EXECUTIVE SUMMARY

Background

The NWT is undergoing an unprecedented boom in non-renewable resource development. One new diamond mine is in production, another is under construction and another two (one just across the border in Nunavut) are in the regulatory process. Over $1 billion worth of oil and gas exploration activities are anticipated over the next few years in the NWT, including an application for a Mackenzie Valley natural gas pipeline.

Non-renewable resources in the NWT are still largely under the jurisdiction of the federal government. Aboriginal governments have some surface and sub-surface land holdings. Co-management bodies have been established under land claims agreements covering various regions of the NWT, generally to carry out land use planning, environmental assessment, and land and water management, and may take on cumulative impact monitoring. An independent, comprehensive environmental audit is to be undertaken in the Mackenzie Valley at least every five years.

The federal government committed to establishing a framework within which the combined effects of all this resource development would be appropriately assessed and managed. This undertaking is known as the Cumulative Effects Assessment and Management Strategy and Framework (CEAMF).

The Project

In order to further the goal of establishing such a Framework, a project was designed to develop an understanding of the concepts of carrying capacity and ecological thresholds and the role that these concepts have in the development and implementation of a cumulative effects assessment and management framework. The Macleod Institute for Environmental Analysis at the University of Calgary (the Institute) was retained to conduct the project, and was asked

a) to develop an approach to integrating the principles of carrying capacity and thresholds into cumulative effects assessment and management in Canada's North, and

b) to review and discuss the potential use of [this] approach in the integrated resource management system set up under the *Mackenzie Valley Resource Management Act* and *Inuvialuit Final Agreement*.

The first step in the project involved a review of leading literature sources on carrying capacity and thresholds as they relate to resource management, particularly at the landscape or regional level. Secondly, the Institute searched for examples in Canada and elsewhere in which the concepts of ecological carrying capacity and thresholds have been used at the landscape or regional level. Thirdly, a number of experts (as identified by the project's steering committee) were interviewed with respect to their experience and insights regarding the use of carrying capacity and ecological thresholds in management frameworks.

The Management Challenge

Industrial and commercial activities are valued for the economic benefits they offer, but they also cause environmental and social impacts. Managing resource development in a way that leaves no lasting ecological damage and improves overall social outcomes is a complicated business. Years ago, proposed developments were dealt with one at a time, more or less as a stand-alone undertaking. Attention was concentrated on immediate impacts caused by emissions, effluents and waste materials from each separate project, and little time was spent on the question of what happened when these were added to the effects of other developments in the same area. As the pace of development increased, however, it was recognized that cumulative effects (incremental effects resulting from the combined influences of various projects) were also important. In 1992, laws were passed to ensure that these cumulative impacts were included in the business of managing industrial developments.

Looking at the cumulative effects of several projects at once tends to force attention away from one project's neighbourhood and broaden it to include whole regions. Instead of focusing on just one river where a project is located, for example, a consideration of cumulative effects will often take an entire watershed into account because of the combined influences of a number of human activities in the area. At the same time, scientists were gaining an increasingly sophisticated understanding of intricate natural systems and encouraged others to take an ecosystem approach to environmental management. There was also a growing awareness that these systems are so complex that it is hard to predict with total certainty what will happen on a large scale when human activities give rise to continuous interventions.

The management challenge is to know, ahead of time if possible, but also as time goes on, how many and what kind of activities will net the best results in the long run from an economic, environmental and social point of view. The concepts of carrying capacity and ecological thresholds and the role they might play in meeting this challenge, are the subject of this report.

Carrying Capacity

The concept of carrying capacity has been around for a couple of hundred years. The World Conservation Union (IUCN) defines it as "the capacity of an ecosystem to support healthy organisms while maintaining its productivity, adaptability, and capability for renewal" (*Caring for the Earth,* 1991). Carrying capacity has also been defined in a development context ("human carrying capacity") as "the maximum rate of resource consumption and waste discharge that can be sustained indefinitely without progressively impairing the functional integrity and productivity of relevant ecosystems" (University of Michigan, 1998).

Theoretically, if you could calculate this maximum rate, or carrying capacity, then management could at any time add up the amount each human activity contributes to the total sum of resource consumption and waste discharge, and decide how many and what kind of activities would be allowed to proceed or continue. Unfortunately, this approach appears to have worked well only on a small scale when a limited number of variables are involved (how many cattle a paddock will support, and for how long, for example). The larger the area, and the greater the number of variables, the more imprecise are the estimates of carrying capacity, and the less reliable the management decisions (cod fisheries on Canada's east coast provide an illustration of failed resource management plans based on carrying capacity concepts).

The fact is, we still don't know enough to be able to calculate a precise, reliable carrying capacity for large, complex systems. Still, it stands to reason (and experience has shown) that there is a limit to what the natural environment can tolerate in the way of human interventions. An approach was therefore developed that built on the theoretical and practical development of past carrying capacity models, but shifted emphasis away from outputs and mathematical calculations to end results and value judgements. This approach is known as the Limits of Acceptable Change.

Limits of Acceptable Change (LAC)

The concept underlying Limits of Acceptable Change is carrying capacity. However, as one scientist has said, LAC makes three important advances (Gimblett, 2001):

- it focuses more on outcomes (i.e., resource conditions to be maintained), than on the number of activities (i.e., the amount and type of resource uses);
- it recognizes that any use causes impacts, and that deciding on how much change is too much change is largely a value judgement; and
- it provides a framework for defensible value judgements.

The LAC process decides how much change will be allowed to take place, where, and the actions needed to control it. It involves deciding what kinds of conditions are acceptable, then prescribing actions to protect or achieve those conditions. If an area does not meet those conditions, then management actions must be taken to correct the situation (US National Forest Service, 2001).

Decisions as to what kinds of conditions are acceptable are made by a multi-stakeholder group that first describes (in narrative form) the *resulting* resource, social and managerial conditions they consider to be appropriate in connection with particular resource uses. Key components of the narrative description are then identified as specific variables that, singly or in combination, are taken to be indicative of the acceptable conditions. These become the measurable resource and social indicators around which standards are set and management programs are designed and implemented.

The LAC approach offers considerable potential for use in Canada's North. It is

- consensus-based — it relies on balancing multi-stakeholder views to choose desired outcomes and to apply them in areas of primary stakeholder interest or concern;
- pragmatic — it acknowledges that human activity will continue;
- principled — it establishes limits to activity that are based on social and ecological factors;
- transparent — it selects measurable indicators and sets attainable standards; and
- action-oriented — it explicitly drives toward a management program that includes an implementation schedule and monitoring agenda.

The fourth point (measurable indicators and attainable standards) leads to a discussion about thresholds.

Thresholds
At its most basic, a threshold is a boundary, limit or line dividing one state from another. In everyday language, we talk of the threshold of a house (the line that marks the difference between being inside and outside a home). Transported into environmental terms, a threshold is commonly said to be the boundary that marks the difference between an acceptable and an unacceptable state or condition of the resource under consideration. Acceptability can be determined from either an ecological or social point of view (or both), and can be expressed either numerically or qualitatively.

Most numerical environmental thresholds have been stated in the form of standards created for specific substances. For example, the Canadian Environmental Quality Guidelines set a limit for mercury releases in community water supplies of 1 microgram per tenth of a litre. Different limits apply to a mercury deposit in soils, according to their uses (agricultural, residential, commercial or industrial). Standards such as these are based on chemical and risk analysis, and have provided important thresholds for a wide range of potential contaminants of concern to human or animal health. However, they tend to describe acceptable conditions in terms of particular pollutants (i.e., not too much mercury) rather than in terms of healthy ecosystems.

To date, very few ecological thresholds have been prescribed for whole ecosystems or regions. The Institute could find only two cases in which they are being applied at a regional scale (Lake Tahoe and Chesapeake Bay). The reason for this lies in the sheer complexity and large number of variables involved in natural systems taken as a whole. Continuing research has, however, demonstrated that all ecological systems exhibit four characteristics (structure, function, interrelationships and change over time) and that these characteristics are revealed in different ways depending on what scale they are being observed. A fair amount of work is being done to establish the scientific basis (similar to the way standards are created for substance releases) for setting non-chemical standards that describe acceptable conditions for these characteristics, but the results of such efforts will not likely be available for general application for several years yet. In the meantime, more and more attention is being given to indicators and their use as representative measures of environmental performance.

Indicators
Indicators are select subsets of data which, taken singly or in combination, are thought to give a good picture of what is happening in an overall system. The Consumer Price Index (CPI) is an example of a combination of indicators used to represent what is happening in the overall economic system from a consumer's point of view. The CPI tracks prices of a fixed basket of commodities (over 600 basic goods and services) purchased by Canadians every year. These prices are then treated as indicators of the rate at which prices change for *all* goods and services bought by Canadian consumers.

A simple example of indicators used in an environmental management program tracks the density and condition of campsites in a recreational zone. In this instance, the acceptable condition for one particular zone of the Rattlesnake National Recreation Area is described as 'pristine', meaning that emphasis is placed on sustaining natural ecological processes. The number of existing campsites and the persistence of visual evidence of camping from year to year are taken as indicators of whether the acceptable condition is achieved.

The advantage of indicators is that they introduce a degree of clarity to environmental objectives that was often missing in previous decades. Typically, a 'bundle' of indicators will be chosen so that the appropriate array of environmental dimensions will be addressed. However, indicators must be chosen carefully, so that they are directly representative of the results which management goals are aiming to achieve.

[1] Valued Ecosystem Components (VECs) and Valued Socio-economic Components (VSCs) often fail this test. They tend to focus attention on charismatic species, rather than on impacts measured as an indicator of what is happening in the ecosystem. In the Rattlesnake National Recreation Area, bears may very well be VECs, for example, but the management goal is to minimize impacts caused by human activities in the pristine zone. Therefore campsite density and condition provide a more appropriate indicator than bears.

Many environmental management programs now use indicators to set quantifiable standards. Again, the Rattlesnake Management Plan (created by stakeholders following the LAC process) is a good illustration of this approach. The standard set for campsite density is "no increase in the existing number of campsites"; and for campsite condition it is "evidence of camping not to persist from year to year". In the event that either of these standards is exceeded, management intervenes to correct the situation.

In effect, acceptable conditions, and indicator values chosen to represent them, are used as thresholds when making managerial decisions and assessing the significance of proposed activities. The indicators/standards are as specific as the current level of (scientific and other) knowledge permits, reflect a balancing of public interests and accommodate certain practicalities such as the feasibility of collecting required data.

Putting It All Together

The Limits of Acceptable Change (LAC) model offers a practical approach to integrating the concepts of carrying capacity and thresholds into the NWT's integrated management system. It factors environmental, social and economic considerations into the framework for managing human activities in a way that maintains respect for ecological well-being. Goals and objectives emphasize the positive, by describing environmental and social conditions that reflect desired outcomes as seen from a multi-stakeholder perspective. LAC is also action-oriented. It explicitly drives toward a management program that includes an implementation schedule and monitoring agenda, yet it avoids mechanistic or formula-driven management interventions.

The LAC approach builds on and is congruent with existing initiatives in the NWT. Land-use goals articulated by the Sahtu and Gwich'in communities, for example, fit well within the model. Both have expressed a desire to balance development and preservation, and both lean towards describing their desired outcomes in terms of the conditions that would prevail if the outcomes were achieved.

Nine steps to apply the LAC model in the NWT are briefly outlined, as follows:

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[1] A VEC is any part of the environment that stakeholders consider to be of particular importance. Similarly, a VSC is any part of the cultural or economic domain that stakeholders consider to be of particular importance.

Step	Purpose	Comments
Ø	Identify issues and principles	a. Stakeholders should include all land-use, impact assessment and other regulatory boards; permit issuers and environmental managers; the research community and similar experts; ENGOs; community members; industry and industry oversight agencies b. Principles will likely include a commitment to integrated resource management, the precautionary principle, sustainable development and ecological integrity c. The LAC process is a consensus-building model. However, the intent is to balance stakeholder interests. Consensus in this context does not require that decisions be unanimous.
Ù	Define elements and describe acceptable conditions	a. A series of elements (what the LAC process calls 'opportunity classes') are defined. Examples could include Industrial Development, Conservation, Recreation etc. b. For each element, hypothetical narrative descriptions are prepared, outlining the range of conditions that stakeholders consider acceptable and attainable
Ú	Select indicators of resource and social conditions	a. Indicators are chosen for the purpose of representing the acceptable conditions described for each element b. The number of indicators for each element are kept to a manageable level c. Indicators will be quantifiable wherever possible
Û	Inventory existing resource and social conditions	
Ü	Specify measurable standards for the resource and social indicators selected in step 3	a. The standards in effect become thresholds around which a management and action plan are structured b. Existing standards and guidelines are incorporated as appropriate. An example would be the *Canadian Drinking Water Guidelines*
Ý	Identify alternative allocations for each element	a. An allocation assigns the elements to specific areas of the region b. Stakeholders identify and rank each proposed alternative allocation c. This is a prescriptive step and final decisions will be made by persons with the appropriate authority, based on the input from stakeholders (see step 8)

Step	Purpose	Comments
Þ	Identify management actions for each alternative	a. Differences, if any, between current conditions (inventoried in step 4) and standards (specified in step 5) are identified b. Management actions that would best bring conditions up to standard are specified c. In addition, potential management actions and policies are identified for the purpose of dealing with future situations d. A tiered management approach is outlined, incorporating the Precautionary Principle etc. e. Roles and responsibilities are clearly identified, according to existing authorities
ß	Evaluate and select a preferred alternative allocation	a. The final allocation decisions are made by persons with the appropriate authority (based on input from stakeholders from step 6)
à	Implement and monitor for feedback	a. Each of the authorities tasked with responsibilities (see step 7) implements the plan b. Monitoring and data collection activities could be coordinated and overseen by a Part 6 (*MVRM Act*) authority, but would also include activities undertaken by industry, existing initiatives such as the West Kitikmeot Slave Study, community-based initiatives etc. c. Periodic, systematic feedback regarding the performance of the management program will lead to improvements and adjustments over time. The management plan is not intended to be cast in stone. Rather it is a living document subject to refinement as circumstance and knowledge dictate

An Integrated Resource Management System

The LAC model is specifically designed to result in a full management program, rather than a data collection activity plan. It incorporates the concepts of carrying capacity and ecological thresholds in every phase of the management cycle, from planning through implementation, to monitoring and feedback. And, as with any management program, effective implementation will only be achieved if senior authorities strongly commit their organizations to the full program.

When applied at a regional scale, the LAC model demands cooperation and collaboration between a large number of regulatory and administrative agencies. This feature of the LAC approach could well be one of its strengths in the NWT context where a strong movement to co-management has been gaining momentum for years. The basic components of an integrated resource management system already exist in the NWT, having been set up under the *Mackenzie Valley Resource Management Act* and *Inuvialuit Final Agreement*.