Identifying Research Priorities to Refine the West Kitikmeot Slave Study Research Framework: Final Report

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ITEM 1: INTRODUCTION

1.1 BACKGROUND

Over the past two years, the West Kitikmeot/Slave Region has experienced a substantial increase in mineral exploration and pre-development activity. Many regional residents and government and environmental agencies are concerned about the pace and scale at which development is occurring in the region, and the implications that this will have on renewable resources and the cultural/social values held by aboriginal groups and regional communities. In recognition of this, the West Kitikmeot Slave Study (WKSS) was initiated to collect and provide information to assist informed decision making, and to facilitate sustainable development. To this end, one of the objectives of the WKSS is to provide a basis for the identification and assessment of cumulative effects for planning and development purposes.

Considerable information is required to thoroughly address the issue of cumulative effects. However, the WKSS Partners have identified, through other reports (e.g. Cizek *et al.*, 1995), workshops and meetings, important gaps in the information and data available for the region. There is now a need to establish a more solid direction for the five year term of the Study, in terms of specific priority research questions and sequencing of research. A research framework is required to identify the most important information related to cumulative effects assessment, and prioritize these research needs.

1.2 WORKSHOP APPROACH

To assess research needs in relation to development within the WKSS region, it is important to design a research framework that provides information that is appropriate to the values of the stakeholders. Since some research and project-specific assessments have already been completed in the area, it is important to identify what information currently exists, what information deficiencies still need to be addressed, and how research funded through the

WKSS can address these gaps in a manner that is useful to environmental assessments.

A two-day workshop was held on November 5th and 6th, 1996 to assist in refining the research framework to accomplish these goals in a way that is logical, practical and easily understood. The process for refining the research framework included the following tasks:

1. Determine the valued environmental components (VECs) and valued socioeconomic components (VSCs) for the study area, and the related issues that have been raised by the WKSS Partners;
2. With the assistance of development scenarios, such as those prepared by Bernard *et al.* (1995), identify the likely development activities associated with existing and future approved projects;
3. Identify potential interactions between these specific development activities in the region and the VECs and (VSCs). For the WKSS research framework, a tool known as interaction matrices helped to identify these interactions. Impact hypotheses, such as those provided in Bernard *et al.* (1995), helped to form these matrices;
4. In order to narrow the list, these interactions were ranked using a specific set of criteria to identify those interactions that are likely to have a significant effect on a VEC or VSC;
5. Identify what information is needed to assess the interactions between development activities and VECs/VSCs which are ranked highly;
6. Determine the important questions to be addressed by WKSS-funded research by comparing these information needs to the information available for the study region; and,
7. Prioritize and determine a sequence for the WKSS to address these important research questions.

1.3 WORKSHOP AGENDA

WKSS Research Framework Workshop

Trappers Lake Spirituality Centre

Tuesday, November 5th

9:00AM	Opening Prayer	
	Welcome, Introductions	John
	Workshop Agenda, Objectives	Hal
9:20AM	Research Framework Presentation	GeoNorth/Axys
9:50AM	Valued Environmental/Socioeconomic Components	GeoNorth
10:15AM	Coffee Break	
10:30AM	Identification of Project Activities / Interaction Matrices	Axys
11:15AM	Pressures and Effects	Axys
12:00PM	Lunch	
1:00PM	Pressures and Effects • environmental • socioeconomic	Working Groups
2:45PM	Coffee Break	
3:00PM	Report of Working Groups	Working Groups
4:00PM	Wrap-up and Closing Remarks	Hal/Jeff

Wednesday, November 6th

9:00AM	Consensus Building	Hal
10:15AM	Coffee Break	
10:30AM	Information Gaps, Research Needs	Alex

	• environmental	
	• socioeconomic	
11:00AM	Discussion on Research Needs	All
12:00AM	Lunch	
1:00PM	Prioritizing Research Needs	Jeff
	• environmental	
	• socioeconomic	
2:45PM	Coffee Break	
3:00PM	Completing the Research Framework	All

ITEM 2: VALUED ENVIRONMENTAL AND SOCIOECONOMIC COMPONENTS

2.1 VALUED ENVIRONMENTAL COMPONENTS

Since 1983, the concept of valued environmental component (VEC) has provided a focus for environmental impact assessment, cumulative effects, and monitoring in Canada. The concept is based on taking an ecological perspective to impact assessment, both in terms of prediction and monitoring, by recognizing VECs as the focus for the assessment. This same ecological perspective is consistent with aboriginal values which generally take a holistic approach to the environment and to impact assessment. For example, these values seem to have provided a basis for the provisions of Article 12: Development Impact of the Nunavut Final Agreement.

A VEC is a resource or an environmental feature which is determined to have special legal, scientific, cultural, economic, or aesthetic value, according to certain criteria. Criteria used to determine the value of an ecosystem component can be purely objective and scientific, or they can be subjective and based upon community values.

2.2 VALUED SOCIOECONOMIC COMPONENTS

The initial concept of VECs stressed ecological considerations, with very little attention given to socioeconomic considerations. Since then increasing attention has been given to socioeconomic considerations, both in the federal EARP guidelines and in the recent Canadian Environmental Assessment Act. CEAA also introduces the need to address cumulative effects of socioeconomic impacts. The objectives stated in the WKSS Partners' Accord include a focus on cumulative effects of socioeconomic impacts on communities. In most instances this means "off-site" impacts in the communities. Various words have been used to refer to them, but in this report we refer to them as Valued Socioeconomic Components or VSCs.

A VSC is a cultural, social or economic aspect of the environment which, if affected by development, would be of concern to regional residents and/or government regulators. Some of the considerations for VSCs in the West Kitikmeot / Slave Study area are:

- community values;
- provisions of the Impact and Benefit Agreements and the Socioeconomic Agreement for the BHP's NWT Diamonds Project;
- cultural impacts on lifestyles and ways of life;
- community health risks;
- the distribution of community benefits/disbenefits;
- cumulative socioeconomic impacts of multiple projects and activities;
- community social adjustments to a wage-base economy;
- training for job skills and life skills;
- archaeological impacts; and,
- impacts on ecotourism or other sustainable development opportunities.

The approach to selecting VSCs should be consistent with the approach for selecting VECs. It basically consists of community value setting, the recognition that there is a range of issues which result in multiple (sometimes conflicting) objectives, and participatory decision making. It requires agreement on the guiding questions that need to be answered, and the stressors or indicators that will be used to research and monitor them.

2.3 USING VECS AND VSCS IN IMPACT ASSESSMENT

The idea is to select, in advance of a project or an impact assessment, parts of an ecosystem which are most highly valued, and which can provide a focus for impact studies and monitoring programs. Examples of types of subjective criteria that may be used to select VECs or VSCs are:

- Relative abundance of wildlife
- Critical habitats
- Community concerns (harvesting areas, sacred places, etc.)
- Scientific concerns
- Economic importance
- Legal status

The advantage using the VEC/VSC approach in impact assessment investigations is that if focuses the assessment on parts of the ecosystem that are considered to be most important in decisions regarding project approval. It requires that the basis of selection of VECs and VSCs be explicitly stated and documented, so they can be subject to scrutiny and validation.

The real challenge is to find measurable indicators for the VEC/VSC that can be used in developing and analyzing impact hypotheses and in monitoring. To determine the accuracy of impact hypotheses, and to monitor impacts and cumulative effects, it is necessary to be capable of measuring change between baseline (or pre-project) conditions and future conditions. A recent study of transboundary rivers systems within the Mackenzie River Basin provides some examples of attempts to identify measurable "ecosystem maintenance indicators." Examples that may be useful as measurable indicators for the West Kitikmeot / Slave Study are:

- The number of caribou using a specific caribou crossing, calving ground, or winter range
- The number of caribou in a herd (or sub-population of a herd)
- HTO indication of decline in caribou abundance
- The level of contaminants in seal/fish/caribou livers
- Arctic Char adult migrants in a stream
- Arctic Char catch per unit of effort
- The level of contaminants in lichens

2.4 VECS AND VSCS IN IMPACT ASSESSMENT GUIDELINES FOR THE STUDY AREA

The two most recent examples of environmental assessment guidelines for project proposals within the study area are the 1995 guidelines prepared for the proposed *BHP Diamonds Project*, and the 1993 guidelines prepared for the proposed *Izok Project.* It is instructive to review how valued ecosystem components were considered in these guidelines.

BHP Diamonds Project

Guidelines for the BHP Diamonds Project were issued by the FEARO Panel based upon over 50 written submissions and 125 verbal presentations during the scoping phase of the review. Section 4.1: Study Strategy and Methodology states that:

> "The proponent should explain and justify methods used to predict impacts of the Project on the valued components of the physical, biological and socio-economic components and on the interactions among these components….The value of a component not only relates to its role in the ecosystem, but also to the value placed on it by humans. The culture and lifestyles of the people using the area affected by the Project are themselves considered valued components."

The Guidelines require the Proponent to demonstrate an understanding of and respect for existing environments, with emphasis to be placed on components that are likely to be affected by the Project and on those identified as issues of public concern during the scoping sessions.

In Volume II, Environmental Setting of the BHP Environmental Impact Statement (EIS), the valued components that are defined in the scoping exercise, are categorized in terms of public concern, professional concern and/or cultural/economic concern. The components that fall into these categories are:

- VECs:
  Aquatic habitat, caribou, eskers, fish, wildlife and wildlife habitat, biodiversity, grizzly bears, wilderness, vegetation, water quality, air quality, climate, groundwater, permafrost and eskers.

- VSCs:
  Community stability/immigration, economic development, employment/training, families, historical sites/burial grounds, human health, traditional knowledge, traditional lifestyle, territorial lands, benefit sharing/partnership, wage economy, culture, outfitters and, land use and stewardship.

Izok Project

Guidelines for the Izok Project were prepared by the Regional Environmental Review Committee chaired by DIAND and including representation from federal and territorial departments, aboriginal organizations, and environmental organizations. Section 3.2: Biophysical Environment states that:

> "The valued ecosystem approach shall be taken in describing the biophysical environment, keeping in mind that the value of a component not only relates to the role of a component in the ecosystem, but also to the value placed on the component by the local, regional and national communities. The cultures and lifestyles of the people using the areas are considered to be valued ecosystem components."

Nevertheless, as can be seen from the valued components identified in the following description, VSCs were a relatively minor consideration in this assessment.

In the *Izok Project* Guidelines, the VECs have been assessed in terms of the potential interaction between a project activity and the effect on the valued resource, whether locally perceived or not. The Guidelines take into consideration the fact that a change in an ecosystem component that is not perceived locally as a VEC can potentially lead to the change in habitat or species abundance of a locally perceived VEC. The potential interaction could eventually lead to a change in lifestyle, as well as health and safety of the community. It is for this reason that in Section 5.1.4., the effects of the potential interactions are ranked according to the following three criteria:

1) A change in carrying capacity of the environment, animals or resource harvest
2) Regional and local significance
3) Lasting effects on the environment

In Section 5.2., specific *Izok Project* activities are highlighted for their potential impacts on the VECs. The Guidelines target potential interactions that result from the activities in the mine area, the winter road, marine port and shipping activities. The following list is a breakdown of the important issues identified by the stakeholders for each project activity:

A) Mine Area: Acid mine drainage was considered the most important impact for its effects on the geomorphology, permafrost and aquatic system in the area. Other potential interactions of the mining site are; the attraction of wildlife, especially bears; sewage management and its effects on the aquatic environment; and effects of hazardous material spills on the terrestrial and aquatic ecosystem.

- VECs:
  sediments, aquatic lower trophic levels, fish, vegetation, waterbirds, raptors, small mammals, wolves/wolverines, grizzly bears, caribou, muskoxen, air quality, geomorphology, permafrost, hydrology and water quality.

- VSCs:
  hunting and fishing

B) Winter Road: The interactions that were identified in the construction and use of the winter road were a possible increase in erosion, effects on the aquatic system and wildlife denning at borrow sites. Road access would be monitored for disturbance of breeding raptors and migrating caribou. Other concerns that were highlighted related to spill prevention and response on the winter road, as well as increased access to local resources by hunters.

- VECs/VSCs:

  all of those for the mine area, plus grouse and small mammals.

C) Port Site Area: The interactions highlighted were the handling of materials and the effects on marine and freshwater systems, the handling of camp garbage and sewage, as well as the impacts on fishing and hunting.

- VECs/VSCs:

all of those for the mine area, plus ice and oceanography, arctic fox, and polar bears.

D) Shipping: The interactions of marine shipping on VECs were identified as:

- effects of potential discharge from ships, including garbage, waste water and exhaust fumes;
- effects of routine shipping operations, including the ship's noise and icebreaking operations;
- effects of accidental spills, including fuel and concentrate; and
- related effects on local resource harvesting and over-ice travel.

- VECs:
  swans, geese, diving ducks, dabbling ducks, shorebirds, Alcids, Terns, Gulls, seals, walrus, Narwhal, Bowhead whale and ice edge communities, integrity of the ice sheet (premature breakup, lead formation, lead refreezing) and polynyas.

- VSCs:
  Whale and seal hunting, and on-ice travel

2.5 VECS/VSCS IDENTIFIED BY WKSS PARTNERS

During the "Transition Working Group" stage leading up to establishment of the WKSS, at previous workshops, and in forums outside the WKSS, the Partners have identified concerns about ecosystem components which they particularly value. In some cases these concerns have not been sufficiently focused, but in many cases they are more specific, they are related to issues, and they are good examples of VECs/VSCs. In both instances, the concerns articulated assisted in the identification of specific VECs/VSCs for the present study. They are as follows:

VECs:

Wildlife and Habitat

- caribou: impact of mining activities on the health of the Bathurst herd (e.g. do caribou drink from tailings ponds and, if so, does this affect their health?); disruption to migration from road traffic; avoidance behaviour of caribou around mine infrastructure; calving ground location and factors affecting use; impacts of fire.

- habitat: important habitats for particular species for activities such as feeding, reproducing, denning (e.g. eskers as habitat for grizzly bear and wolf dens, travel routes for caribou).
- grizzly bears: sustainable population levels; disturbance and mortality due to industrial activity.
- fish: contamination from decline in water quality or mortality due to change in water level.
- waterfowl
- land and wildlife conservation and protection: protection of biodiversity, wilderness.

Physical

- water quality and quantity: effects of contaminants and changing water levels on the health of animals and people, as well as ecosystem health, and concern of the potential impacts of mines on this resources.

VSCs:

- cultural and heritage sites: location and nature of sites and concern over the loss of these sites due to development.
- socio-economic and cultural conditions in communities: particularly community wellness; maintenance of traditional economy and lifestyle.
- employment and training opportunities: those currently in place, as well as potential for improvement resulting from increased industrial activity
- harvestable species (especially grizzly bear, wolves, wolverine): potential impacts of development on these species.

2.6 VECS/VSCS IDENTIFIED FROM REGIONAL LITERATURE

A review of a other regional literature, such as documents related to the BHP Diamonds Project Environmental Review Panel and documents prepared for WKSS, revealed a few other issues of importance to regional residents.

VECs

- permafrost: as it affects engineering, ground stability
- air quality: particularly dust from roads and blasting
- vegetation

VSCs

- participation of Northerners in industry
- opportunities for northern businesses
- family
- cultural integrity

ITEM 3: APPROACH TO REFINING THE WKSS RESEARCH FRAMEWORK

Appendix A reviews CEA methodologies for assessing cumulative effects of developments within the WKSS region. This review suggested the approach used in this project to identify and prioritize research needs for the WKSS. To follow is a description of the approach selected.

3.1 SELECTION OF VECS/VSCS

Based on our review of regional literature sources, environmental impact assessment documents prepared for the BHP Diamonds Project and Izok Lake Project, and key concerns expressed by WKSS Partners related to cumulative effects in the WKSS region (see item 2 of this report), the following lists of Valued Environmental Components (VECs) and Valued Social Components (VSCs) were prepared. For many of the environmental and social components of the region, specific species or attributes have been identified (e.g., caribou for terrestrial wildlife).

Valued Environmental Components

Environmental Components	**VECs**
Air Systems	local and regional air quality (as measured by CO2, SO2, Nox, acidic deposition on vegetation and in waterbodies), global warming
Landforms/Terrain	permafrost, eskers
Ground Water	water quality, water quantity
Surface Water	water quality, water quantity
Soils	
Aquatic Habitat	
Terrestrial Vegetation	
Fish	grayling, lake trout, arctic char
Terrestrial Wildlife	grizzly bear, caribou, muskoxen, wolves
Small Mammals	
Waterfowl	
Raptors	

Valued Social Components

Social Components	**VSCs**
Aboriginal Land Use	cultural and spiritual activities
Aboriginal Resource Use	trapping, hunting, plant collecting, fishing
Commercial Land Use	outfitting, tourism, oil/gas operations, mining
Cultural / Historic Sites	
Human Health	

The VSC list is limited to those components for which there is a direct link between an activity and the impact on the component, as discussed in Appendix A. There has been very little work done to develop impact hypotheses for other social and economic components for which the impact may be indirect (e.g. impacts of new employment opportunities on social conditions in the community).

However, perhaps a more appropriate technique for these social and economic components is to choose indicators which provide information about the component. For instance, hiring associated with a development activity may affect a community (through an increase in average income) and result in fewer number of people per household, as more people can afford to obtain their own housing. This approach has been used in the BHP Socio-Economic Agreement; in order to monitor changes to community well-being resulting from the mine, particular indicators have been chosen (Appendix D).

3.2 DEVELOPMENT TYPES AND PROJECT ACTIVITIES

A number of types of developments currently exist or are anticipated in the WKSS Region over the next 15 years. These include:

- mineral exploration camps
- mine developments
- all-weather roads

- winter roads
- community developments
- tourism
- hydroelectric developments
- transmission line developments
- outfitting camps

Associated with each of these developments are a number of specific activities that could potentially have an effect on the biophysical and socio-economic environments of the region. These are listed on the matrix tables. Identification of each activity was based largely on development scenarios and generic footprints developed by Bernard *et al.* (1995).

3.3 IDENTIFICATION AND RANKING OF INTERACTIONS BETWEEN PROJECT ACTIVITIES AND VECS/VSCS

Based on a review of the following documents and professional judgement, potential interactions between specific development activities and the VECs/VSCs were identified.

- generic footprints developed by Bernard *et al.* (1995)
- impact hypotheses developed by Bernard *et al.* (1995)
- impact hypotheses developed for the IZOK Mine EIA

Each potential interaction between a specific development activity and VEC/VSC was recorded on a series of interaction matrices for each type of development indicated above (Appendix E). As a means of identifying those interactions that are likely to be most significant, each interaction was then ranked based on a preliminary consideration of the extent, magnitude and duration of the potential impact.

Extent: the area that may be affected by the development activity, defined as local, regional, provincial or national

Duration: the period of time that is required for an environmental/social component to recover from an impact, rated as short (less than 1 year), moderate (1-10 years), and long term (10 years or more)

Magnitude: the portion of the resource that may be affected by a development activity, rated as less than 10 percent, or 10 percent or more.

Potential interactions were ranked on a scale of 1 to 5, where a ranking of one indicates that an interaction of minor consequence is reasonably expected to occur between the environmental/social component and the development activity. A ranking of 5 is considered to represent a very important interaction.

Duration (years)	**Magnitude**	**Extent**			
		Local	**Regional**	**Provincial**	**National**
<1	<10 %	1	2	2	3
<1	>10 %	2	3	3	4
1-10	<10 %	2	3	3	4
1-10	>10 %	3	4	4	5
>10	<10 %	3	4	5	5
>10	>10 %	4	5	5	5

All interactions with rankings of 3 or greater (moderately important potential interaction) were considered to deserve further attention in terms of:

1. the information required to address the potential interaction;
2. important information deficiencies that might hamper assessment of the interaction; and
3. research needs to address the identified information gap.

Interactions that received a ranking of 3 or greater are highlighted within the interaction matrices (i.e., shading) to assist in their identification.

These ratings reflect only the potential importance of the interactions between development activities and environmental/social components, and are not intended to indicate an assessment of the significance of any potential impacts.

3.4 PRESSURES AND EFFECTS

A “master list” of these pressures and effects associated with all development activities was developed. This pressure-effect list attempts to summarise the major pressures exerted by the various development activities, as well as the effects of these pressures.

At the workshop, this "master list" was used to guide a discussion on cumulative impacts. A particular pressure - effect relationship may become considerably more important when it is considered that there may be several related pressures being exerted on the environment, either over a particular space or time period. The level of importance (i.e., high, medium, or low) was assigned to each pressure - effect relationships to focus further discussion regarding research needs.

ITEM 4: INFORMATION GAPS

During the establishment of the WKSS, many of the Partners shared their thoughts on important information gaps in the study area through workshops, meetings and correspondence with the study office. Throughout the environmental assessment of the BHP Diamonds Project several intervenors, including some WKSS Partners, provided submissions highlighting other information which was required for the assessment, but not available for the region.

There are also other documents that review available information for the region, and in some cases these identify information gaps. Of particular note is the report by Cizek *et. al.* (1995), which reviewed existing information to assist the WKSS in focusing on information gaps in the region.

For this project, about 30 documents were reviewed to generate a list of information gaps for the region. An attempt was made to extract from the literature not only the topic for which there is a deficiency of information, but also the specific questions which still need to be addressed. All Partners were provided the opportunity to review the first draft of this list to ensure it was complete. The final draft of this list in provided in Appendix F .

The process described in the section 3 assisted the Partners in the identification of those the interactions likely to have a significant effect on a VEC or VSC and to form questions that need to be addressed in order to assess these interactions. The remaining step involved ensuring that the questions to be asked by the WKSS have not already been answered (i.e., data is not already available). The results from the analysis described in the section 3, when compared with this list of information gaps, allowed the Partners to match research needs with the topics and specific questions which need more information before such an assessment could be completed.

ITEM 5: FOCUSING ON SPECIFIC RESEARCH QUESTIONS

5.1 THE NEED TO PRIORITIZE

The process for developing a research framework for the WKSS has, to this point, enabled the identification of research questions focusing on areas where there is not enough information on particular issues which are important in terms of their value to the Partners, and in contributing towards assessing cumulative effects in the WKSS region. Due to the limited time and resources afforded the WKSS, prioritization of research needs funded by WKSS was necessary.

5.2 RECOMMENDED APPROACH

Our team recommended the WKSS develop a set of questions to guide research, as the most appropriate method for forming the WKSS research framework. This approach was used and proven effective by the Northern River Basins Study.

In addition, the Partners had the tools required to formulate these questions: the key ecosystem components (VECs/VSCs); the activities likely to occur in the region; the impact these activities may have on the VECs/VSCs; the most significant of these VEC/VSC - activity interactions; and, the information deficiencies related to these interactions.

Identification of priority research needs was accomplished by ranking the most important interactions between the development activities and VSCs/VECs, through the use of interaction matrices. This assisted in identifying those interactions of greatest importance and for which there is insufficient information to adequately assess the significance of the impact. From this, the Partners developed specific research questions to provide the information needed to assess this impact. The workshop and a follow-up meeting provided an opportunity for all Partners to provide input and participate in the development of these questions.

ITEM 6: PROJECT RESULTS

6.1 RESEARCH FRAMEWORK WORKSHOP AT TRAPPERS LAKE

A two day workshop was held November 5th and 6th at Trappers Lake Spirituality Centre, near Yellowknife, to prioritize elements of the WKSS research framework and develop research questions(see section 1.3 for the workshop agenda). The facilitators from GeoNorth and Axys spent the first morning reviewing some of the process and work that had gone into preparing for the workshop, and obtaining consensus from the Partners and the WKSS staff on the direction the project team had taken.

Pressures and Effects:

In two working groups, the participants focused on a preliminary "master list" of pressures and effects that was developed by the project team. Both groups generally agreed with what the team had prepared, however, some amendments and additions were made (see Appendix G for the final pressures - effects list).

Prioritizing:

Workshop participants undertook the difficult task of prioritizing the effects and designating key areas for research. The project team presented the revised list of pressures - effects, as well as some potential criteria that the participants could use to assist in setting research priorities. These criteria were: timing of the activity; geographic scope; magnitude; duration; frequency; and, risk. The participants added a "level of public concern" criteria and a column for overall of priority of the effect.

After breaking into two working groups, one on socio-economic effects and one on environmental effects, the participants rated each of the effects as high, medium or low against each of the criteria. The participants also spent some time defining the groups responsible for taking actions on each of the effects. This assisted in identifying the high priority effects which are considered important for the WKSS to study and those which could be dealt with by other groups (see Appendix H). The following table summarises the effects considered as high priority and for which WKSS has at least a partial responsibility to study:

Environmental Effects:	Socio - economic Effects:
Alteration of Surface Drainage	Contaminants in the Food Chain
Loss of Eskers	Changes in Human Health
Direct Loss of Wildlife Habitat	Decreased water quality
Habitat Alienation/Sensory Disturbance	Changes in Harvesting
Disruption of Wildlife Movements	Changes in Land Use/Hunting Routes
Habitat Fragmentation/Connectivity	Economic Opportunities
Increased Wildlife Mortality	Increased Economic Variability
Change in Water Quality	Altered Communication/Education

Research Needs:

The next step for the working groups was to attempt to provide some details on research to be done to address the high priority effects. Although considerable progress was made in developing areas on which WKSS research should focus, the time available did not allow either group to develop any definitive research questions for the WKSS. In the following plenary session, the importance of considering the Partner's values in determining research questions was discussed and each Partner had a chance to outline their priorities. It was decided that the project team would work on developing a draft set of questions for the WKSS Partners to review at a later date.

6.2 WORKSHOP FOLLOW-UP

Following the workshop, the project team examined the results of the workshop prioritization exercise (Appendix H), research priorities developed during the working groups, the Partners' research priorities, and the information gaps (Appendix F). From this information, a set of draft research questions for the WKSS was formulated. The team also evaluated current WKSS - funded research projects, as well as research proposals received, but not yet reviewed, by the WKSS (see the workshop report).

Research Questions:

It was decided to hold a follow-up, one day meeting on January 8th, 1997, with the WKSS Partners and staff to complete the task of formulating research questions. The group began with a round table providing some general direction on the nature of the questions. Generally, the group felt the questions needed to:

- be as specific as possible;
- address baseline information needs;
- avoid duplication between questions; and
- link all questions to the impacts of development.

Following this, the group worked through the questions, suggesting improvements to wording, indicating support for questions, combining questions and, in some instances, attaching a level of priority to questions. After the meeting, the draft research questions were edited, according to the group's direction, and a final set of research questions was prepared. These are shown in the following tables:

RESEARCH QUESTIONS	**WKSS PRIORITY**	**PARTNERS' PRIORITIES**
SOCIO-ECONOMIC RESEARCH		
A. Traditional Economy:		

1. What is the baseline information about the nature of the traditional economy for the region, specifically: a) Using conventional and traditional knowledge, what are the existing patterns for each community of: i) natural resource use? ii) harvesting patterns, particularly for caribou? b) Using conventional and traditional knowledge, what is the value of the traditional economy: i) in terms of dollars? ii) in terms of the subsistence value (local consumption, cultural well-being)?	High High	Chamber of Mines Metis Nation - NWT Nunavut Co-mgmt. Federal Govt. NEC (TK)

B. Social and Economic Benefits / Dis-benefits		
2. What are the social and economic benefits and dis-benefits of development to communities?	High	Dogrib
a) Social Benefits / Dis-benefits: i) Which indicators are the most appropriate for monitoring changes in social wellness? ii) What is the baseline information concerning social wellness for each community, using community based indicators? In particular, what is the baseline information concerning family related issues (e.g., violence), substance abuse, services and infrastructure, and economic disparity between and within communities? iii) What is the traditional knowledge about social wellness? iv) What are the socio-economic and human health trends and effects of development, using community based and environmental indicators?	Low	Lutselk'e, Fed. Govt., NEC
b) Economic Benefits / Dis-benefits: i) What is the baseline information concerning economic conditions for each community, using community based indicators? ii) What is the indigenous knowledge about community economic conditions? iii) What is the indigenous knowledge about the socio-economic and human health effects of non-traditional economic development?	Low	Federal Govt., NEC, Metis Nation - NWT

PHYSICAL AND ENVIRONMENTAL RESEARCH		
C. Water Quality:		
3. What is the baseline water quality for the region, specifically: a) What are the key parameters for water quality from a perspective of: i) socio-economic / human health ii) ecological health b) What are the baseline conditions with respect to these parameters? c) Where should these parameters be measured? d) What is the distribution, cause and magnitude of poor water quality with respect to key parameters e) Where should poor water quality be measured? f) What is the traditional knowledge about water quality?	High High High High High High	Lutselk'e Dogrib Nunavut Co-Mgmt Federal Govt. NEC (TK)
4. What are the effects of contamination on the cultural, spiritual, and emotional health of people?	Low	

D. Surface Drainage:		
5. What are the regional patterns and variations in surface water flow: a) from a scientific perspective? b) from a traditional knowledge perspective?	Low	Federal Govt., Lutselk'e, NEC (TK)

E. Baseline Habitat and Land Use:		
6. What is the baseline information about habitat for the region, specifically: a) what is the distribution of: i) soil types? ii) terrain types, especially eskers? iii) vegetation communities? b) how are these habitats used by key species such as humans, grizzly bear, caribou, wolves, and moose? c) How does this use vary seasonally? d) For these key species, what are the: i) most significant habitats? ii) critical areas? iii) migration routes?	High High High High	Lutselk'e Dogrib GNWT Federal Govt. NEC (TK)
7. What is the traditional knowledge about habitat, specifically: a) the distribution of: i) soil types? ii) terrain types, especially eskers? iii) vegetation communities? b) how are these habitats used by key species such as humans, grizzly bear, caribou, wolves and moose? c) how this use vary seasonally? d) For these key species, what are the: i) most significant habitats? ii) critical areas? iii) migration routes?	High High High High	
8. What is the distribution of human facilities in the region, such as: • mines • camps • cabins • trails • communities • seasonal roads • other infrastructure?	Low	Federal Govt.
9. What is the traditional knowledge about land use, including the location of: • cabins • trails • cultural, heritage and sacred sites?	Low	

F. Habitat Loss / Fragmentation / Alienation:		
10. How are human facilities and infrastructure likely to impact: a) key species, such as grizzly bear, caribou, and moose, in a way that is detrimental to the ecosystem and / or human well-being? b) endangered or threatened species? **11. What is the indigenous knowledge about the responses and behaviour and the extent of habitat loss around human facilities to:** a) key species, such as grizzly bear, caribou, and moose, in a way that is detrimental to the ecosystem and / or human well-being? b) endangered or threatened species?	Low Low	Lutselk'e Dogrib Federal Govt.
12. What mitigation methods are effective in minimizing the effects of human facilities on the movements and behaviour of wildlife, particularly caribou? **13. What is the indigenous knowledge about mitigation methods which are effective in minimizing the effects of human facilities on the movements and behaviour of wildlife, particularly caribou?**	Low Low	Dogrib

G. Wildlife Mortality:		
14. What is the magnitude and distribution of mortality to caribou, grizzly bear and waterfowl from human causes, including recreational and subsistence hunting, vehicle-wildlife collision and killing of "nuisance" animals?	Low	

Note:
Other issues re: communication and education were raised as potential areas for WKSS research:

- What are effective, meaningful communication methods and consultation, including community based indicators which reflect the meaning and value of communication and consultation?,
- What is the traditional knowledge about effective communication and consultation?, and
- What are the most effective strategies to inform communities on the outcome of

WKSS research projects?

While these questions do not contribute directly to WKSS' goal to collect information to assist informed decision making, they do address WKSS' ability to provide that information. They are important issues and need to be considered as things WKSS needs to do, apart from the questions listed above. Some of these issues are already being addressed by the WKSS Communications Strategy.

Funding:

During the follow-up meeting, the WKSS Partners and staff discussed the issue of establishing funding envelopes for the major categories of questions. The purpose of setting these envelopes is to ensure that the key research areas are funded in a balanced way, so that one area of research does not get funded at the expense of another research area.

The group focused on answering three major questions:

1. Is it preferable to allocate all research money to research areas, or to withhold a reserve amount?

2. How should the WKSS categorize research areas in order to allocate funds?

3. How should the WKSS determine the amount to allocate to each category?

The Partners approved of the flexibility involved in withholding a reserve from the funding allocation, although no decisions were made as to the dollar amount of such a reserve.

The Partners felt that envelopes should be set based on both research area and type of research, so that a two by two matrix is formed.

	Traditional Knowledge	Scientific	**Total**
Socio-Economic	*x*	*x*	

Physical-Environmental	*x*	*x*	
Total			***100***

Although some options for levels of funding for each category were discussed at the meeting, the Partners felt further discussions were warranted. It was suggested, however, that funding allocations should be considered as targets to be met over the life of the study, not necessarily from year to year.

ITEM 7: NEXT STEPS FOR THE WKSS

The formulation of questions to guide WKSS research activities is a large step forward and will allow other study design tasks to proceed. The development of a research workplan for the WKSS requires determining the existing information on the research questions, consideration of the sequencing of research, funding levels for each of the areas of research, and procedures for updating the workplan. By developing a workplan with these elements, the WKSS can assist the committees reviewing research project proposals and progress by providing them with direction on these issues.

Existing Information on Research Questions:

With precise research questions now established, WKSS should review the body of existing information to determine whether or not the research questions have already been adequately answered. This will ensure WKSS does not duplicate efforts made by other researchers or organizations, and will contribute to cost-effectiveness.

Sequencing of Research:

A crucial part of the development of the workplan is recognising that it may be more appropriate to begin answering some questions before others. Some considerations to be made in this process are:

- Will linking related research projects assist the study in achieving cost-effectiveness?
- Do some questions have to be answered in order to better define other questions?
- Will some projects require several years to achieve useful results?

Funding levels:

Resources for the study are limited, and expenses for one large research project can quickly cut funding available for other projects. The Partners have recognised this and are proceeding towards establishing funding envelopes (see section 6.2) for research categories. In developing a workplan, the Partners may wish to discuss setting these funding envelopes as targets for the life of the study, as well as how and when to evaluate if these targets are being achieved.

Updating the Workplan:

The workplan should be able to adapt to new ideas, issues and knowledge brought to the table by the WKSS Partners or through the results of research projects. For instance, it may be best to terminate a study if review of the results indicate that the predicted influence of an activity is not significant.

The Partners should decide on a process to ensure the workplan is flexible and able to adapt to these changes in information. This will likely include a regular review and update of the workplan, to estimate how the study is progressing in achieving its objectives and make necessary adjustments.

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APPENDIX A

CEA METHODOLOGIES FOR ASSESSING CUMULATIVE EFFECTS OF DEVELOPMENTS WITHIN THE WKSS REGION

A-1 THE ORIGINS OF CEA

Environmental Impact Assessments (EIAs), under provincial or federal legislation, have been done in Canada for more than 20 years. During this time, EIA methods have slowly improved, and the legislation and regulations under which they are performed have changed to meet rising expectations on the accuracy and usefulness of assessments. Each of these assessments arose because a single development project was proposed. The EIAs assessed the effects on the natural environment, and sometimes the nearby human communities, that could occur as a direct result of that *single* project. The effects were assessed typically within an area that was quite close to the project, and in some cases, within only the project area itself.

Over time, it became apparent to decision makers and the public that this was not enough. There was a growing concern that the old way of doing EIAs would “hide” the combined effects of many projects within the region and that only many years later after the projects were in operation would the natural or human environment surprise us with severe problems. There was also the realisation that there was another way of doing assessments. Instead of on a project-by-project basis, assessments could be part of regional planning, to be done *before* any projects may occur, in the hope that serious environmental problems could be avoided. This approach immediately required the need to look at very large areas and at many projects at the same time. Consequently, the expectations of project-specific or regional planning assessments became the same: to “become larger” by considering a larger geographic area, such as an administrative region, and by considering many existing projects, possibly along with projects yet to occur in the future.

What happened, particularly over the last few years, was that “Cumulative Effects” began to appear in environmental assessment legislation. For example, the federal *Canadian Environmental Assessment Act* (CEAA) review process requires consideration of "any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out" for any "screening or comprehensive study" (Government of Canada, 1995, s. 16.1).

EIAs must now also consider “cumulative effects”, and to many people a Cumulative Effects Assessment (CEA) (often, provided as a unique and separate document to the EIA report) became the answer to this requirement. However, this legislative requirement was introduced without a clear understanding of how cumulative effects were to be determined. The expectations that somehow a CEA would “answer all our questions” became common, along with the view that there exists in the world of assessment methodology, a unique and complete approach that would allow the assessment of the complex relationships between many projects in large areas.

However, a review of assessment practice (Hegmann and Yarranton 1995, Hegmann 1995) showed that assessors cannot answer all these questions, and that a single “magic” solution to performing CEAs does not exist. The following section summarises the assessment “State of the Art” as found in the literature (section 8). It includes methods unique to CEA, and those proven over time as dependable EIA approaches. Many unique CEA methods often are as complicated as what they are trying to assess, and in the end do not necessarily help decision makers in understanding what should be done. It is for this reason that we have proposed a recommended approach for use by WKSS that combines many EIA and CEA methodologies.

A-2 A REVIEW OF ASSESSMENT METHODS

Selection of an appropriate CEA methodology for the WKSS region must be tailored to the specific needs of the WKSS Partners and the unique aspects of the region. There are many considerations that may assist in selecting the most appropriate method to address cumulative effects, including:

1. the quality of baseline environmental data;
2. the quality of available information on traditional ecological knowledge;
3. the level of detail available on existing stressors (development/human activities) in the region;
4. the scale of the region;
5. the purpose of the analysis;
6. available financial resources; and
7. the simplicity, flexibility and attention to detail of the CEA approach.

To assist in the selection of a CEA methodology for the WKSS region, a review of the state-of the-art of assessment methodologies for cumulative effects, describing their usefulness and limitations, was undertaken. This provided the direction for selecting an appropriate methodology and recommending an approach for use in the WKSS region.

A-2.1 Organising Methods to do CEAs

Hegmann and Yarranton (1995) suggested that the many methods available could be organised within a “toolbox” of tools, organised in a way that matches the tools to the assessment needs. Some are just ideas that need another tool to be actually used in an assessment. For example, the theory of biogeography requires something to be put into practice. Geographic Information Systems are one specialised and technical tool that could do this. In this case, there is no *one* CEA method, but instead a *combination* of approaches that work together to help complete the assessment. More than 130 tools were reviewed and organised to create this toolbox.

Some "methods" are basic instructions or general guidelines that provide a framework in which one can begin to assess very complex interactions between projects and the environment (the adaptive assessment approach along with the use of impact hypotheses is one such approach, and will be discussed later in more detail). More detailed methods for analysing specific project impacts and effects may also be required.

Figure 1 illustrates the "Toolbox" (Hegmann and Yarranton 1995). The following explains the toolbox contents:

- *Disciplines:* areas of knowledge and research or management (e.g., ecosystem management);
- *Concepts*: ideas used to represent complex environmental and socioeconomic systems (e.g., carrying capacity);
- *Frameworks*: simple step-by-step processes to guide CEA practitioners (e.g., CEAA's suggested approach);
- *Techniques*: specific qualitative or quantitative approaches that organise the collection and analysis of information to answer specific questions (e.g., environmental indices); and
- *Technical aids*: specialised models or numerical tools that can provide detailed analyses (e.g., water quality models).

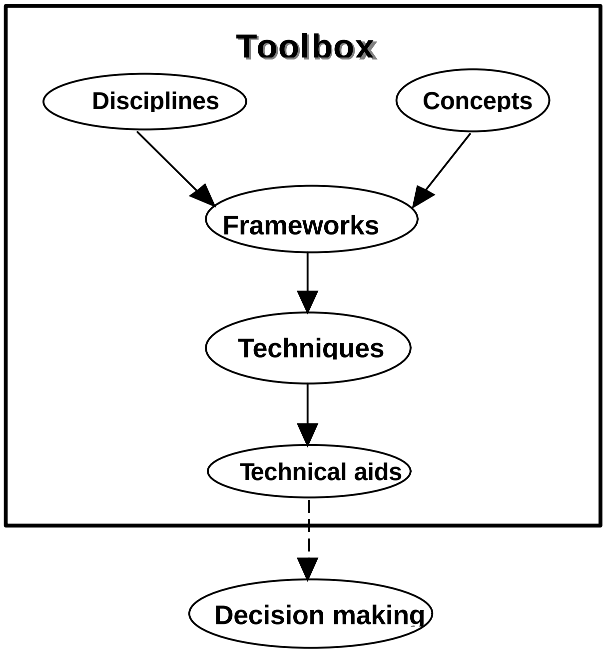

Figure 1: Organization of Tools in the Method's Toolbox

A-2.2 Understanding the Limitations of Assessment Methods

The state-of the art of assessment practice is quite limited. We can only begin to try to answer some of the questions raised by cumulative effects. Certain expectations about what CEAs can do must be lowered. Consider the following as an example, in which the concerns and hopes as to what CEAs can do are expressed by regional planners and residents:

"We know that, in our region, a new mine is being built. Two more are proposed in the next few years. We are concerned that caribou migration will change, and the waters fouled, by mines, new roads, and exploration activity all over the place. Surely, there must be some way to "add" the effects of all these together, and somehow find out if things have gone too far; that is, if we have already or may soon go beyond some threshold. If so, then the caribou may not come, and the fish may not taste good, and our lives will be for the worse."

Assessment techniques cannot answer all of these concerns with any great accuracy. Except in a few very specific cases for air and water pollution, the determination of so called "thresholds" is not possible. Furthermore, the assessment of many interactions can be so complex as to make any such attempt far too difficult. In addition, biologists still cannot determine with a high degree of certainty what the long-term effects of human disturbances will be on many aquatic and terrestrial species. What they may be able to tell you, for example, is what they observed when caribou where approached by helicopters. However, the scientists can only guess, based on scientific theory, on the more important question: how that disturbance may then influence calving and feeding, and hence the long-term population changes of the herds. The opinions of knowledgeable people, whether university scientists or local hunters, should not be underestimated in answering these questions. Even the most advanced models are often useless until a number is eventually provided based on the opinion of such people.

Unless risk and best professional judgement are considered in such assessments, the ability of numerical techniques to model ecosystems reliably has been questioned (Hegmann and Yarranton 1995; Ludwig *et al.*, 1993; Yarranton and Rowell, 1991; Loucks, 1985; Cooper, 1980). There is just not enough known, and any attempts to direct research to find that missing information must ensure its usefulness in assisting those involved in the consultation and assessment process.

A-2.3 Choosing a Method

A method appropriate for the WKSS is found by identifying those approaches within the toolbox that would allow practical implementation of a cumulative effects assessment. Any approach should at least meet the following requirements by considering tools outlined below:

Goals for Approach

- allows for the assessment of the specific types of projects and effects found in the region;
- allows the description of what is happening, and the understanding of what is known and not known;
- includes a formal way of obtaining information and hearing concerns from scientists, government agencies and community residents;
- allows the required information to be obtained and organized;
- provides a visual representation of complex interactions to, as simply as possible, communicate what is happening between the projects and environment; and
- provides for the analysis of specific interactions between the project and the environment.

Tools for Achieving the Goals

- holding **workshops** to allow people to talk about their concerns and what they know;
- developing **diagrams or maps** that represent the relationships between projects and the environment;
- using **computer simulations or models**, if available and applicable, to assist in analysis;
- applying **best professional judgement** and considering risks when performing analysis and making decisions; and
- establishing **research programs** to obtain the missing information for further assessment.

It is important to understand that the above "package" of tools is, *together*, a CEA method. Therefore, there is no one approach, such as only relying on a *single* computer model to help complete a CEA. Instead, given the limitations of what can be analysed, there is no point in beginning with complicated models unless the types of project impacts and their effects on the environment are first well understood.

Examples of Similar Studies in Northern Canada

Important lessons can be learned from what others have done. Of particular relevance to the WKSS is the Hudson Bay Programme and the Northern Rivers Basin Study (two regional based assessments in Canada's north). Both were referred to as cumulative effects studies, for which considerable research effort was made in understanding the interactions in the arctic, particularly in water (lakes, rivers, and oceans) and wildlife. Public consultation, particularly the use of Traditional Ecological Knowledge (TEK), was a fundamental part of the studies.

The Hudson Bay Programme is an excellent example of this. The Programme identified the types of impacts, reviewed a wide range of environmental components, identified data gaps, utilised workshops, incorporated Traditional Ecological Knowledge, and used impact hypotheses and adaptive assessment to move the assessment ahead.

The two studies are described in Appendix B (excerpted from Hegmann and Yarranton 1995). Readers of this report are encouraged to obtain and review the referenced literature for more information.

A-2.4 Moving Ahead to a Recommended Approach

A CEA method that is suitable for the WKSS should be approached in two steps as shown below in Table A-1. In combination, however, the two steps satisfy many of the CEA requirements previously mentioned. The first step involves a start to understanding the effects of various projects on the environment. This step is mostly subjective as it relies on personal knowledge and experience to perform an assessment. The second step, only completed after the first step has accomplished its goals (as determined by the people involved in the assessment and consultation), is to apply more quantitative (i.e., numerical) tools. This step provides more detailed information on interactions, such as the effects of mine drainage on rivers and the effects of roads on hunting and herds of game species.

It is important to understand that Step 2 does not have to be done to have a successful CEA. In many cases, some of the options in Step 2 cannot be used because the data is not available, or the analysis cannot be done. Completion of Step 1 may be adequate to provide enough information to the WKSS to allow decisions to be made on future research studies. What will finally be done will be decided based on how the assessment process proceeds and the quality of information gathered.

Table A-1: The Two Steps to a CEA Approach for the WKSS

Tool	Description
Step 1: Starting to Understand the Environment	
Adaptive Assessment	assessment results are re-evaluated based on new data
Impact Hypotheses	analysis of details in cause-effect relationships by assessing a scientific hypothesis
Impact Matrices	organization and ranking of relationships between activities (e.g., construction, operation) and environmental components (e.g., air, water, soils, fish, wildlife)
Indicators	use of an environmental component which can be monitored to represent changes in the environment due to disturbances
Professional Judgment	use of personal knowledge and experience on which one bases their decisions
Risk Assessment	consideration of the likelihood and magnitude of an effect occurring
Scenario Building	use of different possible types and extent of projects to represent future development options
Step 2: Detailed Analysis	
Cost-Benefit Analysis	determining financial loss and gain due to a project
Habitat Evaluation	determining the type and quality of wildlife habitat before and after development
Environmental Indices	use of numbers to represent the state of the environment
Interaction Coefficients	use of numbers to represent the magnitude of disturbance on an environmental component due to disturbances
Interaction Matrices	a matrix that shows the relationships amongst different linkages between various projects
Network Diagrams	a diagram that illustrates the relationships between all project impacts and effects
Population Viability	determining if disturbances may result in a decrease or loss of a species population
Simulation Modelling	computer simulations of impacts, effects and linkages in which each are assigned a number and the numbers are changed to represent different project and environmental conditions*
Water/Air Quality Models	computer simulations of the concentration of water and air contaminants in the environment

Zones of Influence	a specific distance beyond a disturbance, within which the project is likely to adversely affect all or certain environmental components

A-3 A POSSIBLE APPROACH TO CEA FOR THE WKSS REGION

A-3.1 Important Aspects of the Impact Hypothesis Approach

A substantial amount of work has already gone into development of an analytical framework for identification of potential cumulative environmental effects in the Slave Geological Province (Bernard *et al.* 1995). Central to this framework is the concept of impact hypotheses to focus the assessment on significant environmental questions/issues related to regional development.

Specifically, this study adopted a set a tools to assist in identifying and evaluating the significance of potential cumulative environmental effects in the WKSS region. These included:

1. realistic scenarios of how development may proceed in the region (high, moderate and low) over a 15-year timeframe;
2. generic "footprints" for each major project/activity represented within the scenarios, which describe the probable extent of effects both in time and space; and
3. a series of impact hypotheses that link development activities or disturbances with their effects in the biophysical environment.

While it is recognised that these tools are still in a developmental stage (Bernard *et al.* 1995), these tools nonetheless provide a solid building block from which further refinements tailored to the specific needs of the WKSS can be made. Suggestions for future development work on the CEA methodology are discussed later.

There are a number of important and, in some cases, unique aspects of this framework that warrant consideration when selecting the most effective, practical CEA approach for the WKSS region. These are summarised below.

Impact Hypotheses

The impact hypothesis concept has been used extensively for conducting EIAs, and more recently, has been recognised as a useful tool for assessing cumulative effects. Some of the reasons for this are because use of impact hypotheses:

- focuses the assessment on key issues of concern and, thereby, eliminates the need to assess every possible interaction between development activities/disturbances and the environment;
- forces one to think in interdisciplinary, dynamic terms related to interactions between development/human activities and the environment;
- provides the mechanism for identifying and eliminating those impact pathways that do not act interact;
- provides general principles on which a qualitative analysis can be made if more quantitative analyses are not available; and
- does not rely exclusively on a model or computer-based technique for assessing cumulative effects but does provide the opportunity to integrate quantitative assessment tools into the process.

Impact hypothesis analysis relies on the use of “pathway diagrams” to illustrate various cause-effect relationships and their linkages that occur as a result of a development impact on the environment. Figure 2 gives an example of a pathway diagram for the interaction between caribou and construction activities around mining sites. The advantages of using graphical illustrations is two-fold. Firstly, it presents often complex interactions of impacts in a more easily understood manner. Some impact pathways may be simple, involving only one or two linkages. However, other pathways may be more complex and comprise several linkages. Secondly, it highlights those cause-effects relationships within an impact pathway that can be quantitatively assessed through modelling or other analytical means.

One of the greatest strengths of this CEA framework is its flexibility in adapting and responding to changes in development scenarios as well as to new information on baseline

Figure 2: Pathway Diagram illustrating the Interactions between Caribou and Mine Construction (Bernard *et al.*, 1995)

conditions, ecological processes and impact response mechanisms. This is considered an essential attribute of any CEA approach used for the WKSS region given the fast pace at which development (particularly mining) is proceeding in the region, the limited information base that exists on the biophysical and socio-economic environments, and the need to include traditional ecological knowledge.

Adaptive Assessment

Over the past two years, there has been significant growth in mineral exploration and pre-development activity in the WKSS region. This CEA approach is capable of adapting to these changes by re-focussing existing impact hypotheses or formulating additional hypotheses to address concerns related to new or probable future development activities.

The framework also allows for the incorporation of new information gained through scientific and community research into the assessment of cumulative effects and their significance. Re-evaluation of impact hypotheses provides the mechanism for review of new research in the context of Cumulative Environmental Effects (CEE) and the incorporation of relevant new data into the assessment. This re-evaluation can be an on-going, regular process, which will provide direction to the WKSS related to regional planning initiatives and research and monitoring initiatives to address cumulative effects in the region. Specifically, it can provide WKSS with the information necessary to:

1. validate/invalidate specific issues and concerns that could not be previously assessed due to inadequate baseline data;
2. validate concerns with a higher degree of confidence;
3. reduce the degree of concern for specific impacts or issues; or
4. identify unanticipated impacts that need to be addressed through the process.

Workshops

Central to the impact hypothesis approach is the use of workshops to foster consensus building amongst a broad range of stakeholders, and to collect knowledge from local community members and scientific experts. The value of conducting multi-disciplinary workshops as part of the EIA and CEA processes is well recognised by Aboriginal groups, industry, government and the scientific community because they:

1. provide a neutral ground for the discussion and resolution of environmental and socioeconomic issues; and

2. provide the opportunity for participation by community representatives to ensure that community concerns and traditional ecological knowledge (TEK) are incorporated into the assessment.

This latter point is considered one of the most important features of the impact hypothesis approach in that it allows for the integration of both traditional ecological knowledge and western scientific information into a cumulative effects assessment. The integration of both of these streams of knowledge into the assessment process is a significant undertaking, and one which can be accomplished through a workshop environment. This is not meant to imply that testing of impact hypotheses necessarily provide direction for collection or analysis of TEK, but rather provide the bridge between science and TEK, which is an essential part of addressing cumulative effects.

Impact Scoping

As in any EIA, it is important to adopt some form of impact scoping into the CEA process. The impact hypothesis approach relies on the identification of VECs/VSCs to focus the assessment on the greatest concerns/issues related to regional development while also defining quantitative measurements by which impacts can be assessed (e.g., numbers of animals, quantity of harvest). The VECs/VSCs also provide the focal points for assessing interactions amongst various developments and important components of the biophysical or socio-economic environments.

Identification of Research and Monitoring Needs

One of the strengths of the impact hypothesis approach is that it provides a mechanism for focussing finite funding for research and monitoring on those needs of greatest community and scientific concern related to assessing and managing cumulative environmental effects. All too often, research has been initiated on the basis of individual preferences, desires of stakeholders or individual researchers without defensible rationale for its implementation or usefulness. This process provides a decision-making tool for setting priorities for future research initiatives by:

1. identifying information deficiencies related to baseline conditions, ecological processes and impact response mechanisms that hinder assessment of specific cause-effect relationships;

2. identifying where new information gained through scientific and community research has resolved specific issues/concerns or revealed new issues that need to be addressed; and

3. providing a feedback mechanism for decision-making regarding the need to continue or stop a research program (i.e., has the research adequately addressed the information need or is further study required?).

It is recognised that a substantial amount of fundamental research may be required to adequately address the issue of cumulative effects within the WKSS region. While it may not be necessary, at this time, to actually assess cumulative effects in order to identify/prioritise these research needs, selection of VECs and formulation of impact hypotheses will certainly help in scoping these needs. Impact hypothesis analysis, through an ongoing workshop process, may provide a useful means by which future research initiatives can be identified or ongoing programs can be re-defined on the basis of research results.

A-3.2 Limitations of the CEA Framework

Socioeconomic Issue and Concerns

One of the previous significant shortcomings of this CEA framework was its limitations in addressing socioeconomic issues. The impact hypothesis approach lends itself to addressing environmental issues as well as social issues that arise directly as a result of impacts on natural resources (e.g., resource harvesting). However, there are several concerns related to the cumulative effects of regional developments outside resource harvesting issues that tend to be excluded from the process. It has often been recognised that this approach does not adequately deal with social/cultural/economic effects. The Beaufort Region Environmental Assessment and Monitoring Program (BREAM) is a good example of the complexity of this (Appendix C). Consequently, EIAs and CEAs that have utilised this approach have often dealt with these issues separately with more conventional means of qualitative and quantitative discussion-based assessments.

Bernard *et al.* (1995) acknowledge this shortcoming of the framework and recommends that a parallel effort be undertaken to more fully address social/economic/cultural cumulative effects.

Complexity of Addressing Cumulative Effects

While the impact hypothesis approach is relatively easy to follow in assessing project-specific impacts (EIA), it becomes somewhat more unwieldy in assessing cumulative effects. In theory, assessing each single impact and VEC from all hypotheses seems straight forward provided a clear "audit trail" (or record of decisions, assumptions and uncertainties) is maintained during the assessment. However, in practise, this exercise becomes more complex with the number of VECs, VSCs and development activities being examined.

The use of a well chosen indicator species, for example, is a practical solution to assessing complex and regional effects and is a common approach used in comprehensive EIAs and CEAs. Such species provide the focus for the assessment because they are assumed or known to provide a response that reflects the magnitude of disturbance. These species may also be used as "umbrella" species, that is, species whose responses may be indicative of responses of other species that have similar habitat, food and cover requirements.

A-4 HOW TO BUILD ON THE CEA FRAMEWORK

As noted by Bernard *et al.* (1995), many of the tools developed for the CEA framework for the WKSS region are still in a preliminary form and will require refining before the methodology can be effectively applied to any assessment of cumulative effects. The WKSS will help to provide the information to further develop some of these tools. This will involve:

- updating the scenarios to include any industrial and human activities occurring or likely to occur in the region that may not have been originally considered (e.g., fishing, trapping, air traffic);

- collecting more detailed information related to existing and future stressors in the region and refining the development footprints as necessary; and

- refining the impact hypotheses based on the list of issues and concerns identified as part of the present study.

However, even as these tasks are completed, it would be difficult to implement this assessment framework on a species-specific basis due to a current lack of detailed information related to resources and resource use in the region. Instead, it is suggested that a set of regional indicators be selected to focus the assessment on particular environmental components (e.g., caribou, water quality). Selection of the final suite of indicators should be based, at least in part, on the level of concern related to the potential cumulative effects of regional development on the identified VEC/VSC, the quality of baseline information that is available, and its usefulness in assisting in interpretation of regional trends. For each of the chosen indicators, a set of impact hypotheses can be developed (or refined if already existing) to describe the major impact pathways that are believed to be occurring as a result of regional development. As new information/data emerges from scientific and community research programs, the scope of the CEA can be expanded to include additional VECs/VSCs and impact hypotheses for evaluation, as appropriate.

APPENDIX B

OTHER SIMILAR STUDIES USING CEA METHODOLOGIES

Hudson Bay Programme

Initiated in 1992, the Hudson Bay Programme was a three-year study led by the Canadian Arctic Resources Committee (CARC), Rawson Academy of Aquatic Science and the Environmental Committee of Sanikiluaq. The Programme included two parts: (1) identification of impacts on aquatic systems and determination of cumulative significance of each impact (principally from hydroelectric developments); and (2) development of sustainable development practices amongst regional stakeholders. A cumulative effects approach was necessary to examine the many projects affecting the watersheds surrounding Hudson Bay.

The study did not include data collection, but instead used known data and focussed on selecting VECs and the use of traditional (aboriginal) knowledge. A guiding principle was "to link cumulative effects evaluation with other policy processes in a coordinated and manageable fashion" (Sallenave, 1994, p.3).

The Programme objectives were to identify data gaps, determine effects of economic activities, identify and determine significance and magnitude of trends, and encourage inter-jurisdictional cooperation to develop long-term goals (Sallenave, 1994). The study approach was to identify "ecosystem components or processes which are deemed to be under stress or undergoing change" and then to "evaluate the ecosystem's stress/susceptibility to the cumulative impacts of past and present development" (Sallenave, 1994, p. 18).

To accomplish this, research priorities (e.g. effect of arctic haze, energy flows in Hudson Bay ecosystem) and indicators (e.g. human health, bio-accumulation of toxic substances in top-level marine predators) were determined.

Research papers were commissioned, addressing a wide variety of topics such as effects of stress on human health, physical and biological processes in estuaries, and shifts in native subsistence economies.

In 1992, the Department of Fisheries and Oceans also sponsored a workshop on cumulative impacts of development in the Hudson Bay region (Bunch and Reeves, 1992). This was based on the examination of a series of cause/effect hypotheses similar in format to that used for the Beaufort Environmental Monitoring Program. Although not directly an initiative of the Hudson Bay Programme, this workshop is of interest because it was quite rigorous in developing a cumulative effects methodology.

Each hypothesis was judged on the degree of importance, scope (e.g. local or regional), and availability of data to test the hypothesis. Precedents from other similar projects were used. The hypotheses were provided for the following basic categories:

- *physics* (e.g. in summer, decreased freshwater flow into the bays will increase nutrient inflows to the surface layer);
- *inorganic nutrient, organic carbon and suspended matter fluxes* (e.g. impoundment of terrestrial drainage will reduce the amount of biologically available organic carbon);
- *mercury and other contaminants* (e.g. increased body burdens of mercury and other contaminants can affect the health of fish and marine mammals); and
- *biological resources* (e.g. flow alteration will modify salinity and temperature regimes in estuaries, which will, in turn, affect marine mammals and other biota).

The workshop concluded with the admission that only a limited set of hypotheses was examined; however, an adaptive approach was accepted because "unanticipated impacts are likely to be revealed as more research effort is applied" (Bunch and Reeves, 1992, p. 26).

Northern River Basins Study

The Northern River Basins Study (NRBS) was started in 1990 to "examine the relationships between development and the Peace, Athabasca and Slave River Basins" (NRBS, 1993, p. 1), an area that includes much of northern Alberta. This 3 1/2 year, $12.3 million project, under the provisions of the *Canada Water Act*, is jointly funded by the Government of Canada and the Province of Alberta, with involvement of the Northwest Territories Government. Operations were coordinated by a study board representing various regional stakeholders, with assistance from a science advisory committee.

The study grew out of recommendations for more regionally-based scientific data from the joint provincial and federal environmental assessment review board that reviewed the proposal for the Alberta-Pacific Forestry Industries pulp mill. The panel was concerned that impacts from future projects might adversely impact the region's watersheds. A major part of the study was a public consultation process with residents throughout the region (e.g. at native community gatherings).

The NRBS Board coordinated various research projects to identify data gaps, provided an environmental baseline database (e.g. on contaminant levels), developed models to assess how cumulative effects of development might affect the aquatic environment, and assisted future regional planning efforts. Projects attempted to answer questions such as "How can the ecosystem be protected from the effects of [toxic] compounds?" and "What predictive tools are required to determine the cumulative effects of man-made discharges on the water and aquatic environment?" (NRBS, 1992, p. 7).

Achievement of these objectives was guided by five "components" of research:

- *physical processes* (e.g. hydrology/hydraulics and sediment transport);
- *biological and chemical components and processes* (e.g. nutrients, contaminants and food chain in fish habitat, riparian vegetation/wildlife);
- *resource uses* (e.g. drinking water, fishing);
- *integrated analysis and prediction* (e.g. modelling, use of geographic information systems); and
- traditional knowledge (NRBS, 1993).

APPENDIX C

RESEARCH AND MONITORING CASE STUDY: BEAUFORT REGION ENVIRONMENTAL ASSESSMENT AND MONITORING PROGRAM (BREAM)

The Beaufort Region Environmental Assessment and Monitoring Program (BREAM) was initiated in 1991 by Indian and Northern Affairs, Environment Canada, and the Department of Fisheries and Oceans to assist in the planning component of the Northern Oil and Gas Action Program (NOGAP). Its objectives were to establish research and monitoring priorities related to future oil and gas development and transportation in the Beaufort Sea, Mackenzie Delta and Mackenzie Valley, and to assist in assessing potential impacts of these future developments on the environment, its resources and resource use by northerners. This program combined and built on the efforts of two earlier projects - the Beaufort Environmental Monitoring Program (BEMP) and the Mackenzie Environmental Monitoring Program (MEMP). Like these projects, BREAM was initiated to ensure that environmental research was integrated with industry's plans for exploration and development and to assist in identifying where further information gained through research was needed to assess the impacts of development in the region.

The BEMP, MEMP and BREAM projects utilised the Adaptive Assessment approach (Hollings 1978) to assist in identifying important research and monitoring needs. This involved development of a series of tools, including:

- VECs - this was a critical tool as it focussed discussion of impact hypotheses and research/monitoring needs on those resources and biophysical processes of greatest concern relative to hydrocarbon development and defined quantities for which the impact hypotheses would provide predictions over time.

- Development scenarios - these identified the likely nature, extent and duration of potential development activities in the region and thus assisted in defining the casual chain or impact hypothesis linking specific activities to a particular VEC or group of VECs.

- Impact hypotheses - these provided the framework for identifying and assessing specific cause-effect relationships involved in linkages between development activities and effects on VECs, and making recommendations related to information needs and mitigative measures.

Lessons Learned

Over the 10 years of the BEMP, MEMP and BREAM projects (1983-1994) numerous workshops and technical meetings were held to provide ongoing evaluation of the success of research and monitoring initiatives in addressing information deficiencies, and to adapt the process to new information and changes in the most likely scenario for hydrocarbon development. Through the enormous efforts undertaken during this time, a number of important lessons were learned regarding the usefulness and effectiveness of the process in meeting the objectives of the program.

Research

The BEMP, MEMP and BREAM programs provided a wealth of information on ecosystem processes and impact response mechanisms, which has been useful in the implementation of other regional studies (e.g., Arctic Environmental Protection Strategy, Mackenzie River Basin Study). A substantial amount of research and monitoring initiatives were funded through NOGAP as a direct result of the recommendations made through these programs, which ultimately helped in addressing many of the unknowns related to how hydrocarbon development would affect the northern environment and its resources.

In many cases, results of new research showed that concerns for impacts had been overstated. For example, a study on the effects of ice-breaker traffic on ice stability indicated that icebreaker tracks quickly refroze and stabilised and therefore were unlikely to hamper hunter travel over the landfast ice during the period when polar bears are harvested (Axys 1994). In other instances, it was concluded that, although, the issue/concern was valid, it was impossible or too difficult to prove with additional research. This was most evident in addressing the possible effects of industrial activities on the western Arctic population of bowhead whales. Over the 10-year period, considerable financial resources were directed at examining the potential for exclusion of these whales from feeding areas as a result of the cumulative effects of underwater noise. However, despite this huge effort, it became apparent that this question could not be fully answered through research and no further initiatives were supported.

Community-based Concerns

With exception to the initial planning years of BEMP and BREAM, representatives of the major aboriginal organisations and communities within the Mackenzie Valley and Delta and the Beaufort Sea participated in all technical meetings and workshops. Participation by these community representatives provided the opportunities to incorporate community concerns into the identification of issues and the development of impact hypotheses, as well as to use community-based information in the evaluation of the hypotheses. Community-based concerns represented a large portion of the issues addressed through these programs. However, these issues were restricted to resource-based issues. While social concerns were recognised as being important, it was felt that these could be more appropriately addressed through some other process.

During the BREAM program, it was recognised that more could and should be done to address community-based environmental concerns. In response to this, a technical working group was established with the task of identifying concerns of northern residents and developing processes for incorporating local and traditional knowledge. Nevertheless, the single most outstanding issue expressed by community representatives was the restriction of the program in dealing with social and economic concerns related to hydrocarbon development. While it was argued that BREAM may not be effective in evaluating non-ecological questions, it was apparent that a new initiative was needed to address potential social, cultural and economic impacts.

Traditional Ecological Knowledge

The BEMP, MEMP and BREAM programs fostered the use of TEK in most aspects of the evaluation and assessment processes, and in the development and implementation of research and monitoring programs. While the value of this information may not have been recognised by some scientific participants early on in the process, there was a growing recognition of its importance and the value of collecting and integrating TEK with the scientific database.

Communication of Results

During the BREAM program, a series of newsletters were published for distribution within the communities to communicate the results of the impact assessment process and research and monitoring activities. However, it was felt by many community representatives that these newsletters were not particularly informative or useful given their limited distribution and their presentation. It was clear that a public consultation process was needed to provide a better forum for community input and communication of information back into the communities.

INDICATORS OF COMMUNITY HEALTH AND WELLNESS

The parties agree that the Project will impact on the socio-economic conditions of the "Point of Hire" communities. As well, it is recognized that communities are currently undergoing significant social change. To assess the impact of change the GNWT has agreed to monitor selected indicators. Information gained from the monitoring process will be used, in cooperation with communities, to identify activities which strengthen benefits and mitigate negative impacts of social change.

1.0 The following listing of selected indicators will be used in the monitoring process in "Point of Hire" communities:

- Average income of residents
- Employment levels and participation rates
- Rates of High School Completion
- Housing indicators (number of dwellings, average number of persons per dwelling, average number of people per bedroom, percentage of units with full plumbing and heating systems, etc.)
- Teen birth rates
- Number of children in care
- Number of suicides
- Number of injuries
- Number of potential years of life lost
- Number of communicable diseases
- Social Assistance cases
- Number of alcohol and drug related crimes
- Number of property crimes
- Number of complaints of family violence

2.0 It is understood that the information collected will be shared with the community governments of the "Point of Hire" communities.

3.0 The listing of indicators may be adjusted, from time to time, based on discussions with the "Point of hire" communities and the Parties to this agreement.

APPENDIX E

INTERACTION MATRICES

Interaction Matrix
Mineral Exploration Camp

Exploration Camp	Environmental Components											
	Landforms/Terrain	Soils	Surface Water	Ground water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Water fowl	Small Mammals	Caribou & other Terrestrial Wildlife
Clearing of drill sites/camp	2	2	1	1	1	2	3	2	2	2	2	3
Development of facilities	2	3	2		1	1	3	2	2	2	2	2
Road (Constr & Access)	3	3	3		3	2	3	2	3	3	3	3
Air Transportation		1	1		3	2	2	2	2	2	2	2
Workforce	1	1					2	2	1	2	2	2
Test trenches or pits	3	3	2	3	2	2	3	2	2	2	2	2
Placement of gravel	2	2	1			1	3	1	1		2	2
Accidental spills	1	2	3	2		3	2	2-4	3-4	2-4	2-4	3-4
Drilling	2	2	3	2	1	1	3	1	1	1	1	1
Water Use			2	1		2		2				
Accidental Fires	2	2-3	1		2	1	3-4	1	3-4	3-4	3-4	3-4
Waste Treatment		3	3	3		2	2	3	1	2	2	2
Equipment	1	2	2		1	2	2	2	2	2	2	2

Exploration Camp	Social Components				
	Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Historical & Cultural Sites	Human Health
Clearing of drill sites/camp	2	3	2	3	
Development of facilities	2	2	2	2	
Road (Constr & Access)	3	3	3	3	
Air Transportation	1-2	2	1		2
Workforce	2	3	2		1
Test trenches or pits	2	2	2	3	
Placement of gravel	2	2	2	3	1
Accidental spills	2	3-4	2	2	2-4
Drilling	2	2	2	2	1
Water Use	2	2	2	2	
Accidental Fires	2-4	2-4	2-4	2-4	2-4
Waste Treatment	3	3	2		3
Equipment	2	2			1

Assumptions:

* camp erected to conduct a winter drilling program beginning in 1996 and continuing in winter 1997
* Access by float plane and winter road
* water required for drilling
* culvert required for trail construction
* blasting required for excavation
* gravel pad necessary for camp base
* drill holes left unplugged
* leaching from exposed mineral cores

Interaction Matrix
Mine Development

Mine Development	**Environmental Components** Landforms/Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Waterfowl	Small Mammals	Caribou & otherTerrestrial Wildlife
Road (Constr & Access)	3	3	3		3	2	3	2	3	3	3	3
Air Transportation		1	1		3	2	2	2	2	2	2	2
Clearing of Plant Site	3	3	2		1	2	3	2	3	3	3	3
Trenchs/Pits	3	3	3	1	1	2	3	2	3	3	3	3
Borrow Pits	3	3	2	1	2	1	3	1	2	2	2	2
Stream Diversion	3	3	3	1		3	3	2	1	1	1	1
Draining/Filling of Lakes	3	3	3	3		3	1	3	2	2	2	2
Plant	3	3	3		3		3		2	2	3	3
Tailings Impoundments	2	3	3	2	3	3	3	3	3	3	3	3
Electrical Facilities	1	2	2		1	1	3	1	2	2	3	3
Waste Rock Piles	3	3	3	3		3	3	2	2	2	2	2
Camp	1	2	2	2		1		1	2	2	2	2
Workforce	1	1				1	2	3	1	3	2	3
Accidental Spills	1	2	3	2		3	2	2-4	3-4	2-4	2-4	3-4
Domestic Waste		3	3	3		3	3	3	3	2	3	3
Accidental Fires	2	2-3	1		2	1	3-4	1	3-4	3-4	3-4	3-4
Removal of Plant & Facilit	1	2	1		2	1	1	1	1	1	1	1
Removal of Roads	1	2	1		1	2	3	1	3	2	3	3
Reclamation	2	2	1		1	1	3	1	3	3	3	3

Mine Development	**Social Components** Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Historical & Cultural Sites	Human Health
Road (Constr & Access)	3	3	3	3	1
Air Transportation		2			
Clearing of Plant Site	2	3	2	3	1
Trenchs/Pits	2	2	2	3	1
Borrow Pits	2	2	2	3	1
Stream Diversion		2	1		1
Draining/filling of Lakes		3	2		1
Plant	2	3	1	3	1
Tailings Impoundments	3	3	1	3	2
Electrical Facilities	2	3	2		1
Waste Rock Piles	3	3	3	3	3
Workforce	2	3	2		2
Domestic Waste	3	3	2		3
Accidental Fires	2-4	2-4	2-4	2-4	2-4
Accidental Spills	2	3-4	2	2	2-4
Removal of Plant & Facil	1	1	1		
Removal of Roads	2	2	2		2
Reclamation	1	1	1		

Assumptions:
* construction over 1-year time frame
* site consists of a residential camp, a mill, an airstrip and a tailings pond (created from 2 natural ponds)
* access by winter road until all-weather road is complete
* filling of some waterbodies necessary to form stable surface
* stream re-routed around drained lake
* no smelting or roasting operations at mine
* stockpiled waste rock subject to leaching
* lake drained to access part of mineral deposit

Interaction Matrix
Winter Road

Winter Road	**Environmental Components**											
	Landforms-Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Water fowl	Small Mammals	Caribou & Other Terrestrial Wildlife
Construction, Operation												
Clearing	2	2	1	1		1	2	1	2	1	2	2
Borrow Pits	3	3	2	1	1	1	2	1	1		2	2
Placement of Gravel	2	3	2		1	2	3	2	2	1	2	
Construction Camp	2	2	2	2		2	3	1	1		1	3
Equipment-Vehicles	1	1	1		2	2	3	2	2	1	2	3
Workforce	2	1	1				2	1	1	1	1	3
Domestic Waste		1	1	2	1	2	2	2	2	2	2-3	2-3
Access	1	1	1	1	2	2	2	3	1		3	3
Accidental Spills	1	3	3	2	1	3	3	3	2	2	2	2

	Social Components				
	Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Cultural-Historical Sites	Human Health
Construction, Operation					
Clearing	3	3	2	3	1
Borrow Pits	3	2	2	3	1
Placement of Gravel	3	1	1	3	1
Construction Camp	2	1	2	3	1
Equipment-Vehicles	2	3	3	2	2
Workforce	2	3	1	1	1
Domestic Waste	1	1	2		2
Access	3	3	2	3	1
Accidental Spills	3	3	1		2

Assumptions:

* portages require smoothing- 8m. width of gravel is placed on ground surface..
* the borrow pit is 1 sq. km./ km.
* increased access to wilderness will be 50 km. wide in the winter.
* 1 spill/yr.
* raised road traverses migration route.
* improper treatment of garbage or waste can affect species 20 km. away

Interaction Matrix
All-weather Road

	Environmental Components											
All-weather Road	Landforms-Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Waterfowl	Small Mammals	Caribou & Other Terrestrial Wildlife
Construction, Operation												
Culvert Placement	2		2	2		2		2		2	1	1
Filling of water bodies	2		4	3		4		3	1	2	1	1
Borrow Pits	4	2	2	1	1	1	2	1	1		2	2
Placement of Gravel	2	4	2	1	1	2	4	2	1	2	3	3
Clearing of RoW	3	3	2	1	1	1	3	1	2	2	3	3-4
Equipment	2	2	2	1	2	1	2	1	1	1	2	3
Workforce	1	1					2	1		1	1	2
Domestic Waste		2	2	2		2	1	2	3	2	3	3
Construction Camp	2	2				1	2				2	2-3
Water Use	2		1	1		2		2	1	1	1	1
Accidental Spills	2	2	2	2	1	1	2	2-3	2	2	2	2
Vehicles	1	2	1	1	2	3	3	2	3	2	3-4	3-4
Access	1						2	3-4	2	3-4	2	3-4
Road Maintenance	2	2	2	1	1	1	2	1	1	1	2	3

	Social Components				
All-weather Road	Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Cultural-Historical Sites	Human Health
Construction, Operation					
Culvert Placement	3	2		3	
Filling of water bodies	3	3	3		1
Borrow Pits	3	3	3	3	1
Placement of Gravel	4	4	4	4	2
Clearing of RoW	4	3-4	2	3	
Equipment	2	2-3	2		1
Workforce	2	2	1	3	2
Domestic Waste	2	2	2		2
Construction Camp	2	2	2	3	
Water Use	1	1			
Accidental Spills	2	2	2		2
Vehicles	3-4	3-4	3		3-4
Access	3-4	3-4	3-4	3	3
Road Maintenance	3-4	3-4	2		3

Assumptions:

* borrow pits of 1 sq. km./km.
* culverts (1m. in diameter) placed approx. every 20 Km.
* appox. 1 ha. of water bodies are filled in.
* gravel of 8m. in width is placed on ground surface
* CaCl used to control dust.
* 1.1 spills/yr.
* raised road traverses migration route.
* increased access to wilderness 50m.
* degradation & diversity changes in vegetation at 20m. width along the road.

Interaction Matrix
Community Development

Community Devel.	**Environmental Components**											
	Landforms/Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Waterfowl	Small Mammals	Caribou & otherTerrestrial Wildlife
Clearing of land	3	3	3	1	3	3	2-3	2	2	2	3	3
Filling of waterbodies	3	1	3	1		3	1	3	3	3	3	3
Construction (Roads/Bldg)	3	3	3	1	2	2	3	2	2	2	2	2
Water lines	1	2	2		1	1	2	1	2	2	2	2
Borrow Pits	3	3	2	1	2	1	3	1	2	2	2	2
Workforce	1	1					2		3	3	3	3
Equipment	1	2	2		1	2	2		1	1	1	1
Culvert Placement	1	3	3		1	3	2	3	1	1	1	1
Accidental Spills	1	2	3			3	2	2-4	3-4	2-4	2-4	3-4
Accidental Fires	1-2	2	1	1	1		3-4	3-4	3-4	3-4	3-4	3-4
Water Use	1		3	3		2		1	1	1	1	1
Road Access/Maintenance	1	2	3	1	3		3	3	3	3	3	3
Human Activity	1	1	3		3		3	3	3	3	3	3
Sewage Disposal			3	2	3	3		3	1	3	1	1
Solid Waste Disposal	3	3	1	3	3	2	3	2	2	1	3	3

Community Devel.	Social Components				
	Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Historical & Cultural Sites	Human Health
Clearing of land	3	3	3	3	1
Filling of waterbodies	3	3		3	1
Construction (Roads/Bldg)	3	3	3	3	1
Borrow Pits	3	3	3	3	1
Workforce	2	3	2		3
Equipment	2	2	1		1
Culvert Placement		2	1		
Accidental Spill	2	3-4	2	2	2-4
Accidental Fires	2-4	2-4	2-4	2-4	2-4
Water Use		3	1		2
Road Access/Maintenance	3	3	3		
Human Activity	2	3	3		2
Sewage Disposal	2	3	3		1
Solid Waste Disposal	3	3	3		1

Assumptions:

* parts of waterbodies filled to establish stable surface
* water and CaCL required for dust control
* damage to permafrost
* new plants introduced by residents
* continuous growth of community
* community accesses wilderness for recreational and development purposes
* continuous traffic and hunting pressures
* gravel required for road construction
* erosion of fill around culverts

Interaction Matrix
Tourism

Tourism	**Environmental Component** Landforms-Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Water fowl	Small Mammals	Caribou & Other Terrestrial Wildlife
Construction, Operation												
Clearing (Lodges & Bldgs)	3	1	1	1	1	1	3	1	2	1	2	2
Equipment	2	2	1	1	2	3	3	2	1	1	1-2	1-2
Accidental Spill	1	2	2	2	1	2	2	2	2	1	1-2	1-2
Workforce	2	2	1	1	1	1	2	1	1	1	1	1
Water Use	1	2	2	2	1	3-4	2	3-4	2	3-4	2	2
Vehicles	3	3	1	1	2-3	1	2-3	1	2	1	2	3
Human Activity	3	3	2	2	2	3	3	4	2	4	3	4
Accidental Fires	1	2-3	2	2	2-3	2	3	2	3	2	3	3
Sewage Disposal	1	2	3	3	1	2	1	2	1	2	1	1
Waste Disposal	1	2	2	2	2	2	2	2	2	2	3	3

Tourism	**Social Components** Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Cultural-Historical Sites	Human Health
Construction, Operation					
Clearing (Lodges & Bldgs)	4	3	1	3	2
Equipment	2	1	1-2		1
Accidental Spill	1	2	1	1	1
Workforce	2	2		1	2
Water Use	1	1	1	1	2
Vehicles	3	1	1		1
Human Activity	4	3-4	2		3-4
Accidental Fires	4	3	1	4-5	3-4
Sewage Disposal	1	2	1		2
Waste Disposal	1-2	1	1	1	1

Assumptions:

* small camp used only in summer.
* CaCl is used to control dust of road and gravel paths.
* damage to peat layer with increased access to wilderness.
* raised road traverses migration route.

Interaction Matrix
Hydroelectric Development

Hydroelectric Devel.	Landforms-Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Water fowl	Small Mammals	Caribou & OtherTerrestrial Wildlif
	Environmental Components											
Construction, Operation												
Stream Diversion	3	3	4	4		4	4	4	1	4	2	2
Flooding	4	4	5	5	4	5	5	5	4	4	5	4
Clearing	3	2	2	2	1	1	3	1	2	1	2	2
Borrow Pits	3	3	2	1	1	1	2	1			2	2
Construction Equipment	2	1	1	1	3	1	1	1	2	1	2	2
Accidental Spills	2	2	3	3	2	2	2	3	2	1	2	2
Workforce	2	1	1	1	1	1	2	2	1	2	1	2
Waste Disposal	1	2	1	2	1	2	2	2	3	3	3	3
Access Road	2	1	1	1	3	1	2	1	1	2	2	3
Drawdown-Filling	4-5	4-5	4	4		5	3-4	3	3	2	2	2
Reservoir	3	3	4	4	1	5	4	5	1	3	2	3

Hydroelectric Devel.	Aboriginal Land Use	Aboriginal Resource Us	Commercial Land Use	Cultural-Historical Sites	Human Health
	Social Components				
Construction, Operation					
Stream Diversion	2	2	2	3	1
Flooding	5	5	5	5	4-5
Clearing	2	3	2	4	2
Borrow Pits	2	2	1	4	1
Construction Equipment	2	2	2		1
Accidental Spills	3	2	1	3	2
Workforce	1	1	3		3
Waste Disposal	2	3	1-2		1
Access Road	3	2	1-2	3	3
Drawdown-Filling	1	2	1		
Reservoir	4	4	3	3	2

Assumptions:

* dams require water to be diverted from normal channel.
* must flood area of 5,000 ha in order to establish reservoir.
* 5 ha are cleared for project.
* borrow pits are 2 ha.
* degradation to vegetation over for 20m. along road width.
* no fish ladder constructed.
* road will provide access to wilderness approx. 50km. on either side.

Interaction Matrix
Transmission Line

Transmission Line	**Environmental Component**											
	Landforms/Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Waterfowl	Small Mammals	Caribou & otherTerrestrial Wildlif
Equipment	2	2	2		1	2	2	2	2	2	2	2
Cutline (clearing & maint.)	1	3	3				3		3		3	3
Workforce	1	1					2	2	2	2	2	2
Access	1	1				2	1	3	3	3	3	3
Transmission Line		2	2						3	3		
Accidental Spill	1	2	3			3	2	2-4	3-4	2-4	2-4	3-4

Transmission Line	**Social Components**				
	Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Historical & Cultural Sites	Human Health
Equipment	2	2	1		1
Cutline (clearing & maint.)	1	3	1	3	
Workforce	2	3	2		2
Transmission Line	1	3	2		1
Access	3	3	3	3	2
Accidental Spill	2	3-4	2	2	2-4

Assumptions:

* tranmission line required for mine development
* line is 100 km in length, located within a 20 m wide cleared corridor
* water required for drilling
* clear cutting necessary for installation of poles and lines
* cutline kept clear
* aerial lines are required

Interaction Matrix
Outfitting Camp

Outfitting Camp	Environmental Component											
	Landforms-Terrain	Soils	Surface Water	Ground Water	Air Systems	Aquatic Vegetation	Terrestrial Vegetation	Fish	Raptors	Waterfowl	Small Mammals	Caribou & Other Terrestrial Wildlife
Construction, Operation & Abandonment												
Site Clearing	3	2	2	2	2	1	3	1	1	1	1	1
Camp & Buildings	2	1	1	1	1		2		1	1	1	2
Accidental Spills	2	2	2	2	1	1	2	1	1	1	1	1
Air Transportation	1	1	1		3	2	2	2	2	2	2	3
Road Access	2	2	1	1	2	1	1	3		3	3	4
Accidental Fires	2	3	2	1	2	3	3	2	1	2	2	1
Domestic Waste	1	1	2	2	1	1	1	2-3	3	3	3	3
Fuel Incineration	1	1	2	1	2	2	2	1	2	2	2	2
Removal of Camp & Bldg					1	1	1		1	1	1	2

Outfitting Camp	Social Components				
	Aboriginal Land Use	Aboriginal Resource Use	Commercial Land Use	Cultural-Historical Sites	Human Health
Construction, Operation & Abandonment					
Site Clearing	2	3	1	5	1
Camp & Buildings	1	1	2	1	1
Accidental Spills	2	2	2	1	2
Air Transportation		1	2		2
Road Access	2	1	2		1
Accidental Fires	2	2	2	5	3
Domestic Waste	1	1			2
Fuel Incineration	1	1	1		1
Removal of Camp & Bldg			1		

Assumptions

* 5.1 ha required to build camp.
* <1 ha vegetation lost when clearing.
* normal heating, cooking and fugitive dust will effect air quality within 2 ha of camp.
* oil/fuel spills due to impropoer storage and handling.
* most outfitters use air travel to reach areas.
* wildlife stress & alienation approx. 3km. radius of camp.
* camp blocks of migratory movement.

APPENDIX F

INFORMATION GAPS

Topic	Issues	Source*
WILDLIFE AND HABITAT INFORMATION		
Caribou	♦ Ecology ♦ Calving grounds ♦ Migration ♦ Health of Bathurst herd ♦ habitat selection ♦ Impact of development on . . . ♦ Harvesting data ♦ Winter range variation ♦ Ecosystem linkages	**18**, **68** **71** **9**, **71**, **68** **71** **9** **24**, **68** **71** **68** **71**
Grizzly Bear	♦ Ecology ♦ Impact of development on . . . ♦ Population ♦ "problem" bear data ♦ Food	**9**, **18**, **71** **9**, **24** **68** **9**, **18**, **39** **68**
Muskoxen	♦ population dynamics ♦ update and assessment of conservation plan	**18** **18**
Wolverine	♦ Ecology ♦ denning habitat ♦ population dynamics	**18** **9** **9**
Wolves	♦ distribution, population ♦ den site characteristics ♦ predation of muskoxen and caribou ♦ Impact of development on . . .	**9**, **68** **9** **18**, **68** **24**
Other furbearers	♦ Ecology	**71**
Whales	♦ Movement	**68**
Migratory Birds	♦ Critical habitats	**56**, **24**
Waterfowl, Geese	♦ Ecology ♦ breeding and staging areas ♦ effects of disturbance ♦ population dynamics	**68**, **71** **9** **64** **9**
Raptors	♦ population dynamics ♦ impact of disturbance on food source (small mammals)	**9**, **71** **64**
Aquatic Life	♦ population dynamics ♦ lake productivity ♦ spawning areas ♦ lake ecosystems	**24** **24** **18**, **24**
Wildlife Health	♦ monitoring	**68**
Ecosystem Health	♦ development of indicators	**18**, **71**

	♦ description of healthy ecosystem	**64**
Critical Habitats/ Representative Areas	♦ for protection ♦ aquatic habitat ♦ vegetation communities ♦ habitat use by wildlife ♦ habitat use by aquatic life	**9**, **68**, **56**, **71** **24** **24** **68**, **69** **69**
Wildlife conservation		**18**
Vegetation	♦ vegetation - habitat linkages and assessment	**68** , **71**
Development Impact	♦ habitat loss associated with mining ♦ sensitivity of valued habitats ♦ marine transportation on marine mammals ♦ roads and shipping on aquatic and marine ecosystems ♦ health & environmental effects at abandoned sites ♦ cumulative effects of exploration activities on wildlife ♦ wildlife alienation to disturbed habitat ♦ direct and indirect mortality of large mammals ♦ food reduction ♦ caribou migration disruption from roads, mine operations ♦ impact on valued ecosystem components	**24**, **39** **24** **64** **24**, **64** **25** **9** **24** **24** **39** **39**, **65** **24**
PHYSICAL ENVIRONMENT INFORMATION		
Water	♦ hydrologic data ♦ hydrologic inventory ♦ effects of break-up ♦ small basin studies ♦ lake sediments ♦ quantity ♦ quality ♦ monitoring networks ♦ characteristics and wildlife use ♦ physical river study	**18**, **28**, **65** **18** **24** **18** **18** **18**, **24**, **28**, **71** **18**, **25**, **28**, **71**, **68** **18**, **24** **68** **24**
Climate	♦ meteorological data ♦ monitoring networks	**18**, **24** **24**
Nutrient cycling		**64**, **71**
Permafrost	♦ regional mapping ♦ delineation of characteristics, ground thermal regime ♦ slope stability and terrain disturbance ♦ effects on groundwater and hydrology	**18** **24** **18**, **24** **18**, **24**, **64**

Landforms	♦ mapping and description of physical features	**71**
Eskers	♦ habitat uses ♦ historical sites ♦ resource uses	**71**, **68** **71** **24**, **71**
Geology	♦ mineral distribution and potential ♦ bedrock resources ♦ natural geochemistry	**24**, **68** **24** **24**
Air Quality		**24**
Sea Ice	♦ formation ♦ use by humans and wildlife	**68** **68**
Reclamation and Rehabilitation	♦ aquatic systems ♦ vegetation	**24**, **54**, **71** **71**
Contaminants	♦ data collection and analysis ♦ sources and monitoring	**18** **68**, **24**
Development Impact	♦ industrial footprint case study of physical impacts ♦ water quality	**24** **69**
TRADITIONAL KNOWLEDGE INFORMATION		
Prioritization of TK	♦ based on identifying values of TK holders	**18**, **64**
Ecology	♦ community based studies on all ecological subjects ♦ indicators of environmental change ♦ habitat, e.g denning areas, fish spawning areas, bird habitat ♦ caribou ♦ water quality ♦ water	**18**, **56**, **71** **18** **18**, **25**, **65**, **68** **25**. **68** **18**, **25** **68**
Cultural and Heritage Sites		**18**, **25**
Traditional Use	♦ how to behave in the right way toward the land ♦ land ♦ vegetation ♦ wildlife	**18** **71**, **68** **71** **71**
Development Impact	♦ effectiveness of using traditional methods to divert caribou from developments ♦ impact of mine operations on wildlife ♦ conditions prior to development, e.g. at Rayrock	**9** **65** **18**
SOCIO-ECONOMIC AND CULTURAL INFORMATION		
Social Conditions	♦ development of indicators of family and community wellness, health, and sustainability ♦ monitoring of above indicators ♦ integration of data on social problems with community's attitudes and understanding of	**18**, **38**, **56**, **65**, **71** **38**, **65** **9**, **65**

	how to solve the problems ♦ data on substance abuse, family violence, disabilities, child care and development	 **18**, **65**
Economic Issues	♦ evaluation of economic strategies ♦ evaluation of strategy of preferential hiring ♦ employment and training opportunities ♦ baseline data on family income ♦ alternative economic development ♦ assessment of potential of cultural/eco-tourism and arts & crafts	**18** **68** **71** **65** **56** **18**
Macro-economics	♦ value of traditional economy ♦ value of outfitting business ♦ value of tourism business ♦ value of parks ♦ cost of doing business in communities	**71**, **68** **68** **68** **68** **68**
Traditional Economy	♦ comparison and relationship with wage economy ♦ harvesting data ♦ profile of each community	**9**, **71** **69** **68**
Sustainable land use		**71**
Socio-cultural importance	♦ … of water	**71**
Cultural Studies		**71**
Development Impact	♦ … on community and family social conditions ♦ … of mine closure ♦ … on traditional economy ♦ social impact of boom-bust cycle ♦ … on culture and heritage sites ♦ … on land claims discussions ♦ … on outfitting businesses ♦ … of new transportation corridors	**9**, **65**, **71** **71** **68** **24** **69** **69** **28** **64**
Demographics	♦ baseline data (specifically for N'dilo, Dettah, Bathurst Inlet and Omingmaktok) ♦ baseline data on numbers and ages of children in families, families per household, numbers of single-parent families ♦ human resource inventory	**18**, **7**, **71**, **68** **65** **18**
Socio-Economic	♦ baseline data - (not specified) ♦ gender specific baseline data and anlysis	**9**, **65** **65**

- numbers correspond to numbers on reference list, item 8 of this report.

APPENDIX G

MASTER LIST OF PRESSURES AND EFFECTS

ENVIRONMENTAL PRESSURES-EFFECTS RELATIONSHIPS

	Pressures									
	Atmospheric Emissions	Drainages/Diversions/Culverts	Dams/Flow Regulation	Alteration of Landforms/Terrain	Ground Disturbance	Increased Human Activity	Improved Human Access	Accidental Fires	Contamination	Synergism
Effects										
Reduced Air Quality	■			■	■		■	■	■	■
Surface Erosion/Deposition & Sedimen			■	■	■			■		
Shoreline Erosion & Sedimentation		■	■							
Alteration of Permafrost		■	■	■	■			■		
Alteration of Surface Drainage		■	■	■	■			■		
Altered Ice Regimes			■							
Shift in Aquatic Ecosystems			■							
Loss of Aquatic Habitat		■	■	■	■					
Loss of Shoreline Habitat		■	■							
Loss of Riparian Habitat		■	■		■			■		
Blockage of Fish Movements		■	■		■					
Fish Mortality (harvest, stranding)		■	■				■			
Direct Removal of Terrestrial Vegetation		■	■		■			■		
Direct Loss of Wildlife Habitat		■	■		■			■		
Displacement of Wildlife			■					■		
Habitat Alienation/Sensory Disturbance		■	■	■	■	■	■			
Disruption of Wildlife Movements		■	■	■	■	■	■			
Habitat Fragmentation		■	■	■	■	■	■	■		■
Loss of Habitat Connectivity		■	■	■	■	■	■	■		■
Increased Wildlife Mortality						■	■	■		
Wildlife Drowning			■							
Release of Contaminants (flooding)			■							
Change in Water Quality (chemical)	■							■	■	■
Contamination/Mortality of Fish	■								■	■
Contamination/Mortality of Vegetation	■								■	■
Contamination/Mortality of Wildlife	■								■	■
Synergistic Effects of Contaminants	■								■	
Food Chain Effects	■								■	■

SOCIO-ECONOMIC PRESSURES - EFFECTS RELATIONSHIPS

	Pressures									
	Contamination	Changes in Access	Alterations in Drainage	Atmospheric Emissions	Human Disturbance	Moderate to Large Scale Destruction	Changes in Activities and Opportunities	Increased Income / Employment	Rate of Development Regionally	Changes in investment
Effects										
Contaminants in the Food Chain	■		■	■	■	■			■	
Changes in Nutrition / Traditional Food	■	■			■	■		■	■	
Changes in Human Health	■	■	■	■	■	■	■	■	■	■
Decreased Water Quality	■		■	■	■				■	
Loss of Language							■		■	
Alterations in Cultural Technology					■	■	■	■	■	
Loss of Cultural and Historical Sites		■			■	■	■		■	
Changes in Harvesting	■	■	■		■	■	■	■	■	
Changes in Land Use / Hunting Routes	■	■	■		■	■			■	
Changes in Costs of Living						■	■	■	■	■
Economic Opportunities						■	■	■	■	■
Economic Benefits / Dis-benefits						■	■	■	■	■
Increased Income Levels						■	■	■	■	■
Increased Economic Risks							■	■	■	■
Changes in Economic Stability							■	■	■	
Changes in Cultural Businesses / Activities									■	■
Altered Communication / Education							■		■	■
Increased or Fluctuating Populations					■		■		■	
Increased Number of Transients					■	■	■		■	■
Increases in Crime								■	■	■

APPENDIX H

PRIORITIZATION OF EFFECTS

PRIORITIZATION - ENVIRONMENTAL EFFECTS

	Prioritization Criteria								
Effects	**Concern**	**Timing of Activity**	**Georgraphic Scope**	**Magnitude**	**Duration**	**Frequency**	**Risk**	**Priority**	***Action***
Reduced Air Quality	H	H	L	L	H	M	L	LM	
Surface Erosion/Deposition & Sedimen	H	H	L	L	H	M	H	LM	
Shoreline Erosion & Sedimentation	H	M	L	L	M	H	H	M	
Alteration of Permafrost	H	H	L	L	H	H	H	MH	does not include global warming
Alteration of Surface Drainage	H	H	M	L	H	H	H	H	**WKSS**, with DIAND, Envmt. Cda, Communities
Altered Ice Regimes	H	M	L	H	H	H	H	M	assumes hydro dev't in next 5 yrs.
Shift in Aquatic Ecosystems	H	M	L	H	H	H	H	M	
Loss of Aquatic Habitat	H	H	M	H	H	L	H	H	loss of genetic diversity; beyond capability of WKSS
Loss of Shoreline Habitat	H	H	L	H	H	L	H	M	
Loss of Riparian Habitat	H	H	M	M	M	M	H	MH	
Loss of Eskers		H	L	M	H	M	H	H	**WKSS**, with DIAND, GNWT, NPC, Communities
Blockage of Fish Movements	H	H	M	H	H	H	M	M	
Fish Mortality (harvest, stranding)	H	H	H	L	M	H	H	M	loss of genetic diversity
Loss of Terrestrial Vegetation	H	H	L	H	H	H	H	H	loss of genetic diversity; beyond capability of WKSS
Direct Loss of Wildlife Habitat	H	H	L	H	H	H	H	H	**WKSS**, with GNWT, DOE, Communities
Habitat Alienation/Sensory Disturbance	H	H	H	?	H	H	H	H	**WKSS**, with GNWT, DOE, Communities
Disruption of Wildlife Movements	H	H	H	H	H	H	H	H	**WKSS**, with GNWT, DOE, Communities, Co-Mgmt. orgs.
Habitat Fragmentation / Connectivity	H	H	H	H	H	H	H	H	**WKSS**, with GNWT, DOE, Communities
Increased Wildlife Mortality	H	H	H	H	H	H	H	H	**WKSS**, with GNWT, DOE, Communities, Co-Mgmt. orgs.
Wildlife Drowning	H	L	M	H	L	L	L	LM	concern-caribou drowning in shipping lanes
Release of Contaminants (flooding)	H	M	M	H	H	L	H	LM	
Change in Water Quality	H	H	H	H	H	H	H	H	**WKSS,** w/ DIAND, DOE, GNWT, Comms., Co-Mgt. orgs.
Contamination / Mortality of Fish	H	H	L	H	H	M	L	M	
Contamination / Mortality of Vegetation	H	H	L	L	H	M	L	L	issue of LRTAP*- dealing with point source
Contamination / Mortality of Wildlife	H	H	H	L	H	H	M	M	
Food Chain Effects	H	H	H	?	H	H	?	H	WKSS recommend to AES (NCP)

PRIORITIZATION - SOCIO-ECONOMIC EFFECTS

	Prioritization Criteria								
Effects	Concern	Timing	Scope	Severity	Duration	Frequency	Acceptance	Priority	***Action***
Contaminants in the Food Chain	VH	H	H	H	H	H	H	H	**WKSS**, AES, GNWT
Changes in Nutrition / Traditional Food	H	H	M	M	H	H	M	H	GNWT, CINE
Changes in Human Health	H	H	H	H	H	H	H	H	**WKSS**, GNWT
Decreased Water Quality	H	M	H	H	H	H	H	H	**WKSS**, DIAND
Loss of Language	H	H	H	H	H	H	H	H	Language Commission, Communities
Alterations in Cultural Technology	M	H	H	H	H	H	L	M	None, Largely Accepted or have Choice
Loss of Cultural and Historical Sites	H	H	L	L	L	L	H	L	None, Acceptable Regulations
Changes in Harvesting	H	H	H	H	H	H	H	H	**WKSS**
Changes in Land Use / Hunting Routes	H	H	H	H	H	H	H	H	**WKSS**
Changes in Costs of Living	M	H	H	M	H	H	L	M	None
Economic Opportunities	H	H	M	M	M	M	H	H	**WKSS**
Increased Economic Variability	H	H	H	H	H	M	H	H	**WKSS**
Altered Communication / Education	H	M	H	H	M	H	M	H	**WKSS**
Increased or Fluctuating Populations	H	M	M	H	M	M	H	M	Government / Communities
Increased Number of Transients	H	M	M	H	M	M	M	M	Government / Communities
Increases in Crime	H	M	H	M	M	M	H	M	Government / Communities