Practical Guide for Preparing Cumulative Environmental Effects Assessment

Georgetown, Guyana

NRCan (CANMET) – GENCAPD Mining Project

Our File: M-6763-3 (603430)

January 2004

SNC•LAVALIN Environment

Member of the SNC•LAVALIN Group

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DISCLAIMER

The primary purpose of this publication is to provide a practical guide on preparing Cumulative Environmental Effects Assessments (CEEA). It expresses the professional opinion of SNC-LAVALIN ENVIRONMENT INC. (SLI) regarding the matters set out herein, based on SLI's professional judgment and reasonable due diligence. It is to be read in the context of the agreement of August 4, 2003 (the Agreement) between SLI and Natural Resources Canada (the Client), and in accordance with the methodology, procedures and techniques that SLI used, the assumptions SLI made, and the circumstances and constraints under which SLI carried out its mandate. This document is meant to be read as a whole, and sections or parts thereof should therefore not be read or relied upon out of context.

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1. ABOUT THIS GUIDE

This guide is inspired from the Canadian Environmental Assessment Agency's *Cumulative Effects Assessment Practitioners Guide, updated in October 2003.* Some adaptation and simplification were done in order to make it more suitable to small-scale and medium-scale mining.

1.1 What is the purpose of this guide

The purpose of this guide is to provide stakeholders and practitioners in Guyana with:

- An overview and clarification of current understandings about the practice of CEEA.
- Suggestions on practical approaches to complete CEEAs that meet statutory requirements and best professional practice.
- Case studies of approaches used.
- Practical exercises bearing on the Mahdia region to help in assimilating the concepts.

1.2 CEEA and EIA

This guide assumes the user has a basic knowledge of Environmental Impact Assessment (EIA) fundamentals, as many attributes of CEEAs are based on those originally developed for EIAs. The challenges in implementing CEEAs are very similar to long-standing issues in Environmental Impact Assessment practice. CEEAs typically build upon existing methods and approaches to EIA. In recognition that there is not one single prescriptive method to conduct a CEEA (or an EIA), this guide demonstrates various approaches by way of example. It shows why and how certain methods or approaches have been used by practitioners to deal with cumulative environmental effects associated with selected actions and discusses what lessons can be learned. Practitioners may then choose an approach appropriate to meet their unique assessment requirements.

Although the word “impact” is usually employed when referring to assessing how a project is affecting the environment or the community, in this guide the term “effect” will be often used instead of impact. Effects refer to the response of the environmental or social component to the impact of an action (see section 2.1). This response is what we actually want to know, beyond the impact itself.

2. INTRODUCTION

Concerns are often raised about the long-term changes that may occur not only as a result of a single action but the combined effects of each successive action on the environment. Cumulative Environmental Effects Assessment is done to ensure the incremental effects resulting from the combined influences of various actions are assessed. These incremental effects may be significant even though the effects of each action, when independently assessed, are considered insignificant.

Assessment of cumulative effects is increasingly seen as representing best practice in conducting environmental assessments. Furthermore, in many legislation, assessment of cumulative effects is now required, such as in Canada when an action is subject to a federal environmental assessment under the *Canadian Environmental Assessment Act*.

A major concern of proponents is how to respond to increasing expectations by regulators and the public of what must be considered in a CEEA and how a CEEA is to be performed. When faced with determining an appropriate level of response, the proponent may ask the following questions, all of which are addressed in this Guide:

- How do we avoid assessing everything?
- How do we identify what is important to assess?
- How large an area around the action under review do we have to assess?
- What other actions should we consider?
- Over what duration of time must effects be assessed?
- How do we determine significance of these cumulative effects?
- What do we need to do about these cumulative effects?

2.1 Some definitions

Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions. This definition takes into consideration the effects due to other projects.

Glossary

Action:	Any project or activity of human origin.
Assessment framework:	A description of a process that organizes actions and ideas, usually in a step-by-step fashion. Frameworks help to guide practitioners in carrying out an assessment.
Baseline information:	A description of existing environmental, social and economic conditions at and surrounding an action.
Direction:	The degree to which an effect on a valued environmental component will worsen or improve as the action proceeds.
Effect:	Any response by an environmental or social component to an action's impact. Any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.
Environmental components:	Fundamental elements of the natural environment. Components usually include air, water (surface and groundwater), soils, terrain, vegetation, wildlife, aquatics and resource use.

Impact model: A formal description of a cause-effect relationship that allows the assessing of various components of that relationship through the use of an Impact Statement, a Pathway Diagram, and the validation of linkages and pathways.

Impact Statement: The description of a suspected cause-effect relationship through the use of a formal scientific hypothesis.

Indicators: Anything that is used to measure the condition of something of interest. Indicators are often used as variables in the modeling of changes in complex environmental systems.

Likelihood: The degree of certainty of an event occurring. Likelihood can be stated as a probability.

Linkage: The relationship between a cause and effect in impact models. Linkahes are illustrated in Pathway Diagrams as arrows between boxes.

Mitigation: A means of reducing, eliminating or controlling the significance of adverse effects.

Pathway: A series of consecutive valid linkages in a Pathways Diagram.

Pathway Diagram: A simple diagrammatic representation of a cause-effect relationship between two related states or actions that illustrates an impact model. Pathway diagrams take network diagrams one-step further by evaluating each linkage and assessing the cause-effect relationship in the context of a scientific hypothesis.

Project footprint:	The land or water area covered by a project. This includes direct physical coverage (i.e. the area on which the project physically stands) and direct effects (i.e. the disturbances that may directly emanate from the project, such as noise).
Region:	Any area in which it is suspected or known that effects due to the action under review may interact with effects from other actions.
Significance:	A measure of how adverse or beneficial an effect may be on a VEC.
Scoping:	A consultative process for identifying and possibly reducing the number of items (e.g. issues, VECs) to be examined until the most important items remain for detailed assessment. Focusing ensures that assessment effort will not be expended in the examination of trivial effects.
Threshold:	A limit of tolerance of a VEC to an effect, that if exceeded, results in an adverse response by that VEC.
Valued Ecosystem Component (VEC):	Any part of the environment that is considered important by the proponent, public, scientists and governments involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concerns.

3. ASSESSMENT FUNDAMENTALS

As defined in section 2.1, cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions. CEEA is environmental assessment as it should always have been: an Environmental Impact Assessment (EIA) done well. In practice, the assessment of cumulative effects requires consideration of some concepts that are not always found in conventional approaches followed in EIAs. Specifically, CEEAs are typically expected to:

- Assess effects over a larger (i.e., "regional") area that may cross jurisdictional boundaries [Includes effects due to natural perturbations affecting environmental components and human actions].
- Assess effects during a longer period of time into the past and future.
- Consider effects on Valued Ecosystem Components (VECs) due to interactions with other actions, and not just the effects of the single action under review.
- Include other past, existing and future (e.g., reasonably foreseeable) actions.
- Evaluate significance in consideration of other than just local, direct effects.

Cumulative effects are not necessarily that much different from effects examined in an EIA; in fact, they may be the same. Many EIAs have focused on a local scale in which only the "footprint" or area covered by each action's component is considered. Some EIAs also consider the combined effects of various components together (e.g., a concentrator and its access road). A CEEA further enlarges the scale of the assessment to a regional level. For the practitioner, the challenge is determining how large an area around the action should be assessed, how long in time, and how to practically assess the often complex interactions among the actions. In all other ways, CEEA is fundamentally the same as EIA and, therefore, often relies on established EIA practice.

3.1 Conditions for potential cumulative effects

Cumulative effects may occur if:

- Local effects on VECs occur as a result of the action under review.
- Those VECs are affected by other actions.
  (See section 2.1 for a definition of action).

Human actions often cause a disturbance to the environment. These actions include projects and activities. Projects are typically some form of physical work that is planned, constructed and operated. Projects are usually identified by a specific name. Activities may be part of a project, or not associated with any particular project but arise over time due to ongoing human presence in an area. A mine development, a resource access road, or both together are examples of a project. Overburden stripping, construction of facilities, ore transportation, public traffic along that road are examples of activities.

For the purposes of a CEEA, the effects on the environment of other projects and activities also have to be considered. For convenience, in this Guide, the term "Actions" is used when appropriate to represent both projects and activities. The term "project" is used only in reference to the project being proposed under assessment or under regulatory review.

3.2 Examples of cumulative effects

Here are some examples of cumulative effects:

- Air: combined SO_2 emissions within a regional airshed from three operating natural-gas processing plants.
- Water: combined reductions in flow volumes within a particular river resulting from irrigation, municipal and industrial water withdrawals.
- Wildlife: combined black bear mortalities within a given wildlife management unit from hunter harvest, road kills and destruction of nuisance animals.

- Vegetation: clearing of land resulting in the removal of a patch of regionally rare plant species.

- Resource use: continual removal of merchantable timber from a timber management area.

Case study 1
Cold Lake Oil Sands project: Effects at a regional scale

Environmental Component	Examples of Potential Regional Effects
Air Systems	Plumes from stack emissions combining with the plumes from nearby burns.
Surface Water	Reductions of river water volumes due to use by the project, other energy projects and nearby communities.
Aquatic Resources	Decrease in productivity of spawning habitat due to combined sedimentation from the project and regional forestry operations and activities.
Soils and Terrain	Continued loss of soils.
Vegetation	Less representation of certain plant species on a regional scale.
Wildlife	Increased road access and changes to habitat resulting in further regional changes to numbers and distribution of certain wildlife species.
Resource Use	Forestry activities, land use by the project, and increased road access changes the harvest potential for furbearer species.

Case study 2
Determining if there are cumulative effects

To assist in its deliberations on cumulative effects during the public hearings for a proposed pipeline in Alberta (NEB 1996), the Review Panel identified three requirements that must be met before they would consider as relevant any evidence related to cumulative effects:

1) There must be an environmental effect of the project being assessed.

2) That environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities.

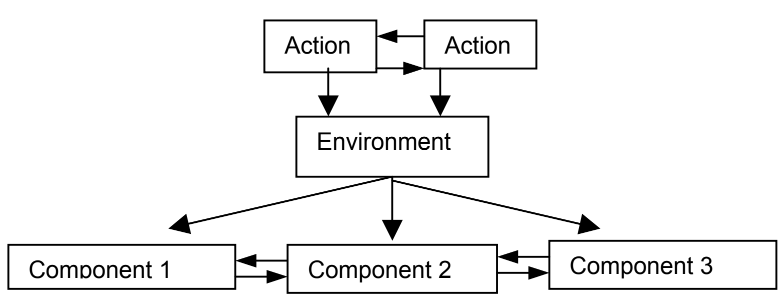
3) It must be known that the other projects or activities that have been, or will be, carried out are not hypothetical.

In the Panel's subsequent Decision Report, the Panel noted that a further requirement was that the "cumulative environmental effect is likely to result".

3.3 Effects pathways

Cumulative effects occur as interactions between actions, between actions and the environment, and between components of the environment. These "pathways" between a cause (or source) and an effect are often the focus of an assessment of cumulative effects (see Figure 3-1). The magnitude of the combined effects along a pathway can be equal to the sum of the individual effects (additive effect) or can be an increased effect (synergistic effect). There are numerous other types of interactions defined in the literature by such terms as linear, multiplicative, compounding, structural surprise, space cycling, and space lags, etc. Although of interest in understanding the complexity of cumulative effects, determining which type is actually occurring (aside from additive effects) and measuring the interaction is often difficult in practice.

Figure 3-1
Effects pathways



3.4 How cumulative effects occur

Cumulative effects can occur in various ways:

- Physical-chemical transport: a physical or chemical constituent is transported away from the action under review where it then interacts with another action (e.g., air emissions, waste water effluent, sediment).

- Nibbling loss: the gradual disturbance and loss of land and habitat (e.g., clearing of land for a new sub-division and roads into a forested area) [This can include alienation of wildlife habitat due to sensory disturbances].

- Spatial and temporal crowding: cumulative effects can occur when too much is happening within too small an area and in too brief a period of time. A threshold may be exceeded and the environment may not be able to recover to pre-disturbance conditions. This can occur quickly or gradually over a long period of time before the effects become apparent. Spatial crowding results in an overlap of effects among actions (e.g., noise from a highway adjacent to an industrial site, confluence of stack emission plumes, close proximity of timber harvesting, wildlife habitat and recreational use in a park). Temporal crowding may occur if effects from different actions overlap or occur before the VEC has had time to recover.

- Growth-inducing potential: each new action can induce further actions to occur. The effects of these "spin-off" actions (e.g., increased vehicle access into a previously unroaded hinterland area) may add to the cumulative effects already occurring in the vicinity of the proposed action, creating a "feedback" effect. Such actions may be considered as "reasonably-foreseeable actions".

4. KEY TASKS IN COMPLETING CEEAs

4.1 The Assessment Framework

CEEAs build on what has been learned and applied in EIA practice for many years. However, assessment practitioners need to know in what ways assessing cumulative effects are different. This Chapter of the Guide identifies and discusses unique tasks in CEEAs for each of the five steps in a basic EIA framework: scoping, Analysis, Mitigation, Significance and Follow-up [Mitigation may also be identified after significance is evaluated; however, the interpretation of significance changes (both approaches have been suggested in the EIA literature as valid). In the order shown in the Framework (mitigation before significance), significance reflects residual effects.

EFFECT – MITIGATION MEASURE(S) = RESIDUAL EFFECT

This approach implies that mitigation must be identified regardless of whether there is a significant effect. However, this is not always an onerous task as many mitigation measures are "standard" practice and often expected to be recommended by regulators. In the reverse order (significance before mitigation), the significance reflects the "worst-case" situation before mitigation is applied, and therefore provides an understanding of what may happen if mitigation fails or is not as effective as predicted. In recent practice, the former approach is more common (mitigation before significance), largely to better reflect the eventual outcome to decision makers under the assumption that mitigation is effective as described.]. This framework itemizes the typical steps followed by practitioners in completing EIAs. Table 4-1 identifies each of the CEEA tasks for these steps.

Table 4-1
Assessment Framework

Basic EIA Steps	Tasks to complete for a CEEA
1. Scoping	• Identify regional issues of concern. • Select appropriate regional VECs. • Identify spatial and temporal boundaries. • Identify other actions that may affect the same VECs. • Identify potential impacts due to actions and possible effects.
2. Analysis of Effects	• Complete the collection of regional baseline data. • Assess effects of proposed action on selected VECs. • Assess effects of all selected actions on selected VECs.
3. Identification of Mitigation	• Recommend mitigation measures.
4. Evaluation of Significance	• Evaluate the significance of residual effects. • Compare results against thresholds or land use objectives and trends.
5. Follow-up	• Recommend regional monitoring and effect management.

Ideally, all aspects of a CEEA are done concurrently with the EIA, resulting in an assessment approach that makes no explicit distinction between the two "parts". In practice, however, the substantive work in a CEEA is often done after the *initial* identification of effects has been completed in an EIA. In this way, the early identification of direct project effects "paves the way" for cumulative effects to be assessed. The Assessment Framework is suitable for assessing actions of any size. However, as discussed in Chapter 5, a scaled-down framework may be more suitable for assessing smaller actions (e.g., in screenings).

During the completion of a CEEA, the five steps of the framework are usually completed in order. However, earlier steps may be repeated during an assessment if new information suggests that earlier assumptions and conclusions were incorrect. Also, it is possible that the results of post-project effects monitoring may indicate that further assessment is required.

4.1.1 What a project-specific cumulative effects assessment fundamentally needs to do

A CEEA, for a single project under regulatory review, should fundamentally do the following:

1) Determine if the project will have an effect on a VEC.

2) If such an effect can be demonstrated, determine if the incremental effect acts cumulatively with the effects of other actions, either past, existing or future.

3) Determine if the effect of the project, in combination with the other effects, may cause a significant change now or in the future in the characteristics of the VEC after the application of mitigation for that project.

With the exception of the consideration of future actions, the above are identical to the requirements of a good EIA (the consideration of the effects of other actions is not necessarily new to CEEA, as the existing environmental setting of a project has typically recognized other actions at least within the EIA's study area).

A key task in accomplishing the above is examining the effect on the VEC until the incremental contribution of all actions, and of the project alone to the total cumulative effect, is understood. Keep in mind that an assessment of a single project (which is what almost all assessments do) must determine if *that* project is incrementally responsible for adversely affecting a VEC beyond an acceptable point (by whatever definition). Therefore, although the total cumulative effect on a VEC due to many actions must be identified, the CEEA must *also* make clear to what degree the project under review is alone contributing to that total effect. Regulatory reviewers may consider both of these contributions in their deliberation on the project application.

The remainder of this Chapter discusses in detail each step of the Assessment Framework.

4.2 Step 1: Scoping

Scoping (or focussing) involves the identification of key issues of concern and VECs, thereby ensuring that the assessment remains focussed and the analysis remains manageable and practical. This assists in determining if the action under review has the potential to contribute to any cumulative effects. Professional judgement is required to achieve an optimum balance between the minimum required by legislation and ideal goals. This is referred to as best professional practice.

Scoping is a well established first step in good EIA practice, and is essential in establishing the assessment's Terms of Reference. Although scoping is not unique to CEEA, the larger regional nature and complexity of assessing cumulative effects means that scoping must be more strictly applied to avoid assessing more than is necessary. A first step in this direction is to focus only on those effects to which the action under review may actually by contributing. For example, although continued reductions in wildlife habitat may be a regional concern, there may be no reason to investigate these effects if the action under review does not contribute to these long-term reductions (e.g., a single pipeline may cause a slight and temporary loss of habitat for some species, while a network of seismic lines or logging roads may cause more significant long-term changes).

The scoping of regional cumulative (i.e., indirect) effects is often completed after the scoping of local (i.e., direct) effects in an EIA. In this case, information and conclusions from the EIA may assist in scoping of the CEEA, including: action description, environmental baseline, identification of issues and VECs, types of effects caused, conclusions about significance of effects, and mitigation measures.

Although local effects may not have been scoped in the EIA in as large a scale as required in a CEEA, the results provide a useful starting point.

4.2.1 What is done first in scoping?

The Assessment Framework identifies five tasks that must be done in scoping a CEEA: issue identification, selection of VECs, setting of boundaries, identification of other actions and initial identification of potential impacts and effects. If performed in that order, the practitioner will be able to make decisions in one step that will guide the decisions for the next. However, this does not always have to be the case. In some situations (e.g., when very large areas have been digitally mapped by remote sensing), it may be more practical to first set some spatial boundaries, then identify other issues and actions, and finally select VECs.

In practice, elements of each of the five steps are often completed concurrently during the earliest stages of scoping. As scoping progresses, it quickly becomes clear what conclusions will be made.

4.2.1.1 Identify regional issues of concern

While many of the issues addressed in an EIA will also be examined in a CEEA, a CEEA may assess a broader range of environmental concerns due to its larger study area. Issues should only be considered if their assessment will influence the decision regarding approval by the regulatory reviewers.

Issues can be identified by soliciting comment from local individuals and regional stakeholders, such as regulators, public organizations, industry, First Nations and directly affected parties. Issues can also be identified by specialists with scientific knowledge of the environmental effects.

Trans-boundary effects (e.g., animal migrations) and global-scale effects (e.g., atmospheric effects such as ozone depletion and global warming) must be addressed if a proposed action may contribute to such effects. However, in recognition of the complexities and often practical difficulty of scoping these effects, the CEEA should at least identify the action's contributing causes, attempt to quantify the magnitude of the action's contribution, and suggest appropriate mitigation responses. In this way, decision-makers can account for the action's contribution within broad (i.e., national or international) initiatives.

It is therefore appropriate for a CEEA to identify and assess trans-boundary or global-level effects that may be affecting the VECs under study; however, the level of mitigative response is often ultimately beyond the capability of a single proponent.

EXERCISE 1

Identification of regional issues of concern in Mahdia

Objective: Identify the regional issues of concern for the Mahdia mining region.
Examples: Water turbidity, mercury in fishes, loss of wildlife owing to noise, deforestation, etc.
Hint: Distinguish between biological, physical and human settings.
Duration: 45 minutes.

4.2.1.2 Select appropriate regional valued ecosystem components

Valued Ecosystem Components (VECs) are components of the natural and human world that are considered valuable by participants in a public review process. VECs need not be environmental in nature. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons. VECs represent the investigative focal point of any EIA or CEEA. CEEA can be concerned with additive or synergistic effects on the same ecosystem components as would be considered in an EIA. In addition to this, CEEA tends to be concerned with larger scale VECs such as within entire ecosystems, river basins or watersheds; and, broad social and economic VECs such as quality of life and the provincial economy. VECs may also be used as indicators.

VECs can be selected by distilling stakeholder concerns, assessing and prioritizing various components through a weighting scheme, and soliciting input from workshops attended by experts and stakeholders.

Case study 3

Issues, Valued Ecosystem Components and Indicators

Cold Lake Oil Sands Project

Environmental Component	Regional Issues of Concern	Regional Valued Components	Examples of Indicators
Air Systems	Acidic deposition, odours, greenhouse gas emissions (global issue)	Air Quality	Emitted gases transported over long distances (NOx, SO2)
Surface Water	Lowering of lake water levels, contamination of water	Water Quality and Quantity	Combined water volume withdrawals, water quality constituents affecting drinking water standards
Groundwater	Depletion of aquifers	Potable well water	Combined water volume withdrawals
Aquatic Resources	Contamination of fish, increased harvest pressures	Sport fish species	Northern pike
Vegetation	Loss of vegetation through land clearing, effects of airborne deposition	Vegetation ecosites	Low bush cranberry, Aspen, White spruce
Wildlife	Loss, sensory alienation and fragmentation of habitat, direct mortality due to increased traffic and hunting harvest	Hunted and trapped species	Moose, black bear, lynx, fisher
Resource Use	Decreased opportunities for resource harvesting (fish, traditional plants, hunting, timber, trapping), increased road access, visual effects	Timber harvest areas, furbearers, game species, new road access, recreational enjoyment	Aspen stands, beaver, moose, campsites

EXERCISE 2

Select appropriate regional Valued Ecosystem Components

Objective: Using the issues of concern defined in EXERCISE 1, select appropriate regional Valued Ecosystem Components and suggest indicators.
Examples: See Case study 3.
Hint: Make a table as in Case study 3.
Duration: 1 hour.

4.2.1.3 Identify spatial and temporal boundaries

Setting boundaries is the process of establishing limits to the area and period of time examined in an assessment. There are two types of boundaries: spatial (i.e., how far?), and temporal (i.e., how long into the past and into the future?). Spatial boundaries are often referred to as the "regional study area".

The challenge facing the CEEA practitioner in establishing appropriate boundaries is in finding the balance between practical constraints of time, budget and available data, and the need to adequately address complex environmental interactions that, theoretically, could extend for considerable distances away and well into the future.

SPATIAL BOUNDARIES

EIAs have traditionally involved defining more or less arbitrary boundaries around action sites that are often local and limited to the effects of the single action. CEEA, by definition, expands those spatial horizons. The practitioner must determine at what point to stop the pursuit of effects as some constraint on information gathering and analysis is necessary. Accurate and reliable determination of the probabilities of occurrence, and the magnitudes and durations of *all* potential effects would be costly, time consuming and excessive.

However, there remains the realities of the cause-effect relationships (known and perceived) caused by the action. The implication of too small a boundary is that important regional and long-term effects may not be examined. The long-range transport of pollutants in airsheds or waterways, the movements of far-ranging wildlife, and the progressive incursion of humans into hinterland areas are all examples that suggest the need to assess effects over a larger and larger geographic area.

The practitioner must determine at what point an effect is trivial or insignificant. The concept that such a point is reached at a certain threshold is attractive but often difficult to define (especially quantitatively) except for cases in which regulated or recommended levels provide a point of comparison (e.g., for air and water emissions). The complexity of any relationship beyond those purely at the physical-chemical level often results in considerable reliance on best professional judgement and the consideration of risk. An adaptive approach should be followed when setting boundaries, in which the first boundary, often arrived at by an educated "guess", may later change if new information suggests that a different boundary is required.

An argument could be made in some cases that the boundary should be national, or even international. This scale of assessment is rarely merited and would usually be appropriate only for air or water effects (e.g., the long-range transport of air pollutants) or where species migrate over considerable distances. On a more pragmatic basis, boundaries can be assigned based on the limits of available data. A well-studied watershed, a well-known caribou migration path or available coverage of remote sensed imagery may influence the spatial extent of an assessment since the cost and time required to obtain more data may be prohibitive to the proponent and may not be justified by the needs of decision makers. The decision as to whether more data must be collected requires that the practitioners judge the adequacy of existing data in providing the basis for a sound and defensible assessment.

Ultimately, the assessment response should be appropriate to the project. Setting boundaries relies less on special CEEA techniques than on the time-honoured basics of EIA practice of:

- Making conservative assumptions about the magnitude and probability of the effect in the face of uncertainty (i.e., assume that effects will be greater rather than smaller).
- Relying on professional judgement.
- Practicing risk management.

- Using an adaptive approach.

Establishing spatial boundaries

Any of the following rules-of-thumb may be used to assist in setting spatial boundaries. It is important to understand that establishing boundaries is often an iterative process, in which a boundary may initially be identified without all the necessary information available, and subsequently modified if new information becomes available.

- Establish a local study area in which the obvious, easily understood and often mitigable effects will occur.
- Establish a regional study area that includes the areas where there could be possible interactions with other actions. Consider the interests of other stakeholders.
- Consider the use of several boundaries, one for each environmental component as this is often preferable to one boundary.
- For terrestrial VECs such as vegetation and wildlife, ensure boundaries are ecologically defensible wherever possible (e.g., winter range boundaries for assessing effects on critical wildlife habitat).
- Expand boundaries sufficiently to address the cause-effect relationships between actions and VECs.
- Characterize the abundance and distribution of VECs at a local, regional, or larger scale if necessary (e.g., for very rare species), and ensure that the boundaries take this into account.
- Determine if geographic constraints may limit cumulative effects within a relatively confined area near the action.
- Characterize the nature of pathways that describe the cause-effect relationships to establish a "line-of-inquiry" (e.g., effluent from a pulp mill to contaminants in a river to tainting of fish flesh and finally to human and wildlife consumption).
- Set boundaries at the point at which cumulative effects become insignificant.

- Be prepared to adjust the boundaries during the assessment process if new information suggests this is warranted, and defend any such changes.

Spatial boundaries should be flexible

Practitioners often establish boundaries based on the "zone-of-influence" beyond which the effects of the action have diminished to an acceptable or trivial state (i.e., very low probability of occurrence or acceptably small magnitude). Ideally, such an approach should be taken for each effect on each environmental component examined (e.g., air, water, vegetation, wildlife), therefore requiring multiple boundaries instead of the more typical single study area. Bounds therefore become flexible, expanding and contracting according to the unique ecological relationships encountered. Using jurisdictional borders to define the study area may appear to be expedient, but such an approach usually ignores the ecological realities of the area.

For example, to determine boundaries for assessing water quality, one may "trace" the path of a chemical constituent along a river as far as one believes it may still be reactive and cause a significant effect. For wildlife with well-defined territories or ranges, one may "follow" the seasonal path of an individual and determine where it may be influenced by other actions, regardless of whether it crosses over national or international borders.

TEMPORAL BOUNDARIES

"How far back in time" and "how far ahead in the future" to consider in an assessment depends on what the assessment is trying to accomplish. Comparison of incremental changes over time requires the use of historical records for establishing an environmental baseline. The possibility of new actions requires the need to look ahead into the future.

The boundary in the past *ideally* begins before the effects associated with the action under review and possibly before the effects of most major actions were present. The boundary in the future typically ends when pre-action conditions become re-established (i.e., VECs have recovered and effects become trivial). However, the further back or ahead in time, the greater the dependence will be on qualitative analysis and conclusions due to lack of descriptive information (e.g., what conditions were like years ago or which other actions may occur in the future) and increasing uncertainty in predictions. For these reasons, in practice the scenario in the past often defaults to the year in which the baseline information for the assessment is collected (i.e., current conditions) and the future extends no further than including known (i.e., certain) actions.

The use of scenarios provides a useful approach to determining temporal boundaries. Scenarios represent a point in time with specific disturbances and environmental conditions. Incremental changes between scenarios can then be compared to assess the relative contribution of various actions to overall cumulative effects within the regional study area.

In practice, temporal boundaries often first reflect the operational life or phases of the action under review (e.g., exploration, construction, operations, abandonment), and then extend to reflect the life of all actions under progressively greater levels of regional development. In either case, the scenarios are often associated with a single year or range of years (e.g., 1997-2000).

Establishing temporal boundaries

In general:

- Organize time-dependent changes in discrete units of time (e.g., as sequential time scenarios).

- Be prepared to adjust the boundaries during the assessment process, and defend any such changes.

The following provides some options for establishing temporal boundaries. In some assessments, more than one temporal boundary may be necessary (e.g., for actions with sequential operational and abandonment phases for different components of the action).

Options for establishing the past boundary

Each of the following options progresses further back in time:

- When impacts associated with the proposed action first occurred.
- Existing conditions.
- The time at which a certain land use designation was made (e.g., lease of crown land for the action, establishment of a park).
- The point in time at which effects similar to those of concern first occurred.
- A past point in time representative of desired regional land use conditions or pre-disturbance conditions (i.e., the "historical baseline"), especially if the assessment includes determining to what degree later actions have affected the environment.

Options for establishing the future boundary

Each of the following options progresses further ahead in time:

- End of operational life of a project.
- After project abandonment and reclamation.
- After recovery of VECs to pre-disturbance conditions (this should also consider the variability of natural cycles of change in ecosystems).

Each option progressively better reflects the true effects of the action; however, assessment becomes more difficult to quantify if the time periods are very long (e.g., >30-50 years).

Case study 4
Examples of establishing spatial boundaries

- Eagle Terrace, a 60 ha subdivision, was proposed on the slopes of a mountain valley in the Town of Canmore, Alberta. In the assessment, boundaries were based on the availability of a vegetation base map that covered enough of a mountain valley to include a considerable number of actions adjacent to the project under review, and to adequately assess the effects on wildlife VECs in that valley.

- In the Cold Lake Expansion Project, boundaries were set for each environmental component (e.g., water, air) based on a combination of administrative boundaries and watershed features (such as rivers), resulting in a regional study area that included several other large actions. The geographic boundaries for some VECs (wildlife, vegetation) were restricted to a township area due to the availability of historical and current information on vegetation composition and wildlife habitat (the extent of available air-photo coverage was also a factor in establishing boundaries). A judgement was made that the available information was sufficient to complete the assessment.
- A section of the Trans Canada Highway in Banff National Park was to be expanded from two to four lanes. In the assessment, the smaller of two regional boundaries was based on the constraining topography (i.e., mountain valleys) and their implications to watersheds and physical barriers to wildlife movements. The larger boundary was based partly on administrative borders.

Case study 5
Temporal boundaries scenarios

Four scenarios were developed for the Eagle Terrace CEEA to assess the incremental changes caused by developments in a mountain valley:

1) *Pristine*: conditions prior to any or extensive human development, which was simulated by removing the footprint of all developments from a Geographic Information System (GIS) database.

2) *Current*: existing conditions.

3) *Future without action*: future conditions that are predicted to occur, but without the action under review.

4) *Future with action*: future conditions that are predicted to occur with the action under review.

Case study 6

Regional development scenarios for temporal boundaries

In 1992, the British Columbia government requested a cumulative effects study in the 5000 km2 Monkman/Grizzly Valley gas development area in north-eastern British Columbia on the Rocky Mountain Eastern Slopes. This was in response to an increase in gas exploration and development in the region, and particularly an application for a gas plant expansion by West coast Energy which would induce other projects to occur. Seven companies, all active in the area and who would use the plant, collaborated in supporting an evaluation of the effects of gas exploration and development over a 15-year period between 1983 and 1998, including additional production from five new facilities.

The assessment, termed an Environmental Protection Strategy, used a regional development scenario to "identify the scale of development likely to occur in the near to medium term" so that "conclusions could be used to establish disturbance thresholds, delineate sensitive areas for key resources, and ensure that mitigation, monitoring and research are focussed on significant environmental issues".

A Regional Development Scenario was used in lieu of specific exploration and production plans from 1993 to 1998. This included determining quantitative limits or thresholds for various indicators during three scenarios: existing, minimum and maximum development. Thresholds were determined for the following: kilometres of seismic lines; kilometres of roads; kilometres of pipelines; number of dehydrating plants; and number of wells.

EXERCISE 3

Identifying spatial and temporal boundaries

Objective: Using the VECs selected in EXERCISE 2, establish spatial and temporal (past and future) boundaries for the study area of the Mahdia CEEA.
Examples: See Case studies 4, 5 and 6.
Hint: Look at actual and past watersheds.
Duration: 1 hour.

4.2.1.4 Identify other actions

All actions need to be identified that have caused or may cause effects and may interact with effects caused by the action under review.

Identifying other actions

1) Within the Regional Study Area(s), identify candidate actions that meet the *Action Selection Criteria* (see below).

2) Characterize the actions according to the *Action Description Criteria* (see below).

3) Clearly identify (e.g., list) each action being considered.

4) Modify the Regional Study Area(s) to accommodate the final list of actions, if required.

ACTION SELECTION CRITERIA

In recognition of spatial and temporal boundaries (section 4.2.1.3), identify actions associated with the project that meet the criteria shown in Table 4-2. [It is often suggested that certain natural events, such as flooding and forest fires, be considered as an action in the same context as human-caused events. This Guide suggests that such natural events should be considered as one of the attributes that describes environmental baseline conditions.]

Table 4-2
Spatial and temporal criteria for selection of actions

Spatial criteria	Temporal criteria
Actions with footprints within the regional study area(s) that may affect the VECs being assessed. Footprints include associated components (e.g., access roads, powerlines), and include air or areas of land or water directly disturbed.	**Past**: actions that are abandoned but still may cause effects of concern. **Existing**: currently active actions.
Actions outside the regional study area if it is likely that any of their components may interact with other actions or VECs within that area.	**Future**: actions that may yet occur.

Past actions

Past actions are no longer active yet continue to represent a disturbance to VECs (e.g., ongoing effects of an abandoned gravel pit on terrain, or a plume of solvents from an abandoned wood preserving factory on a nearby aquifer). It is possible that the effects may no longer be readily observable (e.g., review of maps or air photos shows little evidence of the action). However, significant changes may remain to ecological processes and VECs. In practice, past actions often become part of the existing baseline conditions. It is important, however, to ensure that the effects of these actions are recognized.

Future actions

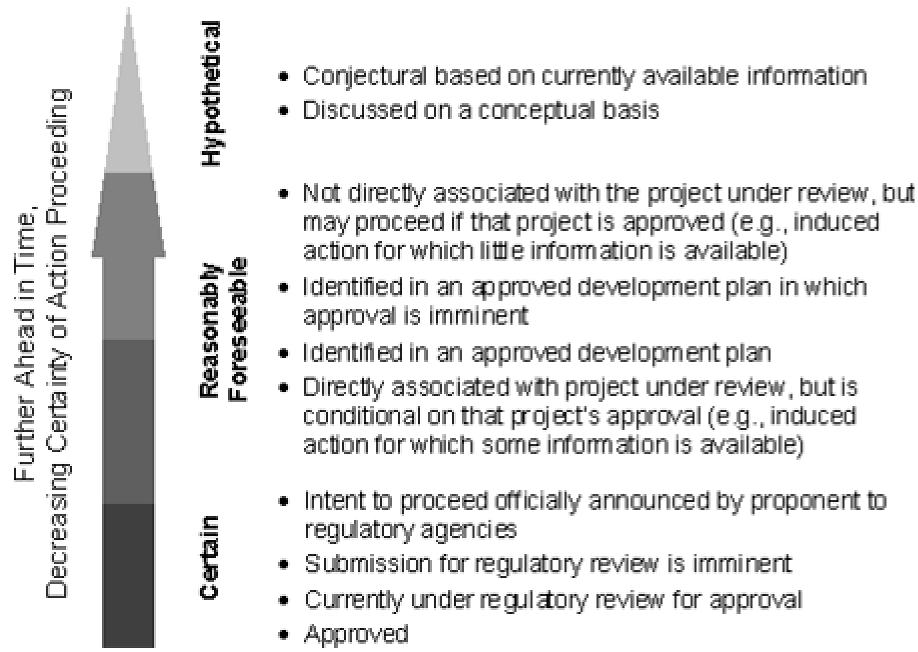
Selection of future actions must consider the certainty of whether the action will actually proceed. Figure 1 lists criteria that may be used in the selection process. The figure categorizes actions into three types:

- *Certain*: the action will proceed or there is a high probability the action will proceed.
- *Reasonably Foreseeable*: the action may proceed, but there is some uncertainty about this conclusion.
- *Hypothetical*: there is considerable uncertainty whether the action will ever proceed.

The selection of future actions to consider should at least reflect the certain scenario and at best the most likely future scenario. Rigid adherence to minimum regulatory requirement however is increasingly becoming unacceptable to many stakeholders if there is reason to believe that at least some reasonably foreseeable projects could have a significant cumulative effect with the project under review (also, precedent setting court and panel decisions on project approvals will continue the evolution of change regarding what is and is not expected and acceptable practice). Practitioners are therefore encouraged to consider the opportunity to also include reasonably foreseeable actions. The final decision for the assessment is often at the practitioner's discretion or under the direction of the regulatory authority.

Figure 4-1
Options for selecting future actions

As one proceeds upwards along the arrow, the certainty decreases of the action occurring.



Although requiring interpretation on a case-by-case basis, the selection of future actions will be a compromise between under-representing the full extent of future change and identifying and assessing an unreasonably large number of actions. As with most matters facing practitioners, compromises are continually made between the minimum required by legislation and the professional obligations perceived by the practitioner.

Induced actions

Induced actions are projects and activities that may occur if the action under assessment is approved. Induced actions may not be officially announced or be part of any official plan. They usually have no direct relationship with the action under assessment, and represent the growth-inducing potential of an action. New roads leading from those constructed for a project, increased recreational activities (e.g., hunting, fishing), and construction of new service facilities are examples of induced actions. Increases in workforce and nearby communities contribute to this effect.

There may always be the potential for induced actions following any action. However, a practitioner usually can only conjecture as to what they may be, their extent and environmental implications. Must the practitioner nonetheless always consider the implications of induced actions? [This argument has especially been made in cases where no other specific future actions can be identified (e.g., in remote hinterland areas). When combined with highly successful mitigation measures, proponents may confidently claim that there are no cumulative effects. However, induced actions may represent the only source of important cumulative effects.]

Induced actions (e.g., public activities) rarely fall under the scrutiny of an approved process: they just happen, and one must examine the likelihood of this based on existing use, precedent and implications of the assessed action proceeding. Best practice suggests that effort should be made in identifying actions if there is reason to believe they may occur, yet are not overly hypothetical. As illustrated in Figure 4-1, consideration of induced actions may be more reasonable if there is sufficient information describing them to allow an adequate assessment of their effects.

Ultimately, because of the uncertainty and often dispersed nature of these actions (i.e., they may occur in many places within a region), induced actions are best considered as part of Regional Land Use Planning Studies involving regional administrative agencies.

Case study 7
Action list

The following is an example of the type of actions that may be considered for an action proposed in a forested area under "multiple-use" conditions.

Resource Extraction	Recreational Use	Land Use and Infrastructure
Resource extraction Hunting / fishing Mining Oil and gas exploration Oil and gas wells Pipelines Processing plants Quarries Saw mills Seismic lines Timber harvesting Trapping	Recreational use Camping Equestrian use Fishing Hunting Mountain biking Nature tours Off-highway vehicle use Outfitting Wildlife viewing	Land Use and Infrastructure Access roads Highways Protected areas Railways Residential communities First Nation's Traditional Land Use Agriculture

ACTION DESCRIPTION CRITERIA

Each action that meets the selection criteria must be described in adequate detail to allow effects to be characterized for later assessment. As a general rule, the amount of information that can be obtained is usually proportionate to the degree of certainty of the action proceeding.

Some actions may have to be assessed generically because there are too many to practically characterize individually. This may be the case if there are many small actions suspected of causing minimal effects due to short duration, low magnitude, irregular and unpredictable occurrences, or temporary duration. If there are numerous actions, it helps if they are organized by some categories in recognition of the similar types of effects they may cause. For example, they can be organized by:

- Shape (e.g., linear, areal dispersed, areal point).
- Sectoral type (e.g., resource extraction, power generation, urban infrastructure).
- Industry type (e.g., mining, forestry, municipal infrastructure).
- Transportation type (e.g., aircraft, boats, road traffic).

The most important information to obtain about other actions is that which will assist in identifying and assessing effects on the same VECs as being assessed for the action under review. These effects can at first be broadly categorized by major environmental components, such as air, water, soils, vegetation, wildlife and resource use.

Some or all of the following information may be required to adequately assess an action's contributing effects:

- Location, physical size (e.g., area covered, volume of process throughput) and spatial distribution of components (e.g., site specific, randomly dispersed, travel corridors).
- Components (e.g., main plant, access roads, waste disposal site) and supporting infrastructure (e.g., waste treatment, powerlines).

- Expected life or period of activity (including start date) and phasing involved (e.g., exploration, construction, standard operations, later plans for upgraded or expanded operations, decommissioning and abandonment).
- Variations in seasonal operation (e.g., winter closures).
- Number of permanent and temporary employees.
- Frequency of use (for intermittent activities, e.g., helicopter use).
- Transportation routes and mode of transport (e.g., roads, railways, shipping lanes).
- Processes used (for industrial activity, e.g., open pit mining, kraft bleaching).
- Approvals received (e.g., permit and license conditions in effect).

Information sources for actions can include:

- Site visits or tours.
- Land use maps and aerial photos.
- Environmental databases, land use planning registers.
- Interviews and consultation with emissions control regulators, residents, businesses, administrative authorities, etc.
- Development plans (e.g., catchment management plans, air quality management plans).
- Other EIAs and State of the Environment Reports.

When information about another action is not available, the assessment must rely on publically available information (e.g., municipal plans) as much as possible. Any limitations this places on the assessment must be clearly stated. If no or little information is available, it is difficult to predict cumulative effects unless the practitioner assumes certain project attributes (e.g., content of waste discharge). These assumptions should be clearly stated, and the uncertainty this causes in the assessment should be explained.

A reasonable attempt to collect information must at least be demonstrated. Lack of usable information about other actions can have important implications to the certainty associated with predictions made in a CEEA.

Case study 8
Grouping project types: Placer Mines

Placer (i.e., in-stream) mining for gold has a long history in the Guyana. Some streams have been extensively mined, in some cases repeatedly by different proponents in the same location over many years. It is not unusual for many placer claims and operational mines (e.g., greater than 10) to exist along the same waterway.

In assessing a project located in or near one of these streams, identifying each placer mine and its cumulative effects with the project under review may be unnecessary. In this case, all the placer mines of similar physical and production size could be grouped to represent downstream and upstream effects on the waterway.

EXERCISE 4
Selecting and describing actions

Objective: Select and describe past, existing, future and induced actions that may have effects on previously identified VECs (EXERCISE 2).
Examples: See Case study 7. Use Tables provided in appendices A, B and C.
Hint: Start by identifying actions associated with the project (mining-related) that meet the action selection criteria shown in Table 4-2. Once this is done, look for other actions.
Duration: 2 hours.

4.2.1.5 Identify potential impacts

Potential impacts must be identified that may affect the VECs. This scoping step is important as it assists the practitioner in beginning to understand one of the most fundamental assessment questions: what is affecting what? Good scoping in the initial stages of the study will mean that the assessment effort will focus on the most likely effect's pathways of concern.

One approach to accomplishing this, a common step in many EIAs, is to first identify environmental components (e.g., air, water) that may be affected by various project components (e.g., land clearing, combustion emissions) for the project being assessed. Then, environmental components that may be affected by other actions in the region of interest can be identified. The scoping could then proceed to focus on the relationships between specific impacts from various actions and specific VECs. The next section describes one means of practically accomplishing this.

Using interaction matrices

An Interaction Matrix is a tabulation of the relationship between two quantities. Matrices are often used to identify the likelihood of whether an action may effect a certain environmental component or to present the ranking of various effect attributes (e.g., duration, magnitude) for various VECs. Matrices are an example of one tool that can be used during scoping exercises to identify the potentially "strongest" cause-effect relationships, and later to concisely summarize the results of an assessment.

Matrices, however, only show the conclusions made about interactions, and cannot themselves reveal the underlying assumptions, data and calculations that led to the result shown; matrices are a simplistic representation of complex relationships. Matrices should, therefore, be accompanied by a detailed explanation as to how the interactions and rankings were derived (e.g., in a "decision record").

A CEEA can also use a matrix to rank the "strength" of the interaction between each action in the regional study area and regional VECs (i.e., how strong is the effect on a VEC due to the overlap of effects from two different actions?). The interactions can be qualitatively ranked (e.g., 1 = low to 5 = high on a 5-point scale), or use a number that represents a physical quantity. The first type of ranking is currently the more commonly used in assessments.

It may also be necessary to return and examine relationships ranked negligible or low if later information suggests they may be more important, or if the public has considerable interest in the issue.

Ranking mechanisms for matrices

The following two tables provide *examples* of using matrices to rank effects. Such simple rating schemes are often used during early scoping exercises, before more detailed assessment confirms the validity of conclusions reached in the matrix.

Table 4-3
Ranking of effects based on effect's attributes

A ranking of L (Low), M (Moderate), or H (High) is determined based on the duration, magnitude and extent of an effect.

Duration	**Magnitude**	**Extent**			
		Local	Regional	Territorial	National/ International
Short-term	Low	L	L	M	M
Short-term	Moderate or High	L	M	M	M
Medium-term	Low	M	M	M	M
Medium-term	Moderate or High	M	M	M	H
Long-term	Low	M	M	H	H
Long-term	Moderate or High	M	H	H	H

Table 4-4
Ranking of effects based on spatial and temporal overlap

Temporal Overlap	**Spatial Overlap of Effects**		
	None	Partial	Complete
Never/Rarely	L	M	M
Sometimes	L	M	H
Often	L	H	H

Case study 9

Perseverance zinc mine overall impact rating matrix

	Project Component	Physical Setting							Biol. Setting			Human Setting				
		Air Quality	Streams and Lakes	Groundwater regime and quality	Sediments of the receiving Stream	Wetlands	Soils	Ground Stability	Vegetation (Terrestrial and riparian)	Wildlife Habitats (Terrestrila and riparian)	Ichtyofauna	Land Use (Hunting, fishing, trapping and logging)	Noise	Local and regional Economy	Nearby Airport	Local population
Mine Construction Phase	Construction of roads													p		
	Filling material – pad of the site													p		
	Construction of buildings and amenities													p		
	Construction of sanitary installations													p		
	Construction of Power Line													p		
	Overburden Stripping for mine and road													p		
	Portal and decline excavation (200 m)													p		
	Preparation of waste and ore pads													p		
	Preparation of mine water settling pond													p		
	Installation and operation of rock breaker													p		
	Excavation of vent raises collars													p		
	Underground development													p		
	Borrow Pits													p		
Mine Production Phase	Underground excavations and dewatering													p		
	Muck, waste and paste transportation													p		
	Operation of waste and ore pads													p		
	Ore comminution (rock breaker)															
	Operation of Maintenance and repair shop													p		
	Operation of offices and dry													p		
	Operation of compressor															
	Operation of ventilation raises															
	Operation of a fuel depot															
	Cement silo															
	Hazardous materials and waste storage															
	Domestic waste															
	Explosives															
	Water management (runoff + mine)															
Closure	Revegetation		p		p						p	p		p		
	Sealing of excavations at surface			p								p		p		
	Removal of buildings and infrastructures											p		p		
	Removal of fill material (pads)											p		p		

P = positive impact

N.B The displayed physical setting impact rating is actually a measure of the effect these activities have on the biological and human settings.

- No impact or unsignificant
- Minor significance
- Moderate significance

Case study 10
Interaction Matrix for various actions

In a CEEA of the Trans Canada Highway, the potential degrees of interaction between various regional actions and environmental components was determined. Sixteen actions were identified and the effects of each action on 10 environmental and social components were ranked from negligible to high. Below is a sample of the matrix used to present the results.

Project	Terrain	Air Quality	Vegetation	Fish	Visual
Existing highway	M	L	L	H	L
Powerline	-	-	L	-	L
Railway	M	L	L	M	L
Townsite	L	-	L	-	L

- = Negligible, L = Low, M = Moderate and H = High

4.3 Step 2: Analysis of effects

4.3.1 Collect regional baseline data

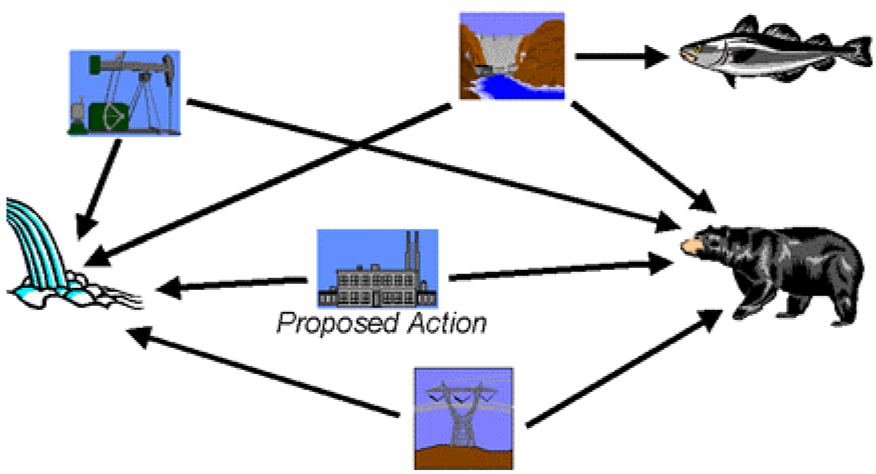
A common concern of proponents is the level of effort and resources (i.e., time and money) required to collect adequate data to assess regional cumulative effects. While early scoping is required to ensure that the assessment is focussed on the most important VECs, it also ensures that data collection is limited to only that required to address these issues. In some cases, the collection of data for some environmental components, such as water quality, air quality and noise levels, provides baseline data that often captures the collective effects of existing actions.

CEEA practitioners must have a clear understanding of how the data will be used in support of a clearly defined and scientifically defensible analysis. As a rule-of-thumb, it is not advisable to embark on costly data collection and analysis without careful consideration of the results it may yield. Practitioners have to often adopt a "coarse filter" approach to data collection; that is, the level of information is not as detailed as in an EIA because of the much larger area covered (also, the *type* of data required may change as the scale of the assessment changes). For example, soils and vegetation field studies may be relatively intensive within the proposed project footprint and involve on-site mapping. However, for regional study areas of thousands of hectares, analysis may have to be based on satellite imagery or existing vegetation surveys completed at very broad scales.

4.3.2 Assess effects on VECs

The analysis of cumulative effects should focus on assessing effects on selected VECs (Figure 4-2). Several approaches are available to assist the practitioner in assessing cumulative effects. However, there is no one single approach to always be used, nor necessarily one type of approach for specific effects or types of actions. Instead, the practitioner must select an appropriate approach or assessment "tool" from a collection or "toolbox" of approaches. The appropriate method is the one that best provides an assessment of the effects on the VECs being examined.

Figure 4-2
Focussing on effects on VECs



The CEEA should be looked at "from the VECs point of view", in which the combined (i.e., cumulative) effects of the various actions on each VEC (i.e., bear and water quality) are assessed (arrows indicate an action causing an effect on a VEC). Furthermore, although the fish is affected by one of the other actions, it should not be considered because it is not affected by the proposed action under review (unless the bear eats the fish!).

Of the many tools available, a few have been repeatably used in EIAs, and more recently, in CEEAs. These are listed in Table 4-5 and one of them (impact models) is described in more detail afterwards.

Table 4-5
Examples of assessment tools and their appropriate use

Tool	Examples of Appropriate Use
Impact Models	Detailed assessment of cause-effect relationships between an action and VECs.
Spatial Analysis using a Geographic Information System	Quantifying physical properties of actions (e.g., length of roads, area of cleared land) and changes to landscape features (e.g., loss of wildlife habitat).
Landscape Level Indicators of Change	Providing numerical values that represent large-scale disturbances or change.
Numerical Modelling	Quantifying physical-chemical constituents (e.g., air and water quality).

This guide will focus solely on impact models because of its relative simplicity and straightforwardness. It is the most readily applicable in the context of Guyana.

4.3.2.1 Questions to ask when assessing effects

- What are the VECs that may be affected?
- What parameters are best used to measure the effects on the VECs?
- What determines their present condition?
- How will the proposed action in combination with existing and approved actions affect their condition?
- What are the probabilities of occurrence, probable magnitudes and probable durations of such effects?
- How much further effect could VECs sustain before changes in condition cannot be reversed?

- What degree of certainty can be attached to the estimates of occurrence and magnitudes of these predicted effects?

4.3.2.2 Checking for spatial and temporal overlap

The concept of the physical overlapping of effects leading to cumulative effects can be a useful approach to understanding the nature of the interactions. The following series of questions could be used in determining the degree of overlap between actions:

1) Do actions rarely or never occur at the same time, and do actions originating in one location rarely or never continue on to other locations? If yes, cumulative effects interaction is weak.

2) Do actions in each location sometimes occur at the same time, and do actions originating in one location sometimes continue on to other locations? If yes, interaction is moderate.

3) Do actions in each location often occur at the same time, and do actions originating in one location often continue on to other locations? If yes, interaction is strong.

4.3.2.3 Impact models

Impact Models have been used extensively in EIAs, and may be adopted as a CEEA approach because they provide a concise description of cause-effect relationships that occur between an action and the surrounding environment. The Impact Model approach involves testing the validity of a statement, similar to that made in a scientific hypothesis. The advantage of using Impact Models is that they provide a simplification of complex systems, allowing a step-by-step analysis of each interaction in a cause-effect relationship. They also facilitate the description of cause-effect relationships over large areas.

Impact Models have three parts:

- Impact Statement.
- Pathways Diagram.
- Linkage Statements.

The assessment of the model involves two steps:

- Linkage Validation.
- Pathway Assessment and Evaluation.

Case study 11
Applying impact models

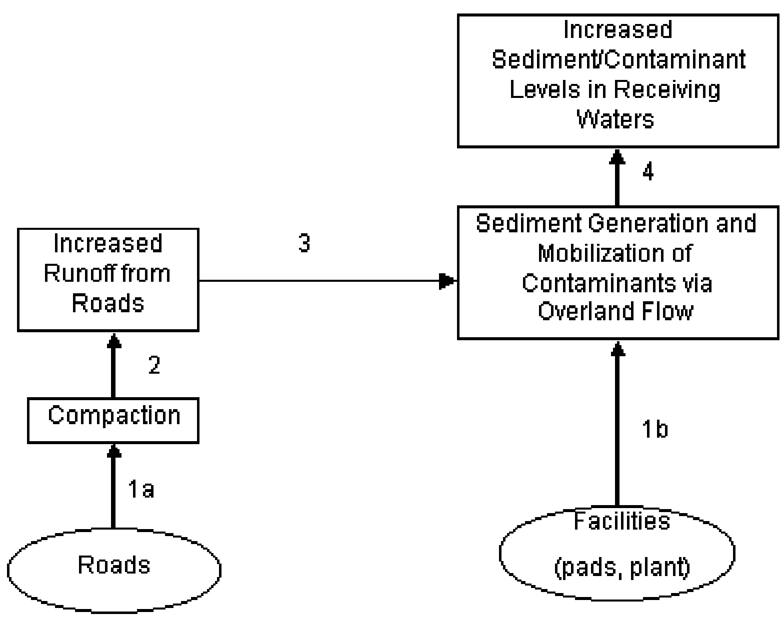
Cold Lake Oil Sands Project.
The following provides an example of an Impact Model (from a total of 35 for the EIA) developed to assess the effects of the Cold Lake Oil Sands Project on surface water quality.

Impact Statement

Operation and maintenance of roads and facilities will result in the generation of sediment and transport of contaminants to receiving waters.

Pathway Diagram

Figure 4-3
Example of pathway diagram



Linkage Statements

1a. The operation and maintenance of roads will lead to compaction of the roadbed.

1b. Operation and maintenance of pads and plant facilities will result in the generation of sediment and mobilization of contaminants via overland flow from these facilities.

2. Compaction will cause an increase in surface runoff from the road.

3. Increased runoff from roads will result in erosion of exposed soils, resulting in an increase in sediment generation and transport. Soluble contaminants from the road and the road bed will be transported along with the sediment.

4. Increased sediment and contaminant transport will result in higher levels of these parameters in receiving waters, which will result in a decline in surface water quality.

Linkage Validation

#	Linkage Description	Validity	Confidence
1a	The operation and maintenance of roads will lead to compaction of the roadbed.	Valid	High
1b	Operation and maintenance of pads and plant facilities will result in the generation of sediment and mobilization of contaminants via overland flow from these facilities.	Valid	High
2	Compaction will cause an increase in surface runoff from the road.	Valid	High
3	Increased runoff from roads will result in erosion of exposed soils, resulting in an increase in sediment generation and transport. Soluble contaminants from the road and the road bed will be transported along with the sediment.	Valid	High
4	Increased sediment and contaminant transport will result in higher levels of these parameters in receiving waters, which will result in a decline in surface water quality.	Valid	High

Pathway Assessment and Evaluation

Pathway	1	2
Links	1a, 2, 3, 4	1b, 4
Scope	Local	Local
Magnitude	Moderate	Moderate
Duration	Long-term	Long-term
Frequency	Continuous	Continuous
Direction	Negative	Negative
Significance	Insignificant	Insignificant
Confidence	High	High

EXERCISE 5

Developing impact models

Objective: Using existing and future actions identified and described at EXERCISE 4, develop Impact Models for the different VECs selected at EXERCISE 2. Use only impact statements, pathway diagrams and linkage statement. <u>Do not use linkage validation nor pathway assessment and evaluation tables</u>.
Examples: Case study 11.
Hint:
Duration: 4 hours.

4.4 Step 3: Identification of Mitigation

Managing cumulative effects in a CEEA requires, as a start, the same type of mitigation and monitoring that would be recommended in an EIA. Mitigating a local effect as much as possible is the best way to reduce cumulative effects; however, to be most effective, mitigation and monitoring must be long term and regionally based. This can be costly, require a few years to complete, and require broader data collection and decision-making involvement than has historically been the case with EIAs (monitoring programs for individual actions are usually designed with the involvement of regional administrative bodies).

The mitigation measures applied in CEEAs may be considerably different from those applied in traditional EIAs. These mitigation measures can be applied to developments other than the proposed development (e.g., through pollution trading). Several administrative jurisdictions and stakeholders will usually fall within an assessment's regional study area. In many cases, the co-operation of these other interests may be required to ensure that recommended mitigation is successfully implemented. Effective CEEAs, therefore, often imply the need for regional stakeholder involvement to solve regional concerns. Considerable reliance is placed on regional efforts to mitigate cumulative effects, such as initiatives to create regional co-ordinating bodies that direct or recommend further land use, monitoring and other effects-related research. Participants are usually selected from provincial and federal ministries, stakeholder groups and commercial interests. The objectives of these initiatives are generally to protect landscape-scale patches and inter-connecting wildlife corridors, and disperse permanent and transient human activities to reduce the magnitude of cumulative effects.

Recommendations for regional initiatives of this type may be the only means of addressing complex cumulative effects issues. It is generally unreasonable to expect a single proponent to bear the burden of mitigating effects attributable to other actions in the region. Often it is more practical and appropriate for regulatory agencies to initiate and help implement these regional initiatives, with project proponents providing data relevant to their project's effects.

When Other Actions Contribute More to Cumulative Effects

What happens if an existing action is found to already be contributing most to cumulative effects in a region? Typically, the administrative jurisdiction of the agency reviewing the action can only address mitigation for the proposed action. Mitigating effects caused by the proposed action may solve *local* effects, but do little to ameliorate the *regional* cumulative effects. In these cases, the reviewing agency or Board (if within its legislative authority) may consider mitigation of effects from existing actions as a condition of approval for the action under review.

Case study 12
Implications of mandatory mitigation

The Huckleberry Copper Mine was proposed in central-west British Columbia. The application of mandatory mitigation measures for discharges to waterways meant that cumulative effects on water quality were unlikely and insignificant. Such mitigation measures would ensure that regulated water quality objectives would be met.

Case study 13
Reclamation of native prairie as mitigation

The proponent for the construction of an express pipeline contended that cumulative effects on native prairie were not significant given that most of the project disturbance would be local to the pipeline right-of-way and mitigable. Most of the project consisted of buried pipeline; any disturbed soils and vegetation along the 30 m right-of-way would be reclaimed. It was expected that 80% of the vegetative composition of the right-of-way would be similar to pre-disturbance conditions within five years, and full recovery of the different botanical components would occur within 20 years. No long-term substantial effects on wildlife were expected as a result of clearing or fragmentation.

Case study 14
Carnivore compensation package

In 1996 Cardinal River Coal proposed to construct the Cheviot coal mine east of Jasper National Park in Alberta. The proponent recognized that regional initiatives were required to mitigate significant effects: some that it could undertake, others that would require a coordinated effort. In the former case, impacts on water quality, old growth forest, rare plants, land use and recreational access, Harlequin duck, and elk could be addressed by the proponent alone. However, regional initiatives would be required to address cumulative effects on grizzly bear.

To compensate for some unmitigable losses to carnivore habitat, it was recommended that a "Cheviot Carnivore Compensation Program" be established. This program would contribute to funding regional research on large carnivore ecology, establishing and supporting a Wildlife Management Board, and offering regional-oriented education packages. Existing regional initiatives were also recognized, such as the establishment of new natural areas (e.g., recent creation of Cardinal Divide Natural Area, Foothills

Model Forest), and the Coal Branch Access Management Plan in the Coal Branch Sub-regional Integrated Resource Plan. Natural areas, along with Jasper National Park, were cited as offering protected reserves that may be used by any wildlife displaced by the mine. An Access Management Plan could also be used to reduce adverse effects by limiting vehicular access, hunting and noise.

Case study 15
Watershed monitoring

In 1989, a joint federal-provincial Review Board held hearings into the proposed Alberta-Pacific Forest Industry's pulp mill. Located in the boreal forest north of Edmonton, the mill would discharge waste process water into the Athabasca River, part of the larger Athabasca-Peace River watershed that encompasses parts of British Columbia, Alberta and the Northwest Territories.

The need for a regional study grew out of recommendations during the Board review for more regional scientific data. The Board was concerned that impacts from the mill as well as existing and future actions might adversely affect the region's watersheds. A major component of the study was a public consultation process, involving residents throughout the region.

The Northern River Basins Study was then initiated in 1990 to "examine the relationships between development and the Peace, Athabasca and Slave River Basins", an area that includes much of northern Alberta. This three-and-a-half year, $12.3 million project, under the provisions of the *Canada Water Act*, was jointly funded by the Government of Canada and the Province of Alberta, with involvement of the Northwest Territories Government. Operations were co-ordinated by a Study Board representing various regional stakeholders, with assistance from a Science Advisory Committee.

The Study Board co-ordinated various research projects to identify data gaps, provide an environmental baseline database on contaminant levels, develop models to assess cumulative effects of development on the aquatic environment, and assist future regional planning efforts. Research was directed towards examining the effects of toxic compounds in the waterways and developing predictive tools to assess the cumulative effects of multiple sources in those waterways.

4.5 Step 4: Evaluation of significance

4.5.1 Approaches to determining significance

Determining the significance of residual effects (i.e., effects after mitigation) is probably the most important and challenging step in EIA. The determination of significance for CEEAs is fundamentally the same; however, it may be more complex due to the broader nature of what is being examined. A cumulative effects approach requires determining how much further effects can be sustained by a VEC before suffering changes in condition or state that cannot be reversed.

Deciding whether effects are likely

Any cumulative environmental effects that are likely to result must be considered. The following questions should be asked:

1) Are the environmental effects adverse?

2) Are the adverse environmental effects significant?

3) Are the significant adverse affects likely?

The determination of likelihood is based on two criteria: 1) probability of occurrence and 2) scientific certainty. In practice, likelihood as an attribute of significance (see Table 4-6) is often rated on a scale: e.g., None (no effect will occur), Low (<25% or minimal chance of occurring), Moderate (a 25% to 75% or some chance of occurring), and High (>75% or most likely a chance of occurring).

Query for evaluating significance

Significance conclusions in assessments should be defensible through some form of explanation of how the conclusions were reached. The following is an example of one approach. A series of questions are structured so as to guide the practitioner through a series of steps, eventually leading to a significance conclusion. The questions follow a basic line of inquiry as follows:

- Is there an increase in the action's direct effect in combination with effects of other actions?
- Is the resulting effect unacceptable?
- Is the effect permanent?
- If not permanent, how long before recovery from the effect?

In more detail, these questions appear below, specifically to address the nature of two different types of VECs.

Biological species VECs

- How much of the population may have their reproductive capacity and/or survival of individuals affected? Or, for habitat, how much of the productive capacity of their habitat may be affected (e.g., <1%, 1-10%, >10%)?
- How much recovery of the population or habitat could occur, even with mitigation (e.g., Complete, Partial, None)?
- How soon could restoration occur to acceptable conditions (e.g., <1 year or 1 generation, 1-10 years or 1 generation, >10 years or >1 generation)?

Physical-chemical VECs

- How much could changes in the VEC exceed that associated with natural variability in the region?
- How much recovery of the VEC could occur, even with mitigation?
- How soon could restoration occur to acceptable conditions?

Table 4-6
The seven significance attributes

Attribute	Options	Definition
Direction	Positive	Beneficial effect on VEC.
	Neutral	No change to VEC.
	Negative	Adverse effect on VEC.
Scope	Site	Effect restricted to a small site.
	Local	Effect restricted to the project footprint.
	Sub-regional	Effect extends to area within a few kilometres of the project footprint.
	Regional	Effect extends throughout regional assessment area.
Duration	Short-term	Effects are significant for <1 year before recovery returns conditions to the pre-project level; or, for species, for less than one generation.
	Medium-term	Effects are significant for 1-10 years; or, for species, for one generation.
	Long-term	Effects are significant for >10 years; or, for species, for more than one generation.
Frequency	Once	Occurs once only.
	Continuous	Occurs on a regular basis and regular intervals.
	Sporadic	Occurs rarely and at irregular intervals.
Magnitude	Low	Minimal or no impairment of component's function or process (e.g., for wildlife, a species' reproductive capacity, survival or habitat suitability; or, for soil, ability of organic soil to fix nitrogen).
	Moderate	Measurable change in component's function or process in the short and medium duration; however, recovery is expected at pre-project level.
	High	Measurable change in component's function or process during the life of the project or beyond (e.g., for wildlife, serious impairment to species productivity or habitat suitability).
Significance	Insignificant Significant Unknown	Based on the analysis, use of Significance Query, and best professional judgment, is the effect on the VEC significant?
Confidence	Low Moderate High	In general, what is the confidence level in the conclusion?

4.5.2 Factors that influence interpretation of significance

A cumulative effect on a VEC may be significant even though each individual project-specific assessment of that same VEC concludes that the effects are insignificant. This is a fundamental principle in the understanding of cumulative effects. Project-specific assessments, that focus on the incremental contribution of the project being assessed, can assist in making such conclusions as they must consider the implications of other actions also affecting the VECs. However, this inclusion (and sometimes the analytical approach used) requires the consideration of various factors that may influence the determination of significance (some which have not always been an issue in earlier assessments without a cumulative effects component). These factors include the:

- Exceedance of a threshold.
- Effectiveness of mitigation.
- Size of study area.
- Incremental contribution of effects from action under review.
- Relative contribution of effects of other actions.
- Relative rarity of species.
- Significance of local effects.
- Magnitude of change relative to natural background variability.
- Creation of induced actions.
- Degree of existing disturbance.

Each of these points are discussed below in detail.

- *Significance may increase if a threshold is exceeded*: if the magnitude of an effect exceeds a threshold for a VEC, and the effect is not brief in duration, then the effect is usually considered significant.

- *Significance may increase as the effectiveness of mitigation measures decreases*: determination of the significance of *residual* effects on a VEC is the most important outcome of an assessment. The effectiveness of recommended mitigation measures should, therefore, be acknowledged in the assessment (mitigation that is 100% effective will result in no residual effects).

- *Significance may appear to decrease as the study area size increases*: an assessment approach used in many CEEAs involves comparing increases in area covered by successive actions in a region. The assessor can determine how much the action under review has contributed to the incremental historical and existing land uses. In such assessments, the study area against which the comparison is made is usually fixed, resulting in comparison against the same reference point. Therefore, the larger the study area, the smaller the apparent contribution of each action to change. In this way, the incremental contribution of even a large action may appear to be insignificant (e.g., <1%) if the study area is sufficiently large. To avoid misleading conclusions, the practitioner should also demonstrate how much change is attributable to the action under review when compared to other actions in the study area (as opposed to the study area itself).

- *Significance may decrease as the relative contribution of an action decreases*: it can be argued that if the effects of an action within a regional study area are quite small relative to the effects of other actions in that same area, then the cumulative effects of that action are likely to be negligible. For example, if a forest cutblock of 4 ha is proposed within a region in which there are already 300 ha of clearcut areas, then the proposed action contributes an incremental loss of potential wildlife habitat of only 1.3%. The validity of this argument depends somewhat on the size of the study area (the larger the regional study area, the smaller the percentage becomes). The argument may not hold true in all cases, especially if that 4 ha supports plant species that are regionally rare, provides particularly important habitat for wildlife (e.g. salt licks for ungulates) or has a unique topographical feature. Furthermore, the argument may not hold if that further loss of 4 ha causes a threshold to be exceeded for a certain VEC, beyond which the VEC cannot recover. However, applying this "straw-that-breaks-the-camels-back" view of the implications of adding one more action are often handicapped by the lack of clearly defined thresholds.

- *Significance may decrease as the significance of nearby larger actions increase*: for an action proposed in close proximity to larger existing actions, its relative contribution to cumulative effects may be minimal. Although this does not mean that a CEEA is not required, it *does* suggest that the effects of the other action(s) should be adequately understood.

- *Significance may increase as a species becomes increasingly rare or threatened*: the significance of effects on a species' population may have to consider the rarity of the species at larger scales (e.g., regional, provincial or global). To illustrate for biological organisms, consider a population of 200 animals or plants living within the "footprint" of a proposed action. Such a population might be severely affected. The importance, however, that is attributed to such an effect will almost certainly depend on whether the population is part of a local, regional or global population of 200, 2000 or 200 million. In addition, it must also be considered if *that* remaining population itself is rare or threatened.

- *Significance may decrease as the significance of local effects decrease*: it has been argued that if the conclusions of an EIA indicate that none of the residual direct effects are significant, then there will be no cumulative effects (as therefore there are no effects remaining to act cumulatively with other actions). While this may be true for some types of effects, this may not always be the case: *an insignificant local effect may still contribute to a significant cumulative effect!*

- The argument of insignificance may be true, for example, if mitigation eliminates or substantially reduces the transport of a constituent elsewhere (e.g., a contaminant discharged into a waterway) or the emanation of a sensory disturbance (e.g., noise). In these cases, the potential for cumulative effects with other actions will be reduced.

- However, the argument may be false if, on a regional scale, there nonetheless remains an important *indirect* effect that results in a regionally important loss of a VEC (e.g., loss of 10% of the population of a rare plant species with the study area) or of a resource on which the VEC depends (e.g., fragmentation of wildlife habitat). This indirect effect most commonly occurs as a result of the clearing of land which, although perhaps not significant at a local scale, may have important regional implications (i.e., the nibbling effect). In these cases, the practitioner must recognize this possibility and, while determining significance, consider the relative scarcity of what is being affected.

- *Significance may decrease if effects are within natural background variability*: if a *direct* effect causes no detectable change in a VEC, then the effect would usually be considered insignificant. If the change caused by the effect is detectable but within the magnitude of naturally fluctuating conditions (e.g., annual water temperatures and flows, percentage dissolved oxygen, seasonal wildlife population size), then the effect would also usually be considered insignificant. However, these arguments may not remain true if a number of individual actions each contribute small incremental changes, each below natural variability, which eventually causes a detectable change and exceedance of natural background conditions. For example, the effects of a series of placer mines or pulp mills along the same river may individually be considered insignificant due to adequately applied mitigation (e.g., the sediment or pollutants are diluted below background levels). However, their cumulative downstream effects may exceed even worst-case natural conditions (e.g., during periods of drought). Furthermore, there is often considerable uncertainty associated with identifying natural variability; its use for comparison purposes must therefore be approached with caution.

- *Significance may increase as the number of induced actions increase*: a proposed action may induce new actions to occur in the region. Although considering these spin-off actions in the CEEA implies some certainty that they will occur, greater significance may be borne by the effects of the action under assessment.

- *Significance may decrease if the surrounding environment is already heavily disturbed*: an action proposed in a region already heavily disturbed due to existing actions may not be significant if environmental components are already compromised (e.g., thresholds have been exceeded). For example, a pipeline could be proposed in an area already crossed by numerous other rights-of-way (e.g., access roads), in which case the pipeline itself would not necessarily be an important contributing cause to a possible collapse of a wildlife population.

EXERCISE 6

Evaluating significance

Objective: Using impact models developed at EXERCISE 5 , the 7 significance attributes, available information and, above all, your professional judgment, evaluate the significance of the effects. Use Table provided in appendix D to report results.
Examples: Case studies 9 to 14.
Hint: You will need Table 4-5, the *Query for evaluating significance* (in section 4.5.1) and the *Factors that influence interpretation of significance* (section 4.5.2).
Duration: 4 hours.

4.5.3 Using thresholds

Thresholds are limits beyond which cumulative change becomes a concern, such as extensive disturbance to a habitat resulting in the rapid collapse of a fish population, or when contaminants in soil suddenly appear in potable water supplies. Thresholds may be expressed in terms of goals or targets, standards and guidelines, carrying capacity, or limits of acceptable change, each term reflecting different combinations of scientific data and societal values. For example, a threshold can be a maximum concentration of a certain pollutant beyond which health may be adversely affected, a maximum number of hectares of land cleared from its existing natural state before visual impacts become unacceptable, a maximum number of deer lost from a valley habitat before the viability of the population is threatened or the maximum number of small mines a watershed can sustain.

Making useful conclusions about cumulative effects requires some limit of change to which incremental effects of an action may be compared. Theoretically, if the combined effects of all actions within a region do not exceed a certain limit or threshold, the cumulative effects of an action are considered acceptable. In practice, however, the assessment of cumulative effects is often hindered by a lack of such thresholds. This is particularly true for terrestrial components of ecosystems. Contaminants affecting human health and constituents in air and water are usually regulated; therefore, thresholds useful for assessment purposes are defined by regulation or available in guidelines (e.g., Governmental drinking water quality guidelines). [Consideration of human health is often implicit is some assessments of biophysical components (e.g., air quality).]

There is not, therefore, always an objective technique to determine appropriate thresholds, and professional judgment must usually be relied upon. When an actual capacity level cannot be determined, analysis of trends can assist in determining whether goals are likely to be achieved or patterns of degradation are likely to persist.

In the absence of defined thresholds, the practitioner can either: 1) suggest an appropriate threshold; 2) consult various stakeholders, government agencies and technical experts (best done through an interactive process such as workshops); or 3) acknowledge that there is no threshold, determine the residual effect and its significance, and let the reviewing authority decide if a threshold is being exceeded.

4.5.3.1 Carrying capacity and limits of acceptable change

Carrying capacity is the maximum level of use or activity that a system can sustain without undesirable consequences. This is very much a subjective determination, which depends on the values and context involved. Ecological carrying capacity reflects biophysical limits, while social or recreational carrying capacity may be determined largely by user perception and levels of satisfaction associated with a specific activity.

The concept of "limits of acceptable change" shifts the focus from identifying appropriate levels of use to describing environmental conditions that are deemed acceptable. The advantage of this approach is that once acceptable conditions have been described, the appropriate combination of levels of use and maintenance interventions required to sustain those conditions can be determined.

Case study 16
Stream sedimentation thresholds in placer mining

The Yukon Placer Authorization specifies maximum acceptable sediment discharge concentrations, based on acceptable effects on fish, for five different classes of streams. For example, the maximum concentration of sediment levels above natural background levels for Type III streams is 200mg/L (the type is based on fish bearing and harvesting attributes). Furthermore, some streams are uniquely classified on a series of map sheets covering much of the southern Yukon. The cumulative effects implication of this Authorization is that any number of actions (i.e., placer mines) may occur on a single stream until the sedimentation limit is reached. This approach, therefore, provides a stream threshold that can assist in future decision making for actions affecting stream sedimentation.

Case study 17
In stream flow needs

The Alberta Government proposed to divert some of the peak flow volume of the Highwood River to supplement water supplies to a proposed reservoir. Concerns were raised about possible effects of water withdrawals on riparian vegetation and fish. A study investigated how to determine minimum in stream flow needs and what the flows should be. These flows represented a threshold, below which the survival of the VECs would be threatened. The flow was determined, based on best professional judgement, as the minimum flow requirements for various stream-related factors (e.g., vegetation regeneration, geomorphological changes, fish survivorship). The final threshold was selected as the highest volume flow required in each season for any one of those factors.

4.5.4 Handling uncertainty

Uncertainty in predicting effects and determining significance can arise due to variations in natural systems, a lack of information, knowledge or scientific agreement regarding cause-effect relationships, or the inability of predictive models to accurately represent complex systems. The degree of uncertainty in addressing cumulative effects is greater than for conventional EIAs because of a longer time horizon and larger study area.

It is recommended that the rules-of-thumb described below be considered when dealing with uncertainty.

Considerations when handling uncertainty

- Make conservative conclusions (i.e., assume that an effect is more rather than less adverse). This is referred to as the Precautionary Principle. [Other definitions exist of this term.]

- Provide a record or audit trail of all assumptions, data gaps, and confidence in data quality and analysis to justify conclusions.

- Recommend mitigation measures to reduce adverse effects and monitoring, followed by evaluation and management of effects, to ensure effectiveness of these measures.

- Implement mechanisms to evaluate the results of the monitoring and provide for subsequent mitigation or project modification, as necessary.

4.6 Step 5: Follow up

The purpose of follow-up is to verify the accuracy of environmental assessments and determine the effectiveness of mitigation measures. Follow-up in practice is normally recognized as monitoring and the establishment of environmental management measures. Frequently, it is the central government who defines and implements the follow-up program. The proponent's responsibilities should be based on their specific action's contribution to cumulative environmental effects, given the understanding that it would usually be unreasonable for the proponent to solely monitor effects caused by other proponents.

The situations in which a follow-up is required include those where:

- There is some uncertainty about the environmental effects of other actions, especially imminent ones.

- The assessment of the action's cumulative effects is based on a new or innovative method or approach.

- There is some uncertainty about the effectiveness of the mitigation measures for cumulative effects.

EXERCISE 7

Determining thresholds

Objective: Using the significance of effects already evaluated at EXERCISE 6 as well as your best professional judgment, determine the threshold number of mining operations the Mahdia region can sustain with (residual) and without mitigation measures.
Examples:
Hint: Work one catchment at the time and then look at the broader watershed.
Duration:

5. ASSESSING SMALL ACTIONS (a chapter for the Regulatory Body)

The majority of applications submitted to regulatory agencies for approval are for actions that do not require a detailed assessment and preparation of a formal EIA report. These actions are subject to a cursory or screening level review because they are relatively small in size and cause predictable and mitigable effects. Many small actions within the same area have the potential to cause cumulative (nibbling) effects. This often happens, for example, when many developments occur in rapid succession (e.g., a resource use boom). These types of actions may cause far more cumulative effects than one large action in the same area.

Almost all CEEA approaches discussed in the literature are intended for assessing large actions (i.e., relatively large in size or with a high likelihood of causing effects at a regional level). It may not always be feasible or necessary for practitioners conducting screening level assessments to carry out these often complex, time consuming and expensive tasks. It is government agencies themselves who often do all or most screenings in response to permit and license applications — some regulatory agencies must process thousands or tens of thousands of applications each year.

Therefore, there is a need to define a process by which cumulative effects of small actions can be considered at the screening level (e.g., as required under the *Canadian Environmental Assessment Act*) that takes into account the limitations of assessing cumulative effects at this level. In effect, a "condensed" or "mini-CEEA" is required, which is nevertheless based on all the approaches suggested in this Guide. Considerable work is still required to formalize such processes that are practical and easily implemented by reviewers.

In essence, addressing cumulative effects in small project screenings involves considering the potential effects that may arise from the project under review in terms of the broader context in which the project would occur. Such an analysis can be done quite effectively by considering three main aspects. First, it is helpful to consider the potential effects of the project under review from the perspective of general trends affecting the VECs (e.g., are there currently known trends of concern, such as gradual loss of water quality that could indicate a need to assess more closely the potential for interactions)? Second, would the project occur in an area where numerous other actions have taken place (e.g., for actions of a similar nature that could result in similar types of effects, such as shoreline modifications along a recreational waterway)? Third, are there any overall policies, thresholds or objectives that have been established at a strategic level of decision making that would be relevant (e.g., provincial guidelines or municipal master plans may establish relevant criteria for cumulative effects of projects such as storm water outlets)?

It is also important to avoid a mismatch between the scale at which impacts accumulate and the scale at which decisions are made. In an ideal world, policies and plans would also undergo environmental assessments, which would include cumulative effects assessments. This would provide a context for addressing cumulative effects at the screening level. In reality, however, this does not always happen and screenings may raise issues that are well beyond the scope of the project under review. In such cases, the broader cumulative effects should be flagged so that they can be addressed at an appropriate level of decision making.

5.1 Elements of a practical design for a screening process

If cumulative effects are to be considered, they must be addressed in a simple and efficient manner that applies simple tests to the action and provides quick answers. The tests must also provide some indication of risk or likelihood of significance to determine if a more detailed review is required. The screener must be able to quickly make decisions; at no point should a screening process leave the screener wondering how to answer a complex question for which resources and time are not available to properly respond.

The following points should be considered when designing an assessment response for a particular agency. The approach should provide:

- A step-by-step process.
- A series of simple question-based criteria for determining rankings (e.g., significance).
- Simple mechanisms to respond to typical CEEA needs such as setting boundaries and identifying other actions.

- A mechanism to support requests for further information both within and outside the agency responsible for the review while ensuring that the screener's knowledge about the type of action and the geographic area can be incorporated.

- Clear, concise questions that do not include terms open to interpretation (e.g., asking "is ecosystem integrity impaired?" would require "integrity" to be explicitly and practically defined).

- A written record to assist in later understanding on what basis decisions were made.

- Clear decision points as to where to go next, including a "bump-up" mechanism (i.e., to move beyond screening to a more detailed level of review).

- A customized response to the types of actions and effects of most concern to the reviewing agency (e.g., focussed on water-related issues for water use licenses) while at the same time identifying the possibility of any indirect effects that may lead to cumulative effects.

The following case studies provide examples of how some agencies have begun to address cumulative effects at a screening level. It is suggested that users of this Guide review these and adopt and modify an approach suitable for their specific requirements.

Query for assessing small actions

1) Will the action potentially affect ecosystems or VECs that are currently exhibiting trends of concern?

2) Will the action occur in an area where numerous other actions have taken place?

3) Are there any overall policies or plans that establish relevant objectives or criteria to facilitate the adoption of a broader perspective?

Case study 18

A "short-cut" approach

Parks Canada has recognized the need for a detailed CEEA approach to address larger and more complex actions, and a short-cut approach to address cumulative effects for smaller actions (Kingsley 1997). The short-cut, a condensed version of the detailed approach, is simply an expedient way to determine if there are any potential impacts, and if so, if they may act cumulatively with other actions. This approach is summarized below.

Step 1: Scoping

A series of questions are first asked:

- Are the potential impacts of the action, as well as other existing stressors, occurring so closely over time that the recovery of the system is being exceeded?
- Are the potential impacts of the action, along with other stressors from other sources, occurring within a geographical area so close together that their effects overlap?
- Could the impacts from the action interact among themselves, or interact with other existing or known future stressors, either additively or synergistically?
- Do the potential impacts of the action affect key components of the environment? Have those components already been affected by other stressors from the same or other actions, either directly, indirectly or through some complex pathway?
- Is the action one of many of the same type, producing impacts which are individually insignificant but which affect the environment in such a similar way that they can become collectively important over the longer term (i.e., nibbling effect)?

If the answer to any of these questions is yes, there is a potential for cumulative effects. The following are then also asked:

- What are the potential impacts of the action that could give rise to cumulative effects?

- What is the appropriate scale to consider those impacts?

Step 2: Analysis

A matrix, describing various attributes affecting each VEC, is then completed. The attributes are: existing stressors affecting the VEC; pathways of change (cause-effect linkages); consequences (i.e., resulting trends of VECs); and contribution of the action to overall changes. Mitigation measures are also identified.

Step 3: Evaluation

The effects are evaluated, using best professional judgment, by asking if the identified changes affect the integrity of the environment as defined in Parks Canada guidelines. These changes are then compared with existing goals.

Step 4: Follow-Up, Feedback and Documentation

All information is documented, uncertainties identified, and feedback and monitoring requirements suggested in the Parks Canada Screening Form.

Case study 19
Matrix-based screening

Natural Resources Canada uses two matrices to assist screeners in completing the Environmental Assessment Report for a project. The first matrix requires the screener to identify if any aspect of the action causes any of 40 types of biophysical effects (e.g., surface water temperature, erosion, breeding disturbance) and any of 12 social-cultural-economic effects. Space is provided for the assessor to include any other applicable effects. The second matrix identifies the potential effects of 26 other common types of actions (e.g., agriculture, mining, solid waste disposal), and provides space to add others. It requires the assessor to identify which other actions are present in the study area, and then which of their effects may combine with those of the project, as identified in the first matrix. In the report, the assessor must then indicate if any of the potential effects are likely, consider mitigation for likely effects, and determine whether the residual effects are significant.

6. KEY CRITERIA FOR AN ACCEPTABLE CEEA

The following proposes criteria that establish the expectations of best professional practice in completing a CEEA.

1) The study area is large enough to allow the assessment of VECs that may be affected by the action being assessed. This may result in an area that is considerably larger than the action's footprint. Each VEC may have a different study area.

2) Other actions that have occurred, exist or may yet occur that may also affect those same VECs are identified. Future actions that are approved within the study area must be considered; officially announced and reasonably foreseeable actions should be considered if they may affect those VECs and there is enough information about them to assess their effects. Some of these actions may be outside the study area if their influence extends for considerable distances and length of time.

3) The incremental *additive* effects of the proposed action on the VECs are assessed. If the nature of the effects interaction is more complex (e.g., synergistic), then the effect is assessed on that basis, or why that is not reasonable or possible is explained.

4) The total effect of the proposed action and other actions on the VECs are assessed.

5) These total effects are compared to thresholds or policies, if available, and the implications to the VECs are assessed.

6) The analysis of these effects use quantitative techniques, if available, based on best available data. This should be enhanced by qualitative discussion based on best professional judgement.

7) Mitigation, monitoring and effects management are recommended (e.g., as part of an Environmental Protection Plan). These measures may be required at a regional scale (possibly requiring the involvement of other stakeholders) to address broader concerns regarding effects on VECs.

8) The significance of residual effects are clearly stated and defended.

6.1 CEEA checklist

Answering the following questions (many during scoping) should ensure that the assessment incorporates important attributes of a CEEA.

Local Effects

- Does the assessment of local effects (i.e., in the EIA) indicate a likelihood of other than negligible residual effects? If so, on which VECs?
- Is the proposed action within a relatively undisturbed landscape, or a landscape already disturbed?
- Do topographic or other constraints spatially limit the effect that the action may have on VECs?

Other Actions

- Is there any evidence that the effects of past actions may still be other than negligible?
- Are the nearest existing actions to the proposed action possibly contributing to effects on the same VECs?
- Have any actions been officially announced by other proponents with the intent to begin submission under statutory requirements?

Regional Issues

- Have any issues or VECs already been identified in the EIA or by local stakeholders that may be of concern beyond the footprint of the proposed action?
- Are any VEC species locally or regionally rare? Are there any environmentally sensitive areas that may be disturbed?

- With or without local significant effects, could the action contribute to regional "nibbling" loss of habitat (terrestrial or aquatic) that may affect VECs that reside or pass through the action's local study area?

Assessment

- Is the assessment focussed on effects on VECs to which the action under review may contribute?
- Is there reliable information (both science and traditional-knowledge based) that describes the VECs and the habitat on which some VECs depend?
- Is there adequate information available about other actions to confidently determine if they are contributing to other than negligible effects on the same VECs?
- Are indicators available to assess VECs?
- Are there indicators of significance other than thresholds that should be considered?
- Could the action induce other actions to occur (especially road access)?
- Can a historical baseline be described against which consecutive changes can be compared?
- Are any effects traceable back to the action under review? Is the action responsible for incrementally contributing to the effect?
- Are certain analytical approaches mandatory for assessing effects on some VECs?

Significance

- Are quantitative thresholds available for any of the VECs? Are qualitative thresholds available that describe intended land use (e.g., land use plans)?

- If landscape indicators are proposed, can the derived values be used to determine if the effects on a VEC have exceeded or may exceed the VEC's ability to recover?

Mitigation

- Is the standard or a novel application of mitigation adequate to mitigate significant effects?
- Can reclamation reduce the duration of land disturbance and hasten the recovery of environmental components to pre-disturbance conditions?
- Is habitat of equivalent capability available elsewhere to compensate for lost habitat?
- Is there an opportunity to initiate a regional level mitigation (or compensation) of effects?
- What is required for monitoring and effects management as follow-up?

7. PERSONNEL

This report has been prepared par Marc Arpin, M.Sc., P.Geo., project manager and reviewed by Benoît Demers, M.Sc.A., Eng., Director, Mining and Environment.

SNC-LAVALIN ENVIRONMENT INC.

Marc Arpin, M.Sc., P.Geo.
Project Manager

Verified for conformity
with ISO 9001 by: ______________________________

Benoît Demers, M.A.Sc., Eng.
Director
Mining and Environment

MA/lj

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APPENDIX A

Identification of actions

Identification of actions

VEC	ACTIONS WITHIN THE REGIONAL STUDY AREA						
	Past		Existing		Future		Induced
	Mining	Others	Mining	Others	Mining	Others	
	ACTIONS OUTSIDE THE REGIONAL STUDY AREA						

APPENDIX B

Description of other actions

Description of other actions

Actions									
Others	**Sector**	**Location and capacity**	**Components**	**Life expectancy**	**Workforce**	**Frequency of use**	**Transportation modes**	**Processes used**	**Remarks**
Past									
Existing									
Future									
Induced									

APPENDIX C

Description of mining actions

Description of mining actions

Actions									
Mining	**Sector**	**Location and capacity**	**Components**	**Life expectancy**	**Workforce**	**Frequency of use**	**Transportation modes**	**Processes used**	**Remarks**
Past									
Existing									
Future									
Induced									

APPENDIX D

Pathway assessment and evaluation

Pathway assessment and evaluation
(evaluating significance and its attributes)

Pathway				
Links				
Scope				
Magnitude				
Duration				
Frequency				
Direction				
Significance				
Confidence				

Pathway				
Links				
Scope				
Magnitude				
Duration				
Frequency				
Direction				
Significance				
Confidence				

Pathway				
Links				
Scope				
Magnitude				
Duration				
Frequency				
Direction				
Significance				
Confidence				

Pathway				
Links				
Scope				
Magnitude				
Duration				
Frequency				
Direction				
Significance				
Confidence				