

**A Reference Guide  
for the  
Canadian Environmental  
Assessment Act**

**Determining Whether A Project  
is Likely to Cause  
Significant Adverse  
Environmental Effects**

**Prepared by the  
Federal Environmental Assessment  
Review Office**

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# Reference Guide: Determining Whether A Project is Likely to Cause Significant Adverse Environmental Effects

## 1. Introduction

This reference guide describes an approach for deciding whether a project is likely to cause significant environmental effects under the *Canadian Environmental Assessment Act (Act)*. It is one of several reference guides intended to provide the supporting documentation for the *Responsible Authority's Guide to the Canadian Environmental Assessment Act* prepared by the Federal Environmental Assessment Review Office (FEARO). All of the reference guides are complimentary to the *Responsible Authority's Guide to the Canadian Environmental Assessment Act* but go into more detail on individual issues. Specifically, this reference guide:

- reviews the concept of significance;
- discusses the relevant requirements of the Act;
- proposes an approach for deciding whether a project is likely to cause significant adverse environmental effects under the Act;
- provides a list of key references on the subject.

As the practice of environmental assessment evolves, it will be necessary to update and revise both the *Responsible Authority's Guide to the Canadian Environmental Assessment Act* and the individual reference guides. These guides should be seen as evolving documents rather than as static textual materials. Any suggestions for updates or revisions should be directed to:

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This guide is intended primarily for responsible authorities (RAs) and the Minister of the Environment (the Minister), since under the Act, they are responsible for determining when a project is likely to cause significant adverse environmental effects.

## 2. The Concept of Significance

Deciding whether a project is likely to cause significant adverse environmental effects is central to the concept and practice of environmental assessment. Whatever

adverse environmental effects are addressed and whatever methods are used, the focus of environmental assessment always narrows down to a decision about whether the project is likely to cause significant adverse environmental effects.

The concept of significance cannot be separated from the concepts of “adverse” and “likely.” Environmental effects that are **adverse**, and significant adverse environmental effects that are **likely**, are referred to for convenience in this guide as “the related matters.”

Deciding when a project is likely to cause significant adverse environmental effects is not new to environmental assessment (EA). This concept was included in the Environmental Assessment and Review Process (EARP) Guidelines Order and can be found in most EA legislation, procedural manuals, documents and the research literature. But there is little guidance available on what to consider when determining significance and the related matters and how this should be done.

### **3. The Requirements of the *Canadian Environmental Assessment Act***

The concept of significance is extremely important in the Act. One of the stated purposes of the Act is:

***to ensure that projects that are to be carried out in Canada or on federal lands do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out ” (sec tion 4 (c)).***

The central test in the Act is whether a project is **likely to cause significant adverse environmental effects**. This determination is an objective test from a legal standpoint, which means that all decisions about whether or not projects are likely to cause adverse environmental effects must be supported by findings based on the requirements set out in the Act.

The definitions of “environment” and “environmental effect” are the starting point for this test . The Act defines the environment as:

***the components of the Earth, and includes***

- (a) land, water and air, including all layers of the atmosphere,***
- (b) all organic and inorganic matter and living organisms, and***
- (c) the interacting natural systems that include components referred to in paragraphs (a) and (b) (section 2(1)).***

***Environmental effect means, in respect of a project,***

- (a) **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, and**
- (b) **any change to the project that may be caused by the environment,**

**whether any such change occurs within or outside Canada (section 2 (7)).**

Only environmental effects as defined in the Act can be considered in determinations of significance and the related matters. It follows that the determination of significance and the related matters can consider only:

- direct changes in the environment caused by the project;
- the effects of these environmental changes on:
  - . health and socio-economic conditions,
  - . physical and cultural heritage,
  - . current use of lands and resources for traditional purposes by aboriginal persons,
  - . any structure, site or thing that is of historical, archaeological, paleontological or architectural significance;
 or
- changes to the project caused by the environment.

For example, the socio-economic effects of a project may or may not be factors in determining significance and the related matters. If a socio-economic effect (such as job losses) is caused by a change in the environment (such as loss of fish habitat), which is in turn caused by the project, then the socio-economic effect is an environmental effect within the meaning of the Act and must be considered when determining significance and the related matters. If the socio-economic effect is not caused by a change in the environment, however, but by something else related to the project (for example, reallocation of funding as a result of the project), then the socio-economic effect is **not** an environmental effect within the meaning of the Act and cannot be considered in the determination of significance and the related matters.

Determinations of significance and the related matters must be made:

- following a screening;
- after a comprehensive study report has been completed;
- after a mediation or review panel report has been submitted.

Following a screening, the RA must decide whether or not the project is likely to cause significant adverse environmental effects, taking into account the implementation of mitigation measures (section 20(1)). If the RA decides that the project is not likely to cause significant adverse environmental effects, it may allow the project to proceed, while ensuring that any appropriate mitigation measures are implemented. If the RA decides that the project is likely to cause significant adverse environmental effects (taking into account the implementation of mitigation measures) and these effects cannot be justified in the circumstances, it must not do anything that would permit the project to proceed.

The RA must refer the project to the Minister for referral to a mediator or a review panel when:

- it is uncertain whether the project is likely to cause significant adverse environmental effects (taking into account the implementation of mitigation measures);
- it decides that the project is likely to cause significant adverse environmental effects that may be justifiable in the circumstances; or
- public concerns warrant a referral.

When a comprehensive study report is sent to the Minister and the Canadian Environmental Assessment Agency (the Agency) by an RA, the Minister is required to make a process decision about whether or not further review of the project is necessary, or whether a final decision can be made by the RA (section 23). This decision must be based on the comprehensive study report. If the Minister decides that the project, taking into account the implementation of mitigation measures, is not likely to cause significant adverse environmental effects or that it is likely to cause significant adverse environmental effects that cannot be justified in the circumstances, the Minister must refer the project back to the RA for appropriate action. If it is uncertain, however, whether the project is likely to cause any significant adverse environmental effects or that the project will cause significant adverse environmental effects that may be justified in the circumstances, the project must be referred to a mediator or a review panel. Public concerns may also warrant referring the project to a mediator or a review panel.

After a panel review or a mediation is completed, or when a comprehensive study report of a project is referred back to the RA by the Minister, the RA must make the final determination and decide whether the project is likely to cause significant adverse environmental effects (section 37(1)). If the project is not likely to cause significant adverse environmental effects, or if it is likely to cause significant adverse environmental effects (taking into account the implementation of mitigation measures) that can be justified in the circumstances, the RA is free to provide federal support to or participate in the project. If, on the other hand, the RA considers that the project is likely to cause significant adverse environmental effects that cannot be justified in the

circumstances, it must not do anything to permit the project to proceed.

Four points merit special attention. First, with the exception of transboundary boundary reviews, the RA makes the determination about whether the project is likely to cause significant adverse environmental effects. The Minister, however, does make a process determination of significance and the related matters following receipt of a comprehensive study report from an RA. After considering whether the project is likely to cause significant adverse environmental effects, as described in the comprehensive study report, the Minister must make a decision whether further study, through a panel review or mediation, is warranted.

Second, in *all* cases, significance and the related matters are determined only after taking into account any mitigation measures the RA considers appropriate. In other words, no final determination can be made about the significance of the likely adverse environmental effects or the related matters unless the implementation of any appropriate mitigation measures has been considered.

Third, public input into the determination of significant adverse environmental effects must limit itself to questions related to scientific analysis and interpretation. The public, for example, could provide new evidence, offer a different interpretation of the facts, or question the credibility of the conclusions. Issues that are not directly linked to the scientific (including traditional ecological knowledge) analysis of environmental effects, such as long-term unemployment in a community or fundamental personal values, cannot be introduced into the determination at this step. Such public concerns and values are given prominence elsewhere in the EA process. Under the Act, serious public concerns can warrant referral of the project to a public review through either mediation or a public panel review. That is, public concerns -- that may or may not have to do with scientific issues -- can prompt the EA process to take a closer look at the project.

Fourth, if there is a determination that the project, taking into account the implementation of appropriate mitigation measures, is likely to cause significant adverse environmental effects, then the RA must also determine whether or not such effects can be justified under the circumstances. The Act is clear that the project may be allowed to proceed if any likely significant adverse environmental effects can be justified in the circumstances. This is the final "test" in the Act. The RA can decide that likely significant adverse environmental effects are not justified after a screening, comprehensive study report, or a public review. It can decide that they *are* justified, however, only after a public review in the form of mediation or a panel review.

The central question for the RA or the Minister in the process decision following submission of a comprehensive study report, remains: "Is the project likely to cause any significant adverse environmental effects?" Thus, only environmental effects that are both *likely and adverse* can be considered in determinations of significance.

Environmental effects that are unlikely or are not adverse cannot be considered in significance decisions. It is important to note that the test is not of “significantly adverse” effects, but of adverse effects that are significant. The “likely” applies to the environmental effects of the project that are both adverse and significant.

#### **4. A Framework**

This section provides a framework for guiding **RAs** in determining whether environmental effects are **adverse, significant, and likely** within the context of the Act.

The framework consists of three general steps:

- Step 1: Deciding Whether the Environmental Effects are Adverse
- Step 2: Deciding Whether the Adverse Environmental Effects are Significant
- Step 3: Deciding Whether the Significant Adverse Environmental Effects are Likely

Each step consists of a set of criteria that **RAs** and the Minister should use to address these three questions, as well as examples of methods and approaches that can be applied. To apply the criteria, the RA and the Minister must rely on information provided by the proponent. Thus, the RA or the Minister should ensure that the proponent provides the necessary information (section 18(2)), by specifying the types of information required to determine significance and the related matters when the scope of the project is defined by the RA or the Minister.

##### **4.1 Step 1: Deciding Whether the Environmental Effects are Adverse**

In making this decision, it may be helpful to separate the effects on people from the effects on the environment, recognizing of course that people are integral to most ecosystems. It is important to remember that only “environmental effects” as defined in the Act can be considered.

Table 1 lists the major factors that should be used to determine whether environmental effects are adverse. Obviously, the importance of individual characteristics will be different in different **EAs**. To assist the RA and the Minister in deciding whether the environmental effects are adverse, the proponent should be required to submit information on these factors.

The most common way of determining whether a project’s environmental effects are adverse is to compare the quality of the existing environment with the predicted quality of the environment once the project is in place, using some or all of the criteria shown in Table 1 as variables. This method implies a need for environmental monitoring information collected over time and/or distance before the project is in place. It also assumes normal baseline environmental conditions, although this may not always be

the case (e.g., fluctuating water levels in a river). It is the proponent's responsibility to ensure that such information is put before the RA. In most cases, the proponent should be expected to collect and synthesize the available information on baseline environmental quality. In some cases where there are gaps in information, the proponent can be requested to collect new information, depending on the size and nature of the project and the proponent's resources.

Occasionally, information from other situations may be helpful in determining whether the environmental effects are adverse. For example, if there are similar or identical projects already in place in similar ecosystems, it may be helpful for the proponent to provide information on their environmental effects.

#### **4.2 Step 2: Deciding Whether the Adverse Environmental Effects are Significant**

There are several criteria that should be taken into account in deciding whether the adverse environmental effects are significant. These are briefly discussed below:

##### ***Magnitude of the adverse environmental effect***

Magnitude refers to the severity of the adverse environmental effects. Minor or inconsequential effects may not be significant. On the other hand, if the effects are major or catastrophic, the adverse environmental effects will be significant. When using this criterion, it is important to consider the extent to which the project could trigger or contribute to any cumulative environmental effects.



**Table 1: Factors in determining adverse environmental effects**

Changes in the Environment	Effects on People Resulting from Environmental Changes
<ul style="list-style-type: none"> <li>• Negative effects on the health of biota, including plants, animals, and fish;</li> <li>• Threat to rare or endangered species;</li> <li>• Reductions in species diversity or disruption of food webs;</li> <li>• Loss of or damage to habitats, including habitat fragmentation;</li> <li>• Discharges or release of persistent and/or toxic chemicals, microbiological agents, nutrients (e.g., nitrogen, phosphorus), radiation, or thermal energy (e.g., cooling wastewater);</li> <li>• Population declines, particularly in top predator, large, or long-lived species;</li> <li>• The removal of resource materials (e.g., peat, coal) from the environment;</li> <li>• Transformation of natural landscapes;</li> <li>• Obstruction of migration or passage of wildlife;</li> <li>• Negative effects on the quality and/or quantity of the biophysical environment (e.g., surface water, groundwater, soil, land, and air).</li> </ul>	<ul style="list-style-type: none"> <li>• Negative effects on human health, well-being, or <b>quality of life</b>;</li> <li>• Increase in unemployment or shrinkage in the economy;</li> <li>• Reduction of the quality or quantity of recreational opportunities or amenities;</li> <li>• Detrimental change in the current use of lands and resources for traditional purposes by aboriginal persons;</li> <li>• Negative effects on historical, archaeological, paleontological, or architectural resources;</li> <li>• Decreased aesthetic appeal or changes in visual amenities (e.g., views);</li> <li>• Loss of or damage to commercial species or resources;</li> <li>• Foreclosure of future resource use or production;</li> </ul>

### ***Geographic extent of the adverse environmental effects***

**Localized** adverse environmental effects may not be significant. Alternatively, widespread effects may be significant. When considering this criterion, it will be important to take into account the extent to which adverse environmental effects caused by the project may occur in areas far removed from it (e.g., acid rain and the long-range transportation of atmospheric pollutants), as well as contribute to any cumulative environmental effects.

### ***Duration and frequency of the adverse environmental effects***

Long term and/or frequent adverse environmental effects may be significant. Future adverse environmental effects should also be taken into account. For example, many human cancers associated with exposure to ionizing radiation have long latency periods of up to 30 years. Obviously, when considering future adverse environmental effects, the question of their likelihood becomes very important.

### ***Degree to which the adverse environmental effects are reversible or irreversible***

Reversible adverse environmental effects may be less significant than adverse environmental effects that are irreversible. In practice, it can be difficult to know whether the adverse environmental effects of a project will be irreversible or not. It will be important to consider any planned decommissioning activities that may influence the degree to which the adverse environmental effects are reversible or irreversible.

### ***Ecological context***

The adverse environmental effects of projects may be significant if they occur in areas or regions that:

- have already been adversely affected by human activities; and/or
- are ecologically fragile and have little resilience to imposed stresses.

To assist the RA and the Minister in deciding significance, proponents should always be required to submit information on these criteria. All of them should be considered in deciding whether the adverse environmental effects are significant or not. Different criteria will be important in different **EAs** and the extent to which an individual criterion will influence the overall determination of significance will vary between assessments.

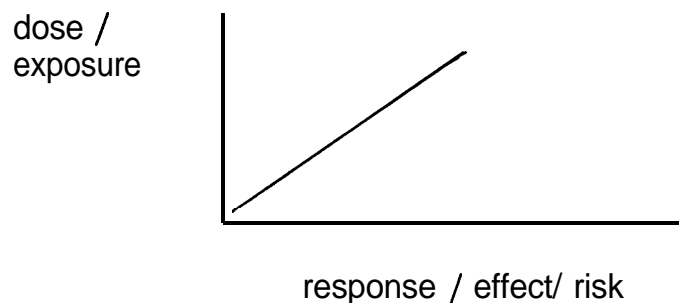
The most common method of determining whether the adverse environmental effects of a project are significant is to use environmental standards, guidelines, or objectives. If the level of an adverse environmental effect is less than the standard, guideline, or objective, it may be insignificant. If, on the other hand, it exceeds the standard,

guideline, or objective, it may be significant.

Environmental standards, guidelines and objectives have been established by federal, provincial, and in some cases municipal departments, ministries, and agencies. They often define either maximum levels of emissions or discharges of specific hazardous agents into the environment or maximum acceptable levels of specific hazardous agents in the environment. They are usually based on the results of studies in the field and with laboratory animals, available technology, and/or prevailing attitudes and values.

However, environmental standards, guidelines and objectives have been established only for a relatively small number of hazardous agents, such as some chemicals, radiation, and physical parameters including acidity and acceptable levels of particulates or suspended solids. Since there are no standards, guidelines, or objectives for most environmental effects, they cannot be used to determine the significance of many adverse environmental effects, nor do they necessarily protect ecological health. In addition, standards, guidelines, or objectives are set on the basis of individual hazardous agents and do not allow for any interactions that may occur (i.e., cumulative environmental effects).

Another method of determining significance is quantitative risk assessment, which is often used to determine the significance of the risks to human health from ionizing radiation and carcinogenic chemicals. Its use is restricted to agents that have predictable dose-response (or exposure-effect) relationships. Often derived from experiments using laboratory animals, these relationships usually approximate straight lines (see below).



The response, effect, or risk is often measured in terms of increased cancer incidence per million people exposed. In quantitative risk assessment, an “acceptable” level of risk is determined. Conventional levels for “acceptable risk” to the public are an increased incidence of between one in 10 thousand to 1 in 10 million. By using the dose-response relationship, it can be determined whether or not the dose/exposure

would result in an unacceptable level of risk. In other words, significance is determined on the basis of an “acceptable level” of a specified risk, often cancer incidence.

This approach assumes that there is an “acceptable” level of risk. In practice, occupational health and safety standards allow for a greater degree of risk than public exposure standards. The Delaney Clause in the U.S. **Food and Drugs Act** establishes zero as the acceptable or significant increased cancer risk associated with food additives. It is important to be clear on who determines acceptable risk levels as well as how they are determined when quantitative risk assessments are included in **EAs**. As well as determining significance, quantitative risk assessment can also be used to determine the probability of occurrence of significant environmental effects, i.e., likelihood.

If there are no relevant environmental standards, guidelines, or objectives and quantitative risk assessment is not possible, other methods and approaches must be used. In larger **EAs**, such as panel reviews, it may be possible to develop methods and approaches for determining significance for individual projects. In others, it will be necessary for the RA or the Minister to use a qualitative approach based on their best professional judgement.

When a project’s adverse environmental effects are being compared to the adverse environmental effects of an alternative means of carrying out the project, weighting and ranking methods can assist in deciding whether the adverse environmental effects are significant. Generally, quantitative methods are used to weight or rank the individual adverse environmental effects of different alternatives which are then added to produce a total effect “score.” These methods can be helpful in summarizing and comparing the effects of alternatives, but they can also hide the assumptions inherent in the weighting or ranking system. As well, weighting and ranking methods compare total effects, so that a locally significant individual effect may appear unimportant in the overall scheme. In other words, there is a loss of specificity. These problems can be at least partially resolved by ensuring that weighting and ranking exercises are conducted by those with a wide variety of experience and expertise.

Whatever methods are used to determine significance, they should be based on the criteria outlined above.

Cost-benefit analysis cannot be used to determine significance in federal **EAs**, because it compares the estimated environmental costs and benefits of a project, whereas the Act clearly states that only **adverse** environmental effects are to be considered in determining significance and likelihood. Although cost-benefit analysis could be used to justify proceeding with a project that is likely to cause significance adverse environmental effects, this justification can take place only **after** the likelihood of the significant adverse environmental effects has been determined.

### **4.3 Step 3: Deciding Whether the Significant Adverse Environmental Effects Are Likely**

When deciding the likelihood of significant adverse environmental effects, there are two criteria to consider:

#### ***Probability of occurrence***

If there is a high probability that the identified significant adverse environmental effects will occur, obviously they are likely. Conversely, if there is a low probability of occurrence, the significant adverse environmental effects are unlikely.

#### ***Scientific uncertainty***

There will always be some scientific uncertainty associated with the information and methods used in EAs. This is often termed the “confidence limits”. If the confidence limits are high, there is a low degree of uncertainty that the conclusions are accurate and that the significant adverse environmental effects are likely or not. If the confidence limits are low, there is a high degree of uncertainty about the accuracy of the conclusion. In this case, it will be difficult to decide whether the significant adverse environmental effects are likely or not. If low scientific uncertainty can lead to an unambiguous conclusion of likelihood or unlikelihood, conversely high uncertainty cannot be a basis for a clear conclusion about likelihood. In this case, only the probability of occurrence criterion should be used to determine likelihood.

To assist the RA or the Minister in deciding likelihood, proponents should be required to submit information on these criteria.

The use of confidence limits has already been mentioned as a method of determining likelihood based on scientific certainty or uncertainty. Others include a range of statistical methods that are used to determine “statistical significance,” which is usually defined as the low probability of error. Although statistical methods themselves are not discussed in this paper, it is useful to note the two commonly encountered types of statistical errors. Type 1 is a false positive, that is, a false conclusion that there will be a significant adverse environmental effect. Type 2 is a false negative, that is, a false conclusion that there will not be a significant adverse environmental effect. Statistical results provided by proponents should always be required to state the probabilities of making both types of errors.

Another method used to determine the probability of occurrence is quantitative risk assessment. (See section 4.2 above.)

**RAs** and the Minister should require proponents to use statistical methods to determine statistical significance, whenever possible. These methods will facilitate a determination of likelihood by the RA or the Minister. In **EAs** where numerical methods cannot be used or are not feasible, the RA or the Minister must use a qualitative approach to determining likelihood, based on their best professional judgement.

## 5. Further Reading

Allelt, E.J. 1986. EIA and Decision Analysis. *Journal of the Operational Research Society* 37: 901-1 0.

Ames, G. 1978. An Approach to the Determination of Significance in the Preparation of Environmental Assessments In: *Environmental Assessment: Approaching Maturity*, edited by Bendix and Graham, 25-33. Ann Arbor Science Publishers Inc. Ann Arbor, Michigan.

Bacow, L.S. 1980. The Technical and Judgemental Dimensions of Impact Assessment. *Environmental Impact Assessment Review* 1(2): 109-24.

Bakus, G., W. Stillwell, S. Latter and M. Wallerstein. 1982. Decision Making: With Applications for Environmental Management. 6(6): 493504.

Caldwell, L.K. 1987. The Contextual Basis for Environmental Decisionmaking: Assumptions are Predeterminants of Choice. *The Environmental Professional* 9: 302-08.

Duinker, P.N., and G.E. Beanlands. 1986. The Significance of Environmental Impacts: An Exploration of the Concept. *Environmental Management* 10(1): 1-10.

Economic Commission for Europe. 1989. *Criteria for Determining the Environmental Significance of Projects*. Meetings of Experts on Environmental Impact Assessment, The Hague, Netherlands, November 27-28. United Nations Economic Commission for Europe. Netherlands.

Haug, P.T., R.W. Burwell, A. Stein, and B.L. Bandurski. 1984. Determining the Significance of Environmental Issues Under NEPA. *Journal of Environmental Management* 18: 15-24.

Hollick, M. 1981. The Role of Qualitative Decision Making Methods in EIA. *Journal of Environmental Management* 12(1): 65-78.

Hundloe, T., G.T. McDonald, J. Ware, and L. Wilks. 1990. Cost Benefit Analysis and Environmental Impact Assessment. *Environmental Impact Assessment Review* 10(1/2): 55-68.

Matthews, W.H. 1975. Objective and Subjective Judgements in Environmental Impact Analysis. *Environmental Conservation* 2(2): 121-31.

Rodericks, J.V., S.M. Brett, and G.C. Wrenn. 1987. Significant Risk Decisions in

Federal Regulatory Agencies. *Regulatory Toxicology and Pharmacology* 7(3):307-20.

Rucklehaus, W.D. 1983. Risk and Public Policy. *Science* 221: 1026-28.

Sharma, R.K., J.D. Buffington, and J.T. McFadden. 1976. The Biological Significance of Environmental Impacts. Proceedings of a Conference on June 4-6, 1975 at the University of Michigan. NR-Conf 002. U.S. Nuclear Regulatory Commission. Washington, D.C.

Slovic, P. 1987. Perceptions of Risk. *Science* 236: 280-85.

Thompson, M.A. 1990. Determining Impact Significance in Environmental Impact Assessments. A Review of 24 Methodologies. *Journal of Environmental Management* 30: 235-50.

Travis, C.C., and H.A. Hattemer-Frey. 1988. Determining an Acceptable Level of Risk. *Environmental Science and Technology* 22(8): 873-76.

U.S. Army Corps of Engineers, Seattle District. 1983. *A Guide to the Analysis of Significance*. U.S. Army Corps of Engineers. Seattle, Washington.

Wolf, P.G. 1982. User's *Guide to Defining Significant Impacts under the Federal EARP*. Federal Environmental Assessment Review Office. Hull, Quebec.