature becomes unacceptable is called a threshold. To determine thresholds, we must then have clear land and resource use objectives in mind, whether broadly for everything over large areas, or specifically within a certain area for a specific environmental feature. Results of planning processes already in place, such as LRMPs and SRMPs, provide some qualitative measure of these objectives.

The observer of the changing landscape would likely say that to solve the cumulative effects problem, one needs thresholds and, at minimum, information to place individual human actions (projects) into some form of a regional context. This context then allows a comparison of the contribution of effects from each action to its surroundings, and then allows a decision-maker to determine if enough has happened, and if future human activity must stop or be sharply curtailed; in other words, to find out “when enough is enough”.

It is true that, ultimately, the review of individual project applications will not solve the cumulative effects problem. It may help in slowing down the pace of change, such as through use of mitigation, or more broadly, through the management of project-specific effects thus minimizing the possibility that these effects will act cumulatively with the effects of other projects. However, unless individual project reviews are done well, over time and depending on circumstances, the recovery of an environmental feature to a desired state will inevitably become more difficult. Yet while a regional perspective is desirable, the practical checking and tracking of individual projects across a landscape is, for better or worse, what we must deal with, as that often is all we have. In some fortunate cases, efforts have been made to look at large regions and declare what is important, what is allowed and not allowed, and to provide some measure by which to plan human use before it actually happens. In most cases, we are not really there yet.

4.1.2.1 The Sustainable Resource Management Strategy

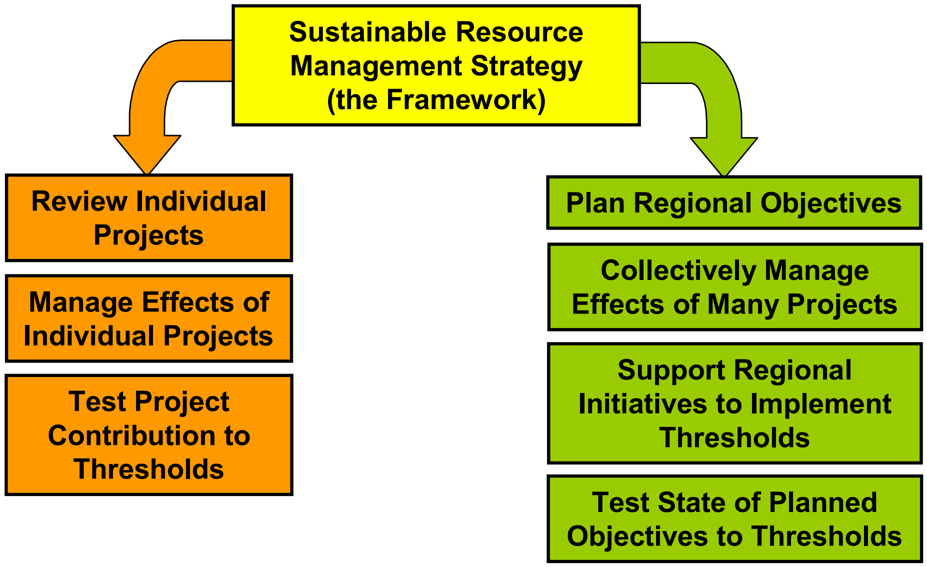
In reality, the problem of cumulative effects is not as simple as described above, and the solution is not as obvious to even the most astute and educated observer. We have, on one hand, what can be done with each project as it arises, and on the other hand, what can be done for all projects before any arise. The first, while readily implementable, is not especially effective in addressing the problem; the latter, while more focused on the problem, requires substantially more effort and time.

Ideally, two integrated approaches, working together and based on the elements introduced in the two linked volumes of this study, should form the basis of an implementable framework (Figure 4-1). It is this dual-tracked approach that is discussed in more detail in Section 4.7. The approach, specific to the needs of the northeast BC region, is referred to as the Sustainable Resource Management Strategy (SRMS) in recognition that the assessment and management of cumulative effects is only an interim step along the way to what is ultimately what decision-makers in the region are tasked to accomplish; namely, the sustainable management of land, water, and air resources.[2]

The term Sustainable Resource Management Strategy (SRMS) is adopted from MSRM's recently implemented Sustainable Resource Management Plan (SRMP), the latter an "umbrella approach to foster economic development and environmental sustainability through strategic resource planning". The SRMS as outlined in this volume describes an approach that links application review by the OGC (and possibly other regulators) and regional planning to specifically assess and manage cumulative effects throughout northeast BC, including the MKMA, with a focus that reflects the OGC's mandate and process.

[2] This CEAMF report does not attempt to address the definition of sustainability and its meaningful and practical interpretation. The intent of the sustainability concept is generally well-understood and is indeed relevant to the proposed SRMS. However, a more refined definition of sustainability as it applies to northeast BC and to matters of cumulative effects would need to be adopted from existing and ongoing efforts by the BC Government, and possibly elsewhere.

Figure 4-1. Framework Overview



Further evolution of a CEAMF in northeast BC will reveal the extent of incorporation of elements of both the strategy and plans, the former implying the incorporation of long-term approaches to manage the cumulative effects of land and resource use over a large geographic region subject to many land use pressures, and the latter implying similar focused efforts over specific (and likely smaller) geographic areas within the region.

The SRMS is a practical approach that can contribute to solving the complex cumulative effects problem. This approach does the best that can be done in the absence of thresholds, does whatever is possible to identify thresholds, and is ready to use thresholds once available to practically implement.

The SRMS is proposed here as a Cumulative Effects Assessment and Management Framework (CEAMF) that is customized for the northeast BC. As such, the term SRMS will be used in the remainder of this section in references to the framework concept instead of the generic CEAMF.

In summary, the SRMS is based on the following key principles:

1. **Dual-track Approach**: Cumulative effects can be tackled both by addressing individual projects and by undertaking regional initiatives on different time scales (i.e., those that are not directly tied by regulatory mechanisms to any one specific sector or project). The latter approach is better; however, most administrative and regulatory processes are currently built on, and fully resourced for, the review of individual applications.

2. **Effects Management Implementation**: The management of project effects, whether implemented for individual projects at a time or jointly for various projects, provides immediate to near-term opportunities to eliminate or substantially reduce environmental effects and the pace at which those effects occur.

3. **Threshold Implementation**: Candidate thresholds are available (as provided in Volume 2); however, their practical implementation will take time given the need to develop capacity to support them and to obtain agreement by stakeholders. Once approved within a practical implementation process that is not onerous, use of a wide suite of context-specific thresholds (i.e., correlated to specific areas and environmental features of concern), whether as part of project-specific review or regional land use planning, offer an effective tool to address cumulative effects.

4. **Administrative Co-ordination**: Co-ordination of resource use decisions amongst government, and the availability of information to support decision-making, is required as meaningful solutions to the cumulative effects problems are enhanced. As such, a central Steering Committee or equivalent is required to facilitate coordination of the SRMS.

5. **Flexibility of Phased Options**: Instead of an over-arching framework that supplants existing institutional responsibilities, the proposed SRMS is based on many tools or options that will each contribute in their own way, or will collectively work together over time. Each option provides an opportunity, at earlier or later points in time depending on the resources available, to support them and their acceptance at whatever government, industry, and public level of participation is appropriate.

6. **Shared Responsibility**: Solution of the cumulative effects problem is, ultimately, a shared responsibility of regional stakeholders. In this way, the dual mandate of protecting the natural environment and accessing and extracting natural resources can benefit by the recognition of compromise and the support of new initiatives. Such initiatives, ultimately, require some measure of restraint, although not necessarily cessation, of current ad-hoc development.

7. **Implementation of Goals**: The framework, through the use of thresholds and various levels of land and resource use plans, provides an opportunity to imbed goals (e.g., for resource utilization and resource harvesting) that can assist in addressing cumulative effects.

8. **Adaptive Management**: Through the implementation of monitoring, information can be updated upon which to continuously improve subsequent decision-making.

4.2 Role of Individual Project Application Assessments

4.2.1 Environmental Impact Assessment

4.2.1.1 What is an EIA and How to Do One

An Environmental Impact Assessment (EIA) is an examination of the effects of a project subject to regulatory review. To do an EIA implies a complete and systematic assessment of all likely cause-effect relationships attributable to the project. An EIA typically also implies that a greater level of such scrutiny is applied than for screening level reviews, although screening level reviews borrow the basic concepts of the typically more comprehensive EIAs.

In any EIA, the primary assessor is the proponent. The secondary assessor (typically, the regulatory reviewer) reviews the assessment and decides if it is satisfactory for its purposes.

If a detailed project assessment (i.e., Environmental Impact Assessment) is required, then the following five steps, common to a full EIA process, are followed:[3]

1. **Scoping**: the early identification of key aspects of the assessment, including issues of concern, valued ecosystem components, spatial boundaries, temporal boundaries, project impacts that lead to various effects, and other projects contributing cumulatively to the same effects.

2. **Analysis**: the prediction of effects of the project alone (project-specific effects) and in combination with effects from other human disturbances (cumulative effects), done through the use of appropriate analytical tools (e.g., spatial and numerical modeling).

3. **Mitigation**: the identification of approaches to manage any negative effects by eliminating or reducing the effect (e.g., air emissions controls, minimization of cleared areas).

4. **Significance**: the evaluation of how important the residual effect (i.e., after mitigation) is, based on appropriate criteria that establish the context in which that effect may be compared (e.g., regulatory guideline, land use policy, scientific empirical evidence, level of social acceptable change, thresholds).

5. **Follow-up**: monitoring of the project to verify implementation and effectiveness of mitigation, and to verify accuracy of prediction of effects.

For oil and gas projects, guidance on options for these steps is provided in Appendix F: Oil and Gas Project Assessment Matrices. Specifically, the matrices provide information for each environmental component reviewed (Section 3) in the Regional Assessment (air and noise, soils and terrain, aquatic ecosystems, vegetation, wildlife, and land use). They include generic information applicable to all types of oil and gas projects, as well as specific information applicable to selected types of oil and gas projects: seismic, exploration drilling, production, and pipelines. These matrices may be modified by users depending on the specific context of project design and environmental setting.

4.2.1.2 What Projects are Subject to EIAs?

The majority of projects in BC (as for most jurisdictions) are however not subject to formal environmental impact assessment (EIA) under the jurisdiction's EIA regulatory review process, and so, there is little opportunity to formally address cumulative effects that way. The *Reviewable Projects Regulation* of the BC *Environmental Assessment Act*, and its federal equivalent under CEAA (the *Law List Regulations*), make clear that only a few energy projects may be assessed in full under the provisions of such acts.

[3] It is beyond the scope of this report to describe these steps in detail. Detailed guidance on their completion is available from the *Cumulative Effects Assessment Practitioners Guide* (Hegmann *et al.* 1999), which can be accessed from CEAA's website at http://www.ceaa-acee.gc.ca/0011/0001/0004/index_e.htm, or purchased from that agency.

In BC (as in Alberta), this means that the majority of the smaller projects in the oil and gas industry (including geophysical operations [seismic], exploratory and production wells, access roads to wells, most plants, and most pipelines) are not subject to such reviews; or if subject to some provision requiring the consideration of environmental effects (e.g., permitting and licensing of such activities), typically include a limited response to cumulative effects in comparison to that undertaken for a full EIA.

4.2.2 The OGC's Current Review Process

The OGC, as is typical with all provincial (and federal) ministries/agencies, first screens each application received and subjects it to checks, as appropriate under its administrative or regulatory mandate. The OGC process, as is the case with most such reviewing bodies, currently has limited explicit reference to cumulative effects in such reviews or the availability of meaningful resources in which to test each project application in the context of its particular contributions to cumulative effects. Notwithstanding this, the OGC is currently exercising opportunities to address cumulative effects through several of its own initiatives (e.g., the General Development Permit, consultation and referrals) or through its involvement with initiatives led by other jurisdictions (e.g., land use planning).

As such, the checks and balances of due process make use, when possible, of information that may assist this effort; however, the efficient and timely processing of applications, the lack of required information, and ultimately, the lack of thresholds mean that the pursuit of cumulative effects-related problems (and solutions) likely do not yet occur, except in the most exceptional of circumstances.

The current OGC review process is shown in Figure 4-2. This process essentially consists of three principle parts: screener, referrals, and decision (Figure 4-3). At the preliminary level, each proposed project is classified as simple (e.g., on private land, non-sour wells, simple water crossings), normal (e.g., on Crown land), or complex (e.g., sour wells, in Special Management Areas, environmentally complex). Each classification implies a certain level of review commensurate to the project's issues.

4.2.3 A Modified OGC Review Process

4.2.3.1 Basis of Approach

There is an opportunity within the current OGC review process to usefully incorporate consideration of cumulative effects for individual project applications that is not onerous, and would not threaten the timely and efficient review process, assuming that certain information sources are available. Such an approach is based on the view that OGC staff do not always have extensive time to spend on individual applications; therefore, a series of quick tests are required that are designed well enough to ensure that projects of concern are captured.

This modified screening process is referred to here as the OGC Application Cumulative Effects Screener (ACES). It's position in the current OGC process (i.e., where it fits in) is shown in Figure 4-3, with ACES shown in summary. Figure 4-4 shows ACES in detail.

Under the proposed modified approach, an application would enter and exit the OGC review process in the same way it does now. However, imbedded in the screening stage of the review process would be a formal screening for cumulative effects. The level of detail of the cumulative effects screen (see below for details) would depend on whether the application was 'routine' or requires an expanded review, of which an 'advanced' cumulative effects screening would be one component (clear criteria are defined for moving from a routine to an expanded level of review).

To make this approach as practical and readily implementable as possible, a modified screening level process that explicitly addresses cumulative effects is used that is based on a series of five steps: conformance check, thresholds check, effects check, effects management selection and monitoring selection.

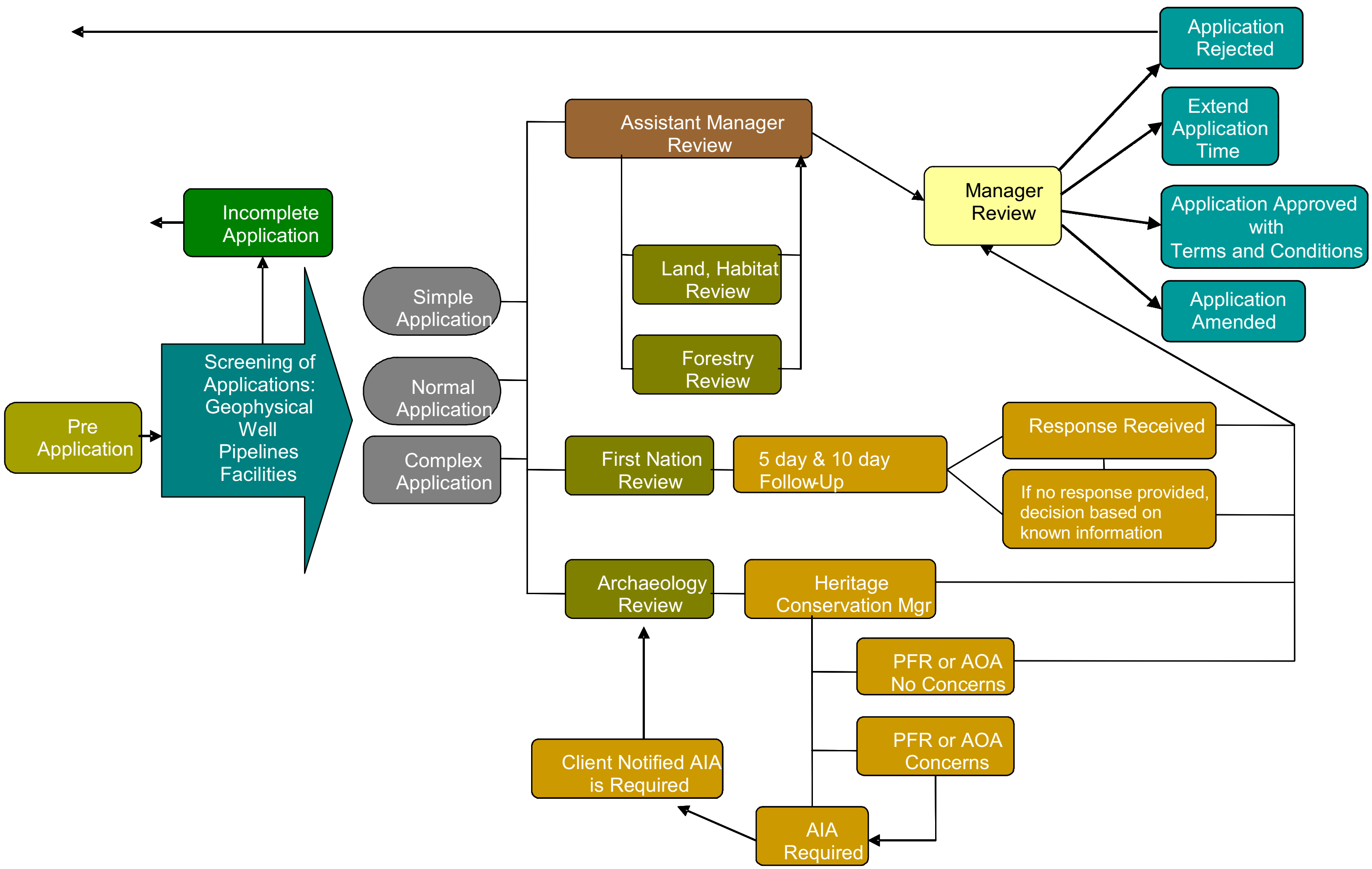
This addition to the current OGC screening step, described in more detail below and in Appendix G, makes use of various elements of the framework described throughout this volume. OGC staff would assimilate various sources of information, by then readily available, to assist in incorporating consideration of cumulative effects into the decision-making process. This process is also generic enough to be readily adapted by any other application reviewing body.

A pilot implementation program, including training, is also proposed (Appendix G) that the OGC may use to test the proposed ACES process in actual application review conditions, but in a parallel process that does not affect the fate of the application. In this way OGC staff familiarize themselves with the process and suggest modifications to customize the process further, if necessary, to best meet the needs of the OGC prior to full implementation.

In summary, attributes of ACES include:

- clear linkages to the existing OGC application review process;
- a series of steps or 'checks' to determine and address the cumulative effects of both routine and complex applications, providing a proportional review response based on the likelihood of effects of concern;
- identification and use of various information sources (including a regional data base), most of which are currently available and some of which would become available upon implementation of the proposed SRMS;
- implementation of thresholds (where and when available);
- continued use of referrals (e.g., First Nations, land management agencies) as a means of obtaining broader input;
- clear guidance to proponents on information requirements; and
- clear guidance to reviewers to assist them in determining the fate of an application.

Figure 4-2. Existing OGC Application Review Process



(from OGC 2002)

Figure 4-3. Relationship of ACES to Existing OGC Review Process

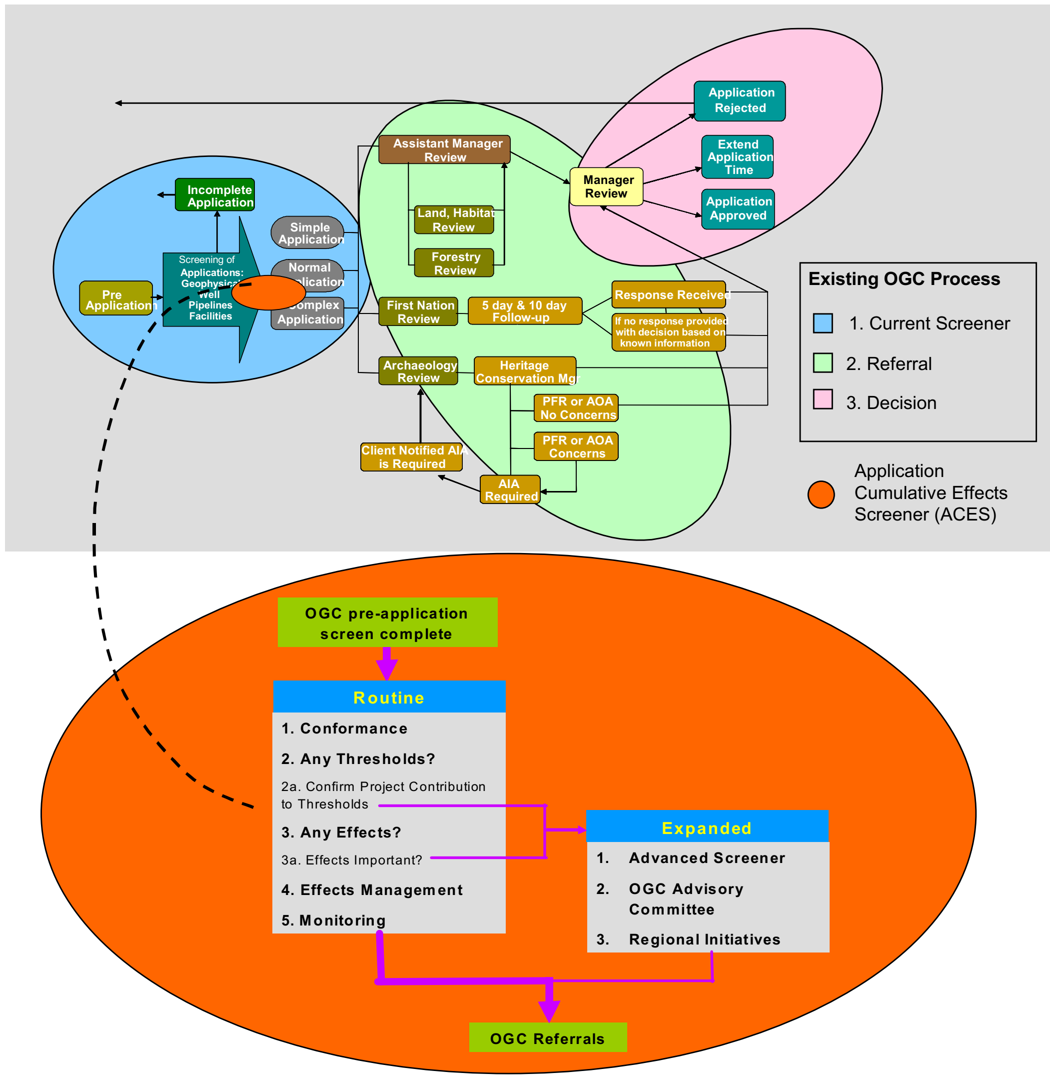
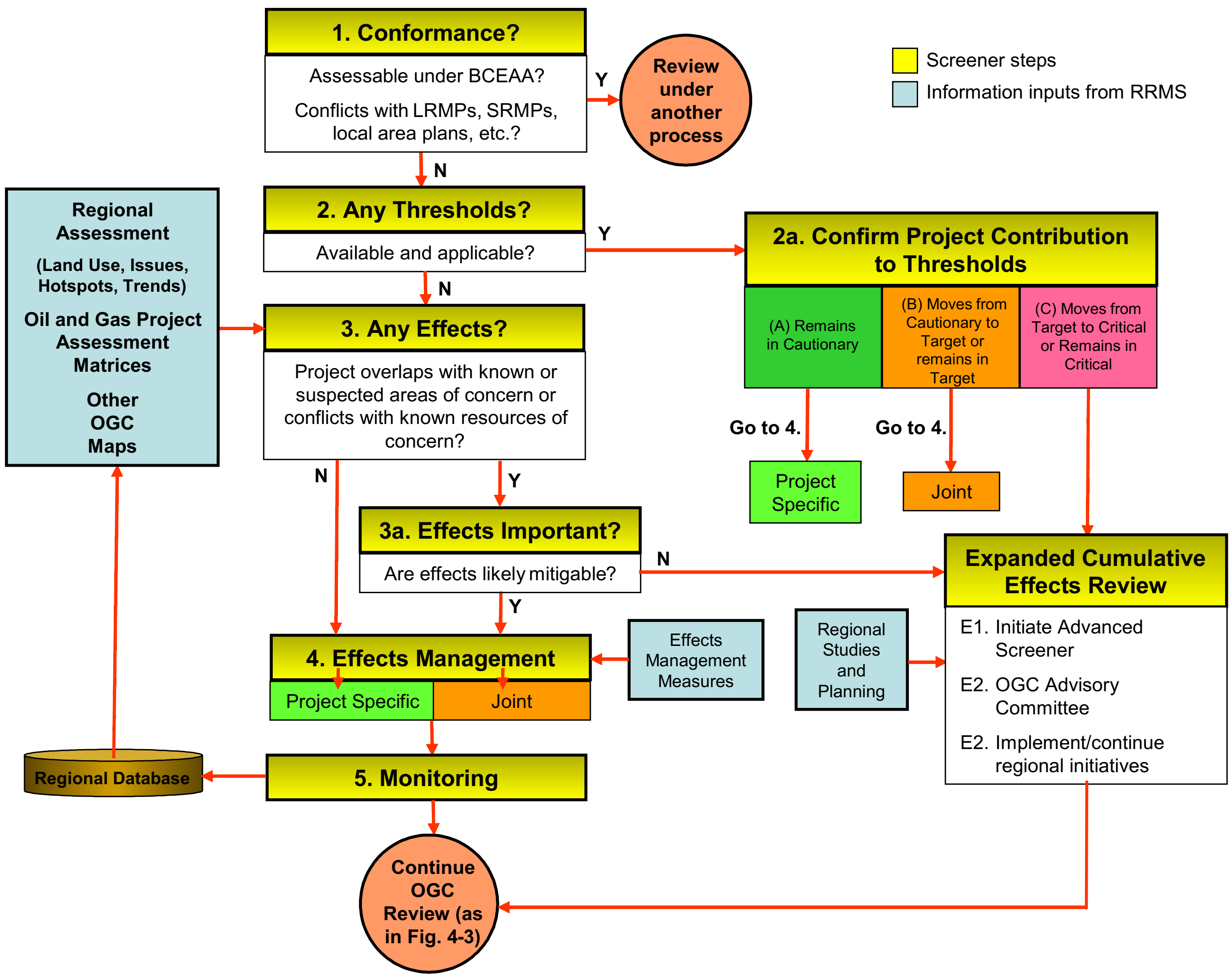


Figure 4-4. Application Cumulative Effects Screener Details



4.2.3.2 Levels of Review

Routine Screening

The routine level of screening is the simpler of the two levels in terms of information and effort required. It is based on a few relatively simple questions and tests performed by the OGC application reviewer. The approach relies on the identification of effective effects management measures (EMMs) or the use of thresholds if available. This level would be applied to the vast majority of applications in any given year.

As shown in Figure 4-4, this approach includes two options based on whether thresholds are not available (steps 1, 2, 3, 4, and 5) or are available (steps 1, 2, 2a, 4, and 5). The only incremental information requirement for applicants is the calculation of their project's contribution to thresholds (if thresholds are being implemented for the region in which their project is located).

A checklist-based form is provided and explained (Appendix G) to guide OGC staff through a routine screening.

Expanded Review

The expanded level of review ensures that projects (of which few are anticipated) that may substantially contribute to a matter of concern, or for which unacceptable uncertainty exists, are 'captured' and assessed accordingly in proportion to those concerns.

The expanded level of screening involves a more detailed review of the application, placing the project under further scrutiny. Use of the term 'review' implies a higher level of assessment than a screening, but not a full EIA (unless further inquiry raises this possibility). It is based on a more expansive approach to addressing cumulative effects than the routine screen. The approach relies on more detailed information of the project's potential effects and on the involvement of more external advice. It also assumes that broader regional effects management initiatives are (or would be) in place. An expanded review is triggered by two criteria (in step 2a, based on thresholds; and, in step 3a, based on ability to mitigate effects) at the routine level. It is anticipated that an expanded review would be required for only a few applications in any given year.

The expanded review reflects an admission that, in some cases and for certain complex projects, effects cannot be readily mitigated away, and that eventually there will be a combination of circumstances that requires mechanisms to address a project beyond the reliance on EMMs or threshold checks. Also, the expanded review ensures that even facing such challenging circumstances, a project continues to receive an opportunity to be considered for approval, with the caveat of being subject to more rigorous review.

As shown in Figure 4-4, this approach includes three parts: i) advanced screener; ii) OGC Advisory Committee; and iii) regional initiatives. This level of review does include further information requirement from proponents.

A checklist based form is provided and explained (Appendix G) to guide the OGC staff through an expanded review.

4.2.3.3 What Additionally is Required?

OGC application reviewers must have additional time to complete a series of checks and selections. The introduction of a cumulative effects component to the application review process assumes that reviewers have adequate knowledge of project types and the regional context to accurately characterize the effects of a project and how such effects may interact with those of other existing or proposed projects. The approach also assumes that information to support a review of cumulative effects, mainly mapped information at an appropriate spatial scale, is readily accessible to reviewers.

If thresholds are available, then they are used; and, if not available, reliance on other means is required.

Where thresholds are available, a project's contribution to a regional threshold would provide the essential test of project acceptability. In such cases, applicants would provide the OGC with a calculation of their project's contribution to the threshold (as explained in more detail in Volume 2). However, it should be noted that even in the worst of situations, a project is never outright rejected until it at least has received the opportunity to be reviewed in more detail. If deemed acceptable, approaches to management of effects would then be determined.

Where thresholds are not available, the likelihood and level of concern (i.e., significance) of potential cumulative effects to which an individual project may contribute are estimated (e.g., in consideration of information in land use plans). This is based on the location of the project (therefore, relying on maps) relative to coarse scale indicators, for which suggestions are provided for specific sources of information. The principle mechanism for addressing cumulative effects is then through effects management, for which options are provided (many, which if implemented well, will prove effective in reducing the rate of adverse environmental change).

Considerable reliance is placed on effects management measures to mitigate potential project effects, reflecting a key attribute of the proposed strategy. Furthermore, additional mitigation is required in the form of joint initiatives in cases of specific possible concerns (thereby creating two levels of mitigation, project-specific and joint). Any project directed to a joint level of mitigation also is subject to any appropriate project-specific mitigation.

4.2.3.4 Information Requirements

The ACES makes two major assumptions: i) the OGC reviewing officer is familiar enough with the types of projects being reviewed to characterize typical environmental effects of such projects; and ii) that readily accessible and comprehensive information is available to assist the reviewer. Ultimately, useful information must be provided to the OGC decision maker (whether the resource officer assigned to a particular project or a manager) so that they, with the additional consideration of cumulative effects, can exercise their decision-making duty. Supplementing this information is any field knowledge gained by OGC staff, and any information subsequently gained through field inspections.

A considerable amount of information is currently available to assist OGC staff and other application reviewers in screening project applications. The proponent, as part of the application process, is required to submit detailed information about their project. Additionally, the OGC's Electronic Petroleum Application Submission (ePASS) system will allow proponents, when implemented, to submit an electronic file of their project footprint[4] (as well as other component of their land use application), which allows OGC staff to more easily map the location of the project in relation to other existing and proposed projects in the same area – an important step in assessing and managing cumulative effects.

Only a minimum of new information is required for routine applications; any information used is that which is readily available. The routine screening level relies on relatively accessible information (i.e., project design, location and typical mitigation) than are required in a potentially more complicated examination of project effects (which are addressed in the expanded review).

Applicants are not called upon for more information for the majority of applications (routine) except when thresholds are implemented as part of the review process; and, applicants are required to provide further information if their application proceeds to an expanded review.

Regional Information

Regional-scale information is available through a variety of sources, many of which have been summarised in this Volume. A comprehensive, accurate and up-to-date database of regional information is critical to the success of the SRMS. Currently, the Ministry of Sustainable Resource Management (MSRM) maintains spatial data for the region and makes these data available to other ministries, government organisations and the public.

The OGC's existing use of the GIS-Oracle Access Tool (GOAT), which includes map coverages, relies on the MSRM database and makes this information available to all OGC staff. As part of the regional assessment (Section 3), data themes contained with the MSRM database were used to generate a series of baseline and hot spot maps showing the geographic distributions of environmental features and values, as well as areas where critical values overlap with existing or proposed development activity. These maps are available for use by OGC staff, although these currently represent only a selected number of disciplines and values.

Information collected in support of an individual project assessment will contribute to the compilation of a regional database (already begun as part of this study), and thus, will build upon existing knowledge of the region's ecological and social components. This process is an important contribution to the SRMS as it increases our understanding of how the environment responds to past human actions, and will increase our understanding of the consequences of future development. This heightened understanding may also assist in the design of more effective mitigation tools and thresholds to limit and manage environmental effects.

4 Spatial entities that comprise the project footprint may include: seismic lines, well sites, pipeline rights-of-way, water crossings, well hold locations, ancillary or other facilities, Water Act application locations, and road centre lines.

Summary of Information Needs

In summary, the following information is required to complete a routine screening using the approach described above:

- The proponent's application, which includes a detailed description of the proposed project, its location(s), the project footprint, and all proposed mitigation and effects management measures;
- If thresholds are available for the area in question, the application should also include the proponent's calculation of their contribution to the applicable thresholds;
- If no thresholds exist, OGC staff should have sufficient information to compare the location of the proposed project to that of any other existing or reasonably foreseeable projects in the vicinity (preferably using georeferenced spatial data);
- Information about the regional context of the project area, including LRMP categories (to determine conformance, project acceptability, and appropriate mitigation), other local or regional level plans, valued components, issues, hot spots, trends in environmental features of interest, and other information. Much of this information is contained within the regional assessment (Section 3) and associated regional database; or, can be obtained from other maps and data;
- Knowledge of project-specific assessment tools and techniques, specific to the type of project being proposed. Guidance for project-specific assessments for four types of projects (seismic, exploration, production, and pipelines) is provided in the Oil and Gas Project Assessment Matrices (Appendix F); and
- Knowledge of the range and types of EMMs available to address project related effects at both the project and regional (i.e., joint management) levels.

To complete an advanced screening, similar information is needed although more extensive analysis and a finer level of detail are required to determine specific project effects and their significance.

It is imperative that new information collected at the screening stage (both routine and advanced) be integrated into the regional database and made available to other reviewing officers and land managers.

4.2.3.5 Roles and Responsibilities

Applicant

Project proponents are those who submit project applications and, by nature of their applications, conduct the first level of assessment of project-specific and regional cumulative effects. Their involvement is focused on individual applications; however, they play an important role in addressing regional cumulative effects by taking measures to reduce the effects of individual projects and by participating in higher-level (i.e., regional) effects management initiatives. Within the context of the regional strategy, the roles and responsibilities of proponents are:

- preparing and submitting an application, including proposed mitigation and monitoring;
- calculating their contribution to regional thresholds (if available);
- assisting OGC staff in understanding the proposed project by meeting information requirements;
- completing an advanced screening (if necessary);
- implementing conditions of project approval (i.e., follow-up); and
- potentially joining and/or funding (either voluntarily or by requirement) new or on-going joint or regional effects management initiatives.

Oil and Gas Commission

The OGC, and specifically OGC resource officers and managers, play a critical role in addressing cumulative effects at a project-specific and regional level. Their principle roles and responsibilities are:

- defining clear information requirements and application guidelines for project proponents;
- screening or reviewing project applications using all available information and resources;
- requesting new information and facilitating incorporation of new information into the regional database;
- applying criteria on evaluating contributing effects based on results and tests from resource planning (e.g., hot spots, thresholds);
- providing guidance to proponents who are required to complete an advanced screening;
- exercise their decision making duty (either routine or advanced) based on the available information;
- recommending management responses and conditions for reasonable and appropriate mitigation and monitoring, some which would need to be performed jointly; and
- monitoring (for compliance, enforcement and verification of predicted effects) as follow-up activities of the proponent’s application, as applicable.

OGC Advisory Committee

The OGC’s existing Advisory Committee is composed of members of various groups (environmental, government, First Nations, oil and gas, and public) to facilitate the contribution of consultation to the OGC’s efforts. The proposed role of this committee in

ACES is to advise the OGC on matters relating to specific applications referred to the Expanded Review process. The nature of the advice sought includes identification of possible further actions required, such as assessment or effects management.

First Nations and Referral Agencies

In addition to the OGC, First Nations and regulators from other government agencies may be asked to review project applications. Their role in addressing cumulative effects at the screening stage is therefore similar to that of OGC staff. Specifically, this includes:

- reviewing project applications vis-à-vis their mandate and responsibilities;
- contributing to knowledge of the regional land base including activities (occurring or proposed) that may interact with the proposed project and potentially result in cumulative effects;
- making recommendations for regional mitigation and monitoring; and
- liasing with and participating on the proposed Regional Steering Committee.

4.3 Role of the Regional Assessment

The Regional Assessment (presented in Section 3) provides direction for scoping individual project reviews, and assists in identifying broad regional trends for land and resource use planning. Specifically, the Regional Assessment addresses the following critical aspects of the SRMS in the study area:

- **Regional Baseline**: using maps, the regional baseline describes the current state of selected land use and environmental features;
- **Issues:** identifies environmental features of concern, valued ecosystem components (VECs), current stressors, and possible future trends. These are done for the five environmental disciplines and the one land use discipline; and
- **Hot spots:** highlight possible areas of concern for specific environmental features. These are done for selected VECs within each discipline.

Collectively, these three sources of information can be used to provide the near equivalent of a State of the Environment (SOE) summary for the study area, based on the following observations:

1. What is the current environment and land use setting?
2. What are the environmental features of concern, and why?
3. Where may there be a problem for a certain environmental feature?
4. What are the possible future trends?

Of practical necessity, the resolution of the map-based information is coarse and not adequate to meet the needs of describing local conditions around specific projects; however, the information is adequate to identify existing and probable cumulative effects risks in the study area.

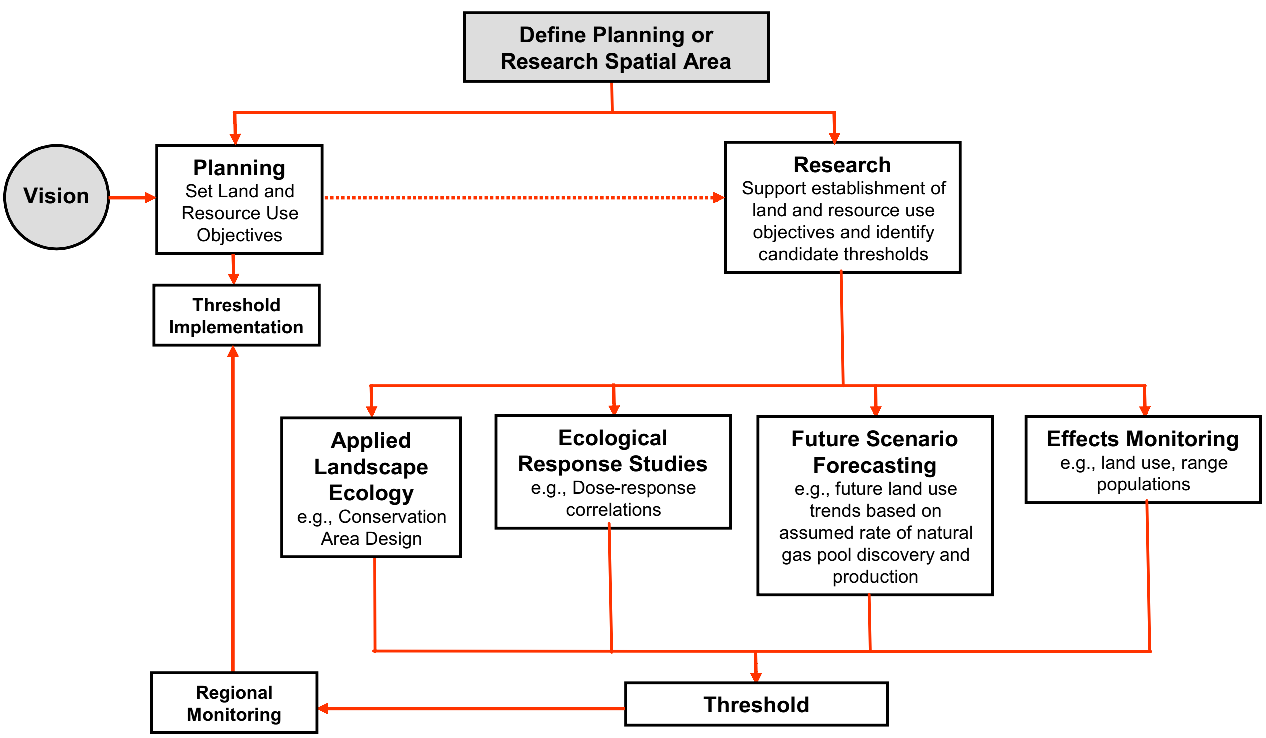
4.4 Role of Regional Planning and Research Studies

4.4.1 Overview

Regional planning and research studies (Figure 4-5) are used to further the understanding of the relationships between human disturbances and the environmental effects they cause, and to provide further information in support of the assessment and management of cumulative effects.

Responsibility to coordinate, facilitate and resource these initiatives typically rests with government given the scope of such efforts; however, industry can be involved in its development or eventually possibly become a key leader in its implementation. These initiatives are geographically broad, typically take many years (particularly those involving field work), require certain expertise, and require a central repository of updated information. By their nature, these initiatives fall under the land and resource management responsibilities of provincial government departments. The OGC can be involved as an observer and on an advisory basis, and would be able to provide information (such as updated land use information) while also benefiting from this work as part of its application review process.

Figure 4-5. Regional Planning and Research Studies



4.4.2 Regional Planning

Land use planning is used to establish vision and objectives for a region, a vital precursor to the establishment of thresholds. Typically, a vision and objectives are defined for a specific administrative area within which certain restrictions may apply to some uses, and certain management practices are identified. Planning thus begins the process of establishing the context in which cumulative effects can be measured, and in which the state of a region and the pace of change can be judged as acceptable or not.

In northeast BC, land use plans such as the LRMPs, local area plans, pre-tenure plans, and the SRMPs (as described in Section 2) provide a useful start in the identification of these goals.

4.4.3 Research

An important component of the SRMS is research that provides information necessary for understanding impact mechanisms and interactions, defining thresholds, and employing best management practices and adaptive management principles.

Research themes that will, over time, most directly advance the assessment and management of cumulative effects (e.g., development of thresholds) include landscape ecology, ecological response studies, future scenario forecasting, and monitoring. Each theme is described below, and current initiatives are briefly described that advance the development of thresholds.

4.4.3.1 Applied Landscape Ecology

Landscape ecology is the study of how spatial patterns affect ecological processes across the landscape. Knowledge of landscape ecology can help managers effectively maintain heterogeneity across the landscape by using and applying the principles of ecology, wildlife biology, cultural anthropology, land use planning, and economics. Limiting factors (e.g., habitat and breeding requirements, predator-prey relationships, traditional lifestyles) are identified and then used to clarify what is needed to maintain ecosystem structure and function across the landscape.

Several research efforts within the MKMA are already applying the principles of landscape ecology to develop insights into managing cumulative effects. These include:

- classifying species according to their similar feeding and breeding habitat requirements. Key representative species are selected for each life form and are then monitored to determine if feeding and habitat structural components can be used to monitor biodiversity over the landscape;

- developing a conservation area design (CAD) through species-based connectivity analysis. Attempts will also be made to integrate cultural importance; and

- studying ecological processes such as predator-prey dynamics and fire to develop a design to maintain habitat connectivity.

Although these initiatives do not explicitly develop management thresholds, they do provide a link between landscape level objectives (e.g., habitat connectivity) and local level decision-making (e.g., pre-tenure planning processes) that can substantially contribute to the development and verification of thresholds. Understanding these ecosystem processes will assist in identifying where (or when) certain developments should not occur.

4.4.3.2 Ecological Response Studies

Ecological response refers to the reaction of one or more ecosystem parameters to a stress or disturbance. Ecological responses occur with both natural and human-induced disturbances. In the context of developing thresholds to manage cumulative effects, these studies provide information that suggests acceptable limits of change to human-induced pressure. Dose-response models are currently being developed in Alberta that quantitatively describe human activity over ecological spatial scales, and is then correlated with species occurrence. This ultimately provides an index of cumulative effects that is capable of capturing a wide range of industrial activities over the landscape.

One research initiative (The University of Alberta's Integrated Landscape Management Program) is applying the principles of ecological dose-response to develop an understanding of the different spatial scales at which ecosystem processes are being disturbed. This represents an attempt to move away from the umbrella species concept towards an approach that includes more species from different taxa into an aggregated index. The index is correlated with industrial activity to form a surrogate of factors that pressure wildlife populations. For example, responses of passerines to different types of human disturbances at different spatial scales are being identified using this methodology. This information may prove useful in managing cumulative effects by providing information on the spatial scale that is most suitable to direct management efforts.

4.4.3.3 Future Scenario Forecasting

Future scenario forecasting involves the prediction of future conditions and occurrences based on how we believe an ecosystem will function under different management regimes. Future scenario forecasting allows managers to weigh the pros and cons of a desired land use condition. This is also a strategy to manage the risk of being caught off-guard by what the future might hold (e.g., uncertainty surrounding issues such as climate change can be explored).

A Landscape Cumulative Effects Simulator

The Alberta Northern East Slopes Sustainable Resource and Environmental Management Strategy (NES Strategy) provides an example of how future scenario forecasting is being applied to strategic land use planning with the long-term objective of managing cumulative effects. This forecasting is being conducted with a model called ALCES (A Landscape Cumulative Effects Simulator), a landscape accounting tool that can contribute to cumulative effects management by proving a mechanism for integrating information from different resource sectors, and creating linkages to more specialized decision support tools (Hudson 2002).

In the NES case, each sector and conservation interest (e.g., forestry, oil and gas, agriculture, conservation biologists, and water resource managers) define and run their own future scenario forecasting models (e.g., energy model, forestry model, population models, water basin models), which are then integrated using ALCES. It is hoped that this approach will build trust among industrial and conservation interests as all inputs to the forecasting model are analyzed using the same tool, thereby creating a more level playing field among sectors. Tools such as ALCES can also be useful in the development of thresholds; for example, ALCES is capable of quantifying the rate of land use change, and correlating changes in specific habitat or population variables.

Ultimately, from the land and resource manager's perspective, use of these tools provides the following information that may assist their planning and decision-making:

- the time period (i.e., years) before a resource of management concern reaches an unacceptable state (e.g., it will take 16 years before the regional moose population may decrease below minimum viable population). As such, the level and timing of a management response can be designed proportional to the predicted time remaining to head off a management issue of concern; and

- the degree by which various effects management measures will alter the above time period. For example, an 'as-is' scenario likely will result in the resource being of concern sooner than if a comprehensive suite of management practices were exercised. As such, the manager can choose an optimum effect management approach given the availability of time and budget.

Global Methodology for Mapping Human Impacts on the Biosphere

The Global Methodology for Mapping Human Impacts on the Biosphere (GLOBIO), developed by the United Nations Environmental Programme (UNEP), is based on quantifying species response to human disturbances. It aggregates the responses of many species to access disturbances (based on the conventional concept of alienation buffers). This concept currently serves as a major part of most EIAs that include wildlife assessments. What is new is the intent to gain acceptance of this approach at very large landscape scales, based on coarse land use and species response descriptions. This then supports mapping of large regions (typically based on satellite imagery interpreted to describe land use and environmental features), such as an entire province, which at a gross landscape level can indicate degrees of alienation that are attributable to the incursion of human access (i.e., roads) into wildlife habitat. If the base mapping is available over long periods of time, 'snapshots' can be taken of these conditions over many years to visually show the progression of human effects on wildlife. This reflects what is typically the single greatest contributor to cumulative effects anywhere in the world; namely, the continued expansion of roaded access, particularly new access into unroaded hinterland areas.

The advantage of GLOBIO is that it provides a relatively quick and inexpensive means of assessing cumulative effects over very large geographic areas. The disadvantage is the uncertainty associated with interpreting its results given the highly coarse spatial mapping scale and the gross aggregation of species response (e.g., general disturbance coefficient for birds) to simplified access descriptions.

This approach was recently used by Canadian Arctic Resources Committee (Cizek, McCullum and Booth 2002) to map cumulative effects in the Fort Liard region of the southwest Northwest Territories (immediately north of, and adjacent to, the northeast BC CEAMF study area). The land use pressure of concern was oil and gas exploration and production. This study quantified human activities (e.g., oil and gas tenures, well sites, pipelines, all weather and seasonal roads) in a 100 km^2 radius around Fort Liard at four points in time. The study's conclusions were based on the percentage of landbase that is increasingly alienated to wildlife over a 50-year period. For example, in the year 2050 (with the level of oil and gas activity extrapolated from current trends), approximately 30% of the study area would be considered to have a high risk of effects on plants, animals and food chains. It is highly likely, however, that such model results are overly conservative if the recovery of disturbed areas over such extended periods of time is not included.

4.4.3.4 Effects Monitoring

Monitoring refers to repetitive measurement of a variable consistently and over a long period of time (Beanlands and Duinker 1983). It is a fundamental part of any land and resource management strategy. Monitoring can be used to update land and resource information, confirm compliance to approval conditions, confirm the application and effectiveness of effects management, and verify predictions of effects. Ideally, monitoring is used to validate and modify thresholds, and to quantify ecological parameters to ensure that land use pressures do not induce an ecological response that exceeds a threshold. In the absence of thresholds, monitoring is used to quantify ecological response and land use trends. As changes in ecological responses become correlated with changes in land use trends, thresholds materialize.

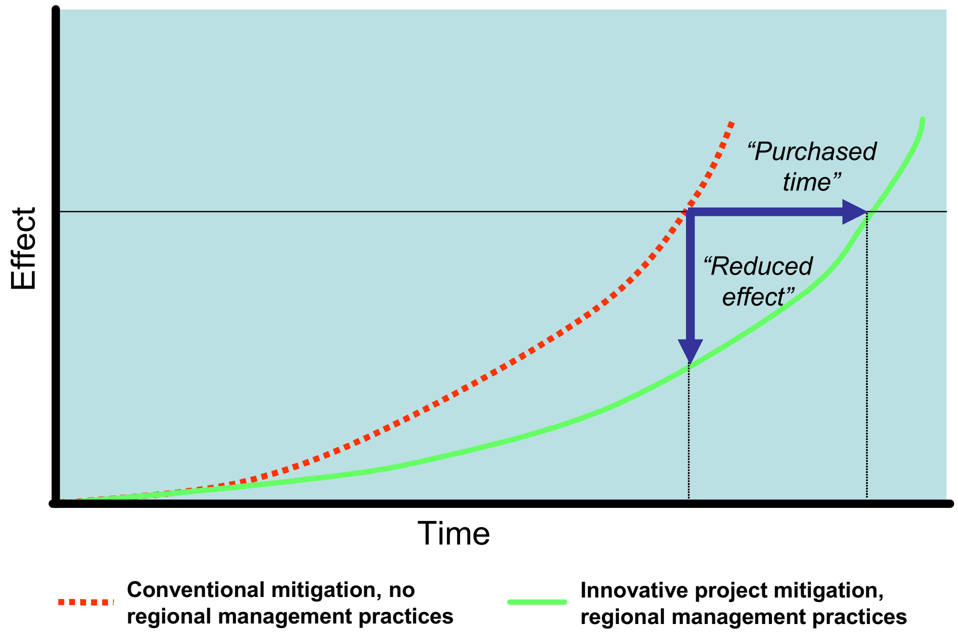
4.5 Role of Effects Management

4.5.1 Overview

The SRMS relies on two principle techniques to manage effects: effects management measures (EMM); and thresholds. The first technique has the benefit of including options that are already implemented and can be recognized as contributing to the management of effects. Another benefit is the potential use of numerous further options that can be readily implemented, or implemented with a reasonable application of current proponent and/or government resources. The second technique has the advantage of truly addressing cumulative effects over large areas that are subject to numerous land use pressures.

In the absence of thresholds, the role of effects management is to do the best that can be done to buy time by slowing the pace of an adverse environmental effect (Figure 4-6), time that can be used to progress other regional initiatives, especially the implementation of thresholds (the ALCES simulations in Volume 2 are an example of this). Therefore, the more effective the EMMs, the longer the time before an unacceptable level of effect is reached (if ever). The default 'as-is' approach to EMM is accelerated for terrestrial and some aquatics effects in situations where there is continuing net environmental degradation caused by reclamation that cannot compensate for continued disturbances.

Figure 4-6. Implications of Effects Management on Pace of Environmental Change



Ultimately, the CEAMF concept, as interpreted in this report, emphasizes the "M" for management over the "A" for assessment as the most important contributor to the success of the framework; hence, the SRMS's explicit inclusion of management in the name. The basis for this is the practical and both immediate and long-term benefit of the contribution of management practices. Although assessment has and should continue to play an important role, in the end it often does a better job in identifying potential effects than evaluating how important (i.e., significant) many effects may be.

This view is also an application of the precautionary principle, which essentially states (in the context of this discussion) that we should move ahead and apply effects management even if we are not absolutely sure of what environmental effects are happening, and how they are happening. [5] As such, what we can learn from assessments, and in recognition of what we do not know or are unclear of, should not necessarily give reason to deter management measures under the excuse of uncertainty. That said, the onus then on decision makers is the responsibility to ensure that a reasonable standard of understanding (scientific or otherwise) is investigated prior to implementing the principle.

[5] Likely the most commonly used definition of the precautionary principle, and adopted by the Government of Canada, was developed in 1992 during the United Nations Conference on Environment and Development (as part of the Rio Declaration, or Agenda 21), which states: *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*

4.5.2 Types of Effects Management Measures

The first and most important step for managing cumulative effects is to manage where those effects start; namely, at each of the individual projects that contribute to effects. Some EMMs can reasonably and non-onerously be the responsibility of individual project proponents. Some of these measures may be conventional, some best practice, and some innovative.

However, in some cases these project-specific EMMs may not be adequate, and a meaningful contribution to managing effects can only be accomplished through jointly coordinated efforts with other operators who share contributions of effects to common environmental features.

Furthermore, some measures are only reasonably supported and coordinated by government. These typically involve many years of effort, the collection and organization of large amounts of regional data, and the formulation of public policy. Such measures are not directly tied to one specific project, but reflect the on-going contributions of many forms of human disturbance over large areas for many years.

In summary, EMMs can be categorized into three types:

- **project-specific**: applied only to an individual project, and are the responsibility of that project operator subject to government requirements and best practice;
- **joint project**: applied to multiple projects by multiple operators, and are jointly coordinated amongst operators with government participation; and
- **regional**: applied over a large geographic area, independent of requirements for any project, and are implemented by government with industry participation.

There already are many management techniques being implemented in northeast BC. Some of these and others are gaining wide acceptance and implementation in other jurisdictions (such as Alberta)[6], all of which are readily adaptable to BC. Table 4-1 identifies 29 EMMs for the three types explained above.

[6] For example, three of the EMMs identified in Table 4-1 (Integrated Landscape Management, Constraints Mapping and Low Impact Exploration) have been adopted for voluntary compliance by all members of the Athabasca Oil Sands Cumulative Effects Management Association (CEMA). A detailed description of these measures are provided in AXYS and Lorrnel (2002), downloadable from www.axys.net.

Table 4-1. Effects Management Measures

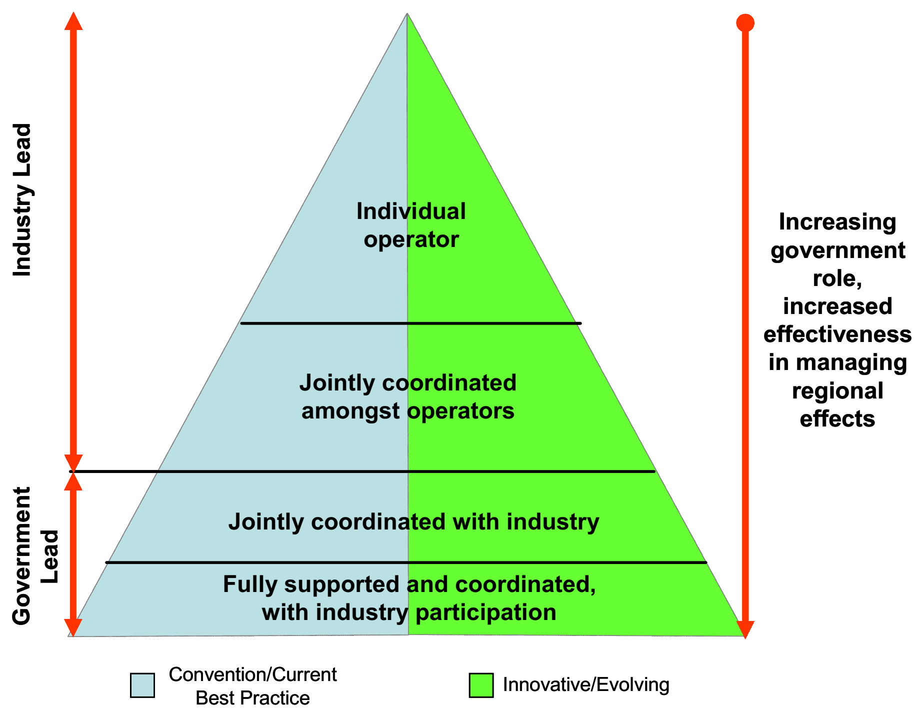
Level	Project	Joint Project	Regional
Lead Role	**Individual Operator Subject to Government Requirements[1] and Best Practice**	**Jointly Coordinated Amongst Operators with Government Participation**	**Government with Industry Participation**
Options	Codes of Practice	**Development Plans[3]**	**Conservation Area Design**
	Conservation and Reclamation Plans	**Integrated Landscape Management**	**Future Scenario Forecasting**
	Constraints Mapping	**Trunk Road Coordination**	Indicators (for monitoring/thresholds)
	Construction Best Practices		Local Area Plans
	Environmental Protection Plans		**Pre-tenure Plans**
	Forestry Operations/Management Plans		Protected Areas Strategy
	Geophysical Operating Guidelines		**Regional Access Management**
	Geophysical/Environmental Field Reports		Regional Ecological Monitoring
	Low Impact Seismic		Regional Spatial Databases[4]
	Minimization of Clearing		Regional Plans and Zoning
	Planning and Engineering Design		Regional Thresholds
	Setbacks[2]		Resource Management Plans[5]
	Timing Windows		SRMS Steering Committee

Notes:
1. For example, as described in the *BC Oil and Gas Handbook*
2. Provided in current OGC Minimum Disturbance Criteria
3. Provided in current OGC General Development Permits
4. Includes land use and environmental features
5. Includes species range management
Bolded options are relatively new, innovative, and still evolving

Selection of the most appropriate EMMs is based on the particular circumstances involved; selection therefore must be done on a case-by-case basis. Factors involved in a selection include the nature of the projects, their effects, mandatory measures (as part of statutory requirement) and any voluntary measures for that region.

This organization of management measures is further illustrated in Figure 4-7. Initiatives at the base of the triangle provide the broadest and most comprehensive contributions to the management of effects, but with a smaller range of options. The peak of the triangle provides options applicable to individual projects or collections of projects that are more often implemented many times. Each level, therefore, contributes in its own way to addressing cumulative effects. In the current BC context, the proportion of government led efforts is decreasing while the proportion of industry led efforts is increasing as expectations change to have industry take more of a lead role.

Figure 4-7. Levels of Effects Management Measures



It is useful to note that some initiatives not commonly viewed as effects management techniques are, in fact, major contributors to managing effects at large landscape scales. Protected area strategies (approximately 9% of the CEAMF study area has a protected status) and conservation area designs are examples of these. Their contribution to managing effects is through the planned removal of some areas from all or some types of development, thereby providing areas that are secure from human-induced change, while allowing change to occur elsewhere.

In summary, there are many levels at which effects management may occur, based on involvement by one or more project proponents, and one or more reviewing bodies working either alone or in combination (e.g., industry alone, industry working with government, or government alone). The usefulness of these techniques improves with greater collaboration and with broader regional perspective.

4.5.2.1 Broadening the Collaboration

Related to government responsibility is the need to involve more than one government department, ministry, or agency during project reviews or planning if cumulative effects are to be addressed. For project-specific reviews for the oil and gas industry, the OGC's provision of a one-window application process would, at first, appear to preclude such involvement. At second glance, the referral process suggests an opportunity to at least request comment by other external parties; however, the exigencies of processing so many applications likely would not make this practical, except in the occasional unique circumstance.

Furthermore, as expressed by the intent of joint project EMMs, the participation of other project proponents would further broaden the scope of effects management, and therefore increase the success of such measures. Also, other proponents could be involved with overlapping interests, including oil and gas operators, and possibly those from other sectors (such as forestry).

An opportunity possibly exists to broaden the scope of the EMMs, and ultimately, make them more effective, through expansion of the current development plans supported by the OGC; namely, the General Development Permit (see Section 4.5.3.2), for which a proponent must disclose the full intent of their plans regarding exploration and production of their oil or gas tenures. Such plans currently only apply to one project proponent.

Table 4-2 summarizes the full scope of opportunity, indicating six levels of review. Starting with conventional individual project applications reviewed by a single reviewing body, the table moves on to development plans involving either more operators, more reviewers, and ultimately, more sectors (e.g., energy and forestry). Each next option (identified by a number) provides, incrementally, a more comprehensive contribution to managing cumulative effects.

As to how far one needs to go in applying an effects management response beyond the minimum, as dictated by standard convention, will first depend upon the degree to which a given project is contributing, along with other projects, to a clear effect of concern (as indicated in Step 3 of ACES as shown in Figure 4-4). Such conditions can arise, for example, at the discretion of the OGC, in a relatively confined or local area, such as a river valley or natural gas pool in which access by many operators is desired. An appropriate effects management response may include a coordinated plan to share a common trunk road access, at least as long as possible, while still providing the opportunity for individual operators to eventually access their respective leases.

Table 4-2. Managing Effects as Single Applications and Under Development Plans

	Number of...			Option #	Description
	Proponents	Use Sectors	Reviewers		
Single Application	One	One	One	1	Current convention for all projects
			Multiple	2	Additional issues possibly identified
Development Plans	Multiple	One	One	3	Identification of full build-out
			Multiple	4	Inclusion of other overlapping or nearby projects
	Multiple	Multiple	One	5	Inclusion of other operators
			Multiple	6	Inclusion of full disturbances by all projects

Note: Option 3 is the level of the OGC's current General Development Permit

4.5.3 Description of Effects Management Measures

The following provides a brief description, in alphabetical order, of each level of the EMMs identified in Table 4-1, with a focus on how they apply to oil and gas activities.

4.5.3.1 Project

Codes of Practice: A code of practice is a tool that provides guidelines on how industry should conduct business on the landscape at a level specified in legislation. For example, the OGC's Maximum Disturbance Review Criteria (MDRC) Operating Code provides guidelines for oil and gas construction contractors and service firms. The results-based code of the *Forest and Range Practices Act* provides guidelines for the forest industry that are applied provincially.

Conservation and Reclamation Plan: Conservation and Reclamation (C&R) Plans are designed to return conditions at a project site to their pre-disturbance state following decommissioning. These plans deal with the removal of equipment or buildings, decontamination of buildings or other structures, stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land, or any other related procedure, operation, or requirement specified in legislation.

Constraints Mapping: Constraints mapping illustrates where valued land and water features occur within a project area so that proponents can substantially reduce some environmental and cultural effects. Constraints maps are generated by first developing a map of environmental and cultural sensitivities (e.g., key overwintering habitat, and aboriginal gravesites), which are then translated through a numerical weighting process to indicate a certain degree of constraint of the project siting (AXYS and Lorrnel Consulting 2002).

Construction Best Practices: Construction best practices are measures a proponent takes beyond convention. The development of construction best practices should take into account the unique characteristics of the landscapes affected.

Environmental Protection Plans: Environmental Protection Plans (EPPs) are similar to C&R plans in format, but contain a briefer environmental overview and description of mitigation to potential environmental issues. EPPs are an effective tool for proponents to implement best practices and operational guidelines (developed in their planning phases) in the field during construction and abandonment phases of their projects.

Forestry Operations and Management Plans: Under the results-based forest and range practices regime for BC, forestry operations and management plans are developed by industry, and overseen by government using guidelines from the *Forest and Range Practices Act.* Forestry Operations and Management Plans in BC must be in place before industry can obtain Resource Development Permits (RDP) to cut and develop roads. Based on these plans, the Ministry of Forests monitors the effectiveness of industry in achieving sustainable forest management.

Geophysical Operating Guidelines: Geophysical Operating Guidelines are a set of land use expectations (i.e., operating guidelines) set forward by the provincial government for geophysical (seismic) operations. For example, BC requires a geophysical exploration program be prepared in relation to factors such as wildlife and habitat disturbance, destruction of forest cover, protection of streams and rivers, erosion prevention, site and restoration. Final project plans must be prepared showing the location of all roads, trails, and cutlines that were used or made, the location of each shot point, and the location and size of campsites and landing strips. All construction and changes in construction must be approved. The guidelines address operating procedures, including those camps and relationships with trappers in the area, and also set out general restoration requirements.

Geophysical/Environmental Field Reports: Typically, a geophysical or environmental field report is a compulsory part of the application approval to conduct a geophysical exploration program; thereby, proponents exercise due diligence by requiring identification of significant environmental resources. The process of identifying significant environmental resources prior to application approval in the MKMA is the pre-tenure planning process (PTP), which allows industry and government to identify desirable and appropriate locations for exploration while also considering other values.

Low Impact Seismic: Low impact seismic (LIS) minimizes line width (e.g., 1 m to 4.5 m, not to exceed 5 m), minimizes the line-of-sight of seismic lines (e.g., to less than 200 m), and avoids standing timber while minimizing disturbances to soil and vegetation ground cover. LIS was developed to reduce the amount of timber lost to seismic line construction and to reduce the cost of the related timber damage assessment.

Minimization of Clearing: Minimization of clearing simply refers to reducing the amount of land disturbed or lost as a result of a project (e.g., removing vegetation and habitat, both for wildlife and fish), and thus, helps maintain core security and edge habitat, maintain connectivity, and reduce corridor widths. [7] Minimization of clearing can be accomplished by planning, engineering, and construction practices that reduce the footprint of a project and its individual components (e.g., for well pads and fence lines), and that employ best construction practices on a site-specific basis. The OGC Information Letter (IL) 02-08 acknowledges the benefits of minimization of clearing, and encourages it as part of its policy on Environmental Upgrade Notice.

Planning and Engineering Design: Reduction of ecological disturbance and fragmentation can be accomplished through engineering features such as minimizing the graded surface of RoWs, reducing the number of surface facilities, and controlling noise, dust, and light. Development plans also reduce ecological disturbance and fragmentation by identifying beforehand, where the project footprint will occur, and by consolidating the footprint as much as possible. Related to planning is conformance to project siting

[7] The concept of no-net-loss is often raised as an option to broadly address cumulative effects, based on the principle that if a land or riparian area is disturbed, another area of equivalent geographic extent and/or function would be constructed to offset the project's effects. Although this technique may be successful in some circumstances, its ability to ultimately contribute to addressing cumulative effects is handicapped by two factors: i) the approach assumes the availability of another area to do this, which may not always be the case, especially in areas under intensive development and with private lands; and ii) any such efforts typically will only maximize benefit for only one or a few selected species, and not necessarily for the full suite of species originally ecologically dependent on the new site.

restrictions; for example, outright exclusion from entry into certain areas, or default minimum well spacing requirements (e.g., in the Peace River District, 1 gas well per section and 1 oil well/quarter-section).

Setbacks: A setback is a mandatory distance that a project component or construction-related activity must be from an environmental feature. Such features are typically water bodies and niche wildlife habitat. As specific examples, the OGC requires a 200 m minimum construction setback from a Trumpeter Swan nest, and the Ministry of Forests requires that a well site edge must be set back from the breaks or banks of classified streams and water bodies (OGC 2002).

Timing Windows: Timing windows are periods of time within certain geographic areas in which all, or specific activities may not occur. For example, forest practices are subject to timing windows for stream crossings based on the migratory behavior of fish.

4.5.3.2 Joint Project

Development Plans: Development Plans are an approval in principle for oil and gas activities and pipelines in a local area, allowing for concurrent examination of the surface effects of oil and gas activities and pipelines in that area. The OGC's version of this, the General Development Permits (GDPs), have recently been formed after amendments to the *Oil and Gas Commission Act* and the *Petroleum and Natural Gas Act* in what is now known as Bill 36, the *Energy and Mines Statutes Amendment Act* (2002). Development Plans also are a requirement (EUB IL 93-9) for applications submitted before the Energy and Utility Board (EUB) in Alberta's Southern Eastern Slopes region.

Integrated Landscape Management: Integrated Land Management (ILM) reduces the industrial footprint over a landscape through the coordination of industrial and conservation activities. For ILM to be effective, infrastructure development plans, resource extraction activities, and other ILM concepts must be identified early in a project's life. Proper pre-planning, preliminary analysis, and identification of stakeholders with similar interests or common needs are essential to the ILM process.

Trunk Road Coordination: Trunk road coordination refers to the collaborative planning process that must take place among industrial players to effectively accomplish the goals of ILM. Trunk road coordination allows for both forest and energy sectors to share roads in the short and long term, and allows for the minimization of single-user access corridors as a means of reducing cumulative effects. The OGC IL 02-08 acknowledges the benefits of this to project applications as part of its policy on Review Corridors and Minor Changes to Approved Activities.

4.5.3.3 Regional

Conservation Area Design: Conservation Area Design (CAD) is a strategy for attaining specific conservation objectives through the use of landscape ecology principles. A CAD is currently (2003) being developed for the MKMA through species-based connectivity analysis. Ecological processes such as predator-prey dynamics and fire are being investigated to help develop a design to maintain habitat connectivity.

Future Scenario Forecasting: Future scenario forecasting involves the prediction of future conditions and occurrences based on the how we believe an ecosystem will function under different land use and effects management scenarios. Future scenario forecasting allows managers to weigh the pros and cons of a desired land use condition, determine the period of time before an unacceptable environmental condition is reached, and assist in identifying the degree of management effort required to prevent that condition from occurring.

Indicators (for monitoring and thresholds): An indicator is a quantified variable that describes or measures an environmental or social condition. It is imperative that indicators are realistically defined and consistently measured so that environmental and social conditions can be monitored on an on-going basis. To identify thresholds, the monitoring of selected indicators must be performed in conjunction with the monitoring of changes in land use. As changes in an ecological or social condition become correlated with changes in land use, it is apparent that a threshold is being reached.

Local Area Plans: In BC, local area plans are used to provide management direction for specific areas that fall under, and are consistent with, strategic objectives defined through sub-regional LRMPs. Examples of local area plans include park management plans, forest development plans, wildlife management plans, and oil and gas pre-tenure plans.

Pre-tenure Plans: A pre-tenure plan (PTP) is a local level planning mechanism that is used to guide the environmentally responsible development of oil and gas resources through the identification of objectives and strategies for development activities, and through compliance to specific EMMs. Currently, only Phase 1 of the Besa-Prophet PTP (in the MKMA) and the Upper Sikanni Management Plan has been developed, with other PTP processes scheduled for completion in 2003.

Protected Areas Strategy: A Protected Areas Strategy (PAS) outlines a strategy and defines objectives for creating and maintaining a system of protected areas. A PAS establishes the concept of ecosystem representation as the fundamental premise that guides the identification and selection of new protected areas. Strategic land use plans are the principle mechanism for reaching decisions on new protected areas under a PAS while local level plans (i.e., management plans) provide strategic direction of individual protected areas within the system.

Regional Access Management: Access management is usually accomplished through the use of various in-field measures such as gating, closures, and reducing ease of access (e.g., using berms and slash piles) along any otherwise accessible RoW. Regional access management is a coordinated approach at implementing these measures among all industrial proponents who would share common access in a region.

Regional Ecological Monitoring: Regional ecological monitoring quantifies ecological and social conditions at a landscape level. Parameters that are quantified at this scale are called indices, and they reflect a coarser level of monitoring. Examples of this type of monitoring include tracking of access road density.

Regional Land Use/Environmental Mapping Databases: Regional land use and environmental mapping databases are essential tools in the support of land use management. These tools assist in the dynamic tracking of land uses, and in incorporating environmental features collected from studies and monitoring support while implementing effects management tools.

Regional Plans and Zoning: Regional plans provide guidance for land use over a large land base. Sustainable Resource Management Plans (SRMPs) and Land and Resource Management Plans (LRMPs) are examples of sub-regional or regional plans. The plans make use of zones to define land uses, and they provide information about permissible activities. For example, within LRMPs, resource management zones (RMZs) provide general objectives and strategies for maintaining unique resources within the zone.

Regional Thresholds: A threshold is a quantified parameter that represents an unacceptable environmental or social condition. Maximum access densities or minimum core security patch size (i.e., area) are examples of thresholds that can be quantified at the regional level.

SRMS Steering Committee: A Steering Committee (not presently in place in northeast BC) is a group that reviews, critiques, and supports regional initiatives that promote the management of cumulative effects. A Steering Committee comprised of regional stakeholders provides a link between cumulative effects initiatives in a defined study area.[8]

Species Range Management: Species range management involves maintaining effective habitat for one species based on an umbrella species concept. For example, caribou populations are directly affected by loss of peat habitat, old growth habitat, and distribution of forest cover; therefore, caribou are often used as an indicator species of the overall health of boreal forests. A Wildlife Management Plan (such as for the MKMA) is an example of a broader management plan that addresses many species and habitat needs.

4.5.4 Details for Selected Regional Techniques

The following provides further description of three effects management options — integrated landscape management, access management, and development plans — that may, in many cases, prove to be the most effective and implementable in northeast BC. All of these are already in place, albeit currently in a limited but growing extent, in both BC and Alberta in direct response to forestry and oil and gas activities.

4.5.4.1 Integrated Landscape Management

Integrated Landscape Management (ILM) is used to manage regional cumulative effects by reducing industrial footprints on a shared landscape through the coordination of industrial activities and conservation efforts that are being undertaken by two or more proponents. The success of ILM depends upon the will of industrial proponents to collaborate and pre-plan infrastructure development and resource extraction activities at a landscape level.

[8] The current Peace Managers Group performs, for example, some functions of the proposed Steering Committee, especially in resolving situations involving cross-jurisdictional issues.

Generally, there are two components of the ILM process that contribute to effects management. The first is the sharing of routes to gain access to resources of interest, thereby eliminating the need for each proponent to build their own road. Secondly, clearings are shared among proponents. For example, harvesting of cutblocks is coordinated with the placement of well pads over the landscape, thus eliminating the need for the oil and gas proponents to conduct clearing. The principle ecological benefits of ILM are reduced habitat fragmentation and maintenance of habitat connectivity.

Development plans (discussed in more detail below) that are coordinated among industrial users (e.g., use of shared access) may contribute to the success of ILM at planning stages.

4.5.4.2 Access Management

Access management is a conventional approach used to manage the effects of motorized vehicles along industrial access routes. Traditionally, access management techniques have included gating, closures, and reducing the ease of access through mechanisms such as berms and slash piles. Access management is already a priority in managing environmental effects in the MKMA. For example, the Besa Prophet Pre-Tenure Plan cites access management as “the most critical element in achieving the plan’s goals for oil and gas activity in the MKMA” (BC MSRM 2002). In addition, the MKMA was originally designated under the *Wildlife Act* to restrict public off-road vehicular access to designated roads in order to protect wildlife habitat.

Coordination of trunk road access into still relatively inaccessible areas is an example of one emerging access management approach. An example of this is an industry-led initiative occurring in Chungo Creek, Alberta, that is undertaking proactive planning to reduce the impacts of industry (primarily oil and gas and forestry) at the landscape and project level. The process includes two main parts: an information letter (IL) and an environmental field report (EFR). The IL explicitly identifies discipline components (e.g., aquatics, wildlife) and corresponding guidelines to manage new access. The IL also points out new requirements for shared access, including early dialogue among proponents and reclamation of roads in a timely fashion. The EFR captures the results of the proponent’s efforts to collaborate with other industrial players. For example, as one of the steps in the EFR, proponents must pre- and post-survey their communications with other industrial players and report their activities back to government land managers.

Research being conducted in the Athabasca Oil Sands Region of Alberta has led to the development of mitigation measures to reduce the effects of access on caribou. These mitigation measures include encouraging the use of hand-cut seismic lines and heli-portable seismic operations, complete roll-back of trees and debris onto seismic and pipeline RoWs, and prompt revegetation of linear corridors with native trees species, and limits to reduce industrial developments in woodland caribou habitat. It has been recommended that similar measures be adopted in the MKMA (Hawkes and Searing 2001).

Research being conducted by the Regional Carnivore Management Group, a research initiative operating in parallel to the NES Strategy in Alberta, is addressing the management of cumulative effects of access by calculating threshold and target values for assessing appropriate landscape conditions for grizzly bear (e.g., density of all weather roads over 0.3 km/km^2 has an adverse effect on grizzly bear populations). This work illustrates the link between threshold research and effects management of increased access due to industrial roads.

4.5.4.3 Development Plans

Development plans in general, and specifically those submitted as part of the OGC's General Development Permit (GDP) application, outline an approach to the management of the effects of multiple activities on the landscape. In this process, proponents are required to submit a plan outlining proposed access options, exploration drilling, and production and pipeline scenarios and options to the OGC before approval of any activity. The development plan is modified as new information on land use is gained. The development plan describes a proponent's build-out scenario assuming resource expectations are met. In this way, an approval-in-principle is provided that reflects the opportunity to reduce environmental effects by one proponent, or by multiple proponents planning to operate in an overlapping fashion on the land base or in close proximity to each other (such as occurs in the opening of a new gas field).

The proponent, for example, first demonstrates compliance with the land use objectives specified in a pertinent higher-level plan such as an LRMP. An Environmental Protection Plan (EPP) is then developed, which identifies mitigation measures such as minimizing clearing, conducting drilling programs and pipeline construction during winter months to minimize impacts on resident wildlife, implementing access control mechanisms such as gating, monitoring wildlife, and reclaiming roads.

Plans as part of forestry Resource Development Permits (RDP) may also be incorporated. Proponents in these permits must prove that old growth targets are met, cumulative hydrologic impacts are identified, and public issues and concerns are supported (Government of British Columbia 2002).

Prior to preparing the development plan, an environmental overview assessment is conducted to assist the proponent in responsibly planning a drilling and development program. The environmental overview includes a project description, methods used to gather information, descriptions and the significance of all biophysical factors, description of lands, First Nation's area of traditional practice, and recommendations to facilitate environmentally sensitive planning and development in the tenure area.

In Alberta, the EUB's IL 93-09 *Oil and Gas Developments Eastern Slopes (Southern Portion*) is another example of a development plan, one which recognizes planning at both the pool delineation and pool development stages.

4.6 Role of Thresholds

4.6.1 Regional Vision and Objectives

To properly assess cumulative effects, and to appropriately plan management of those effects, the desired state of environmental features must be known. Whether it is air quality for a community, depth of agricultural soil, or hectares of forest habitat for songbirds, the significance of an effect can only be determined through a well-educated guess in the absence of a clear understanding of what is an acceptable state of an environmental feature, and inversely, what is an unacceptable state.

Sustainability (as introduced in Section 4.1.2.1) and land use planning (as discussed in Section 4.4) can contribute to the identification of a regional vision and objectives; however, in most cases, these goals as expressed are too broad to be used as thresholds. In these plans, the objectives and guidelines consist mainly of recommended EMMs subject to voluntary compliance, and not ultimate land use goals expressed as a measurable target (e.g., a maximum number of hectares that can be cleared for specific types of conventional projects such as access roads).

Generally, what is needed are specific limits or thresholds for certain environmental features. To be useful, thresholds must be quantitative, that is, represented by a measurable number. Regional visions and objectives, as expressed through plans, provide an interim step towards a defined limit of acceptable change.

4.6.2 Implementing Thresholds

4.6.2.1 Challenges to Implementation

The significance of the contribution of an individual project to an environmental effect may generally be judged most easily as follows, referred to here as the 'thresholds test'. For a given area and environmental feature of concern:

- If the project's contribution to the effect (for that feature within that area) does not cause an exceedance of a threshold, then the project's contribution to cumulative effects is acceptable (e.g., not significant).

- If the project's contribution to the effect does cause an exceedance, then the project's contribution is not acceptable (e.g., significant).[9]

However, regulatory (mandatory) thresholds currently exist only for a limited number of environmental components; mainly air and water-borne physical constituents. Some thresholds for biological features such as wildlife and fish do exist, typically as guidelines; however, they are limited in their direct application to address broad (i.e., landscape scale) cumulative effects issues. Environmental management techniques such as setbacks, as expressed, for example, in the OGC's Minimum Disturbance

[9] One possible exception is the interpretation of significance where thresholds have already been exceeded (e.g., in areas already substantially compromised). The question then becomes if the addition of another project makes any difference, assuming that at least, various forms of effects management and monitoring are already in place.

Criteria, are not land and resource use thresholds. Some thresholds reflect social views (e.g., recreational limits of acceptable change).

Thresholds are not necessarily readily implementable until certain initiatives are completed (Volume 2). There are many examples of what could be used to define those missing thresholds based on scientific research, the better of which is based on empirical study (i.e., field research). Once translated into a practical implementation process, they can be used to guide decision-making both at the individual project and regional landscape level.

Before being implemented, thresholds must have the advantage of at least being proven to be reasonable and based on accepted science and traditional observation. They must, therefore, be robust and defensible prior to implementation in a regulatory review process in which the fate of applications includes a thresholds test. To do so is a challenge, for herein lies the meeting point between the interpretations of science versus administrative process. Given the considerable uncertainties associated with thresholds based on ecological response or land use, an overriding justification for implementation of thresholds is required based on another interpretation; namely, of regulatory mandate (in the case of the OGC), and mandate as regards land and resource use management (in the case of provincial ministries).

To do otherwise will inevitably lead to the day when a restriction or outright rejection of a project application will be required to meet a threshold's conditions, a situation for which there is no known precedent for non-regulated environmental features. Such a decision, although in keeping with the intent and spirit of thresholds, likely would be challenged by the project proponent. Subsequent jurisprudence may fall in favor of the proponent unless mechanisms are clearly in place to resolve such conflicts arising from the thresholds test; and, good science supports the thresholds. Conversely, decisions in favor of government could be based on use of the precautionary principle in that the implementation of best management practices (i.e., thresholds, in this case) should not be delayed under the excuse that not enough is known about an effect.

4.6.2.2 Decision Options

Given the above challenges, a means of resolution must include an opportunity to engage the applicant in examining project-specific and joint project EMM options, while initiating or becoming part of a parallel regional initiative (such as regional monitoring). The latter route is commonly used in Alberta's Athabasca Oil Sands, in which project proponents apply project-specific EMMs while deferring some or all measures for managing cumulative effects to the on-going CEMA initiatives (jointly funded and co-ordinated by industry themselves; see Appendix B). This omnibus approach to the management of cumulative effects, which currently includes preparatory work for air- and water-based thresholds, presents an option to proponents, especially in areas of intensive development where collaborative CEMA-like processes are more reasonably effective and supported.

This, therefore, suggests the following possible range of options for the fate of applications before the OGC given implementation of a thresholds test:

- approval — no project contribution to a threshold exceedance;
- approval with standard conditions (i.e., those already required and in common practice);
- approval with exceptional conditions (i.e., those specifically required to address cumulative effects). Prior to this decision, the applicant will be provided an opportunity to discuss the nature of their commitments with the OGC. If matters are not resolved, the application could be referred to mediation; or
- rejection.

4.6.2.3 A Threshold Implementation Strategy

Volume 2 provides a detailed description of the theory and practice of thresholds, concluding with candidate thresholds for northeast BC and a proposed implementation process. In summary, three sets of cumulative effects thresholds are presented: generalized road density (based on road and trail densities), generalized core area, and species-specific thresholds for caribou (based on corridor density). For each type, thresholds are proposed as they related to three LRMP land management categories: enhanced resource management areas; general resource management areas; and special resource management areas.

A project's contribution towards each threshold is calculated and compared to three tiers of numerical thresholds — cautionary, target, and critical — each successively reflecting a greater degree of concern.

In this way, the degree of contribution of individual projects to thresholds within each RMA can be used to test that project's acceptability to regulators. The result also provides an update on the regional status of land use and effects within each of the three types of land management categories, which in an adaptive fashion can be used to provide a better understanding on a landscape scale (i.e., regionally) of the:

1. state of land use or habitat indicators that represent cumulative effects concerns;
2. pace at which the next threshold for that indicator may be approaching; and
3. need for enhanced environmental protection measures and monitoring.

A future scenario forecasting tool (such as ALCES) may be used to evaluate possible future trends for an indicator or species of concern, to evaluate economic tradeoffs, and to suggest the time period before a management point of concern is reached.

In the proposed implementation process, project proponents would submit, with their OGC application a calculation of the contribution of their project relative to the thresholds. The intent is that these calculations would be standardized, quick and non-onerous. For example, construction of a wellsite access road would cause an incremental increase to access densities in the resource management zone in which it is proposed. The combined density would be compared to established thresholds. Once approved, this development would be added to the database and included in future calculations.

What then follows (as shown in Figure 4-4) is that projects in areas with low to moderate cumulative effects hazard (i.e., below cautionary and target thresholds) are subject to project-specific and joint project EMMs, and projects with high or uncertain cumulative effects hazard (i.e., above target and critical thresholds, or in designated hot spots)[10] are subject to enhanced assessment and review. Such review could include the OGC Advisory Committee, which would be requested to review the project as a special case, with the committee acting in an advisory capacity to regulatory reviewers. This process reflects the view that a project in an area already at 'target' or 'critical' cannot necessarily be held responsible for solving the cumulative effects problem if the problem already exists due to other projects.

What can be done beyond addressing the individual project, being a major component of the OGC's current mandate, remains the on-going responsibility of the government. Regulators could declare a change in the acceptability of further applications in these 'compromised' areas (possibly including closure to all applications until certain land and resource use objectives are met), or impose extraordinary requirements for project, joint project, and regional EMMs, such as access management or cooperative compensation programs.

In summary, the OGC's determination on the acceptability of an application would be based on the following, all reflecting elements of administrative process already in place or proposed in this SRMS:

1. relative contribution of the project to the regional threshold;
2. state of the regional threshold in consideration of contributions from all human disturbances;
3. likely trend of future land use pressures and state of environmental indicators; and
4. potential contribution of effects management options, either for that project alone or collectively through a jointly coordinated technique, in minimizing the effects.

Although Volume 2 provides specific candidate numerical thresholds, a process will be required to introduce and formalize their use. Further details are provided in that volume.

Implementation will require agreement on definitions of acceptable change, threshold values, a standard public database, a standard process to calculate indicator values using this database, and project-specific and cooperative management actions to be implemented. The existing public database will need to be enhanced and made more readily accessible. The OGC's use of the existing GIS-Oracle Access Tool (GOAT),[11] which includes map coverages for numerous themes (including certain environmental features), should likely be able to support the incorporation of the ecological thresholds approach.

[10] The hot spot maps provided in this Volume (Section 4), although implying a threshold for each mapped feature, were not designed to correlate to the thresholds as described in Volume 2. In some cases geographic areas of concern for some features, as indicated in the hot spot maps, may possibly also occur within areas for which a target or critical threshold exists. The hot spot maps are based on a different set of criteria and serve another purpose; namely the identification of specific areas of possible concern for specific features, and are intended for use in the absence of the Volume 2 thresholds, and to supplement the scoping of possible specific areas of concern when those thresholds are implemented.

[11] Originally developed by MSRM and MWLAP.

A pilot study is recommended to better understand the ecological, economic, and social implications of threshold implementation in northeast British Columbia. Two areas with existing data and high cumulative effects hazard are proposed for consideration (see Volume 2).

4.7 Implementation

The concept of the SRMS, introduced earlier in Section 4.1.2.1 and Figure 4-1, provides a basis for practical implementation of a cumulative effects assessment and management framework. The SRMS is the name given to a CEAMF that is customized to specifically meet the needs of the OGC, and to generally meet the objectives of land and resource management in northeast BC.

The SRMS is discussed here in more detail based on the concept illustrated in Figure 4-8. The SRMS includes two specific approaches or ‘tracks’ that work both independently and in a coordinated fashion, along with some common components between them.

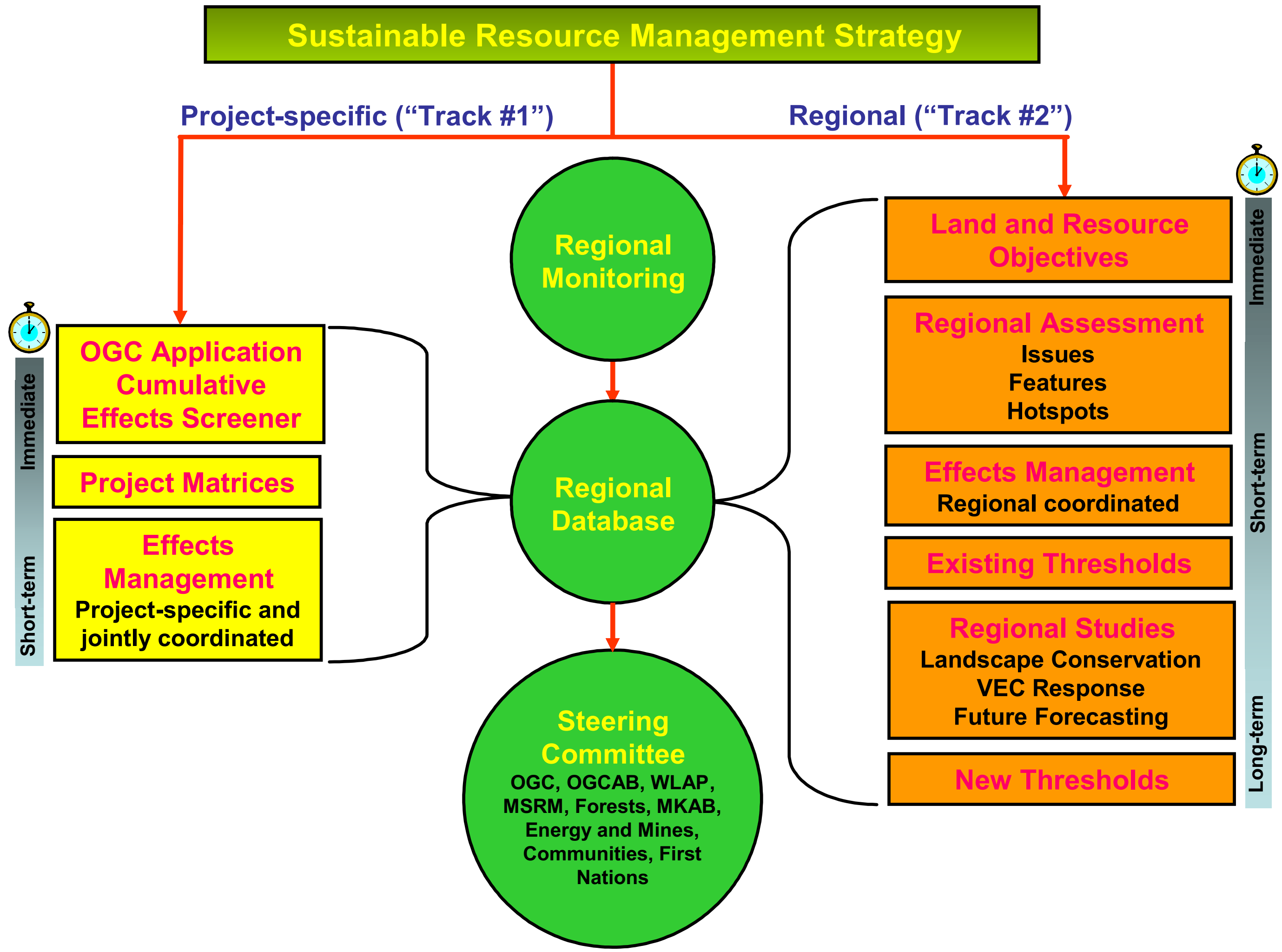
4.7.1 Dual Tracks

The dual track approach directly reflects the two foundations of the SRMS: initiatives associated with specific projects, and initiatives pursued at a regional scale not directly associated with specific projects (but typically reflecting the collective or cumulative influence of many projects).

Track One (the initiatives on the left side of Figure 4-8) is based on addressing cumulative effects at the project-specific level. It includes the ACES (Section 4.2.3 and Appendix G), project matrices (Appendix F, for oil and gas projects only), and various EMMs (discussed in Section 4.5.3).

Track Two (the initiatives on the right side of Figure 4-8) is based on regional initiatives that contribute to both improved land and resource use planning and individual project review (by providing improved information on which to test the project application). This track includes the Regional Assessment (Section 3, including regional issues, description of environmental features, and hot spots), regional studies, various regional EMMs, land and resource management objectives, and thresholds (Volume 2).

Figure 4-8. Sustainable Resource Management Strategy



Both tracks include components that are already implemented, may be immediately implemented, or may require more time before they are ready to be implemented.

The components of both tracks have been described earlier in detail. Further common elements between the two tracks — Regional Steering Committee, regional database, and regional monitoring — are described below.

4.7.2 Common Elements

4.7.2.1 Steering Committee

The purpose of the proposed SRMS Steering Committee is to guide direction of the SRMS in northeast BC. The objectives of the committee would include:

- identifying and coordinating joint regional initiatives that are consistent with and contribute to the achievement of a regional land use vision as defined through strategic level plans;
- identifying more clear and pragmatic land and resource use objectives that can be used at the operational level of the OGC and provincial ministries;
- sourcing funding for joint regional initiatives;
- forecasting future land use and environmental trends and identifying appropriate responses;
- facilitating government and industry information transfer and decision-making on land and resource use;
- identifying and prioritizing research areas aimed at developing thresholds for managing cumulative effects;
- guiding the development of regional monitoring programs (e.g., through defining data requirements, indicators), reviewing the results from such programs, and identifying appropriate project or regional actions; and
- critiquing the effectiveness of initiatives in contributing to the regional goals which they advocate.

The committee would be composed of regional stakeholders, possibly drawn from all or a combination of the following organizations: OGC; OGC Advisory Committee; Ministry of Water, Land and Air Protection; Ministry of Forests; Ministry of Sustainable Resource Management; Ministry of Energy and Mines; Muskwa-Kechika Advisory Board (MKAB); First Nations; industry; local communities; and NGOs. The roles and responsibilities of the committee has similarities to that of the MKAB, especially regarding a mandate to generally oversee the direction of a large geographic area under multiple land use pressures.

Precedents to the use of a central advisory body serving similar functions can be found in other existing initiatives (Appendix B). The NES Strategy in Alberta uses a similar body, consisting of members that will be directly affected by the outcome of the strategy. Members are to sit as individuals and not as representatives of groups or constituencies. The Northwest Territories CEAMF also includes the involvement of a steering committee. In some cases, a professional, independent facilitator oversees the meetings of the committees.

A funding arrangement for the SRMS Steering Committee could be structured similar to that already in place by the Cumulative Effects Management Association (CEMA) initiative in Alberta's Athabasca Oil Sands (Appendix B). In the CEMA example, the framework is jointly funded by industry and government, and is facilitated by a secretariat.

4.7.2.2 Regional Database

The purpose of the regional database is to provide a centralized repository of land use and environmental information that could be accessed as part of project-specific or regional cumulative effects assessment and management initiatives. Objectives to be met by the database include:

- providing OGC staff with the information they may need to review applications and better assess the acceptability of new projects. This would include information about the threshold(s) state (i.e., cautionary, target, critical) within the land management area to which the application applies, as well as the threshold tests (i.e., the degree of contribution of individual projects to the defined thresholds for this area);

- providing information to the Steering Committee and ministries with land and resource use management responsibilities that assists them in better understanding the state of land use and the environment; and

- providing proponents with information that would assist them in better characterizing the land use and environmental setting of their project, and in calculating their project's contribution to land use and/or defined thresholds.

The information contained in the regional database would be spatially referenced (i.e., in a GIS system), readily accessible, and available to the public. Information would be collected from existing databases, individual project applications, and regional effects management initiatives, especially regional monitoring programs.

Use of a regional database as a tool to facilitate management of cumulative effects has precedent in the CEMA initiative, which is working towards managing the cumulative effects of industrial activities in the Athabasca Oil Sands Region of Alberta. CEMA is using a Regional Information System (RIS) to manage the vast amounts of data being collected through its various working groups and independent research initiatives in the region.

4.7.2.3 Regional Monitoring

The purpose of regional monitoring is to collect up-to-date information on changes in environmental conditions and land use in the study area. These data are then incorporated into the regional database and made available to all parties. Objectives to be met by monitoring include:

- tracking land use features and patterns, particularly access corridors (in support of the proposed thresholds relying on road and trail features);
- tracking post-reclamation recovery of disturbed sites;
- compiling data from field surveys of ecological indicators (e.g., herd populations, watershed forest cover). The selection of such indicators should be based on the particular human impacts and ecological features within the area of concern;
- verifying the appropriate implementation of EMMs and monitoring their success; and
- identifying major natural or human caused effects (e.g., insect infestations and areas of ‘boom’ natural gas exploration, respectively) that may accelerate the approach of any given area to a higher threshold level (i.e., an ‘early-warning’ check that supplements the threshold-based indicators).

Monitoring for all of these objectives, for the practical reasons of cost and capacity, is likely not possible within the entire northeast BC study area by any one or even a combination of existing administrative bodies; therefore, customized monitoring programs, likely under partnership arrangements, must be established to meet priority areas of concern based on level and type of human activity, and on the level of concern for affected environmental features.

4.7.3 Roles and Responsibilities

The following outlines roles and responsibilities of key participants in the SRMS:

4.7.3.1 Government (Resource Managers and Planners)

Government staff that would have the most direct role in implementing the SRMS are resource managers and planners.

Working individually and jointly, their roles include:

- identifying land and resource use objectives;
- establishing criteria for land use acceptability that are consistent with land and resource use objectives;
- considering cumulative effects in their permitting and regulation of activities for which they have authority;
- providing information necessary for project proponents to determine contribution to regional thresholds (if available);
- participating in application referrals; and
- administering, co-ordinating, and supporting regional initiatives (e.g., mitigation, monitoring, planning, threshold identification, future scenario forecasting, regional environmental and land use database).

4.7.3.2 Application Reviewers

Regulators who review project applications include OCG staff as well as First Nations or government ministries to which applications may be referred by the OGC. These groups play a critical role in addressing cumulative effects issues at a project-specific level.

Their principle roles are:

- defining clear information requirements and application guidelines for project proponents;
- screening project applications;
- accessing available information;
- requesting new information and facilitating incorporation of new information into the regional database;
- applying criteria on evaluating contributing effects based on results and tests from resource planning (e.g., hot spots, thresholds);
- determining the fate of applications, using available information on project and environmental setting; and
- recommending management responses and conditions for reasonable and appropriate mitigation and monitoring, some which would need to be performed jointly.

4.7.3.3 Project Proponents

Project proponents are those who submit project applications and, by nature of their applications, conduct the first level of assessment of project-specific and regional cumulative effects.

In terms of the CEAMF, the role of project proponents are:

- calculating their contribution to regional thresholds (if available);
- preparing and submitting an application;
- responding to information requirements and requests;
- implementing conditions of project approval; and
- potentially joining and/or funding (either voluntarily or by requirement) new or on-going joint or regional effects management initiatives.

4.7.3.4 Steering Committee

The objectives and proposed structure of a SRMS Steering Committee has been described in Section 4.7.2.1.

Specifically, its roles are:

- advising government and industry on appropriate actions as they relate to cumulative effects;
- improving sharing of information and communication within government, and between government and other stakeholders;
- providing a forum for government, industry, and the public to participate in implementation of the CEAMF; and
- identifying priorities for research and regional effects management initiatives.

4.7.3.5 First Nations

There is a legal relationship between the Government of BC and proponents to ensure that activities on Crown land do not infringe on existing aboriginal rights and title unless there is proper justification; consequently, there is need for the SRMS to identify, incorporate, and consider First Nations' values and interests on the land base.

Some of the roles of First Nations are:

- participating in application review as part of referral process;
- identifying ways in which indigenous knowledge can contribute to the regional database while recognizing the sensitivity of this information and maintaining First Nations ownership;
- helping application reviewers determine how a project will affect First Nations interests and values (e.g., by identifying specific issues or hot spots); and
- identifying indicators to help measure regional effects on First Nations values, and participating in research initiatives that address these indicators.

4.7.3.6 Muskwa-Kechika Advisory Board

The Muskwa-Kechika Advisory Board (MKAB) would play a similar role in the MKMA as the SRMS Steering Committee plays for the region as a whole. They would maintain the distinctive strategic role they currently provide, and participate in initiatives that have implications for cumulative effects within the MKMA.

The roles of the MKAB include:

- participating in planning processes within the MKMA (e.g., pre-tenure planning, wildlife management plan) that serve to identify management objectives and define appropriate land uses;
- advising government and industry on appropriate actions as they relate to cumulative effects within the MKMA;
- improving sharing of information and communication among stakeholders;

- providing independent review of complex and unusual proposals within the MKMA;
- identifying priorities for research and regional effects management initiatives within the MKMA; and
- participating with the Steering Committee to ensure that the concerns of the board are expressed.

4.7.3.7 Public and Non-Government Organizations

Private citizens and member of non-government organizations can actively participate in the implementation of the SRMS.

Their roles include:

- participating in planning processes that set regional land use vision and objectives;
- identifying issues of concern, and valued ecosystem and social components;
- providing independent review of complex and unusual proposals;
- acting as a 'watchdog' as to the success of SRMS implementation; and
- participating with the Steering Committee to ensure that general public and community concerns are expressed.

4.7.4 Decision and Information Flow

Figure 4-9 illustrates how the individual parts of the SRMS, as introduced in Figure 4-8 and described above, sequentially fit together into a series of clear and consistent steps. This shows who does what, where one starts, where one ends (and with what products and results), and what it takes to get through the process. The figure, therefore, summarizes where the decisions are made and how the information flows.

This decision and information flow essentially consists of four major parts, identified by the letters A, B, C, and D in Figure 4-9, as summarized below:

- **Part A *Preparation***: This part prepares the information needed for the SRMS to begin. It includes the identification and verification of existing land and resource use objectives, and the review of available land and resource use information. Once this is completed, implementation splits between the two SRMS tracks based on whether the intended actions relate to project-specific review or regional planning and research.
- **Part B *Project-specific Review***: This part processes individual project applications through the existing OGC review process, modified by addition of the proposed ACES. Possible additional review by other regulatory bodies can be added.
- **Part C *Regional Planning***: This part implements various planning and research activities, some possibly related to the development and refinement of thresholds,

that will eventually help improve understanding of land and resource use in the region, and of the effects of such uses on valued components.

- **Part D: *Regional Monitoring***: This part, common to Parts B and C, provides the means of collecting and updating information that will eventually feed back into the process. Part D sees the process return to the earlier decision point from which either a new project application is reviewed or a new regional initiative is begun. This indefinite cyclic pattern reflects the principles of adaptive management (i.e., modify an action based on more recently obtained information and review of earlier assumptions).

Viewed in another way, the SRMS reflects initial planning (Part A), regulation by sector (Part B), and adaptive resource management (Parts C and D) to provide a complete and integrated response to assessing and managing cumulative effects both on a project and regional basis.

Table 4-3 provides some examples of typical situations in which cumulative effects concerns arise. First introduced in Section 4.1.1 as examples of cumulative effects problems, the table provides an example of a course of action constituting possible solutions based on the SRMS model. This table, therefore, serves as guidance, by way of example, on how the pieces of the SRMS may come together. Specific decision-makers or advisory bodies active in the northeast study area would pick and choose the most appropriate information and tools from the SRMS to assist them in whatever task they face, whether on a day-to-day basis for specific applications or strategically over an extended period of time.

Figure 4-9. Pulling it all Together: SRMS Decision and Information Flow

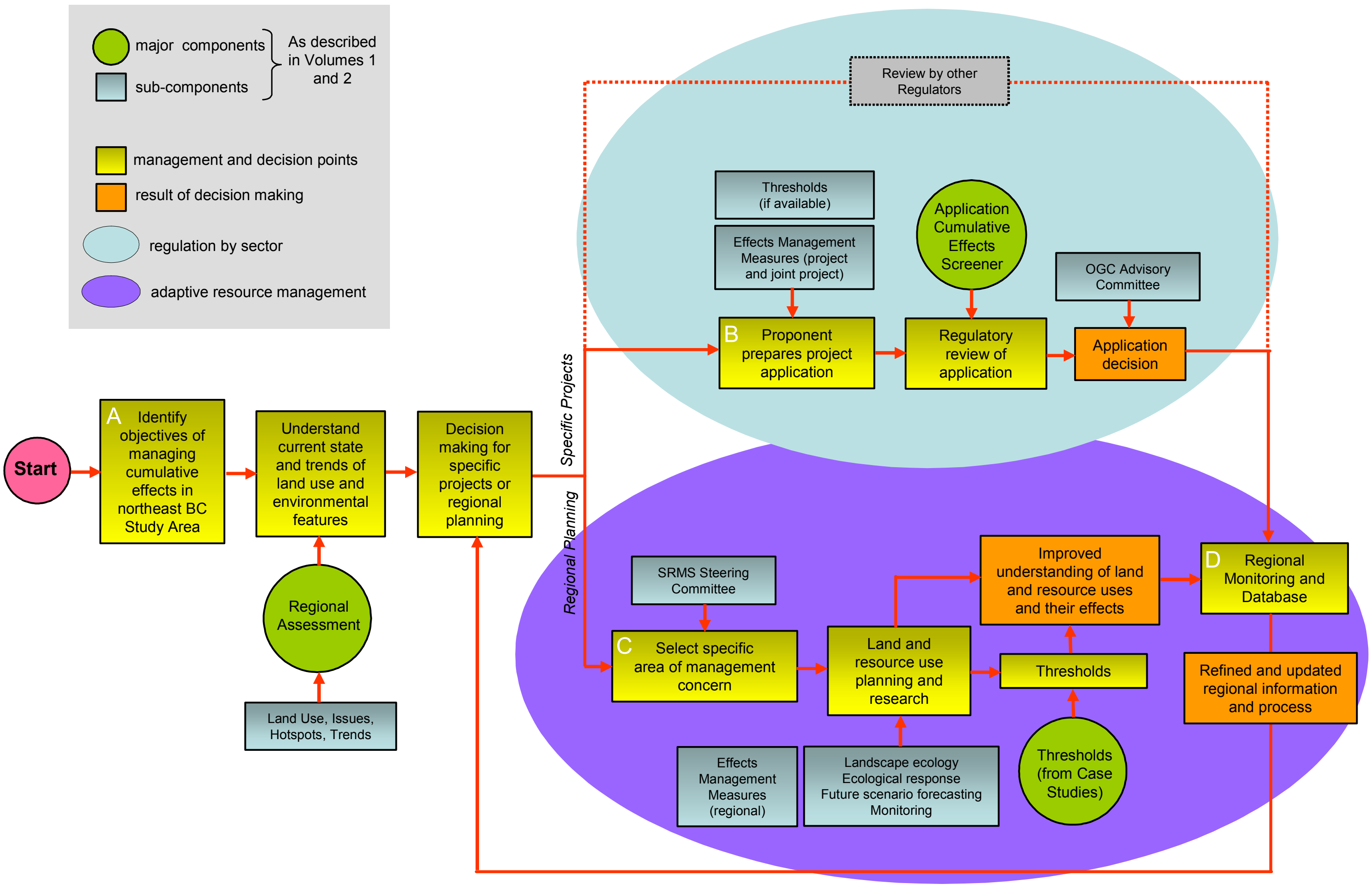


Table 4-3. Examples of SRMS Implementation Scenarios

Scenario	Issue of Concern	Example Solution
A proponent wishes to construct another well in a certain area (e.g., a valley, a new natural gas pool), where there are currently already a number of resource users.	Will this additional application compromise something of environmental importance?	The OGC reviews the application using ACES's routine screener. The application is approved with project-specific or regional EMMs, or forwarded to Expanded Cumulative Effects Review.
A proponent wishes to construct a resource access road in a topographically constrained area, such as a valley, that is currently inaccessible except by an ATV trail.	What are the future implications of more use once the road is built?	The OGC reviews the application using ACES and determines that cumulative effects based on known conditions are unlikely. Government bodies responsible for land and resource management in that area determine if any additional planning or EMMs should be introduced to apply to possible future activities.
An area of well-defined boundaries is already experiencing 'boom' conditions and applications for project approvals are coming in faster than due process allows time to investigate some matters of environmental concern (unless substantial delay occurs in the reviews).	What is the most effective way in such situations to not compromise on environmental responsibilities?	The OGC reviews the application using ACES. Most applications automatically default to regional EMMs. Government bodies responsible for land and resource management in that area adaptively prioritize and coordinate regional EMMs, whereby the implications of on-going development and existing thresholds are re-evaluated to ensure that government response is as effective as possible.
An area of generally understood boundaries that is currently experiencing minor human use and is expected to substantially pick up in the future in regards to resource extraction (e.g., coal bed methane, natural gas, or timber harvesting).	What can be done now to prepare for this eventuality?	Government bodies responsible for land and resource management in that area review current state of environment and land use conditions, forecast possible future changes to these conditions, and design appropriate additional planning or EMMs to apply to possible future activities.

In conclusion, the SRMS approach reflects the following:

- There is not necessarily one solution to the cumulative effects problem (as expressed in Section 4.1.1), nor one perfect solution. There are a variety of options to choose from, many described in the framework, to meet the needs of any given situation.

- Application of thresholds works in parallel with the application of effects management measures. Both contribute to addressing cumulative effects in their own way. The use of EMMs becomes particularly important when thresholds have not yet been implemented as part of regulatory review or planning.

- The proposed thresholds (Volume 2) represent a coarse scale approach that, if applied over time over large areas for any types of human disturbances, will contribute to collectively minimizing cumulative effects. Application of these thresholds will not necessarily address immediate and specific local issues of concern. For example, in the second scenario involving the road in the valley (Table 4-3), there does not yet exist (anywhere) an approach that, at such relatively small spatial scales and for a wide variety of possible environmental effects, will confidently determine how much activity in the valley is too much.

- Some approaches can be exercised by individual project proponents and the OGC based on either the on-going implementation of effective EMMs or the control of allowable activities through the use of thresholds. This approach does place considerable reliance on the effectiveness of the EMMs; as such, adaptively monitoring and modifying EMMs is critical to ensure they will continue to contribute to eliminating or reducing cumulative effects.

- Some approaches can be exercised by government, and influenced by advisory bodies, based on regional planning, forecasting, and research.

CHAPTER 5: SUMMARY AND RECOMMENDATIONS

CUMULATIVE EFFECTS ASSESSMENT AND MANAGEMENT FRAMEWORK (CEAMF) STUDY

5 Summary and Recommendations

5.1 Summary of Key Framework Components

The purpose of this report is to describe a framework to assess and manage cumulative effects in northeast BC. A regional Cumulative Effects Assessment and Management Framework (CEAMF) is an administrative structure that combines various initiatives that assist decision-makers in assessing and managing the effects of human use on the land. This framework was developed in response to concerns in the region about the possibility of worsening environmental effects due to multiple land and resource use activities. Specific concerns exist about the potential contributions of oil and gas projects to these effects.

Previous sections of this report have described the key components of the CEAMF; namely:

1. **Regional assessment:** The regional assessment characterizes the state of the land and resource use in the study area. It also describes environmental features (air quality, soils and terrain, aquatic resources, vegetation, and wildlife) according to their respective issues, effects, valued components, and specific areas of possible concern (referred to as hot spots). The regional assessment provides, at a coarse scale over a large geographic area, information of use to both project-specific reviewers and regional planners.

2. **Regional Planning and Research Studies:** Regional planning and research studies are described, providing various initiatives that improve and add to existing information that is useful and necessary to decision-makers. Regional planning and research studies that would likely have the greatest contribution to the development of thresholds are applied landscape ecology, ecological response studies, future scenario forecasting, and effects monitoring.

3. **Effects Management:** Effects management includes any measures that can minimize or eliminate effects from human disturbances. Effects Management Measures (EMM) may either be the responsibility of a single project proponent, of multiple project proponents, or of government. As such, these measures are either project-specific or regional in nature. Twenty-nine EMMs are described, recognizing those already being implemented or considered in northeast BC and elsewhere, as well as new and innovative approaches.

4. **Project Assessment Matrices:** The project assessment matrices provide generic and specific information that is useful in the review of individual oil and gas project applications. This information covers seven disciplines that are commonly examined in EIAs: air quality; soils and terrain; aquatic ecosystems; vegetation; wildlife; land and resource use; and First Nations. The information provided in the matrices is based on the five conventional steps in project assessment, including scoping, analysis, mitigation, significance evaluation, and follow-up.

5. **Project Screener:** The project screener, referred to as the Application Cumulative Effects Screener (ACES), is a step-by-step process for OGC staff to follow when reviewing project applications for possible cumulative effects issues. The process has two options: one is a simple series of questions that can be answered readily with available information; and the other is based on thresholds that can be used when they become available. An expanded review process is also described for situations warranting more detailed review of an application as a result of certain environmental concerns.

6. **Thresholds:** Thresholds are measures of limits of acceptable change. Four types of thresholds are proposed based on access density in broad landscapes, access density within watersheds, core habitat security, and species-specific thresholds. In the framework, contribution to the threshold by each project is compared to three levels of thresholds (cautionary, target, and critical). The thresholds are introduced and summarized in this report, and are fully detailed in Volume 2.

7. **Monitoring:** Monitoring is the ongoing determination of environmental conditions, the verification of predicted effects, and the verification of the effectiveness of applied effects management measures. Monitoring is a critical component of the CEAMF in that it can help measure the effectiveness of EMMs, and can help reduce cumulative effects.

8. **Sustainable Resource Management Strategy**: The Sustainable Resource Management Strategy (SRMS) is a version of a CEAMF (which is a generic term) that is customized for northeast BC. While focused on addressing oil and gas projects within this discrete region, it can be adapted to address the cumulative effects of any type of human activity, and adapted for implementation elsewhere in BC. The SRMS essentially ties together all the individual components (i.e., points 1 to 7 above) into one sequential series of steps. It includes three principal parts: initial planning; regulation by sector; and adaptive resource management. Fundamental to the SRMS is the concept of a dual-track approach, whereby cumulative effects are addressed both by examination of individual project applications and on a regional and jointly supported basis.

The proposed approach to assessing and managing cumulative effects is based on many tools or options that would each contribute in their own way, or would work together, collectively. Each tool or option provides an opportunity to address cumulative effects issues, at earlier or later points in time, depending on available resources and acceptance at whatever government, industry, and public level of participation is appropriate.

5.2 Contributions of the SRMS to Science and Decision-making

Although other regions have attempted to develop and implement frameworks for addressing cumulative effects (see Appendix B), the proposed SRMS for northeast BC makes a significant contribution to science and decision-making, and is unique in comparison to many other frameworks in its emphasis on immediate and practical implementation.

Specifically, the SRMS contributes to science and decision-making as described below.

- It can be immediately and practically applied as it builds on existing tools and requires limited changes to the current administrative and management structures in place for the region (the only change being the addition of the proposed SRMS Steering Committee).
- It recognizes and is consistent with both local and strategic level planning for the region. As such, the implementation of the framework does not require that land use objectives be re-visited in the short term although it recommends that such objectives occasionally be reaffirmed in light of new information.
- It builds on and supports scientific research and provides a mechanism (in the form of the regional, publicly-accessible database) that can be used to continually update the state of knowledge for the region. The regional database is a tool to identify geographic areas of concern (i.e., hot spots), prioritize areas for future research, and adapt land management plans and strategies in light of new information and data.
- While focused on the environmental effects of oil and gas activities, the concepts presented in the framework are readily adaptable for use by other land management agencies and for use in the assessment and management of social, cultural, recreational and economic effects.
- It provides realistic options for assessing, managing, and mitigating cumulative effects resulting from oil and gas activities, at both the local and regional scale, based on knowledge of what is appropriate to the region and what has been proven successful elsewhere.
- It breaks new ground in its identification of scientifically-based indicators and thresholds, which are customized for use in the region to which they would be applied, and which are implementable at a pilot scale in the short term (in conjunction with the recommended project screener). The proposed thresholds represent a coarse scale approach that, if applied over time over large areas for any type of human disturbances, would collectively minimize cumulative effects.
- It recommends a workable and non-onerous approach to incorporating cumulative effects into the day-to-day application review procedures currently in place by the OGC, while requiring only minimal changes to those procedures for the majority of application reviews. The project screener (ACES) provides the OGC with a formalized approach to assessing and managing cumulative effects and meeting due diligence requirements.
- It relies not on one management agency to solve the problems of cumulative effects but rather provides an ‘umbrella’ under which all cumulative effects management decisions could be made, by any agency or organisation, at any time. The introduction of a regional steering committee to specifically address cumulative effects issues in Northeast BC is a unique concept for the region.
- In generally, it provides reference points, guidance and options which support decision-making, which are adaptable to a variety of situations, and which are linked to other planning and management processes at the local, sub-regional, and regional scales.

5.3 Recommendations

The principal recommendation of this report is to adopt the Sustainable Resource Management Strategy (SRMS) as a means of practically implementing a region-wide CEAMF. The eight recommendations that follow provide specific direction for implementing the critical components of the SRMS. Given the integrated and adaptive nature of the SRMS, each recommendation is linked to the others. Further, each recommendation has one or more ‘ongoing’ components making it difficult to classify the recommendations according to short, medium or long timeframes. That said; many of the recommendations could be implemented immediately, using existing information and data, while others could be phased in over time as resources and pertinent information become available.

It is expected that the OGC and MKAB, in consultation with other ministries and stakeholders, and in consideration of available resources and current priorities, would determine which of the recommendations they have the capacity to immediately implement, and which would be attended to at some point in the future. Notwithstanding this expectation, it is the first four recommendations that would provide the greatest overall contribution to the framework and would effectively ‘set the stage’ for the implementation of the remaining recommendations. The first recommendation is overarching, while the other three specifically address the steering committee, data management, and project screening components of the SRMS.

1. Adopt a ‘dual-track’ approach so that cumulative effects can be addressed at two levels: project-specific and regional

Cumulative effects should be tackled both by addressing individual projects, and by undertaking regional initiatives (i.e., those that are not directly tied by regulatory mechanisms to any one specific project). This is referred to as a ‘dual-track’ approach. Components of the SRMS that are applicable to Track 1 (project-specific) are project-specific assessments, application screening, and project effects management measures. Each of these can be implemented immediately and adapted on an ongoing basis. Components of the SRMS that are applicable to Track 2 (regional) are land and resource management objectives, regional-scale assessment of cumulative effects issues and hot spots, regional studies, thresholds, and effects management measures. Each of the components can be implemented as time and resources permit.

2. Form a central SRMS Steering Committee to advise on regional initiatives

Solution of the cumulative effects problem is ultimately a shared responsibility among regional stakeholders. Further, co-ordination of resource use decisions within government, and the availability of information to support decision-making, are required before any meaningful solution to the cumulative effects problem becomes apparent. The dual mandate of protecting the natural environment and accessing and extracting natural resources can only be accomplished through collaboration and the support of new initiatives. Recognizing these realities, some components of the SRMS, and, in fact, many of the critical aspects of the SRMS (particularly in Track 2: Regional) can only be exercised collaboratively. Thus the formation of a central SRMS Steering Committee is recommended.

The Steering Committee would play a key role in advising government and industry on appropriate actions as they relate to cumulative effects, improving the sharing and communication of information, providing a forum for broad participation in implementation of the SRMS, and identifying priorities for research and regional effects management initiatives. The committee would be composed of regional stakeholders, possibly drawn from government agencies (local, regional, provincial, and federal), the Muskwa Kechika Advisory Board (MKAB), the OGC Advisory Board, First Nations, industry, local communities, and NGOs. The first tasks relating to this recommendation are the selection of participants and the development of Terms of Reference based upon the provided preliminary list of roles and responsibilities.

3. Establish and maintain a centrally located and publicly-accessible regional database of information that builds on the information collected and utilized as part of the Regional Assessment component of the framework

The purpose of the regional database is to provide a centralized repository of land use and environmental information that could be accessed as part of project-specific or regional cumulative effects assessment and management initiatives. The information contained in the regional database would be spatially referenced (i.e., in a GIS system), readily accessible, and available to the public. Information would be collected from existing databases, individual project applications, and regional effects management initiatives (especially regional monitoring programs), and would require regular updating. The results of analyses conducted using these data (e.g., the creation of hot spot maps) should also be made readily available.

4. Amend the current OGC application review process to incorporate a screening for cumulative effects

There is an opportunity within the existing OGC review process, at the screener stage, to incorporate consideration of cumulative effects for individual project applications that is not onerous, and would not threaten the timely and efficient review process, assuming that certain information sources are available. The recommended screening approach is based on a clear series of steps; however, to implement the screener, two changes to the existing OGC review process are required:

- if thresholds are implemented, then applicants should provide the OGC with a calculation of their project's contribution to the regional threshold (as explained in more detail in Volume 2); and
- for OGC staff (i.e., resource officers and managers), additional time should be allocated to complete a series of checks and selections using various information sources, including maps and look-up tables.

5. Continue the process begun as part of Volume 2 of this work relating to the identification and implementation of appropriate cumulative effects indicators and thresholds for northeast BC

Once approved within an implementation process that is practical and not onerous, use of a wide suite of context-specific thresholds (i.e., correlated to specific areas and environmental features of concern), whether as part of project-specific review or regional land use planning, offer the most effective tool to address cumulative effects. However, their practical implementation will take time given the need to develop capacity to support them and to obtain agreement by stakeholders. To implement thresholds broadly throughout northeast BC, initiation of a pilot program is recommended to demonstrate practical application of thresholds within a regulatory review and provincial planning process. Following a successful pilot, thresholds would be incorporated within the OGC's and other review processes. Detailed recommendations relating to a thresholds implementation strategy, and expected outcomes of such a strategy, are discussed in Volume 2.

6. Encourage research projects on cumulative effects issues in the region, and incorporate the results back into the framework

An important component of any CEAMF is research, which provides information necessary for understanding impact mechanisms and interactions, defining thresholds, and employing best management practices and adaptive management principles. Research themes that will, over time, most directly advance the assessment and management of cumulative effects (e.g., development of thresholds) include landscape ecology, ecological response studies, future scenario forecasting, and monitoring. The SRMS Steering Committee would play a key role in identifying research priorities, and in co-ordinating the incorporation of research results back into the regional database. Mechanisms to fund such research are already in place in the form of, for example, the OGC's Environmental Fund (since renamed the Science & Community Environmental Knowledge Fund), and the Muskwa-Kechika Trust Fund.

7. Make information on appropriate Effects Management Measures (EMM) available to proponents and land and resource planners, coordinate joint and regional EMMs, and monitor the effectiveness of EMMs in reducing cumulative effects

The management of project effects, whether implemented for individual projects at a time or jointly for various projects, provides immediate to near-term opportunities to eliminate or substantially reduce environmental effects and the pace at which those effects occur. There already are many management techniques being implemented in northeast BC. Some of these, and others, are gaining wide acceptance and implementation in other jurisdictions (such as Alberta), and are all readily adaptable to BC. Related to government responsibility is the need to involve more than one government department, ministry, or agency during project reviews or planning if cumulative effects are to be addressed. The participation of other project proponents would further broaden the scope of effects management, and therefore, increase the success of such measures. Also, other proponents should be involved with overlapping interests, including oil and gas operators and those from other sectors (such as forestry).

In the absence of thresholds, the SRMS places considerable reliance on the effectiveness of the EMMs; as such, adaptively monitoring and modifying EMMs is critical to ensure that they will continue to contribute to eliminating or reducing cumulative effects. In addition to monitoring undertaken by proponents, priority for research funding should be given to research projects that monitor and assess the effectiveness of various project-specific and region EMMs.

8. Implement an adaptive management approach that monitors key indicators and collects new information to feed back into the framework and database

The purpose of regional monitoring is to collect up-to-date information on changes in environmental conditions and land use in the study area. These data are then incorporated into the regional database and made available to all parties. With the incorporation of monitoring and adaptive on-going evaluation of framework objectives and procedures, the framework can continually evolve to meet the mandate of government and the interests of northern BC communities and resource users.

CHAPTER 6: REFERENCES

CUMULATIVE EFFECTS ASSESSMENT AND MANAGEMENT FRAMEWORK (CEAMF) STUDY

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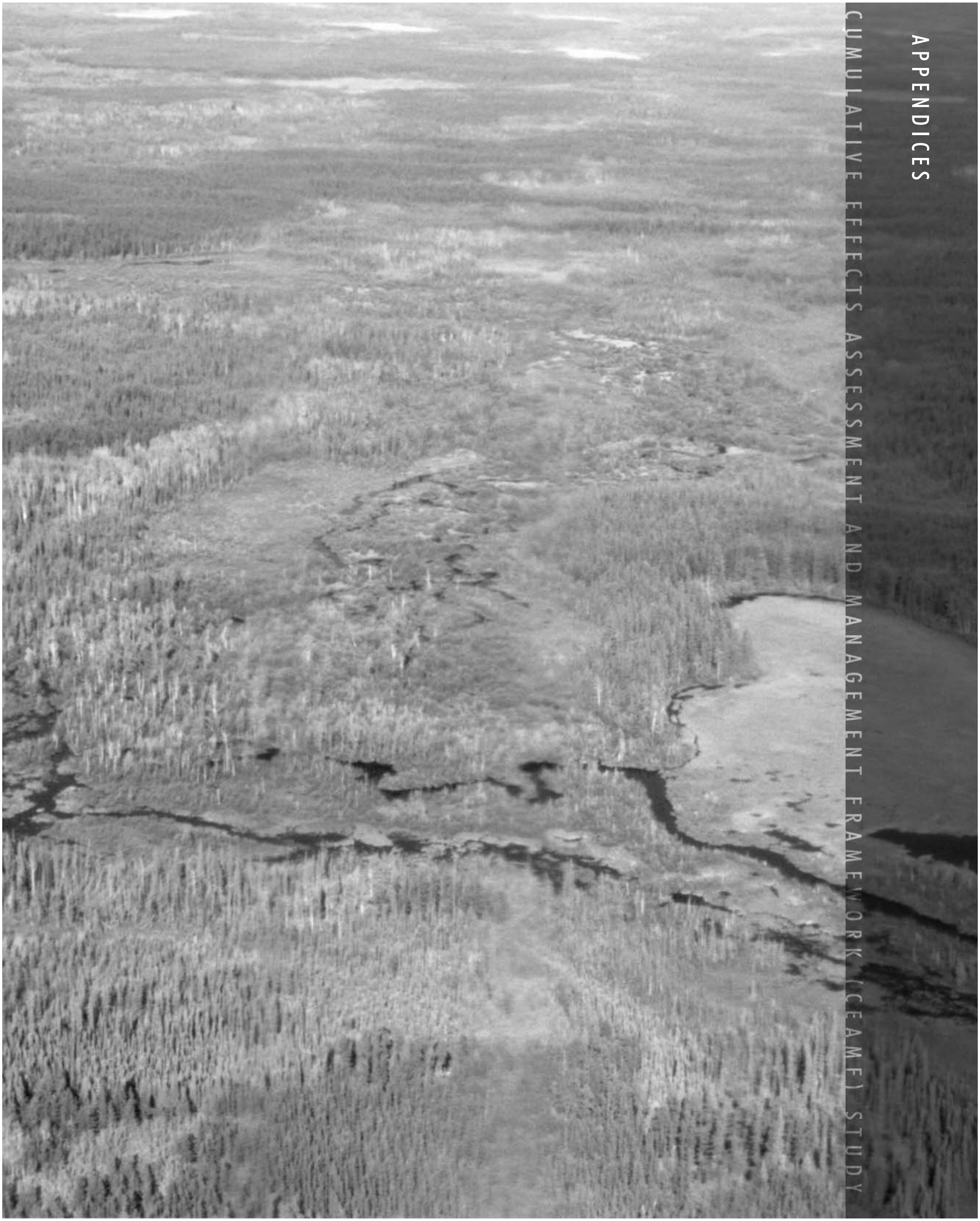


APPENDICES

CUMULATIVE EFFECTS ASSESSMENT AND MANAGEMENT FRAMEWORK (CEAMF) STUDY

Appendix A: Project Terms of Reference

The Terms of Reference for the project have been extracted from three integrated proposals submitted to the BC Oil and Gas Commission in April 2000. Some of the terminology used in the proposal documents and subsequent project Terms of Reference may differ from terminology used in the report.

COMPONENT 1: Development of a Practical Framework for Cumulative Effects Assessment and Management for Northeast British Columbia

Project Summary

AXYS Environmental Consulting Ltd., Diversified Environmental Services and Salmo Consulting Inc. are proposing to conduct three separate but integrated studies which, in combination, will provide an over-arching strategy and approach for identifying, scoping, assessing, and managing cumulative effects in northeast BC (these components will be referred to collectively as cumulative effects assessment and management (CEAM)). All three components will contribute towards the development of a decision-support framework for aiding the BC Oil and Gas Commission (OGC) in ensuring that cumulative effects are consistently and efficiently addressed and managed as part of their on-going project approval process. The three proposed components are:

- CEAM Framework: development of an overall approach, specific to this region, for conducting project-specific and regional cumulative effects assessments (CEA);
- CEAM Case Studies: detailed assessment of cumulative effects in two representative areas in northeast BC; and
- CEAM Project Screener: development and testing of an application screening process to assist the OGC in making decisions on project applications.

The CEAM Framework will recommend approaches for scoping CEAs (e.g., identification of important regional issues, selection of indicators for ecosystem and socio-economic effects), analytical approaches and tools for CEAs, approaches for mitigation and management, determination of impact significance (including thresholds), and follow-up and monitoring requirements. A variety of existing data sources will be used to develop a spatial overview of existing cumulative effects in the region (i.e., a regional database) so that potential areas of concerns (hot spots) can be identified and significant data gaps noted. These products can eventually be used by the OGC and industry as:

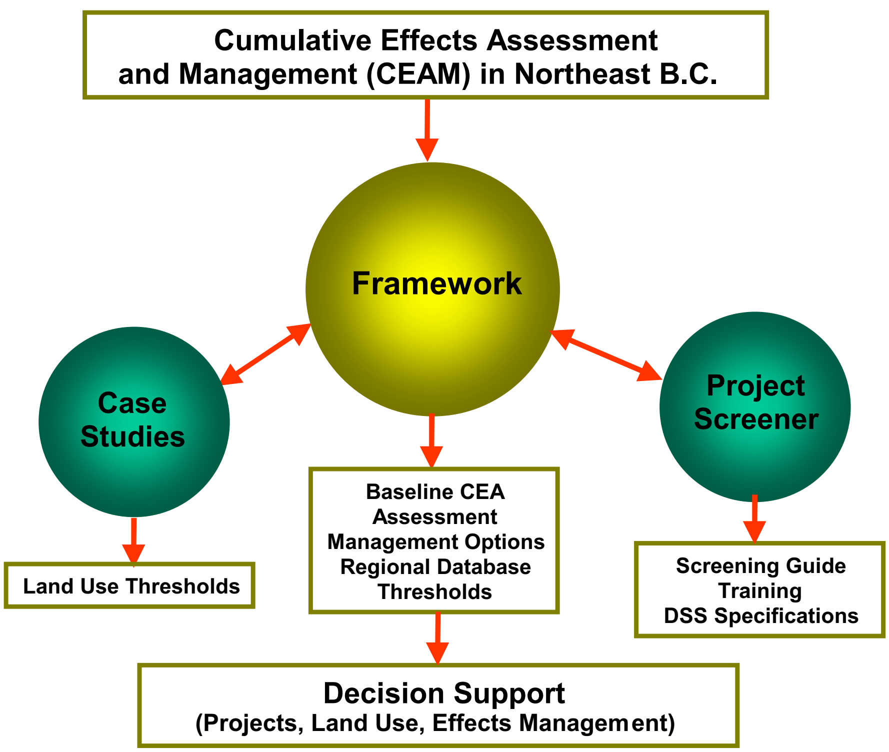
- a means to flag regional hot spots and areas requiring remediation and management;
- a preliminary planning tool to aid in review of future applications and management initiatives;
- a baseline for future assessments;
- a guide to proponents on how the CEAM Framework can be applied in an assessment;

- a practical application for incorporating results from other research; and
- a means to identify important data gaps and set priorities for follow-up and monitoring.

Background and Approach

Under the cumulative effects research envelope of the OGC Environment Fund, AXYS Environmental Consulting Ltd., Diversified Environmental Services and Salmo Consulting Inc. are proposing to conduct three separate but integrated studies which, in combination, will provide an over-arching strategy and approach for identifying, scoping, assessing, and managing cumulative effects in northeast BC (these components will be referred to collectively as cumulative effects assessment and management (CEAM)). All components will contribute towards the development of a decision-support framework for aiding the OGC in ensuring that cumulative effects are consistently and efficiently addressed and managed as part of their on-going project approval process. The three components will build from the results of existing and past initiatives such as Land and Resource Management Plans (LRMP), Forest Renewal BC policies and planning, landscape unit and pre-tenure planning, and ongoing work by the OGC. The three proposed components are (Figure A-1):

Figure A-1. Relationship Between Proposed Cumulative Effects Assessment and Management Components



1. **CEAM Framework**: The framework involves the development of an overall approach, specific to the northeast, for conducting project-specific and regional cumulative effects assessments (CEA). The framework will recommend approaches for scoping of CEAs (e.g., identification of important regional issues, selection of indicators for ecosystem and socio-economic effects, setting of spatial and temporal boundaries, and identification of projects and human actions to be considered in a CEA), analytical approaches and tools for CEA, approaches for mitigation and management, determination of impact significance (including thresholds), and requirements for follow-up and monitoring. As part of the framework, a variety of existing data sources will be used to develop a spatial overview of existing cumulative effects in the region (i.e., a regional database) so that potential areas of concerns (e.g., hot spots) can be identified. Important data gaps will also be identified.
2. **CEAM Case Studies**: The case studies provide a detailed assessment of cumulative effects in two representative areas in northeast BC to demonstrate how the CEAM Framework can be used in a real context. The case studies will provide several detailed 'windows' for looking at cumulative effects in the region, and will be useful in testing and developing approaches for assessing cumulative effects, addressing impact significance, and identifying important data needs. The end product of this component will be a detailed CEA for each study area. Deliverables will include a spatially explicit database on existing biophysical and land use attributes for the study areas, the development and use of tools and indices for assessing cumulative effects appropriate to each study area, a review of existing information on thresholds for cumulative effects, recommendations to the OGC on use of these tools and thresholds, and the identification of important needs for data, analytical tools, and thresholds. Information from the case studies will be used to modify and refine the CEAM Framework.
3. **Project Screener**: The Project Screener aids staff in rapidly assessing applications for a wide range of activities and cumulative environmental effects. The screener would not reduce the responsibility and authority of the agency, but rather would provide a systematic and consistent method to assist decision makers, as well as an audit trail for documenting these decisions. This component of the proposal would entail the development and testing of an application screening process to assist the OGC in making decisions on petroleum exploration, development and production proposals, and the management of cumulative effects. This initiative would also include recommendations on establishing, managing and updating regional databases, and allocating funds for a training workshop for OGC staff. This process will reflect the CEAM Framework and will also incorporate findings of the Case Studies.

In combination, the three proposed projects will offer opportunities to immediately incorporate results from other OGC-funded research under the air emission, cumulative effects, and ecological integrity envelopes. For example, information from the ecological integrity projects could be used to better understand impact mechanisms and interactions, define thresholds for key resource groups, and identify and employ best management practices. Data derived from other research programs, such as the Muskwa-Kechika Trust and UNBC initiatives, could also easily be incorporated. We suggest that the CEAM Framework, Case Studies, and Project Screener projects be used to ensure that information from the other research projects will be of immediate and practical use by the OGC and other government agencies. The CEAM Framework could be used to encourage researchers to provide data that can be used to define impact thresholds or to better describe how cumulative effects are occurring. Similarly, developers of cumulative effects models could be encouraged to use standard spatial databases (e.g., TEM data), temporal scoping, and action inclusion lists, and to provide useful outputs to the OGC and industry.

We recognize that this is an ambitious and complex task. It is not our intent to subsume or intrude upon the authority or responsibilities of the OGC. Rather, we hope that together these three initiatives will assist the OGC in effectively addressing cumulative effects and managing the activities of the oil and gas industry in an environmentally sustainable manner. To be most effective, our team will work closely with the OGC in developing and applying the Framework, formulating input and output guidelines with other researchers, integrating industry needs, and creating the decision support system. Interactions with front-line staff in the OGC will be critical in ensuring that the approaches, processes, tools, and outputs from these initiatives are of maximum value. We believe these tools will also assist the oil and gas industry in better understanding, addressing, and managing cumulative effects, and will potentially encourage other industry users (e.g., forestry) and regional stakeholders to work with the OCG and the oil and gas industry to manage cumulative effects.

Objectives

Objectives of the project will be to:

- develop a CEAM Framework that will serve as a guide to the OGC and industry for assessing and managing cumulative effects;
- refine the CEAM Framework through workshops with the OGC, industry, and other stakeholders;
- update the draft CEAM Framework using information from the Case Studies (Component 2) and other Environment Fund research;
- complete an overview assessment of cumulative effects in northeast BC using the CEAM Framework to serve as a baseline for future assessments, as well as a demonstration of how the Framework can be used in a real application; and
- provide technical and process information to assist the development of the Project Screener (Component 3).

The end products of the CEAM Framework project will be a report and guide. The report will summarize the technical elements of the Framework (as described above), as well as the key decisions and input from the workshops. The guide will be a simpler description of the elements of the Framework and will be prepared primarily for distribution to industry proponents to assist them in ensuring that they adequately address cumulative effects issues and, most importantly, implement measures to minimize project-specific and regional cumulative effects.

Deliverables

Deliverables for the regional assessment will include:

- a 1:250,000 scale database that summarizes existing levels of human activities and infrastructure, and the status of biophysical resources, including sensitive areas;
- assessment and reporting on existing cumulative effects in the region; and
- recommendations on on-going management and upgrading of the database.

COMPONENT 2: Cumulative Effects Case Studies For Northeast British Columbia

Project Summary

Salmo Consulting Inc., Diversified Environmental Services, and AXYS Environmental Consulting Ltd. propose to complete Cumulative Effects Case Studies for one or two areas where oil and gas exploration and production have occurred under different biophysical and land management conditions. Resource Management Zones (RMZs) identified in approved Land and Resource Management Plans (LRMP) will be used as the basis for the case study areas to allow results to be applied to other areas of northeast British Columbia. Government, industry, and public stakeholders will be consulted to identify case history areas; however, one area in each of the Fort St. John and Dawson Creek Forest Districts have been proposed.

This project links with two other proposals by the same project team, namely, "Development of a Practical Framework for Cumulative Effects Assessment and Management (CEAM) for Northeast British Columbia", and the "Cumulative Effects Project Screener", both submitted under separate cover.

The case studies will help test and develop approaches for assessing cumulative effects, determining impact significance, and identifying important data needs. A Geographic Information System (GIS) model will be constructed for each finalized study area, and will include data on topography, hydrology, linear features, facilities, cleared areas, stream habitat, biogeoclimatic units, wildlife capability, merchantable timber values, rare species potential, human use, and management boundaries. Readily available digital data sources will be used and will be supplemented by interviews with knowledgeable local specialists.

Information on disturbance patterns and biophysical resource availability, abundance, distribution, and trends will be generated for one or more points in time for each study area. This work will incorporate preliminary information generated for this region, a review of available files at OGC, Ministry of Environment, Lands and Parks, and Ministry of Forests (MOF) offices, and interviews with knowledgeable individuals. Hunter and trapper harvest data and other pertinent reports will also be obtained to document historical trends in harvest and inferred abundance.

A literature review and interviews will be initiated to document recent developments and applicability of all cumulative effects models, indices, and criteria that are applicable to this area. These models and thresholds will then be tested using data from the GIS database and historical review. Important needs for data, analytical tools, and thresholds will be identified. A report for each case study area will include historical land use and disturbance trajectories; trends in abundance of biophysical resources; an annotated bibliography of potential cumulative effects models, indices, and criteria; and recommendations for future applications and data management.

Objectives and Deliverables

The objectives of the Cumulative Effects Case Studies component will be to:

- apply the approaches and methodology of the CEAM Framework (Component 1, submitted under separate cover) using detailed data from the region;

- summarize literature on cumulative effects indices and thresholds applicable to northeast BC;
- confirm suitability of these indices for OGC project screening in northeast BC;
- create a spatially-explicit Geographic Information System (GIS) model that documents existing development and biophysical features in selected study areas;
- relate biophysical resource availability, abundance, and distribution to land use and disturbance patterns, and document trends and apparent thresholds;
- assess the utility of existing data for use in cumulative effects models and assessments; and
- confirm or identify key research and monitoring issues for cumulative effects assessment and management.

The following deliverables will be provided:

- GIS electronic files for each case study area; and
- a report for each case study area that includes historical land use and disturbance trajectories; trends in abundance of biophysical resources; an annotated bibliography of potential cumulative effects models, indices, and criteria; and recommendations for future applications and data management.

COMPONENT 3: Cumulative Effects Screener

Project Summary

The proposed project involves the development of a formal process to assist decision makers in making their decisions, drawing together various types of information, and recording that information. Elements of the proposed screener include forms for the collection of information, the identification and use of various data sources (including a regional database), referrals (e.g., First Nations, MELP), the determination of effects and their significance, clear guidance to proponents on information requirements, and clear guidance to reviewers to assist them in making the "public interest" test.

This project links with two other proposals by the same project team, namely, the "Cumulative Effects Assessment and Management (CEAM) Framework", and the "CEAM Case Studies", both submitted under separate covers.

The end product of the Project Screener will be a process by which cumulative environmental effects can be consistently assessed and documented as part of the OGC's application reviews. Currently, cumulative effects are not explicitly addressed within applications, nor do OGC reviewers (e.g., Resource Officers) necessarily have available the information they require. The screener will provide them with the tools to make such considerations and to document their justification for such decisions. As more applications are reviewed, a considerable and growing amount of information can be accessed to assist reviewers.

In recognition of the now more than 1000 applications processed annually by the OGC, and the review period target of 12 working days, the proposed screener must be simple to use, fit into the existing application review process, and be clear on what constitutes cumulative effects of concern and how to arrive at such conclusions. The proposed project will make use of similar work conducted for the Department of Indian Affairs and Northern Development (DIAND) (AXYS 1997) as a basis from which a screener may be customized for the OGC's needs. This process, the only known one in Canada, assists DIAND Level 1 screeners under CEAA in identifying possible cumulative effects for permit and license applications for roads, mines, forestry operations, industrial facilities, and other types of projects.

In recognition of the need for the OGC to rapidly build its internal capability to meet increasing workloads and rising expectations for environmental review, the proposed project is designed in two phases. The first phase can be implemented with existing resources, making use of the already considerable body of available knowledge and information on land use (e.g., conformity to LRMPs). Phase 2 would build on the first phase through the design and implementation of computer-based tools, and the incorporation of information from a regional database that would be developed as part of the CEAM Framework and Case Studies. Finally, a training program would be designed and delivered to ensure that OGC staff understand the basic concepts of cumulative effects and how to effectively implement the proposed modifications to their application review process.

Objectives and Deliverables

The purpose of the Project Screener is to incorporate the consideration of cumulative environmental effects into the OGC's application reviews, and to provide an efficient and effective means of documenting the consideration of these effects in project approvals.

The objective of the program is to customize a screener for the practical day-to-day use by OGC Resource Officers so that it is simple to use, and will maintain the existing review period targets (i.e., 12 working days). Development of the screener would be phased, starting with optimizing the use of existing information and OGC resources, and progressing with the gradual incorporation of broader information sources and more sophisticated computer-based decision-making tools.

The deliverables of the proposal include:

- details for an overall phased plan to implement a screener for incorporating cumulative effects into the OGC's review of project applications;
- a detailed description of Phase 1 (Basic Screening), an immediately implementable system for OGC Resource Officers, including forms and checklists;
- a summary description of Phase 2 (Advanced Screening), including the proposed design and implementation process for an Automated Cumulative Effects Screener (see below);
- recommendations for any expanded or new information requirements from proponents; and
- delivery of a training workshop for OGC staff on cumulative effects assessment.

The attributes of the evolving screener would include:

- a process that clearly guides reviewers step-by-step;
- forms, checklists, and guidelines;
- eventual automation of a forms-based approach (see Phase 2: Advanced Screening Process);

- incorporation of information from existing data sources and referrals, eventually accessing information from a central spatial database (i.e., Geographic Information System or GIS);
- pre-defined conditions for "bump-up" to a higher level of review involving other regulatory bodies (e.g., BCEAO, NEB, DFO);
- an audit trail that records and tracks information and the conclusions that led to a decision; and
- an effects management options checklist based on the type of project and major effects.

Appendix B: Cumulative Effects Frameworks in Other Areas

The following summarizes the three best current examples of Cumulative Effects Assessment and Management Frameworks (CEAMF) in Canada. All are in western or northern Canada. They are either fully implemented (Athabasca Oil Sands) or still under development (NWT CEAMF, Northern East Slopes).

Athabasca Oil Sands Cumulative Effects Management Association

The Cumulative Effects Management Association (CEMA) is the independent organizational body responsible for facilitating the delivery of a CEAMF for the Athabasca Oil Sands in northeast Alberta. The Association, jointly funded by industry through a cost sharing agreement, was a response to the Alberta government's Regional Sustainable Development Strategy in 1999, in which a regionally coordinated approach to assessment, monitoring, research, and management was advocated as the most appropriate approach to address concerns of effects due to the many existing and proposed oil sands projects in the region.

Initiatives within CEMA are largely directed and implemented by five working groups, namely, sustainable ecosystems (including three subgroups: wildlife and fish, landscape and biodiversity, and cultural and historical resources), trace metals and air contaminants, NO_x/SO_x management, water, and reclamation.

Although most of the effort to date has focused on monitoring and baseline data collection and mapping, regional thresholds are being developed and will be implemented based on a three-tiered system (i.e., cautionary, target, and critical thresholds). A threshold already exists for Potential Acid Input, to be followed by thresholds for air quality and ecological effects due to airborne transport of contaminants.

Additional information can be found at the following URL:

http://www.cemaonline.ca

Northwest Territories CEAMF

The Northwest Territories (NWT) CEAMF was initiated in late 1999 as a condition to the approval, under the *Canadian Environmental Assessment Act* (CEAA), of the Diavik diamond mine, and in recognition of further regional potential environmental effects, especially those due to future exploration and development of mineral and diamond resources. A steering committee was formed in early 2000, which has established priorities and overseen the focusing of the framework's design. A secretariat from the Department of Indian Affairs and Northern Development (DIAND) in Yellowknife provides administrative support. The majority of funding comes though Diavik, DIAND, and the federal Department of the Environment (DOE).

The geographic area included covers all of the NWT south of the Inuvialuit Settlement Region, thus representing a large portion of the Mackenzie River Basin.

A preliminary framework was developed by late 2001; however, progress has been delayed due to funding issues and the inherent challenges of establishing direction and consensus amongst such a disparate and large committee.

The NWT CEAMF consists of the following major components:

- vision and objectives;
- land use planning;
- baseline studies and monitoring;
- research;
- audit and reporting;
- project-specific screening, environmental assessment and review;
- regulation and enforcement;
- information management;
- CEAMF coordination; and
- NWT Cumulative Effects Assessment and Management Framework.

Additional information can be found at the following URL:

http://199.247.124.123/ceam/00_FrameSet.htm

Northern East Slopes Sustainable Resource and Environmental Management Strategy

The Alberta Ministry of Sustainable Resource Development and other provincial departments established a Northern East Slopes Strategy (NES) in 1999 to address concerns about multiple land uses along the north ranges of Alberta's foothills (approximately east of Jasper National Park). Grazing, timber harvesting, mining, hunting, and energy exploration and development all occur in this region. A primary purpose of this initiative is to coordinate the development of an Integrated Resource Use Plan among many different governments, departments, and land users.

A Regional Steering Committee, consisting of NES members and representatives of local communities, has published an Interim Strategy report. Following community consultation, a planning process was identified that included the following components:

- establishment of a regional vision;
- identification of values and goals;
- development of indicators;
- identification of regional resource management issues;
- identification of resource management objectives;
- collection of baseline information, forecasting of future resource management scenarios, and selection of suitable options;
- development of strategies to achieve objectives;
- implementation of strategies through regional initiatives; and
- improvement of strategies through implementation, measurement, and monitoring.

Additional information can be found at the following URL: http://www3.gov.ab.ca/env/regions/nes/strategy.html.

Appendix C: Workshop Notes

A two-day workshop was held during 30 and 31 January 2002 in Fort St. John. The workshop brought together participants from:

- provincial government: BC Oil and Gas Commission, Ministry of Energy and Mines; Ministry of Forests; Ministry of Sustainable Resource Management; Ministry of Water, Land and Air Protection; Muskwa-Kechika Management Board;
- First Nations: Fort Nelson First Nation Kaska Dene Council, Prophet First Nations;
- industry: Canadian Association of Petroleum Producers; Canadian Natural Resources Ltd.; Westcoast Energy Inc.;
- non-government organizations: Peace Habitat and Conservation Endowment Trust;
- academia: University of Northern BC; and
- consulting firms: Round River Consulting; Salasan Associates.

The workshop had two general objectives:

1. Disseminate information to participants about cumulative effects assessment and management, and about the project objective of developing a Cumulative Effects Assessment and Management Framework (CEAMF) for northeast BC. This included:

- providing background information on cumulative effects and on the project so all participants had a common understanding of the issues, and of the goals and objectives of the project;
- providing an overview of the components of the project: Framework, Case Studies, and Screener;
- presenting some of the challenges of doing cumulative effects assessment (e.g., selecting spatial and temporal boundaries), and engaging the participants in a discussion about these issues; and
- linking the CEAMF to other processes in northeast BC (e.g., LRMP processes, pre-tenure planning), and seeking input from the participants about our understanding of the linkages.

2. Elicit responses from participants about the approach, the data used, the analysis employed, and the preliminary conclusions. This included:

- presenting the data that were assembled and verifying it through discussions with the participants; and
- presenting a preliminary analysis and asking the participants to critically assess the analytical methods. We presented the hot spot maps developed by each discipline specialist and discussed with the participants the methodology employed and the preliminary conclusions derived.

Day One of the workshop focused on laying the groundwork for developing a CEAMF. This included presentations by the project team on: cumulative effects assessment; land use trends, planning and management; project overview; CEAMF as an overarching approach; case studies; regional database development; and discipline specific approaches to regional cumulative effects assessment covering air, terrain and soil, aquatic systems, vegetation, wildlife, resource use, and indigenous knowledge.

During Day Two, the workshop participants were divided into three breakout groups to facilitate more detailed discussions on the themes: Building Blocks of the CEAMF, and Options for Implementation of the CEAMF. Key discussion topics included:

<u>Scale and Scope</u>

Nested scales

- project level
- landscape level
- strategic/operational level
- subregional level
- regional level (e.g., LRMP)

<u>Data Needs and Management</u>

Data access

- cost of incorporating indigenous knowledge
- data exchange and agreement protocols
- mandatory requirement of industry
- inappropriate use of disseminated database

Historical activity

Automatic updating and relevancy

RIC standards for format consistency and quality control

Full disclosure of limitations and assumptions of data

<u>VECs, Thresholds, and Hot Spots</u>

VECs based on existing plans

Connectivity

Value of wilderness

Detailed disturbances expressed in terms that relate to thresholds (i.e., degree of impact on values)

Establishing spatial/temporal boundaries based on hot spots

Using hot spots to identify pristine, sensitive, and ecologically valuable areas against all land use pressures

Accommodating uncertainty

<u>CEAM Framework</u>

Assessment and management

Consistently applying the Framework to all sectors

Including the Framework as part of a planning process

Relating the Framework to varied planning horizons and planning processes (e.g., LRMP, pre-tenure planning)

Predictive component

Phased implementation

Adaptive monitoring

Appendix D: Database Description

A reliable information base is critical to a CEA. To accurately determine the impact of a development and mitigate its associated effects (e.g., utilize existing rights-of-way) on the landscape, existing infrastructure and land use information must be available. To serve as a tool in the preparation of CEAs, a regional database, consisting of a variety of environmental and topographic data was developed for the study area. The database consists of spatial coverages and related attribute tables at a variety of scales, and was assembled from files available from the Ministry of Sustainable Resource Management (MSRM); Ministry of Forests (MOF); and the Oil and Gas Commission (OGC). The database includes only those data that were available for most of the study area, and were free of charge to MSRM and the OGC. The database includes an assembly of data concerning:

- land use;
- disturbances (human activities and industrial development);
- wildlife habitat;
- rare and endangered species;
- fish distribution;
- soils and terrain;
- topographic base data (at scales of 1:1,000,000; 1:250,000; and 1:20,000);
- air photos;
- management boundaries;
- biogeoclimatic data;
- terrestrial ecosystem mapping;
- watersheds;
- protected areas; and
- place names.

In addition to the data types listed above, a number of derivative datasets were developed to generate seamless coverages for a specific theme for the entire study area, and to analyze and summarize data (e.g., for creating the hot spot maps and various density maps). These coverages and their attribute tables have been incorporated into the regional database provided.

The database represents the most current digital information base for the study area; however, users of the data should be aware of its limitations:

- The purpose of the database is to provide a regional overview of both the data available and the environmental characteristics of the study area. If a detailed CEA is being conducted, users should verify that the data is the most current, and determine if more detailed information is available for their specific area of interest.

- As mentioned above, the data have been provided at a variety of scales. Users should be aware of the consequences of mixing data at different scales, and should select a working scale appropriate for the spatial extents of their particular development.

Data layers presently found in the database are listed in Table D-1.

Table D-1. CEAMF Database: Current GIS Data

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
Air Quality				
Airdnsty	Air quality density grid	1:250k	ARCInfo GRID	Derivative analysis (Note 1)
Air Photos				
rec####-19##	Rectified (greyscale) air photos (TIF) from 1950, 1970, & 1987	variable 1:15k to 1:40k	TIFF	MSRM
Agriculture				
Btmdstrb	BTM residential-agricultural mix	1:250k	SHP poly	MSRM
Btmdstrb	BTM rangeland	1:250k	SHP poly	MSRM
Btmdstrb	BTM cultivated land	1:250k	SHP poly	MSRM
Bei_cultivation	>= 50% Cultivated Field BEI	1:250k	SHP poly	MSRM
Biogeoclimatic Data				
MK_BEC	Biogeoclimatic zones clipped to M-K study area	1:250k	SHP poly ARCInfo poly	MSRM Data Clipped to Study Area
qes_bc	Ecosection coverage including ecodomain, ecodivision, ecoprovince, ecoregion	1:250k	ARCInfo poly	MSRM
Mk_qbei	Broad Ecosystem Inventory	1:250k	SHP poly	MSRM Data Clipped to MK Study Area
BTM	Baseline Thematic Mapping	1:250k	SHP poly	MSRM
Boundaries				
mk20nov00	Boundary – M-K management area from LUCO	1:250k	ARCInfo arc	MSRM
mk_study_bnd	Boundary – study area as	1:250k	ARCInfo	MK Management

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
	created by AXYS from project specs		poly	Area (from MSRM) and 1:250,000 provincial border merged to develop study area polygon
qrmz_jo, qrmz_fn, qrmz_mac	Resource Management Zones for Ft. St. John, Ft. Nelson, Mackenzie	1:250k	ARCInfo poly	MSRM
slrmp_bc	Land Resource Management Plan boundary	1:600k	ARCInfo poly	MSRM
Btfl_bc	Tree Farm Licence boundaries	1:2M	ARC poly	MSRM
Qmu_bc	MOE management units	1:250k	ARCInfo poly	MSRM
Btsa_bc	TSA boundaries	1:2M	ARCInfo poly	MSRM
Sfds_bc	Forest District boundaries	1:1M	ARCInfo poly	MSRM
Brgd_bc	Regional Districts	1:2M	ARCInfo poly	MSRM
Indian_bands	Preliminary Indian Band boundaries	unknown	SHP line	MSRM
CDC Data				
arebr_bc	CDC - Rare and Endangered Species, Element Occurrence Buffered Points	arbitrary	SHP poly ARCInfo poly	MSRM
areor_bc	CDC - Rare and Endangered Species, Element Occurrence Areas	arbitrary	SHP poly ARCInfo poly	MSRM
areop_bc	CDC Rare and Endangered Species, Element Occurrence Points	arbitrary	SHP point ARCInfo point	MSRM
aresr_bc	Rare and Endangered Species, CDC Sites	arbitrary	SHP poly ARCInfo poly	MSRM
Crown Land				
http://www.elp.gov.bc.ca/clrs/	Crown Land Registry web page			

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
DEM				
Elev_250	250 m elevation grid from NTS mass points		ArcView GRID	MSRM data merged & clipped to study area
coarse			ArcView GRID	MSRM data merged & clipped to study area
coarse_grid			ArcView GRID	MSRM data merged & clipped to study area
mk_dem_cov			ArcView GRID	MSRM data merged & clipped to study area
mk_grd			ArcView GRID	MSRM data merged & clipped to study area
mk_grid			ArcView GRID	MSRM data merged & clipped to study area
ne_bc			ArcView GRID	MSRM data merged & clipped to study area
north			ArcView GRID	MSRM data merged & clipped to study area
northern_bc_dem.shp			SHP poly	MSRM data merged & clipped to study area
mk_dem_coarse.shp			SHP poly	MSRM data merged & clipped to study area
Disturbance Coverages				
distnsv2	Combined disturbances (no seismic lines)	1:250k	SHP poly	Merged disturbances from individual map sheets
Fisheries				
qfshlu_mac	Fish Units for the Mackenzie LRMP	1:250k	ARCInfo	MSRM
qgray_mac	Arctic Greyling distribution in Mackenzie Forest District	1:250k	ARCInfo	MSRM
arc_grayling_hotspot_area	Arctic Grayling hot spot coverage	1:250k	SHP poly	Diversified Services
bull_trout_hotspot_area	Bull Trout hot spot	1:250k	SHP poly	Diversified

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
	coverage			Services
Critical-habitat-fish	Critical fish habitat	unknown	SHP point	Diversified Services
http://www.bcfisheries.gov.bc.ca/fishinv/fishinfobc.html	FishInfo BC			MAFF
Forestry				
thlb_djo thlb_dfn thlb_dmk	Timber harvest for Ft. St. John, Ft Nelson, MacKenzie Districts, and Cassiar ftp://ftpprg.env.gov.bc.ca/pub/outgoing/srm/rii/arc/landuse/thlb	unknown	ARCInfo E00 interchange fomat	MSRM
Forest Cover	Forest cover	1:20k	ARCInfo poly	MSRM
Btmdstrb	Recently burned	1:250k	SHP poly	MSRM
Btmdstrb	Selective logging	1:250k	SHP poly	MSRM
Btmdstrb	Recent logging	1:250k	SHP poly	MSRM
qndt_r7	Natural Disturbance Types for MOE Region 7	1:250k	ARCInfo poly	MSRM
btfl_bc	Tree Farm Licences for BC	2 million	ARCInfo poly	MSRM
btsa_bc	Timber Supply Areas for BC	2 million	ARCInfo poly	MSRM
http://www.for.gov.bc.ca/ftp/Prince_George_Region/!Regional_Office/external/!publish/ArcInfo_warehouse/				
Hillshade				
mk_mos2.jpg	Muskwa-Kechika hillshade mosaic JPG	1:250k	JPG image	Hillshade derived from provincial DEM
mk_mos2	Muskwa-Kechika hillshade mosaic GRID	1:250k	ARC GRID	Hillshade derived from provincial DEM
*.jpg	Over 200 georeferenced JPGs for entire province (on CD)	unknown	JPG image	MSRM
Urban / Industrial				
Btmdstrb	Mining	1:250k	SHP poly	MSRM
Btmdstrb	Selective logging	1:250k	SHP poly	MSRM

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
Btmdstrb	Recent logging	1:250k	SHP poly	MSRM
Btmdstrb	BTM urban areas	1:250k	SHP poly	MSRM
Bei_urban	Urban areas derived from BEI polys	1:250k	SHP poly	MSRM data merged & clipped to study area
NTS_Mine	Mine points from NTS	1:250k	SHP poly	MSRM data merged & clipped to study area
NTS 094A-094P 104I & 104P				
qctr	Contour lines	1:250k	ARCInfo arc	MSRM
qcul	Cultural points and lines	1:250k	ARCInfo arc & point	MSRM
qcvr	Land cover	1:250k	ARCInfo arc	MSRM
qmisc	Miscellaneous features	1:250k	ARCInfo arc	MSRM
qntl	Mapsheet neatlines, tics, and grids	1:250k	ARCInfo arc & point	MSRM
qsrf	Surficial geology and soil cover	1:250k	ARCInfo arc	MSRM
qtrn	Transportation (pipelines, power, rail, road, air, ferry routes)	1:250k	ARCInfo arc	MSRM
qtxt	Annotation text	1:250k	ARCInfo anno	MSRM
qwtr	Surface water	1:250k	ARCInfo arc	MSRM
qdem	Digital Elevation Model	1:250k	ARCInfo point	MSRM
Oil & Gas				
All_pipelines	Oil/gas pipelines from Oil & Gas Commission	unknown	SHP line	OGC
All_wells	Oil/gas wells from Oil & Gas Commission	unknown	ARCInfo point	OGC
Ogc_wells_clipt	Oil/gas wells from Oil & Gas Commission	unknown	SHP point	OGC data clipped to study area
seismic.dgn	Seismic lines, points, & polys for Region 7	unknown	MicroStation design	MSRM

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
			file	
Seismic	Seismic lines	unknown	SHP line	MSRM
Seisdens	Seismic line density grid	1:250k	ARCInfo GRID	MSRM
NTS_well	Oil/gas well points from NTS	1:250k	SHP point	MSRM data merged & clipped to study area
NTS_Facility	Oil/gas facility points from NTS	1:250k	SHP point	MSRM data merged & clipped to study area
Pipeline	Oil/gas pipelines from NTS	1:250k	SHP line	MSRM data merged & clipped to study area
wllden3k	Oil/gas well density (3 km neighborhood)	1:250k	ARCInfo GRID	Derivative analysis (Note 1)
Welldens	Oil/gas well density grid	1:250k	ARCInfo GRID	Derivative analysis (Note 1)
Parks & Protected Areas				
Tpas_bc	Protected Areas	1:20k	ARC poly	MSRM
pa5aug99	Protected Areas from MOE	unknown	ARCInfo poly	MSRM
tpas_prg	Protected Areas for Prince George MOE District	1:20k	ARCInfo poly	MSRM
tppa_gl2	Goal 2 proposed Protected Areas for Ft. St. James LRMP	1:20k	ARCInfo poly	MSRM
Nts_camppicnic	Campsites and picnic sites from NTS	1:250k	SHP point	MSRM data merged & clipped to study area
Places & Names				
BC_Places	Towns and place names		SHP point	MSRM
Major_Places	Cities and place names		SHP point	MSRM
bcmj_bc	BC major places and names		ARCInfo point	MSRM
LUCONAME	LUCO place names		ARCInfo annotation	LUCO
Slope				
mk_slope	Slope coverage from DEM (clipped to study area)	1:20k	SHP poly	Generated in ArcInfo from provincial DEM

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
Smoothed Densities				
Marsh	Smoothed marsh density grid	1:250k	ARCInfo GRID	Derivative analysis (Note 2)
Streams	Smoothed stream density grid	1:250k	ARCInfo GRID	Derivative analysis (Note 3)
Transprt	Smoothed transportation density grid	1:250k	ARCInfo GRID	Derivative analysis (Note 3)
Wells	Smoothed well density grid	1:250k	ARCInfo GRID	Derivative analysis (Note 1)
Soils				
Bcc002_albers	Soil Landscapes of Canada (SLC)	1:1M	ARC poly	Agriculture & Agri-Food Canada: Canadian Soil Information System
eroshaz2	Erosion hazard grid	1:250k	ARCInfo GRID	Derivative analysis (Note 4)
soils_terrain	Soil terrain coverage	unknown	SHP poly	Agriculture & Agri-Food data clipped to study area
Terrestrial Ecosystem Mapping				
ltem_idx	TEM index coverage (for 50k TEM projects) Smith/Fishing 97/98 Liard River Hotsprings Dunedin 97/98 LaBiche 96/97 Sandy Cr 97/98 Snake/Sahtenah 97/98 Besa/Prophet 97/98	1:50k	ARCInfo poly	MSRM
ttem_idx	TEM index coverage (for 20k TEM projects) Trutch Cr Akie/Pesika	1:20k	ARCInfo poly	MSRM
tecp_aki	TEM polygons for Akie/Pesika project	1:20k	ARCInfo poly	MSRM
teci_aki	TEM field sampling points for Akie/Pesika	1:20k	ARCInfo point	MSRM
lecp_bes	TEM polygons for	1:50k	ARCInfo	MSRM

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
	Besa/Prophet project		poly	
leci_bes	TEM field sampling points for Besa/Prophet	1:50k	ARCInfo point	MSRM
lecp_dun	TEM polygons for Dunedin project	1:50k	ARCInfo poly	MSRM
leci_dun	TEM field sampling points for Dunedin	1:50k	ARCInfo point	MSRM
lecp_bic	TEM polygons for LaBiche project	1:50k	ARCInfo poly	MSRM
leci_bic	TEM field sampling points for LaBiche	1:50k	ARCInfo point	MSRM
lecp_san	TEM polygons for Sandy Creek project	1:50k	ARCInfo poly	MSRM
leci_san	TEM field sampling points for Sandy Creek	1:50k	ARCInfo point	MSRM
lecp_sv	TEM polygons for Smith Vents project	1:50k	ARCInfo poly	MSRM
leci_sv	TEM field sampling points for Smith Vents	1:50k	ARCInfo point	MSRM
Traditional				
aems_bc	Pollution prevention monitoring sites	arbitrary	SHP point	MSRM
com_watshd	Community watersheds in BC	unknown	SHP line	MSRM
hydrometric	Hydrometric survey stations	unknown	SHP point	MSRM
qsit_bc	Contaminated Sites Registry	1:250k	SHP point	MSRM
snow-pillowa	Active snow pillow locations	unknown	SHP point	MSRM
wella	Observation well location	unknown	SHP point	MSRM
wins_a	Points of diversion	unknown	SHP point	MSRM
http://www.archaeology.gov.bc.ca/	MSRM Archaeology web page			MSRM
Transportation				
BC_rail_albers83	DCW rail	1 million	SHP line	Digital Chart of the World
BC_road_albers83	DCW roads	1 million	SHP line	Digital Chart of the

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
				World
road_main_polyline	Roads		SHP line	MSRM
mk-dcw-road.shp	DCW roads in M-K study area	1 million	SHP line	MSRM Data Clipped to Study Area
bcrailg	National Atlas Rail Lines	2 million	ARCInfo arc	MSRM
bcroadg	National Atlas Roads	2 million	ARCInfo arc	MSRM
NTS_roads	Roads/tracks from NTS	1:250k	SHP line	MSRM data merged & clipped to study area
NTS_trail	Trails from NTS	1:250k	SHP line	MSRM data merged & clipped to study area
NTS_rail	Rail lines from NTS	1:250k	SHP line	MSRM data merged & clipped to study area
NTS_airports	Airport, heliport, etc. from NTS	1:250k	SHP point	MSRM data merged & clipped to study area
TRIM				
TRIM 094A051-100 094H001-050	TRIM data can be accessed through MSRM contractor's FTP site: http://www.elp.gov.bc.ca/gis/trimcont/ *Located in the GIS source directory*			
tctr	Contour lines	1:20k	ARCInfo arc	MSRM
tcul	Cultural points and lines	1:20k	ARCInfo arc & point	MSRM
tcvr	Land cover features	1:20k	ARCInfo arc	MSRM
tmisc	Miscellaneous features	1:20k	ARCInfo arc	MSRM
tsrf	Surficial geology and soil cover	1:20k	ARCInfo arc	MSRM
ttrn	Transportation (pipelines,	1:20k	ARCInfo	MSRM

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
	power, rail, road, air, ferry routes)		arc	
ttxt	Annotation text	1:20k	ARCInfo annotation	MSRM
twtr	Surface water	1:20k	ARCInfo arc	MSRM
tdem	Digital Elevation Model	1:20k	ARCInfo generate	MSRM
Vegetation				
mkqbei_v3	Vegetation classification	1:250k	SHP poly	MSRM data clipped to study area
Veghstrc3	Vegetation hot spot grid	1:250k	ARCInfo GRID	Derivative analysis (see Appendix E)
Water				
bc_drain_albers83	DCW rivers, lakes, and streams	1 million	ARCInfo poly	Digital Chart of the World
bc_drain_albers83.shp	DCW rivers, lakes, and streams	1 million	SHP line	Digital Chart of the World
dnnet	DCW rivers, lakes, and streams (dd)	1 million	ARCInfo arc & poly	Digital Chart of the World
bcdraing	National Atlas river, lakes, etc. (dd)	2 million	ARCInfo poly	National Atlas
qrlw_bc	NTS rivers, lakes, and wetlands for BC	1:250k	ARCInfo arc & poly	MSRM
qwtr_mk	NTS rivers, streams for Muskwa-Kechika (1:250 nts features appended)	1:250k	ARCInfo arc	MSRM data merged & clipped to study area
lakes_alb1mil.shp	DCW lakes and reservoirs for all of BC	1 million	ArcView poly shape	Digital Chart of the World
mk-dcw-river.shp	DCW rivers, streams for Muskwa-Kechika study area	1 million	ArcView arc shape	Digital Chart of the World clipped to study area
qglr_bc	NTS glacier and water features for BC	1:250k	ARCInfo arc	MSRM
taqf_bc	Groundwater aquifers in BC	1:20k	ARCInfo poly	MSRM
Water Quality				
rivers	River grid	1:250k/ 125m cell size	ARCInfo GRID	Generated from vector river coverage

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
river_c5	River density grid (5 km neighborhood analysis)	1:250k	ARCInfo GRID	Derivative analysis (Note 3)
marsh_c5	Marsh density grid (5 km neighborhood analysis)	1:250k	ARCInfo GRID	Derivative analysis (Note 2)
lakes	Lake GRID	1:250k/ 125m cell size	ARCInfo GRID	Generated from vector lake coverage
lakes_c5	Lake density grid (5 km neighborhood analysis)	1:250k	ARCInfo GRID	Derivative analysis (Note 2)
Watersheds				
Watershed Atlas	*Watershed boundaries from MOE for the following watersheds: Beaver, Coal, Dunedin, Finlay, Fontas, Fox, Frog, Gataga, Hay, Ingenika, Kahntah, Kotcho, Lwr Beatton, Lwr Ft Nelson, Mid Ft Nelson, Upr Ft Nelson, Lwr Halfway, Upr Halfway, Lwr Kechika, Upr Kechika, Lwr Muskwa, Mid Muskwa, Upr Muskwa, Lwr Peace, Upr Peace, Lwr Petitot, Upr Petitot, Lwr Prophet, Mid Prophet, Upr Prophet, Lwr Sikanni, Upr Sikanni, Milligan, Ospika, Sahdoanah, Sahtaneh, Shekilie, Toad, Toodoggone, Tsea, Turnagain, Upr Liard, Liard*		*On CD*	
lwsl_*	Rivers, Lakes, Wetlands – BC watershed atlas	1:50k	ARCInfo poly	MSRM
lwss_*	Stream network layer – BC watershed atlas	1:50k	ARCInfo arc	MSRM
lwsd_*	Watershed polygons – BC watershed atlas	1:50k	ARCInfo poly	MSRM
Wildlife/Habitat				
ALALHSPT	Moose hot spot grid	1:250k	ARCInfo GRID	Derivative analysis (see Appendix E)
MAAMHSPT	Marten hot spot grid	1:250k	ARCInfo GRID	Derivative analysis (see Appendix E)

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
			GRID	
RATAHSPT	Caribou hot spot grid	1:250k	ARCInfo GRID	Derivative analysis (see Appendix E)
URARHSPT	Grizzly Bear hot spot grid	1:250k	ARCInfo GRID	Derivative analysis (see Appendix E)
WARBHSPT	Warbler hot spot grid	1:250k	ARCInfo GRID	Derivative analysis (see Appendix E)
caribou_habitat	Combined caribou habitat for M-K	1:250k	SHP	MSRM data merged & clipped to study area
qcar_mac	Caribou habitat suitability for Mackenzie LRMP	1:250k	ARCInfo poly	MSRM
qmos_mac	Moose habitat for Mackenzie LRMP	1:250k	ARCInfo poly	MSRM
qcarma_mac	Mackenzie Forest District caribou management areas	1:250k	ARCInfo poly	MSRM
qcms_mac	Caribou management strategy, Mackenzie LRMP	1:250k	ARCInfo poly	MSRM
qer_bc	Ecological reserves, wild man. & rec. areas for BC	1:250k	ARCInfo poly	MSRM
qgriz_mac	Grizzly Bear habitat for Mackenzie LRMP	1:250k	ARCInfo poly	MSRM
qgot_r7	Guide outfitter territory	1:250k	ARCInfo poly	MSRM
qtrp_r7	Trapper territory	1:250k	ARCInfo poly	MSRM
llehb_bc	Limited Entry Hunting Zone: Bison	1:50k	ARCInfo poly	MSRM
llehc_bc	Limited Entry Hunting Zone: Caribou	1:50k	ARCInfo poly	MSRM
llehd_bc	Limited Entry Hunting Zone: Mule Deer	1:50k	ARCInfo poly	MSRM
llehe_bc	Limited Entry Hunting Zone: Elk	1:50k	ARCInfo poly	MSRM
llehg_bc	Limited Entry Hunting Zone:	1:50k	ARCInfo poly	MSRM
llehm_bc	Limited Entry Hunting Zone: Moose	1:50k	ARCInfo poly	MSRM
llehs_bc	Limited Entry Hunting Zone: Mountain Sheep	1:50k	ARCInfo poly	MSRM
llehw_bc	Limited Entry Hunting	1:50k	ARCInfo	MSRM

Coverage Name	Description & Source	Scale	Type & Projection	Source/ Custodian
	Zone: White-tailed Deer		poly	
llehz_bc	Limited Entry Hunting Zone: Grizzly Bear	1:50k	ARCInfo poly	MSRM
http://www.elp.gov.bc.ca/rib/	MSRM Resource Inventory Branch			
http://www.for.gov.bc.ca/research/	Ministry of Forest Research Branch			
http://www.for.gov.bc.ca/resinv/homepage.htm	MSRM Terrestrial Information Branch			

Derivative Analysis Descriptions

Note 1 – Density of point features methodology

Applies to the following coverages:

- Air quality density
- Oil and gas well density
- Smoothed well density

The development of each of the derived point feature density coverages involved the following steps:

1. Point features were converted to a raster coverage (grid) based on a 125 metre cell size.
2. The grid was reclassified with each cell being assigned a value of 0 (no data) or 1 (data present). In the case of the air quality density the air emission value was used for the cell value.
3. The number of point features being summarized per pixel of raster data was determined (e.g., the total number of point features divided by the number of raster cells).
4. The reclassified grid developed in step 2 was multiplied by the factor determined in step 3 to generate a density statistic.
5. The raster-based cells are aggregated to a larger grid cell size (e.g., 5 kilometres). During this step the number of points calculation of the aggregated cells is summed.
6. For some datasets a neighborhood analysis is conducted to smooth the data for cartographic purposes. This involved determining the average density within a 15 kilometre radius.

Note 2 – Density of polygon features methodology

Applies to the following coverages:

- Smoothed marsh density
- Lake density (5 km analysis)
- March density (5 km analysis)

The development of each of the derived polygon density coverages involved the following steps:

1. Vector features (polygons) were converted to a raster coverage (grid) based on a 125 metre cell size.

2. The grid was reclassified with each cell being assigned a value of 0 (no data) or 1 (data present);
3. The area of polygonal features being summarized per pixel of raster data was determined (e.g., the total area of polygonal features divided by the number of raster cells)
4. The reclassified grid developed in step 2 was multiplied by the area factor determined in step 3 to generate a density statistic;
5. The raster-based cells are aggregated to a larger grid cell size (e.g., 5 kilometres). During this step the area calculation of the aggregated cells is summed;
6. For some datasets a neighborhood analysis was conducted to smooth the data for cartographic purposes. This involved determining the average density within a 15 kilometre radius.

Note 3 – Density of linear features methodology

Applies to the following coverages:

- Smoothed stream density
- Smoothed transportation density
- River density (5 km analysis)

The development of each of the derived linear density coverages involved the following steps:

1. Vector features (polylines) were converted to a raster coverage (grid) based on a 125 metre cell size;
2. The grid was reclassified with each cell being assigned a value of 0 (no data) or 1 (data present);
3. The length of linear features being summarized per pixel of raster data was determined (e.g., the total length of linear features divided by the number of raster cells)
4. The reclassified grid developed in step 2 was multiplied by the length factor determined in step 3 to generate a density statistic;
5. The raster-based cells are aggregated to a larger grid cell size (e.g., 5 kilometres). During this step the length calculation of the aggregated cells is summed;
6. For some datasets a neighborhood analysis is conducted to smooth the data for cartographic purposes. This involved determining the average density within a 15 kilometre radius.

Note 4 – Erosion hazard grid

The development of each of the erosion hazard grid involved the following steps:

1. Land use data was obtained from the Baseline Thematic Mapping (BTM) map series.
2. Agricultural and forestry related land uses were extracted from the BTM coverage.
3. A grid coverage was developed using a 125 m cell size depicting forest land.
4. A grid coverage was developed using a 125 m cell size depicting agricultural land.
5. The grids were reclassified with each cell being assigned a value of 0 (no data) or 1 (data present).
6. A slope grid was developed from the 1:250,000 scale provincial DEM.
7. The slope grid was reclassified based on slope classes for both agricultural and forest land uses.
8. Each land use grid was then multiplied by the appropriate slope classification grid to generate a land use specific erosion hazard coverage.
9. The two derivative erosion hazard grids were subsequently merged to yield an erosion hazard coverage for the study area.

Appendix E: Hot Spot Derivation

E.1 Hot Spot Maps: Definition and Use

Hot spot maps identify spatial interactions between Valued Ecosystem Components (VEC) and human disturbances. They help us quantify how vulnerable a given VEC is to a stressor (e.g., development activities). The primary goal of the hot spot maps is to identify those parts of the regional study area that have relatively high levels of remaining natural resources (e.g., wildlife habitat) which are currently experiencing high levels of human pressure. Hot spot maps serve the following functions:

- they allow for quick and easy identification of VECs that are potentially affected by existing or proposed development;
- they identify areas (i.e., hot spots) for monitoring, and thus, allow potential negative or positive trends in the environmental conditions of the region to be quantified (e.g., area statistics of potentially affected habitat can be calculated for different years and tracked over time). Examination of these trends allows environmental managers and planners to identify potential problem areas, and to develop priorities for management actions; and
- they allow sampling efforts to be focused on particular areas of interest (e.g., increase sampling in hot spot areas and sample to a lesser degree outside those areas), thereby increasing the efficiency and cost effectiveness of data-gathering programs.

E.2 Common Elements

Although the specific methodology to generate each hot spot map varies, as detailed in the following sections, fundamentally, hot spots are identified through the development of an interaction index between a defined VEC and disturbances in the region (including disturbances from non oil and gas activities). Common to all hot spot maps are the following basic steps:

- develop a map that depicts the spatial extent of the VEC (e.g., a wildlife habitat capability coverage);
- select the disturbance(s) that are affecting the VEC;
- establish a Zone of Influence (ZOI) for disturbances and develop a map that depicts the ZOI (note: the ZOI will be unique to the VEC in question);
- overlay the ZOI coverage with the VEC coverage to identify areas of interaction;
- develop an interaction matrix to quantify the degree of impact; and
- develop the hot spot map - a thematic map based on the classifications defined in the interaction matrix.

Many of the maps relied on a disturbance coverage that was generated for the study area, and used as a basis for defining a ZOI for each VEC. The following themes were used to generate the disturbance coverage:

- agriculture;
- residential/agriculture mix;
- range land;
- railways;
- roads;
- trails;
- pipelines;
- transmission lines;
- urban areas;
- recent logging;
- selective logging;
- oil and gas facilities;
- active airstrips;
- inactive airstrips;
- oil/gas wells;
- mining; and
- recreation areas.

Seismic line data is available for the study area; however, these data were not included in the disturbance coverage as many of the seismic lines are known to be 25-30+ years old, and therefore, will have revegetated naturally. Unfortunately, there is no date attribute in the seismic line coverage, and therefore, no way to identify older lines. Thus, this theme was excluded.

The hot spot maps generated for this project were based on existing applicable disturbances and a select number of VECs that were chosen as environmental indicators. The maps identify areas of potential concern within the regional study area, and can be used as a reference tool for assessing the general environmental conditions of the area, and for developing strategic planning.

The maps do not illustrate the *relative contributions* of different types of disturbances. This would only be possible by either mapping disturbance types individually and defining unique ZOI coverages for each disturbance type and respective VEC as a respective mapping exercise; or by weighting disturbances based on their predicted effects on a VEC relative to other types of disturbances. As the focus of the hot spot analysis was to illustrate areas of potential *cumulative* effects, individual disturbance types were not mapped.

It is important to note that the maps have been generated at a regional scale (i.e., 1:250,000), and thus, are highly suited to support regional planning or other initiatives. They should not be used for detailed planning and assessment in isolation of other, finer-scale information that is applicable to a precise area of interest (e.g., a proposed well site). However, in detailed, project-specific assessments, the hot spot maps could be used to help select indicator species, and to focus assessment efforts on the VECs that are potentially affected by a proposed development.

E.3 Map Derivation by Discipline

Hot spot maps developed as part of this study are listed in Table E-1. These are examples of the types of maps that could be generated using information in the regional database for selected VECs. This is not an inclusive list of all potential hot spot maps. The following sections describe the general methodology for preparing maps for each discipline. All maps were derived using a Geographic Information System (GIS).

Table E-1. Hot Spot Maps

Discipline	VEC	Disturbance	Hot Spot Map
Soils and Terrain	Soil Acid Sensitivity	SO_2 emissions	Soil Acid Sensitivity
	Erosion Risk	ZOI for soils and terrain	Erosion Risk
Vegetation	Vegetation	ZOI for vegetation	Vegetation VECs
Wildlife	Grizzly Bear	ZOI for grizzly bear	Grizzly Bear Habitat Capability
	Moose	ZOI for moose	Moose Habitat Capability
	Marten	ZOI for marten	Marten Habitat Capability
	Warblers	ZOI for warblers	Warbler Habitat Capability
	Caribou	ZOI for caribou	Caribou Winter Habitat
Aquatic Ecosystems	Aquatic Ecosystems	Not applicable	Aquatic Ecosystems
Air Quality	Air Quality	Well Head Density Sulfur Emissions	Well Head Density Sulfur Emissions

Air Quality

Two criteria were used for creating the air quality land use hot spot maps – well head density and sulfur-weighted well head density.

For the well density map (Figure 3-10), each well was assigned an arbitrary ZOI of 3 km. Once the 3 km ZOI was applied, the number of wells per km^2 could be classified for the entire study area (ranging from areas containing 0 wells per km^2 to areas with up to 100 wells per km^2). Figure 3-10 thus provides a rough idea of where cumulative impacts may occur under the current development scenario.

Figure 3-11 is a sulfur-weighted plot that was created by multiplying the well density by the H_2S content of the well. Figure 3-11, then, is a better illustration of potential cumulative impacts on air quality because the amount of SO_2 released from a well is directly proportional to the amount of H_2S in the gas. This map was generated by using the ZOI spatial coverage generated in Figure 3-10, and weighting the coverage with the emissions data. To do this, a grid was developed that depicted the emission value per well. A derivative grid was then developed summing the total emission level within each square kilometre. A neighbourhood analysis was then run to sum the data for the 3 km ZOI, and the derivative grid was themed based on the emission levels.

Soils and Terrain

Acid Sensitivity

Risk ratings for sensitivity of soils to potential acid inputs (PAI) were assigned based on the ability of the regional soils to buffer the impacts of soil acidification. High risk soils have low buffering capacities due to low pH levels, low cation exchange capacities, and relatively low calcium reserves. They are primarily derived from coarse textured fluvial or glaciofluvial parent materials, and are classified as Dystric or Sombric Brunisols. Eutric and Melanic Brunisols are considered to be moderately sensitive to PAI, and are also developed on glaciofluvial material. All other soil types exhibit higher buffering capacities, and thus, are considered low risk to PAI.

To develop the sensitivity polygons shown in Figure 3-13, soil data from the CANSIS 1:1,000,000 scale dataset were grouped based on the following classifications (Table E-2):

Table E-2. Soil Acid Sensitivity Classes

Sensitivity	Soil Type
High	Dystric and Sombric Brunisols
Moderate	Eutric and Melanic Brunisols
Low	All Others

Erosion Risk

Erosion risk categories were established using different criteria for agricultural and forestry land. With no litter layer and an absence of well-established vegetation rooting, agricultural soils are at greater risk of significant erosion on gentler slopes than are forest soils. Erosion risk values were assigned based on the classifications listed in Table E-3. To generate the map, a slope grid was developed from a Digital Elevation Model (DEM) for the study area that was generated from Terrain Resource Inventory Mapping (TRIM) data. Slope values were then reclassified according to the defined classes (Table E-3). The classified slope grid was subsequently overlaid with land use data from the Baseline Thematic Mapping (BTM) dataset to produce a derivative coverage that delineated erosion potential (Figure 3-14).

Table E-3. Soil Erosion Sensitivity Classes

Sensitivity	Agricultural Land Slopes	Forest Land Slopes
High	> 10 % (> 5°)	> 45 % (> 24°)
Moderate	6 - 9 % (3-5°)	30 - 45 % (16.5 - 24°)
Low	< 6 % (< 3°)	< 30 % (< 16.5°)

Aquatic Ecosystems

Data Limitations

Delineation of hot spots requires spatial and temporal information that describes links between VECs and cumulative effects of environmental stressors. Ideally, that data might include basic descriptions of pristine water quality or aquatic community composition and abundance. That data would include functional relationships that link changes in a VEC to some manipulation or disturbance. With these data and relationships, a map could be produced that showed the distribution of pristine lakes and streams based on chemical criteria, similar to that produced for an ecozone classification by Perrin and Blyth (1998). The map might also show the distribution of fish VECs (e.g., bull trout and grayling abundance, and critical rearing and spawning habitat). Zones of pristine wetlands, lakes, and streams, and zones where fish may be sensitive to disturbance might be considered hot spots where they coincide with existing or planned industrial activity.

Unfortunately, data required to produce these types of maps are generally lacking, particularly for water quality criteria within the study area. In development of the aquatic ecozone classification, Perrin and Blyth (1998) found a limited and clumped distribution of chemical data for surface waters in the entire northeast part of the province, which includes the project study area. Lake and stream data from the Peace Plains Aquatic Ecoprovince was distributed mainly near Fort St. John in the lower Beatton River and Peace River drainages, but there was no indication of water quality in headwaters. In the Taiga Plains Aquatic Ecoprovince, surface water data included only two observations of three parameters from small lakes in drainages of the lower Prophet River, Fort Nelson River, and Sikanni Chief River. All sites were in proximity to road access points from Fort Nelson and the Alaska Highway. In the Muskwa Ranges, which characterize the

MKMA, only two observations were available from lakes in drainages of the Fox River and upper Muskwa River. These data do not provide adequate basic descriptive evidence of chemical characteristics of any type of surface water throughout the study area, mainly because sample sizes are too small to yield adequate precision, most drainages have not been sampled, and no time course measurements are available for examining temporal or seasonal variation.

Data describing fish presence and distribution is somewhat better, largely because fish end-points have been of particular interest for both resource management agencies and industry. In recent years, fish and fish habitat inventory funded by Forest Renewal British Columbia, and environmental impact assessments funded by various industrial interests have greatly expanded our knowledge of fish distribution within the study area. While information gaps exist, point sampling for fish presence has occurred widely across the study area (e.g., by MWLAP, Fort St. John). Data resulting from past fish surveys have provided evidence of physical features of aquatic habitat that support indigenous fish species.

The vulnerability of some regional fish species, coupled with the deficiency in water quality information, pointed to the use of fish to describe cumulative impact hot spots for fish and water quality of aquatic ecosystems. The premise here was that fish (mainly bull trout and Arctic grayling) as VECs are, in fact, indicators of water quality. This decision was based on well-known evidence that fish are sensitive indicators of change to physical and chemical conditions in water, particularly change associated with land disturbance (e.g., acute change in suspended solids concentration) and exposure to effluents or discharges associated with human and industrial activity (CCME 1999). In fact, fish species are used as standard organisms for testing effects of contaminants in fresh water (e.g., EPS 1992).

There are currently no databases available with which rules may be applied to search for certain combinations of habitat features and fish distributions, and to examine their associations with industrial activity. It is possible to suggest, in a generalized sense, that fish abundance is some inverse function of obvious independent variables like density of roads or exploration drilling sites. These developments may affect fish populations by affecting water quality and fish abundance due to changes in suspended sediment loads or contaminant discharges. Developing human access into the mainstem corridors of major river systems also puts adult populations of sport fish at risk from increased angling pressure (both legal and illegal). These independent variables might then be used as surrogates for predicting distribution of fish, or even water quality; however, this approach may provide misleading information as it is not based on actual knowledge of fish distributions or characteristics of water quality, and thus, could contain serious errors.

A mechanism comprising part of the former Local Area Agreement implemented within a portion of the Fort St. John Forest District is currently being developed as part of a Best Management Practices protocol by MWLAP, the OGC, and industry. This mechanism will use physical and mapping features to default non fish-bearing reaches, and focus on areas of fisheries concern using a 1:20,000 TRIM base. It is, however, of limited utility for broad scale application using the NTS map base.

Aquatic Ecosystem Hot Spot Map

The approach used to delineate the aquatic ecosystem hot spots (Figure 3-16) was to draw polygons around drainages that contain important habitat for VECs (i.e., bull trout and Arctic grayling) where those drainages occur in the vicinity of current or planned industrial activity.

Drainages or groups of drainages where sampling data indicates moderate to high densities of each VEC species were highlighted to produce distribution polygons for each VEC. The VEC densities were considered in relative terms based on their occurrence at multiple sampling points within drainages or groups of drainages. Areas with little or no likelihood of industrial development in the near future, including provincial parks, protected areas, and portions of the MKMA not currently subject to pre-tenure planning, were excluded from the analysis.

Known and extrapolated bull trout and Arctic grayling distribution was used as an indicator of the presence of sensitive aquatic habitats. These habitats are generally characterized by riffle/pool morphologies originating on uplands where average gradients are greater than 0.5%, and where substrates are dominated by gravels and cobbles.

Hot spot polygons represent areas that currently have increased potential for conflict between industrial development and sensitive aquatic resources; they do not assume the absence of concern elsewhere. Hot spots derived from Arctic grayling distribution dominate upland portions of the Interior Plateau, while hot spots associated with bull trout presence occur in mountain and foothills terrain in the southwest portion of the study area. Hot spots for aquatic systems are generally larger than those for other VECs due to the fluidity of water resources and the potential repercussions of site-specific impacts spread across watersheds.

Water quality hot spots correspond to these polygons based on the assumption that present or potential land disturbance or effluent discharge associated with industrial development can affect both fish abundance and the chemical and biological characteristics of aquatic ecosystems.

Vegetation

The intersection of the vegetation ZOI with the occurrence of the three vegetation VECs (old-growth forests, wetlands, and rare units) was used to identify areas of concern related to the potential for cumulative effects from oil and gas exploration (Table E-4). Level of concern categories are defined as follows:

Some Concern: further disturbance has some implications for integrity of the VEC;

Hot Spot – Moderately Disturbed: further disturbance has serious implications for integrity of the VEC; and

Hot Spot – Highly Disturbed: present disturbance has seriously reduced integrity of the VEC; further disturbance compromises opportunities for recovery or restoration.

The vegetation hot spot map is shown as Figure 3-19.

Table E-4. Vegetation VEC Hot Spots: Assignment of Level of Concern Related to Potential for Cumulative Effects from Oil and Gas Exploration and Development

	Amount of Disturbance		
Vegetation VEC	**Low**	**Moderate**	**High**
Old-growth Forests	Some Concern	Hot Spot – Moderately Disturbed	Hot Spot – Highly Disturbed
Wetlands	Some Concern	Hot Spot – Moderately Disturbed	Hot Spot – Highly Disturbed
Rare Units	Some Concern	Hot Spot – Moderately Disturbed	Hot Spot – Highly Disturbed

Wildlife (Grizzly Bear, Moose, Marten, and Warblers)

Broad Ecosystem Inventory-(BEI) based wildlife habitat capability mapping at a scale of 1:250,000 was used to determine hot spots for four wildlife VECs: grizzly bear, moose, marten, and warblers (caribou, also identified as a VEC, is discussed below). Capability is the ability of a habitat, under optimal seral conditions, to support a given species, irrespective of that habitat's current seral condition (RIC 1999). A habitat capability rating is the value assigned to a habitat according to its potential to support a given species, compared to the best habitat in the province used by that species (RIC 1999). The habitat capability maps used in this project have a four-class rating scheme (1 – high, 2 – moderate, 3 – low, 4 – nil) as described in the British Columbia Wildlife Habitat Ratings Standards (RIC 1999).

The intersection of the relevant wildlife (grizzly bear, moose marten and warblers) ZOI coverage (with neighbour analysis) and habitat capability values was used to identify areas of concern relating to the potential for cumulative effects from oil and gas activity (Table E-5). Level of concern categories are defined as follows:

Negligible Concern: further disturbance has negligible implications for habitat capability;

Some Concern: further disturbance has some implications for habitat capability;

Hot Spot – Moderately Disturbed: further disturbance has serious implications for habitat capability; and

Hot Spot – Highly Disturbed: present disturbance has seriously reduced habitat capability; further disturbance compromises opportunities for recovery or restoration.

Results of wildlife hot spot mapping are shown in Figures 3-25 to 3-28.

Table E-5. Grizzly Bear, Moose, Marten, and Warbler Hot Spots: Assignment of Level of Concern Related to Potential for Cumulative Effects from Oil and Gas Exploration and Development

	Amount of Disturbance		
Habitat Capability Rating	**Low**	**Moderate**	**High**
Nil	Negligible Concern	Negligible Concern	Negligible Concern
Low	Negligible Concern	Some Concern	Some Concern
Moderate	Some Concern	Hot Spot – Moderately Disturbed	Hot Spot – Highly Disturbed
High	Some Concern	Hot Spot – Moderately Disturbed	Hot Spot – Highly Disturbed

Wildlife (Caribou Winter Habitat)

The BEI-based habitat capability information available for caribou is less appropriate for the boreal eco-type of woodland caribou. As an alternative, caribou winter habitat was used to determine caribou hot spots. Typical caribou winter habitat in northern BC, Alberta, and Alaska includes alpine areas, and open subalpine forests and upland forested areas that are 80 years or older (Anderson et al. 2000, Rettie and Messier 2000, Apps et al. 2001, Culling and Culling 2001, Szkorupa 2002). The categories used to describe stand age in the BEI database did not, however, permit this age distinction, so for the purpose of identifying hot spots at the regional scale, caribou winter habitat was identified using the following Broad Ecosystem Unit (BEU) types and structural stage (stand age) parameters:

- Forest (non-riparian) units >140 years old: Boreal White Spruce-Trembling Aspen (BA), Boreal White Spruce-Lodgepole Pine (BP), Englemann Spruce-Subalpine Fir Dry Forest (EF), Lodgepole Pine (LP), White Spruce-Subalpine Fir (SF), and Black Spruce-Lodgepole Pine (BL);
- Alpine units: Alpine Meadow (AM), Alpine Tundra (AT), Alpine Grassland (AG), and Alpine Shrubland (AS); and
- Open subalpine forest units >140 years old: Subalpine Fir-Scrub Birch Forest (FB), Subalpine Fir-Mountain Hemlock Wet Parkland (WP), and Englemann Spruce-Subalpine Fir Parkland (FP).

These parameters describe ‘current’ caribou winter habitat - i.e., winter habitat that is not necessarily in use at present, but does currently meet the criteria for caribou winter habitat (within the limitations described above). ‘Potential’ caribou winter habitat - i.e., forested habitats 140 years old or less that may be used as winter habitat in the future, was identified as follows:

- Forest (non-riparian) units ≤140 years old: same BEUs as described for current caribou winter habitat
- Open subalpine forest units ≤140 years old: same BEUs as described for current caribou winter habitat

The intersection of the caribou ZOI coverage with areas of current and potential caribou winter habitat was used to identify areas of concern relating to the potential for cumulative effects from oil and gas activities (Table E-6). Level of concern categories are defined as follows:

Negligible Concern: further disturbance has negligible implications for availability of caribou winter habitat;

Some Concern: further disturbance has some implications for availability of caribou winter habitat;

Hot Spot – Moderately Disturbed: further disturbance has serious implications for availability of caribou winter habitat; and

Hot Spot – Highly Disturbed: present disturbance has seriously reduced availability of caribou winter habitat; further disturbance compromises opportunities for recovery or restoration.

The caribou hot spot map is presented in Figure 3-29.

Table E-6. Caribou Winter Habitat: Assignment of Level of Concern Related to Potential for Cumulative Effects from Oil and Gas Exploration and Development

	Amount of Disturbance		
	Low	**Moderate**	**High**
Potential Winter Habitat	Negligible Concern	Hot Spot – Moderately Disturbed	Hot Spot – Highly Disturbed
Current Winter Habitat	Some Concern	Hot Spot – Moderately Disturbed	Hot Spot – Highly Disturbed

Appendix F: Oil and Gas Project Assessment Matrices

A regulatory Environmental Impact Assessment (EIA) is typically comprised of the following five steps:

1. **Scoping**: the early identification of key aspects of the assessment, including issues of concern, valued ecosystem components (VEC), spatial boundaries, temporal boundaries, the project's impacts that lead to various effects, and other projects that are contributing cumulatively to the same effects;
2. **Analysis**: the prediction of effects of the project alone (project-specific effects), and in combination with the effects from other human disturbances (i.e., cumulative effects), using appropriate analytical tools (e.g., spatial and numerical modelling);
3. **Mitigation**: the identification of approaches to manage any negative effects by eliminating or reducing the effect (e.g., air emissions controls, minimization of cleared areas);
4. **Significance**: the evaluation of how important the residual effect is (i.e., after mitigation), based on appropriate criteria that establish the context in which that effect may be compared (e.g., regulatory guidelines, land use policies, scientific empirical evidence, levels of acceptable social change, thresholds); and
5. **Follow-up**: monitoring of the project to verify the implementation and effectiveness of mitigation, and to verify the accuracy of predicted effects.

Cumulative effects are addressed, to greater and lesser degrees, under each of these steps

The matrices on the following pages provide general and specific guidance for each of these steps in relation to seven components that are commonly examined in EIAs:

- Table F-1. Air Quality;
- Table F-2. Soils and Terrain;
- Table F-3. Aquatic Ecosystems;
- Table F-4. Vegetation;
- Table F-5. Wildlife;
- Table F-6. Land and Resource Use; and
- Table F-7. First Nations.

It is not the intent of this project to provide a detailed guide for proponents; however, these matrices could be used as part of a project-specific assessment to help identify:

- potential effects;
- candidate valued ecosystem and social components;
- useful analytical tools;
- appropriate effects mitigation measures;
- guidelines for significance determination (e.g., existing standards or thresholds); and
- options for follow-up and monitoring.

Use of the matrices to guide a project-specific cumulative effects assessment assumes that the assessor has taken care to identify all sources of potential disturbance within a defined spatial area (i.e., those in addition to the project to which the assessment applies). A Project Inclusion List (PIL) for the cumulative effects assessment is normally developed early in the assessment process. The PIL should include both existing projects and proposed projects (i.e., reasonably foreseeable projects for which some information is available, which normally happens when an application or public disclosure document is filed). Examples of local or regional projects that would be included in the PIL are:

- other oil and gas activities and facilities;
- mining activities and facilities;
- forestry activities;
- hydroelectric facilities and utilities;
- agricultural and livestock areas;
- transportation corridors, industrial access corridors, and other access routes;
- utility sites and corridors;
- residential communities;
- hunting and trapping areas and camps/cabins;
- tourism and recreation sites, trails, and camps; and
- human-caused and natural disturbances such as forest fires.

Ultimately, the PIL will reflect land use activities presently occurring (or proposed) within the local and regional study area in question.

The matrices should be used in combination with site-specific information and an understanding of site-specific issues and valued components in the area of application. Additionally, as part of the overarching Cumulative Effects Assessment and Management Framework (CEAMF), the matrices should be periodically updated to include new information (e.g., with regard to analytical tools, thresholds, etc.).

Detailed guidance on completion of the five steps in the assessment process is available from the *Cumulative Effects Assessment Practitioners Guide,* which can be purchased from the Canadian Environmental Assessment Agency or accessed from the agency's website: http://www.ceaa-acee.gc.ca/0011/0001/0004/index_e.htm.

Table F-1. Air Quality

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Effects	• Air emissions resulting in air quality degradation may be caused by vehicle exhaust; road dust; fugitive dust emissions from vehicles; equipment exhaust; combustion products from chain saws, off-road vehicles, heavy-duty vehicles and road vehicles; emissions from camp heaters, generators and garbage burning; other waste disposal (incineration) • Odour impacts and non-lethal health effects may occur at levels below regulatory control limits	Air emissions resulting in air quality degradation may be caused by: • **S:** Emissions are from ground-based sources, and are relatively small in magnitude. Noise may be an issue if near settlements or sensitive wildlife areas • **E:** Well test flare emissions can be significant, especially if the well is producing sour gas. Local assessments are required for sour gas well test flaring if the H_2S content is greater than 5%. • **P:** Emissions are from well flaring during stimulation and maintenance operations; heater, compressor, cogeneration, and flare emissions at the batteries, gas processing, and straddle plants; and Sulphur recovery plant emissions. NOx, SO_2, and CO emissions can be significant • **PL:** Emissions can be produced from well blowdown operations that may be vented directly or flared and from compressor and cogeneration units. Compressor NOx, SO_2, and CO emissions can be significant
	VECs	• Combustion emissions include NO_x and CO with smaller amounts of VOC and PM • Fugitive emissions including PM and chlorinated compounds from garbage burning	• **E:** Well test flaring can produce significant amounts of SO_2 if sour gas is flared; odours are also produced • **P:** In some cases, the use of a sour fuel can produce SO_2 emissions • **P:** Fugitive plant emissions include HC and H_2S and other TRS compounds; sulphur recovery plants can produce SO_2 emissions and associated sulphur handling can produce PM and H_2S (TRS) emissions; visibility restrictions (fog/ice fog) due to H_2O emissions and odours are also produced • **PL:** Venting results in the release of HC emissions; flaring can result in SO_2 emissions; visibility restrictions (fog/ice fog) due to H_2O emissions also occur

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Spatial Boundaries		• **S:** Local effects are less than 100 m from the emission source • **E:** For flaring, maximum concentrations are expected to occur within 10 km, and may occur on any elevated terrain in the area • **P:** Maximum concentrations are expected to occur within 10 km, and may occur on any elevated terrain in the area • **PL:** Maximum concentrations are expected to occur within 10 km, and may occur on any elevated terrain in the area
Scoping	Temporal Boundaries		• **S:** Effects are periodic and short-term • **E:** Flaring tends to be short-term (~1 to 5 days). In the extreme, an under-balanced test may persist for ~30 days), simultaneous events in the same airshed should be avoided • **P:** Flaring emissions occur during startup, maintenance, shut down, and upset operations and tend to be short term; Plant emissions from combustions sources are continuous • **PL:** Venting and flaring operations are limited to startup, maintenance, and shut down periods, and are short term; compressor and cogeneration emissions from combustion sources are continuous
Analysis		• Understanding of local and regional emission sources, meteorology and terrain is required • Understanding of relevant ambient air quality objectives and risk factors is required • A large number of computer models are available to calculate emission plumes and emission concentrations for daily, monthly, and annual periods. All of these models require field data on emissions, as well as weather data	• **S:** Detailed analysis is not normally required unless frequency and intensity create the potential for significant impacts
Mitigation		• Site facilities in locations that are favourable to dispersion • Increase energy efficiency of operations • Adopt operation procedures to reduce the magnitude, frequency and duration of fugitive emissions • Establish well-defined upset notification criteria and actions (OGC Draft Guideline under review)	• **S:** Detailed analysis is not normally required unless frequency and intensity create the potential for significant impacts • **E:** Increase stack height; flare during periods when vegetation is less sensitive to exposures; add supplementary fuel gas; adopt a meteorological or ambient monitoring plan to restrict emissions during undesirable periods • **P:** Use sweet gas for fuel; adopt prudent operation procedures to reduce the magnitude, frequency, and duration of fugitive emissions; adopt low NO_x burners; adopt high sulphur recoveries • **PL:** Use sweet gas for fuel; adopt low NO_x burners

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Significance	• Compare to relevant ambient air quality objectives and deposition criteria • Linkage to human, health, vegetation, and soils disciplines may be required • Risk analysis re: effects below objectives or criteria to be based on cumulative impacts to determine acceptability	• **S:** Detailed analysis not normally required unless frequency and intensity create potential for significant impacts
Follow-up	• Ambient monitoring and associated pre- and post-vegetation monitoring may be required • Record reporting of monitoring results including deposition in cumulative database	• **S:** Detailed analysis is not normally required unless frequency and intensity create the potential for significant impacts • **P:** Conduct source monitoring to confirm that emissions meet design specifications • **PL:** Conduct source monitoring to confirm that emissions meet design specifications

Table F-2. Soils and Terrain

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Effects	• Surface disturbance of soil • Soil compaction (e.g., along rights-of-way or at facility sites) • Soil erosion (e.g., during road/facility construction or along improperly reclaimed rights-of-way or from use of ATVs) • Degraded soil quality • Impacts on permafrost soils	• **S:** Erosion on steep slopes and along streams; subsidence in permafrost areas; increased ATV access leading to soil erosion • **E:** Contaminant spills; acid/trace element deposition; on- and off-site drainage impacts; Topsoil/organic salvage • **P:** Contaminant spills; acid/trace element deposition; on- and off-site drainage impacts; Topsoil/organic salvage • **PL:** Drainage obstruction, particularly in wetlands; pipeline ruptures/leaks into soil; topsoil/organic salvage
	VECs	• Soils on steep slopes / highly erodible soils • Riparian soils • Permafrost soils • Rare soils • High quality/capability soils; highly productive for agriculture or forestry	• **E**: Acid-sensitive soils • **P:** Acid-sensitive soils
	Spatial Boundaries	• Site-specific, except for potential drainage contamination due to erosion • Link to land use (high capability forest and agricultural areas, access density links to terrain stability)	• **E:** Linkage to Air Quality for acid deposition effects • **P:** Linkage to Air Quality for acid deposition effects
	Temporal Boundaries	• Track/note season, and site conditions during disturbance/ reclamation	• **S:** Periodic and short-term • **E:** For the duration of the disturbance/emissions • **P:** For the duration of the disturbance/emissions • **PL:** Ground disturbance is periodic and short-term; rupture/leak potential exists for the operative life of pipeline
Analysis		• Sum total of VECs lost to development (e.g., use GIS overlay to identify VEC proximity to development, and/or affected extent) • Soil erodibility (e.g., through modelling using topographic and soils data) • Measurement or modelling of sediment loads (e.g., total suspended solids and total dissolved solids, and plume dispersions/overlaps	• **E:** Water quality analysis to quantify erosion impacts (chemical, nutrient, salinity, sedimentary); link with Air Quality on acid deposition model • **P:** Water quality analysis to quantify erosion impacts (chemical, nutrient, salinity, sedimentary); link with Air Quality on acid deposition model

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Mitigation	• During planning and design, avoid areas with sensitive terrain (e.g., slopes with unstable soils), and areas with discontinuous or continuous permafrost • In areas of discontinuous permafrost, it is very important that the overlying vegetation not be disturbed. Thus, reduce disturbances to native vegetation by minimizing the width of the cleared area • Where clearing of vegetation is required, set the blading height above ground level (e.g., 10 to 20 cm) so that root balls and ground covers are left intact • Use low-impact vehicles (e.g., low pressure-tires or wide-pad tracked vehicles) • If soils are disturbed, use temporary erosion control measures (silt fencing, hay bales, soil fabric) to minimize effects, followed by revegetation, where necessary • Seasonal closures may be used to avoid the movement of equipment on soft substrates and sensitive terrain. Where equipment must be moved across sensitive vegetation or terrain, do so when the ground is solidly frozen using low-impact vehicles	**S:** Ensure that cutlines do not run down slope in areas prone to erosion by surface or near-surface drainage
Significance	• There are no current standards or thresholds for soil loss outside of conservation and reclamation guidelines • Balance goals of regional land use plans with extent and location of VECs	• **S:** Dependent on frequency and intensity of seismic work • **E:** Linkage to Air Quality and Vegetation is required for acid deposition • **P:** Linkage to Air Quality and Vegetation is required for acid deposition
Follow-up	• Follow monitoring protocol in project conservation and reclamation plans • Monitor cumulative regional loss of VECs • Continue linkage with Air Quality, Vegetation • Monitor sediment loads in watersheds	• **S:** Not required unless intensity of work creates erosion concern within watersheds, or the extent of disturbance impacts regional productivity • **E:** Conduct periodic regional soil sampling/analysis for changes to nutrient regime and chemical parameters • **P:** Conduct periodic regional soil sampling/analysis for changes to nutrient regime and chemical parameters

Table F-3. Aquatic Ecosystems

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Effects	• Disposal of treated or untreated wastewater or solid waste (e.g., associated with camp operations) can result in changes to surface water quality. Effects may include transport of fecal coliforms making water unusable downstream, and nutrient enrichment of surface water leading to increased algal production and eutrophication that can degrade fish habitat and reduce fish abundance • Episodic release of toxic effluents or solid waste can result in changes to surface water quality, leading to mortalities of benthic invertebrates, and fish of all age classes • Road access creates potential for spills of truck-transported fluids which can cause fish toxicity in watercourses, and contamination of downstream water supply. Soil erosion and particle transport also occurs from roads and off-road ATV use • Potential disruption of fish passage at stream crossings (perched culverts, velocity barriers, mass wasting, etc.) can occur • Water withdrawal (camp use, hydrostatic testing), or water quality degradation may restrict water use and availability downstream. Water withdrawal may also reduce wetted area of fish habitat and cause isolation of pools • Disturbance of soils can result in the release of sediment to surface water causing anomalous turbidity and limiting water use and suitability downstream. Other effects from increased sediment load include decreased fish survival rates (including decreased spawning success), increased sublethal effects in fish (e.g., gill abrasion, decreased feeding effectiveness), effects of acute turbidity on individual fish, and impacts of sedimentation on incubating eggs, and invertebrate fauna)	• **S:** Temporary or permanent barriers to fish movement due to ice bridges or slash can occur • **E:** Leaching of contaminated fluids from containment pits leading to exfiltration and release of toxic fluids can cause mortalities or abnormalities in benthic invertebrates and fish of all age classes. Other effect include downward migration of contaminated fluids; potential groundwater contamination; mortality of fish due to changes in water quality or altered water flows; and alteration of natural drainage patterns that may disrupt groundwater flows and reduce availability of suitable bull trout spawning habitat • **P:** Episodic and chronic release of toxic fluids to surface water caused by failure of production facilities (e.g., release of glycol, salt water, condensate, lubricants, crude oil, etc.) can cause mortalities or abnormalities of benthic invertebrates and fish of all age classes: other effects include potential reduction in groundwater aquifers and flows; altered surface water flow patterns, changes in channel morphology, or channel locations due to inappropriate lease location leading to changes to rearing and spawning habitat, and restriction of movements • **PL:** Episodic toxic fluid releases, due to pipeline failure, can affect water quality and lead to fish mortality (with resulting impacts to the food web); altered surface water flow patterns, changes in channel morphology, or channel locations (e.g., scouring, channelization) can lead to changes to rearing and spawning habitat, and restriction of movements

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Effects (cont'd)	• Potential disruption of fish passage at stream crossings (perched culverts, velocity barriers, mass wasting, etc.) can occur • Alteration of natural drainage patterns (in particular, disruption of groundwater flow patterns) may have effects on suitability of bull trout spawning habitat. Altered water flows from facilities construction, water withdrawls, etc. can affect natural drainage patterns • Exploitation of fish by crews/staff during recreation time • Exploitation of fish can increase in previously inaccessible areas. Effects vary with methods employed (i.e., heli-portable/hand-cut versus traditional heavy-machine access). This is primarily an issue for foothill streams where vulnerable congregations of sport-fish occur during ice-free months (i.e., adult grayling over summering habitat and bull trout spawning areas)	
	VECs	• Water quality and quantity for human consumption • Habitat quality for all indigenous fish species (including water quality and quantity) • Bull trout distribution and abundance throughout the MKMA • Arctic grayling distribution and abundance throughout the study area, particularly in the Interior Plateau • Critical habitat areas (i.e., spawning, overwintering) • Intact riparian communities (post-disturbance riparian community is left in such condition to prevent ongoing erosion (i.e., vegetation becoming re-established, etc.)	

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Spatial Bound-aries[1]	• Depending on site characteristics, impacts may be local to regional scale for both sediment transport and wastewater discharges • Water quality effects, and effects due to alternation of habitat are typically local where risk is perceived to be high or site-specific sampling is required as a condition of the permit. Data would be collected from index sites (protected areas) and potentially affected sites • Effects due to water withdrawl are typically local • Effects of alteration of drainage patterns are typically subregional • Effect due to barriers to movement are typically subregional • Effects of access are typically subregional to regional scale depending on facility/access density, but with local emphasis where risk is perceived high (i.e., access in vicinity of critical habitats).	• **E:** Subregional for release or migration of toxic effluent or fluids and wastewater discharges. Local scoping is used to determine significance of effects based on no net loss tolerance in Federal *Fisheries Act* • **P:** Subregional for release or migration of toxic effluent or fluids and wastewater discharges. Local scoping is used to determine significance of effect based on no net loss tolerance in Federal *Fisheries Act* • **PL:** Subregional to regional for release or migration of toxic effluent or fluids (i.e., due to pipeline failure)
	Temporal Bound-aries[2]	• Under normal circumstances, typical sediment transport events are resolved in the short- to medium-terms therefore, look back 10 years within one reach upstream and one reach downstream • Water withdrawal issues and barriers to movement are long-term • Effects of altered hydrology may be long-term • Effects of increased exploitation of fish stocks resulting from access development are long-term; all historical access development within watershed group must be considered • Potential exists for catastrophic, long-term impacts to individual populations (e.g., BT spawning aggregations); recovery time is undetermined)	• **E:** Potential for episodic release of contaminants from facility failure is short-term (for the duration of project) • **P:** Chronic long-term sediment disturbance from permanent production sites; long-term for episodic or chronic toxic fluid release resulting from failure of production facilities (must look at all historical development within the watershed group) • **PL:** Chronic long-term sediment transport from sites that are not stabilized; long-term potential for episodic toxic fluid release for the duration of pipeline use

[1] Spatial scales defined as: **Local** immediate area of activity i.e., RoW, lease, workspace, or camp facilities) on a reach or sub-drainage scale. Layout would include upstream to downstream comparisons before, during, and after disturbance; **Subregional**: within a watershed group or multiple groups (if disturbance is near the d/s boundary of a group, then adjacent group will need to be considered); and **Regional:** ecoregion, as defined for terrestrial systems (Demarchi 1995) or aquatic systems (Perrin and Blyth 1998)

[2] . Temporal boundaries for aquatic ecosystems defined as: **short-term:** less than 1 year; **medium-term:** 1-10 years; and **long-term:** greater than 10 years

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Analysis	• Cannot assess significance of an effect on a fish population without background information on the population • For surface water, measurement or modelling of sediment loads (e.g., total suspended solids and total dissolved solids, and plume dispersions/overlaps • For water quality and fish habitat issues, apply stressor thresholds to determine potential effects. Thresholds may be density of seismic lines, roads, drilling locations, production facilities, percent riparian area cleared, average stream crossing frequency, etc • Map threshold density values to identify hot spots or a graded scale of categories showing potential risk of effect (high density means increased risk). Lay seismic density data on terrain stability data to determine potential areas of risk) • Develop a reference map coded with broad categories of fish habitat quality for VEC species to be used as a baseline to determine the risk of site disturbance • Sampling to be co-ordinated under a cumulative effects design, including reference sites in protected areas. This process is required to build a water quality database that is virtually non-existent for the study area at present. Data can be used in regional water quality models • Criteria that determine critical reaches or bodies of water need to be determined from local data (e.g., inventory, radio telemetry studies) and indigenous knowledge. These criteria can be upgraded over time with any index site and impact site sampling that would be required as a condition of operating permits	• **E:** For water withdrawal effects, calculate estimated consumption rates per rig site extrapolated to rig site density; groundwater information and modelling tools will be required to determine the potential dispersion zone from the drilling program, and the potential for overlap with other similar effects • **PL:** For water withdrawal effects calculate estimated consumption rate (hydrostatic testing) extrapolated to site density

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Mitigation	• Schedule and complete construction activities in existing instream work windows • Access management - avoid development of permanent access, manage temporary access through use of gated roads, reclaim temporary access upon project completion • Use existing linear openings and encourage use of shared linear corridors and workspaces • Maintain riparian buffers • Bank armouring • Reclaim temporary access upon project completion • Undertake stream habitat restoration initiatives, where applicable	• **S:** Coordinate seismic programs (i.e., use of shared access and existing linear corridors); maximize use of heli-portable and hand-cut line seismic methods • **E:** Heli-portable exploration drilling; horizontal directional drilling (HDD) or horizontal punch or bore methods to minimize streambank disturbance; use of non-toxic additives; use of diversion ditches • **P:** Stabilize and revegetate riparian areas; liquid waste to be removed or treated before discharge • **PL:** Employ best-practices stream crossing methods to minimize erosion and allow unimpeded fish access; encourage installation of pipe diameter in excess of current capacity requirements; use of horizontal directional drilling (HDD) or horizontal punch or bore methods to minimize streambank disturbance.
Significance	• Follow regulatory guidelines (e.g., Canadian Council of Ministers of Environment guidelines, *Forest and Range Practices Act*, *Federal Fisheries Act)*, and thresholds based on evidence in the primary literature	
Follow-up	• Benthic invertebrate and fish sampling for minimum of one growing season after completion of clean-up/recovery or failure event (not applicable for seismic) • Develop a comprehensive regional water quality monitoring program. Companies operating in areas where there is potential risk of effects can co-operatively fund a program that contributes to a central water quality database from which a regional scale CEA could be done.	• **S:** Index of seismic sites.

Table F-4. Vegetation

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Effects	• Direct immediate loss of vegetation (structure, function and composition) due to clearing • Fragmentation (spp. alienation and reduced distribution) of large patches of vegetation due to clearing • Altered species composition and successional stage of plant communities due to clearing • Altered species composition and vigour of wetland plant communities due to hydrological changes resulting from vegetation clearing • Altered ratio and distribution of uplands and wetlands due to vegetation clearing	• **E:** Changes in health and species composition of plant communities due to air emissions from construction activities, well test flaring, and service vehicles and equipment; direct physical effects and indirect chemical effects on vegetation due to road dust and road salt • **P:** Changes in health and species composition of plant communities due to air emissions from construction activities, well test flaring, and service vehicles and equipment; direct physical effects and indirect chemical effects on vegetation due to road dust and road salt
	VECs	• Plant Species at Risk (provincially, federally) • Plant species or communities that are significantly abundant regionally, provincially, or federally • Plant species or communities of socio-economic importance (e.g., First Nations traditional use) • Plant species or communities that are components of rare or sensitive ecosystems, or that are highly susceptible to disturbance	
	Spatial Boundaries	• For each VEC, select spatial scales at the site-specific level by using distributions of plant species and communities, and location and extent of disturbances	
	Temporal Boundaries	• For riparian plant communities, temporal boundaries will vary with site-specific conditions and extent of restoration efforts • For rare ecosystems, temporal boundaries will vary with ecosystem type and extent of restoration efforts • Impacts to sensitive vegetation such as old-growth forests, riparian plant communities and rare ecosystems will be typically long-term in durations. For example, for old-growth forests, the temporal boundary should be at least 120 years past the decommissioning phase	• **S:** Because areas cleared along seismic lines are not reclaimed, and generally, are kept open by recreational users, impacts are expected to be permanent • **E:** Air emissions and chemical toxins are expected to affect plant health of all VECs from at least 0-life of development activity; however, residual effects could last much longer • **P:** Air emissions and chemical toxins are expected to affect plant health of all VECs from at least 0-life of development activity; however, residual effects could last much longer • **PL:** Pipelines are generally buried, and are allowed to revegetate naturally following abandonment

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Analysis	For measuring cumulative effects on a project-specific basis, develop measures based on site-specific information such as TEM and baseline inventories of plant species and communities, which could include measurement of: • Changes in area of vegetation types or communities (e.g., ha vegetation cleared for different communities) • Changes in juxtaposition of vegetation communities (Note: this is a component of fragmentation) • Changes in integrity of single plant communities (Note: this is a component of fragmentation) • Changes in vegetation community composition • Changes in plant species' relative or absolute abundance • Changes in plant species' distribution	
Mitigation	• Avoid sites with uncommon or sensitive plant communities • Limit extent of vegetation clearing • Avoid fragmenting large patches of vegetation • Co-ordinate seismic line or access road development among tenure holders • Where new road access must be created, minimize the length of the new road that is required and, where possible, control public access to the road • Develop progressive rehabilitation plans based on direction from MK Act and land use planning zones	• **S:** Avoid starting seismic lines along an existing right-of-way or road. Use hand-cutting for the first 50 to 100 m to maintain a buffer of natural vegetation (this will prevent easy access by ATVs and other vehicles to the right-of-way) • **E:** Drill multiple wells from single pad where possible (i.e., directional drilling) • **PL:** Re-vegetate major access points
Significance	• Refer to existing standards such as the results-based code of the *Forest and Range Practices Act* • For rare plants or unusual plant communities, a loss of more than 5 to 10 percent of the regional population would likely be considered unacceptable • Identify appropriate thresholds for vegetation, e.g., maximum density of linear and block disturbances km^2, Minimum retention of each vegetation community to prevent extirpation of vegetation units (i.e., plant species or communities) and loss of vegetation types	

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Follow-up	• Establish pilot study areas and monitor plant species and community changes over time, e.g., monitoring ecosystem effects on old-growth, riparian, and rare systems/species • Create benchmark monitoring areas to assess vegetation recovery rates from disturbances • Undertake sensitive ecosystem inventories and mapping to monitor changes in plant species and communities over time (e.g., BEC-site series mapping at the operational scale)	

Table F-5. Wildlife

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Effects	• Direct habitat loss due to vegetation clearing • Habitat fragmentation and alienation due to vegetation clearing • Mortality due to increased human and predator access • Disruption of wildlife movements due to vegetation clearing and increased human and predator access • Sensory disturbance due to construction/camps (i.e., greater levels of human activity and noise that can cause some wildlife species to avoid the area) • Problem wildlife incidents at camp sites	• **E:** Sensory disturbance from drilling activities • **P:** Sensory disturbance from plants and processing sites
	VECs	• Species at Risk (provincially, federally) (e.g., grizzly bear) • Species or populations which are significantly abundant regionally, provincially, or federally (e.g., ungulates) • Species or populations of socio-economic importance (e.g., First Nations traditional use, species that are hunted/ trapped such as moose and marten) • Species that are dependent on rare or sensitive ecosystems (e.g., warblers are dependent on boreal forests during the migratory period)	
	Spatial Boundaries	• For each VEC, select spatial scales at the site-specific level by using species home ranges and territory sizes, habitat availability, and suitable buffers	
	Temporal Boundaries	• Boundaries will be dependent upon the specific issues and the individual habitat requirements of each VEC. For example, sensory disturbance and increased mortality due to construction activities will be reduced when the construction period ends (i.e., short-term). Conversely, impacts to habitat may be long-term. For example, for fisher and marten, which generally require old-growth forest habitats, impacts may last over 100 years (i.e., the time it takes old-growth forests to recover)	

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Analysis	For measuring cumulative effects on a project-specific basis, develop measures based on site-specific information such as TEM and baseline inventories of local populations, which may include measures such as • Species-specific habitat modeling (e.g., changes in availability of habitat types over time; changes in availability of core security habitat over time) • Changes in species' relative or absolute abundance over time • Changes in mortality rates over time • Changes in fur returns over time • Changes in cow:calf ratios over time • Seismic line density; road and trail density; distance of seismic lines, roads, and trails from towns (regarding access issues) • Location of logging, hunting, and recreational camps; location of guide-outfitter territories (regarding access issues) • Road, seismic line, and pipeline location relative to wildlife movement corridors • Buffer zones around different developments can be identified to measure areas of sensory disturbance and avoidance by wildlife	
Mitigation	• Coordinate planning efforts with other industries to minimize the size and number of areas cleared (e.g., for access) • Reclaim areas cleared for seismic lines as soon as possible • Close roads once activity has been completed • Minimize disturbances (e.g., hunting, harassment) to wildlife from work crews • Use pre-development field surveys to locate the best placement of facilities so sensitive habitats are avoided	• **S:** Use existing utility corridors wherever possible; close rights-of-way once seismic activity has been completed • **PL:** Use existing utility corridors wherever possible; close rights-of-way following abandonment

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)

Significance	• Refer to guidelines and objectives in regional land/resource use plans and regional wildlife management plans
	• Refer to existing standards and guidelines (e.g., the results-based code of the *Forest and Range Practices Act*, the BC Identified Wildlife Management Guidelines, Boreal Caribou Committee Industrial Guidelines)
	• Identify appropriate thresholds for wildlife. For example:
	  • Wildlife Abundance
	  • Minimum cow:calf ratio
	  • Minimum number of individuals per km^2
	  • Habitat Loss/ Fragmentation
	  • Minimum habitat effectiveness (%)
	  • Minimum core security habitat area
	  • Minimum area of contiguous habitat
	  • Maximum number of vehicles per day
	  • Maximum number of backcountry visitors per day
	  • Maximum density of linear disturbance per km^2
	  • Wildlife Mortality
	  • Maximum loss of females per year (number per 100 females)
	  • Wildlife Movements
	  • Minimum area of contiguous habitat
	  • Maximum number of vehicles per day
	  • Maximum number of backcountry visitors per day
	  • Maximum density of linear disturbance per km^2	

Follow-up	• Monitor key wildlife species population changes over time by conducting on-going inventories • Monitor areas and patterns of losses and changes in habitat types over time using air photo coverage and TEM • Monitor rates of wildlife mortality by collecting and analyzing statistics on roadkills, problem wildlife incidences, and hunting and trapping returns • Collect data on wildlife movements by conducting on-going radio telemetry studies; use this information to monitor changes in wildlife movements due to sensory disturbances from development projects	

Table F-6. Land and Resourse Use

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Effects	• Visual impacts • Decrease in wilderness solitude experience and loss of sustainable economic opportunities dependant on wilderness (e.g., ecotourism) • Other industrial users may be affected by temporary or permanent loss of resources (e.g., timber or agricultural land) • Indirect impacts to wildlife or fish, if significant, could impair hunting, trapping or fishing success in the region	• **S:** Creation of new access is the primary issue • **E:** May result in disturbances to other resource users by way of noise, dust, odours, visual impacts, loss of areas of use, or the creation of new access • **P:** May result in disturbances to other resource users by way of noise, dust, odours, visual impacts, loss of areas of use, or the creation of new access. There may also be a permanent loss of lands for other uses • **PL:** Creation of new access along rights of way; disturbance to patterns of use of trappers or guide outfitters; and loss of timber or other resource use capability along the right of way
	VECs	• Wilderness Quality (important in region for recreation and supports economic activity, e.g., tourism, guide outfitting) • Wilderness Access (important in region and supports economic activity, e.g., tourism, guide outfitting) • Industrial Access (important to support region's resource-based economy) • Alternate Economic Opportunities (e.g., Ecotourism) (important in promoting diversified economic activity) • Viewscapes (important in maintaining wilderness values)	

Assessment Process		Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Scoping	Spatial Boundaries	• Recreation access: estimate the distance on either side of a right-of-way/seismic line that users might likely travel (i.e., determine the user footprint). This distance could then be used to buffer the right-of-way and create polygons of access representing a spatial boundary • Recreation experience: in some cases spatial boundaries have been determined using noise, dust or odour plumes (most applicable for impacts resulting from construction phase) • Visual quality: models of visual impacts (i.e., viewshed analyses) can be used to determine the geography extent of visual impacts • Land clearing (e.g., availability of harvestable timber): may be appropriate to use management units as spatial boundaries (e.g., Timber Supply Areas) • Hunting, trapping and fishing uses: use spatial boundaries that have been set for harvested species (e.g., watersheds for fisheries) or management/ administrative boundaries such as wildlife management units or trapper/outfitter territories	• **PL:** Pipelines are often used as transportation corridors by land users. For VECs that relate to access, spatial boundaries could be determined by following access off the pipeline until contact is made with a public road, which the project has no control over access
	Temporal Boundaries	• For all types of activities, for land and resource use impacts, the life of the project is typically used as a temporal boundary, after which time lands can be reverted to their pre-project use (assuming access will be removed)	**S:** Life of seismic line as it exists for non-industrial resource users (i.e., until it is not longer usable as a right-of-way) is an appropriate temporal boundary
Analysis		• Existing land use plans provide a tool for determining whether current or projected uses are consistent with land use objectives • Calculate the amount of land lost to other uses, e.g., determine loss of merchantable timber or high quality arable land • Use scenario development forecasting to show incremental losses of land for other purposes or use remotely sensed data to show changes in landscape over time • Information from visitor use studies could be use to qualitatively/ quantitatively discuss loss of or satisfaction with present wilderness recreation opportunities • Model incidental access that may be created by a new access corridor • Use air quality or noise plume modeling, or viewshed modeling, to show extent of impacts	**S:** Road density analysis: calculate the total km (or km per area) of access created by seismic lines **PL:** Road density analysis: calculate the total km (or km per area) of access created by pipelines

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Mitigation	• Notify other land users of activities to avoid conflicts • Minimize noise and air quality impacts through project scheduling and enforcement of standards for noise, dust, emissions, etc • Minimize disturbances to existing access through project scheduling and provision of alternative routes • Minimize impacts of crews on resources (e.g., hunting and fishing) through proponent-enforced restrictions • Minimize visual impacts and impacts to other resource users by limiting total clearing as much as possible • Coordinate industrial access to minimize changes to existing land use patterns	**S:** Close rights-of-way once seismic activities completed through roll-back and other techniques **PL:** Close rights-of-way when no longer needed for pipeline operations, through roll-back and other techniques
Significance	• Refer to LRMPs or lower-level plan objectives for land use and identify cumulative impacts that may not be consistent with these objectives • Some standards exist for visual quality (i.e., Visual Quality Objectives for forestry). May also be site-specific guidelines for access (e.g., in the MKMA), hunting, trapping, or fishing • Significance may also be measured in terms public acceptance of impacts, permanent versus reversible impacts, and impacts that cannot be compensated • Some work has been done on determining thresholds for km of new access (needs further investigating) • Measures of Limits of Acceptable Change (LAC) may be derived with public input • In some high-value recreation areas, the Recreation Opportunity Spectrum may be used to identify desirable conditions	
Follow-up	• Monitor specific impacts, e.g., changes to hunting success that may be attributed to the project • Review past and projected changes to land use patterns over time to estimate rate of change in the region • Monitoring of land use on a regional scale must involve many different agencies that manage land and resource use activities	

Table F-7. First Nations

<table>
<tr><th colspan="2">Assessment Process</th><th>Generic to All Project Types</th><th>Specific to Certain Project Types
(S = seismic; E = exploration; P = production; PL = pipeline)</th></tr>
<tr><td rowspan="4">Scoping</td><td>Effects</td><td>• Wildlife and wildlife habitat
• Water quality
• Fish and fish habitat
• Affect on traditional lifestyles and values, cultural/spiritual sites and values
• Traditional and contemporary use i.e., access to hunting, harvesting, and trapping areas
• Increased harvesting pressures
• Botanical resources and other sustenance resources
• Fragmentation of habitat, and increased roads</td><td></td></tr>
<tr><td>VECs</td><td>• Use indigenous knowledge, Traditional Use Studies, or community land and resource plans (when available) to identify key values such as important harvested plants and wildlife species, or culturally/spiritually significant sites</td><td></td></tr>
<tr><td>Spatial Boundaries</td><td>• For First Nations VECs, boundaries should be determined through consultation with First Nations and ideally incorporate indigenous knowledge</td><td></td></tr>
<tr><td>Temporal Boundaries</td><td>• For First Nations VECs, boundaries should be determined through consultation with First Nations and ideally incorporate indigenous knowledge</td><td></td></tr>
<tr><td colspan="2">Analysis</td><td>• Involvement of First Nations in baseline inventory and research studies
• Use of Traditional knowledge, Traditional Use Studies, and other First Nation community-based management plans (when available), which could be obtained through information sharing agreements
• Ecological land classification</td><td></td></tr>
<tr><td colspan="2">Mitigation</td><td>• For First Nations VECs, boundaries should be determined through consultation with First Nations and ideally incorporate indigenous knowledge</td><td></td></tr>
</table>

Assessment Process	Generic to All Project Types	Specific to Certain Project Types (S = seismic; E = exploration; P = production; PL = pipeline)
Significance	• For First Nations VECs, boundaries should be determined through consultation with First Nations and ideally incorporate indigenous knowledge	
Follow-up	• For First Nations VECs, boundaries should be determined through consultation with First Nations and ideally incorporate indigenous knowledge	

Appendix G: OGC Application Cumulative Effects Screener (ACES)

Appendix G is organized into the following three parts:

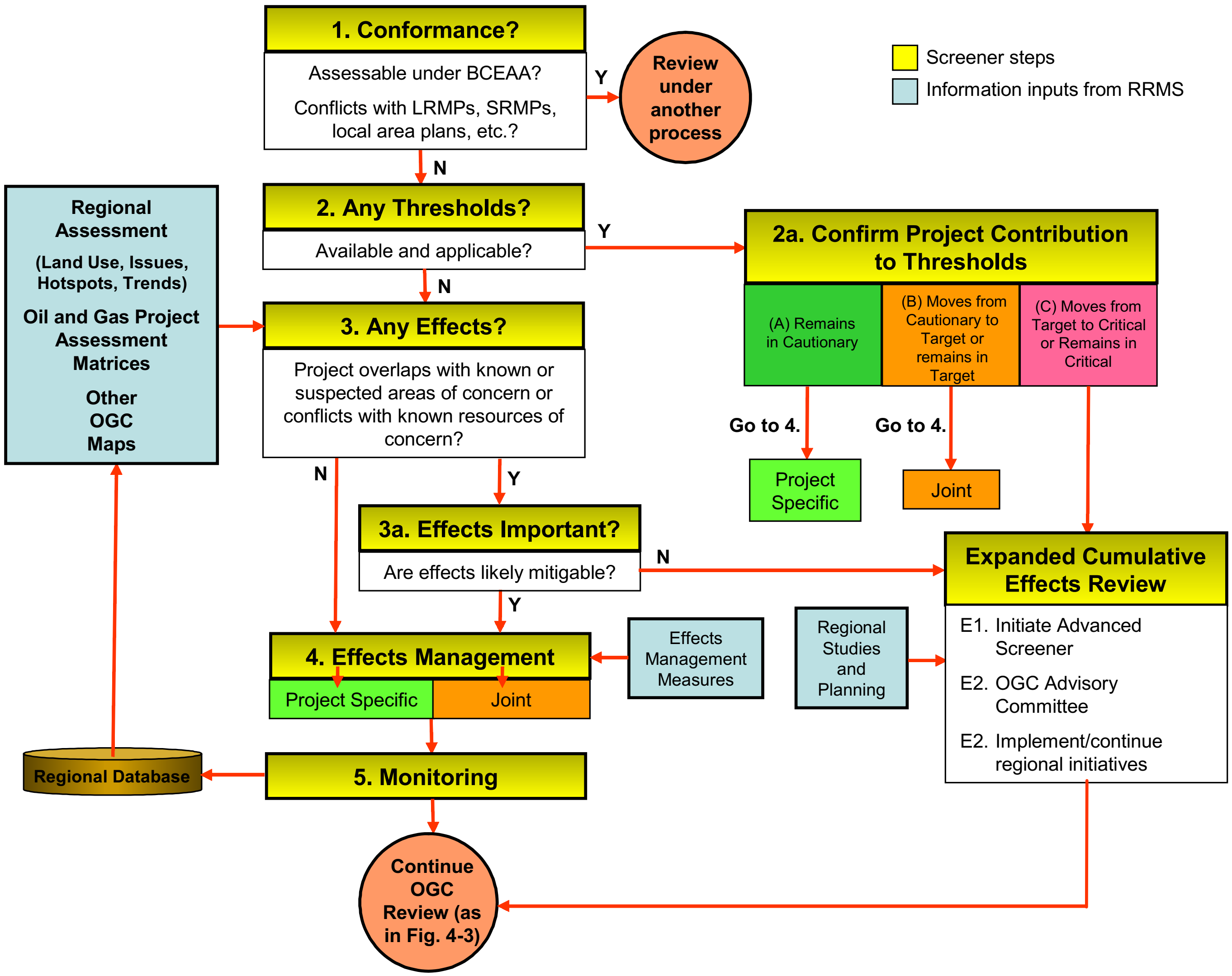
- Part 1: Routine Screener
- Part 2: Expanded Review
- Part 3: Pilot Implementation

Parts 1 and 2 begin with a 'Users Guide' or annotated version (i.e., provides an explanation of how to complete the forms) followed by the actual form that can directly be used by the OGC (this is simply the same form that appeared before, but without all the explanatory notes).

Part 3 outlines a pilot implementation process that the OGC may use to test the proposed ACES.

For convenience, Figure 4-4 has been reproduced on the next page (as Figure G-1) to assist interpretation of the information provided in Parts 1 and 2 of this appendix.

Figure G-1: OGC Application Cumulative Effects Screener (ACES)



Part 1: Routine Screener

Users Guide

Note the following:

1. *An answer of "yes" [Y] or "no" [N] is written into each box in the rightmost column.*
2. *The table provides a version appropriate for understanding the screening process, providing decision criteria and examples of sources of information.*
3. *The table does not provide space to record items contributing to the decisions (e.g., data sources actually used, assumptions, comments, mitigation measures required). The tables can however be expanded to include such space to meet OGC requirements for an audit trail or record of the screening.*

OGC Routine Screener

Project Information

Project Title:

Proponent:

Location:

File #:

1. Conformance?

Is the project assessable under the *BC Environmental Assessment Act* (BCEAA)?	
Does the type of project and its location conflict with applicable land use plans?	

If yes to either question, refer the application to another appropriate review process.

Decision criteria: A conflict occurs when it is clear that the project is unacceptable based on unconditional exclusion of such activities.

Information sources: Examples of plans include Land and Resource Management Plans (LRMPs), Sustainable Resource Management Plans (SRMPs), and local area plans (e.g., recreation, wildlife).

2. Any Thresholds?

Are thresholds available and applicable to this project?	

If no, go to Step 3

If yes, go to Step 2a

Decision criteria: Thresholds are applied if the OGC has indicated as such for specific geographic areas.

Information sources: Information on thresholds would be available following the completion of a thresholds implementation plan and acceptance to proceed with such thresholds as part of the OGC's regulatory review process.

2a. Confirm Project Contribution to Thresholds

Based on the threshold calculations prepared by the project proponent and submitted to the OGC with their application, which of the following is true based on the project contribution within its applicable designated threshold region (only one of these conclusions is possible for an application)?

(A) project would not change an existing "cautionary" threshold level for region ☐

If yes, go to step 4, project-specific [effects management]

(B) project would move region from "cautionary" to "target" or would not change an existing threshold of "target" in region ☐

If yes, go to step 4, joint [effects management]

(C) project would move region from "target" to "critical" or would occur in a region already at the "critical" threshold ☐

If yes, go to Expanded Cumulative Effects Review

Information sources: When thresholds are implemented, the OGC will have to develop appropriate notification and instruction to applicants (i.e., define new information requirements). A current description in detail indicating the technical aspects of such requirements is provided in Volume 2.

3. Any Effects?

Does the project overlap any known or suspected areas of concern? ☐

Decision criteria: An overlap occurs when the project footprint (as submitted by the proponent) physically resides in the area of concern (i.e., there is a spatial overlap). An area of concern is any pre-defined geographic area associated with an environmental feature of importance (e.g., as established by government notices); and, the project has a reasonable likelihood of affecting that feature given the project's location and type. The question is answered "yes" if the project has a reasonable likelihood of affecting that area given the project's location and type; and, that area is of management concern to government authorities responsible for its management.

Information sources: Potential areas of concern may be obtained and identified from hotspot maps (Appendix H), other map products (e.g., from GOAT, such as fisheries and wildlife mapping), and any published government notices (e.g., Guidelines, Information Letters).

Does the project conflict with known resources of concern? ☐

If yes to either question, go to Step 3a.

If no to either question, go to Step 4.

Decision criteria: A resource of concern is any environmental feature as described above; however, one that is not necessarily correlated to any specific pre-designated area? For mobile resources (e.g., wildlife), such conflict is more likely if the project occurs at the same time as the resource occurs in the vicinity of the project (i.e., there is a temporal overlap). The question is answered "yes" if the project has a reasonable likelihood of affecting that feature given the project's location and type; and, that feature is of management concern to government authorities responsible for management of that resource. The likelihood of cumulative effects is therefore greater for a conclusion of "yes" as opposed to "no".

Information sources: The Oil and Gas Project Assessment Matrices (Appendix F) may assist in identifying likely spatial and temporal boundaries.

3a. Effects Important?

Are the project's effects likely mitigable? ☐

If yes, go to step 4.

If no, go to Expanded Review

4. Effects Management

As conditions of application approval, implement <u>project-specific</u> EMMs if:

no in step 3; or ☐

had conclusion (A) in step 2a ☐

As conditions of application approval, implement <u>joint</u> EMMs if:

yes in step 3a; or ☐

had conclusion (B) in step 2a ☐

Information sources: Information on effects management options are provided in Section 4.5 and from the OGC's own list of mandatory and voluntary options. EMMs for the application should be itemized.

5. Monitoring

As conditions of application approval, implement appropriate monitoring measures. ☐

Information sources: Information on monitoring is provided in Section 4.7.2.3 and from the OGC's list of mandatory and voluntary options. Data on project is submitted to regional database. Monitoring measures for the application should be itemized.

Screening Summary

Is the application:

1. Referred to another review process (from step 1)? ☐

2. For an area where thresholds apply (from step 2)? ☐

3. Responsible for moving region to a higher threshold level (from step 2a)? ☐

4. Subject to unique project-specific EMMs? ☐

5. Subject to joint EMMs? ☐

6. Sent to Expanded Review? ☐

If "yes" to (1), identify alternate review process

If "yes" to (4) or (5), proceed with recommendation to approve subject to results of referral process

If "yes" to (6), proceed with referral process but subject to conditions of expanded review

Routine Screener Form

The next page (front and back) provides the form for the routine screener.

OGC Routine Screener

Project Information

Project Title:

Proponent:

Location:

File #:

1. Conformance?

Is the project assessable under the *BC Environmental Assessment Act* (BCEAA)? ☐

Does the type of project and its location conflict with applicable land use plans? ☐

If yes to either question, refer the application to another appropriate review process.

2. Any Thresholds?

Are thresholds available and applicable to this project? ☐

If no, go to Step 3

If yes, go to Step 2a

2a. Confirm Project Contribution to Thresholds

Based on the threshold calculations prepared by the project proponent and submitted to the OGC with their application, which of the following is true based on the project contribution within its applicable designated threshold region (only one of these conclusions is possible for an application)?

(A) project would not change an existing "cautionary" threshold level for region ☐

If yes, go to step 4, project-specific [effects management]

(B) project would move region from "cautionary" to "target" or would not change an existing threshold of "target" in region ☐

If yes, go to step 4, joint [effects management]

(C) project would move region from "target" to "critical" or would occur in a region already at the "critical" threshold ☐

If yes, go to Expanded Cumulative Effects Review

3. Any Effects?

Does the project overlap any known or suspected areas of concern? ☐

Does the project conflict with known resources of concern? ☐

If yes to either question, go to Step 3a.

If no to either question, go to Step 4.

3a. Effects Important?

Are the project's effects likely mitigable? ☐

If yes, go to step 4.

If no, go to Expanded Cumulative Effects Review

4. Effects Management

As conditions of application approval, implement project-specific EMMs if:

no in step 3; or	☐
had conclusion (A) in step 2a	☐

As conditions of application approval, implement joint EMMs if:

yes in step 3a; or	☐
had conclusion (B) in step 2a	☐

5. Monitoring

As conditions of application approval, implement appropriate monitoring measures.	☐

Screening Summary

Is the application:	☐
1. Referred to another review process (from step 1)?	☐
2. For an area where thresholds apply (from step 2)?	☐
3. Responsible for moving region to a higher threshold level (from step 2a)?	☐
4. Subject to unique project-specific EMMs?	☐
5. Subject to joint EMMs?	☐
6. Sent to Expanded Review?	☐

If "yes" to (1), identify alternate review process

If "yes" to (4) or (5), proceed with recommendation to approve subject to results of referral process

If "yes" to (6), proceed with referral process but subject to conditions of expanded review

Part 2: Expanded Review

Users Guide

Note the following:
Check (✓) each box in the rightmost column as verification that the action was done.

OGC Expanded Review

Project Information

Project Title:

Proponent:

Location:

File #:

E1: Advanced Screener

1. Project Effects

Identify effects caused by project ☐

Definition: An effect is a response by the environment to the project.

Decision criteria: Identify effects based on the type of the project and the surrounding environmental conditions.

Information sources: Refer to the Oil and Gas Project Assessment Matrices (Appendix F) for examples of effects.

Identify likely zones of influence for effects ☐

Definition: A zone of influence (ZOI) is the spatial extent of an effect.

Decision criteria: Identify a likely maximum ZOI based on experience and knowledge of effects for the type of project and receiving environment.

Information sources: Refer to the Oil and Gas Project Assessment Matrices (Appendix F) for examples of ZOI.

2. Valued Components

Identify Valued Components (VCs) affected by project ☐

Definition: A Valued Component is an environmental or human feature of importance that could be affected by the project.

Decision criteria: Select only those VCs that are most likely to be affected and for which an effect would be of management concern (i.e., regarding the management of that resource) or of concern to people relying on that resource.

Information sources: Refer to the Oil and Gas Project Assessment Matrices (Appendix F) for examples of VCs.

3. Cumulative Effects

Identify other human actions that may overlap with the project ☐

Definition: An "action" is any project or activity not associated with the project under review.

Decision criteria: For each VC, identify actions that lie within the ZOI for each effect and that also affect the same VCs.

Information sources: Any map sources.

Determine if there are any cumulative effects

Definition: An effect on a VC is cumulative when that VC is affected by more than one human action.

Decision criteria: Itemize each effect and the VC affected for which an overlap occurs.

Information sources: Any sources as described above.

4. Effects Management Measures

Identify appropriate project-specific and joint EMMs

Definition: An effects management measure (EMM) is any initiative to reduce or eliminate an effect.

Decision criteria: First identify mandatory EMMs, then any additional EMMs that likely would be effective in managing the effect while remaining reasonable regarding the degree of responsibility for their implementation by the proponent.

Information sources: Refer to the Oil and Gas Project Assessment Matrices (Appendix F) for examples of EMMs and to Section 4.5 for descriptions of selected EMMs.

5. Residual Effect

Estimate the likely residual effect on each VC

Definition: A residual effect is the state of an effect after the application of EMMs.

Decision criteria: Estimate based on experience of effects from the type of project, receiving environment, and degree of success of the EMMs. The likely trend of a VC is also considered, which is described by the likely direction of an effect (positive, negative or neutral) and the likely duration of the effect's recovery.

Information sources: Experience and knowledge of OGC staff and referrals.

6. Significance of Effects

Evaluate the significance of the project's contribution to cumulative effects

Evaluate the significance of the overall cumulative effects

Definition: Significance is a measure of the importance of an effect. The project's contribution to cumulative effects is the project-specific effect on each VC. The overall project effect is the effect from the project *and* from all other identified actions that affect a VC.

Information sources: Use Tables 1 and 2 to assist in evaluating significance.

E2: OGC Advisory Committee

Refer the project the OGC Advisory Committee

Information sources: See Section 4.2.3.5 for the role of the Committee.

E3: Regional Initiatives

Identify appropriate regional initiatives

Decision criteria: Identify initiatives (regional planning and research studies) that may contribute to a better understanding of the project's effects and/or of the surrounding environment. Such initiatives are typically supported, coordinated and implemented on a regional basis by government or industry and government coalitions.

Information sources: Refer to Section 4.4 for a description of such initiatives.

Evaluating Significance (for Step 6)

Table 1 Criteria for Evaluating Class of Significance

Magnitude of Effect on VC	Trend of VC	
	Positive	Negative or Neutral
Low	Class 1	Class 1
Moderate	Class 1	Class 2
High	Class 2	Class 3

Table 2 Criteria for Evaluating Significance

Project Specific Class on a VC	Overall Class on a VC		
	Low	Moderate	High
Low			
Moderate			
High			

To use the tables to evaluate significance:

1. Using Table 1, select the appropriate magnitude of an effect of the project. Magnitude is a measure of the severity of an adverse effect.
2. Using Table 1, select the appropriate trend of the likely future state of the VC. Positive means the state of the VC is likely improving, negative means it is likely worsening, and neutral means it is likely unchanged.
3. Using Table 1, identify the class of effect given the selected magnitude and trend. This is the project-specific class of effect.
4. Repeat steps 1 to 3 for overall class. Overall class is based on the cumulative effect of all human actions on the VC by that effect, including the effects of the project under review.
5. Repeat steps 1 to 4 for any other effects on the VC.
6. Using Table 2 as a guide (i.e., not necessarily definitive), identify the likely significance of each effect given the combination of project-specific and overall class as follows (ensure that any conclusion can be defended):
   - Green combinations are unlikely to be significant for project under review.
   - Amber combinations may be significant for project under review.
   - Red combinations likely to be significant for project under review.
7. Repeat steps 1 to 6 for each other VC affected by the project under review.

Expanded Review Form

The next page (front and back) provides the form for the expanded review.

OGC Expanded Review

Project Information

Project Title:

Proponent:

Location:

File #:

E1: Advanced Screener

1. Project Effects

- [ ] Identify effects caused by project
- [ ] Identify likely zones of influence for effects

2. Valued Components

- [ ] Identify Valued Components (VCs) affected by project

3. Cumulative Effects

- [ ] Identify other human actions that may overlap with the project
- [ ] Determine if there are any cumulative effects

4. Effects Management Measures

- [ ] Identify appropriate project-specific and joint EMMs

5. Residual Effect

- [ ] Estimate the likely residual effect on each VC

6. Significance of Effects

- [ ] Evaluate the significance of the project’s contribution to cumulative effects
- [ ] Evaluate the significance of the overall cumulative effects

E2: OGC Advisory Committee

- [ ] Refer the project the OGC Advisory Committee

E3: Regional Initiatives

- [ ] Identify appropriate regional initiatives

Evaluating Significance (for Step 6)

Table 1 Criteria for Evaluating Class of Significance

Magnitude of Effect on VC	Trend of VC	
	Positive	Negative or Neutral
Low	Class 1	Class 1
Moderate	Class 1	Class 2
High	Class 2	Class 3

Table 2 Criteria for Evaluating Significance

Project Specific Class on a VC	Overall Class on a VC		
	Low	Moderate	High
Low			
Moderate			
High			

Part 3: Pilot Implementation

Routine screening

In the Absence of Thresholds

A key assumption of the CEAMF is that the screening of projects for cumulative effects should occur now, rather than wait until thresholds are in place. Thus the proposed changes to the OGC screening process can be readily implemented in the absence of thresholds. It is recommended that the routine screening process be tested through a pilot study (similar to that described for thresholds). The pilot study would apply to all areas of northeast BC that are outside areas where candidate thresholds are being tested.

For a recommended six-month period, one selected OGC screening officer would test the proposed changes to the screening process against new project applications. During this period, each application would also be reviewed under the existing process to determine the actual fate of the project (as for the threshold implementation strategy, the fate of the project would not be influenced by the results of the pilot testing).

The OGC screening officer conducting the test would be asked to document any issues or proposed changes to the screening process based on its practical application (see below for the discussion under 'Refinement'). The testing of changes to the screening process would stop should a project be referred to an advanced screen.

In Association with a Threshold Implementation Strategy

Although Volume 2 provides specific candidate numerical thresholds, a process will be required to introduce and formalize their use. Implementation of thresholds will require agreement on definitions of acceptable change, threshold values, a standard public database, a standard process to calculate indicator values using this database, and project-specific and cooperative management actions to be implemented. The existing public database would need to be enhanced and made more readily accessible.

A pilot study is recommended to better understand the ecological, economic, and social implications of threshold implementation in northeast British Columbia. Two areas with existing data and high cumulative effects hazard are proposed for consideration (see Volume 2 for further details). The threshold implementation strategy would coincide with the pilot testing of the proposed amendments to the OGC application screening process (i.e., ACES).

A one-year test period is proposed during which time applications for projects within the selected area(s) would be reviewed by two OGC screening officers: one would apply the existing OGC review process and determine the fate of the application; while the second would apply the proposed amendments to the screening process including the 'threshold test'. During this test period, the results of the 'threshold test' would have no bearing on the fate of an application. However, participation from proponents would be imperative, as proponents would be asked to submit along with their applications a calculation of their project's contribution to the threshold. This would serve to also test the ability of proponents to meet this additional requirement.

The OGC staff conducting the test would be asked to document any issues or proposed changes to the screening process based on its practical application (see below for the discussion under 'Refinement'). The testing of changes to the screening process would stop should a project be referred to an advanced screen. The advanced screening process would be tested separately (see below).

Advanced Screening

Testing of the advanced screener process would not require a parallel application review process such as that proposed for routine projects. Testing of the advanced screener should not occur on a new project application for two reasons. First, the advanced screening is only one part of the expanded review process that would ultimately determine the fate of an application. In the absence of the other two components (referral to OGC Advisory Committee and participation in joint effects management initiatives) the advanced screener alone cannot be fully tested. Second, the advanced screener would require that the proponent undertake a detailed assessment of the effects of the proposed project. As the pilot testing would have no effect on the outcome of the application, it would not be reasonable to require the proponent to invest the additional time and expense of undertaking the advanced screener at this stage.

Rather, the advanced screening process should be tested on an already approved application whereby a selected member of the OGC (or a consultant) would undertake the screening, and a separate OGC screening officer would review the screening report and make a hypothetical decision. Preparation of the advanced screening report would not be conducted by the proponent at this stage but the proponent's involvement would be helpful in two ways: 1) the proponent could help compile necessary information about the project or environment that may not have been included in their original application; and, 2) the proponent would have an opportunity to see how the advanced screener is conducted and provide feedback to the OGC about the implications to industry.

The OGC screening officer conducting the test would be asked to document any issues or proposed changes to the screening process based on its practical application (see below for the discussion under 'Refinement'). It is recommended that a minimum of two approved applications be 're-screened' in this way. A six-month test period is recommended, which would coincide with the test period for the screening of routine applications outside candidate threshold areas.

Refinement

As discussed in Section 4, the concept of a CEAMF relies heavily on the principles of adaptive management. That is, to effectively assess and manage cumulative effects at a regional scale, it is necessary to continually learn from what is being done, update what is known, and adjust practices where necessary. Like the CEAMF as a whole, the application screening process is subject to the same principles. Refinement of ACES would occur at two stages: initially following the pilot implementation period and before formal adoption of the process; and later following one-year of full implementation. The latter stage would involve an independent review of the process, and refinements based on the results of the review.

The review would consider topics such as:

- practical use (e.g., ease of use, clarity of process);
- sufficiency of information available to complete the screening;
- time required to complete different types of screenings;
- appropriateness of thresholds and practical use of thresholds (by proponents and OGC staff);

- reactions of OGC staff , referral agencies and proponents; and
- summary of screening outcomes for routine and advanced applications.

Once pilot implementation, review, and refinement have been completed, the changes to the screening process would be formalized and officially adopted, and any changes from the existing process would need to be clearly communicated to affected parties.

It is also at this stage where the OGC should consider the applicability of the changes to their application review process outside of northeast BC. The proposed screening process has been designed to be readily adaptable to all application types throughout the OGC's areas of jurisdiction[1]; however, as presented here, the northeast BC process makes specific reference to information, data, and components of the proposed CEAMF that would not yet be in place or available elsewhere in the province.

Electronic Information Support System

In recognition of the need for the OGC to rapidly build its internal capability to meet increasing workload and rising expectations for environmental review, the cumulative effects screening process is designed to be implemented in a relatively short-timeframe, with existing resources and making use of the already considerable body of available knowledge and information. However, following an appropriate test and refinement period, OGC staff would benefit from the future design and implementation of an electronic information support system (EISS) that:

- maintains a database of each application processed;
- automatically assigns record numbers when new applications are received and entered to assist with application tracking and archiving information linked to a specific application;
- contains computer-based checklists for routine and advance screenings, including an audit record and decision record;
- references or provides direct links to information sources or spatial databases;
- references or provides direct links to information on assessment tools (e.g., Oil and Gas Project Assessment Matrices);
- provides mapping capability so the proposed project could be mapped in relation to environmental features and other projects in the vicinity (this would require that maps or data themes be readily available and in a compatible format);
- calculates a proposed project's contribution to a threshold;
- identifies and provides information on appropriate effects management measures based on type of project, location, threshold status or other criteria;
- identifies appropriate referrals based on type of project, location, threshold status or other criteria; and
- generates and prints screening reports (and accompanying back-up information) for forwarding to referral agencies or, if a screening is complete, for final approval as necessary by an OGC manager.

[1] Some modifications may be necessary to adapt the screener to offshore areas.

Training

OGC staff involved in application review should receive training to best understand how to effectively implement the proposed modifications to their application review process. A half- to one-day training session is proposed, which would cover the following topics:

- introduction to concepts and elements of the CEAMF;
- overview of key cumulative effects issues in northeast BC with specific reference to oil and gas related activities;
- overview of proposed changes to the OGC application screening process;
- overview of requirements of OGC staff (e.g., information, time);
- detailed description of the steps in the routine screening process: conformance, thresholds, effects assessment, effects management, monitoring; and decision;
- overview of the advanced screening process and the role of OGC staff in guiding the proponent through the process;
- discussion and questions; and
- implementation (i.e., 'how to get started').

Appendix H: Oversize Maps

Table H-1. List of Baseline and Hot Spot Maps

Figure Title		Fig. #
Component	**Description**[1]	
Land and Resource Use	Generalized Land Use	3-1
	Residential Settlement and Transportation	3-2
	Pipelines and Wellpads	3-3
	Seismic Line Density	3-4
	Protected Areas	3-5
	LRMPs Overlapping Study Area	3-6
	Fort Nelson LRMP	3-7
	Fort St. John LRMP	3-8
	MacKenzie LRMP	3-9
Air Quality	Well Density	3-10
	Hot spots (Sulphur Emissions)	3-11
Soils and Terrain	Soils Classification	3-12
	Soil Hot spots (Acid Sensitivity)	3-13
	Soil Hot spots (Erosion Risk)	3-14
Aquatic Ecosystems	Arctic Grayling and Bull Trout Observations	3-15
	Hot spots (Drainages)	3-16
Vegetation	Biogeoclimatic Zones	3-17
	Sensitive Features	3-18
	Hot spots (Sensitive Features)	3-19
Wildlife	Grizzly Bear Habitat Capability	3-20
	Moose Habitat Capability	3-21
	Marten Habitat Capability	3-22
	Warbler Habitat Capability	3-23
	Caribou Winter Habitat	3-24
	Grizzly Bear Hot spots (Habitat Capability)	3-25
	Moose Hot spots (Habitat Capability)	3-26
	Marten Hot spots (Habitat Capability)	3-27
	Warbler Hot spots (Habitat Capability)	3-28
	Caribou Hot spots (Winter Habitat)	3-29
Disturbance	Disturbance Coverage	E-1

[1] Shaded cells indicate hot spot maps; remaining cells are baseline maps.