3.0 ASSESSMENT METHODOLOGY

3.1 INTRODUCTION

This chapter describes the methods used to identify and evaluate likely effects associated with the PNGS B Project. It includes a description of:

- Temporal and spatial boundaries adopted for the assessment;
- Environmental components used in the assessment;
- Methods used for assessing measurable effects of the project on the environment, including project-environment interactions, characterizing the existing environment, identifying Valued Ecosystem Components (VECs), and identifying mitigation measures;
- Methods used for assessing likely effects of the environment on the project (i.e., effects associated with severe weather or seismic events);
- Methods used for assessing effects of credible malfunction and accident scenarios;
- Methods used for assessing likely cumulative effects;
- Evaluation of significance of residual environmental effects;
- Consideration of community and stakeholder comments; and
- Preliminary scope and rationale for the follow-up and monitoring program.

3.2 ENVIRONMENTAL ASSESSMENT METHODOLOGY

3.2.1 Overview of Assessment Methodology

The methodology for the assessment of the effects of the project requires that each of the project works and activities be considered to determine how it may interact with the environment. To this end, it is first necessary to:

- define and describe the project within its individual systems and works, activities, and events referred to as the **Project Works and Activities**. This was presented in Chapter 2.0;
- establish the temporal boundaries (time frames) relevant to the project;
- establish spatial boundaries (study areas) relevant to the project; and
- identify the applicable environmental components**.**

The project-environment interactions are then identified and each is systematically evaluated to determine measurable environmental effects, mitigation measures, and residual effects.

3.2.2 Temporal Boundaries

The temporal boundaries for the assessment define the time periods for which project-specific and cumulative effects will be considered. The following dates have been adopted as the temporal framework for the purposes of this assessment.

Refurbishment Phase

For the purpose of the EA study, the refurbishment phase includes the work necessary to prepare for and implement the refurbishment of each of the PNGS B units, returning the reactors to full power, and management of refurbishment waste. The construction of refurbishment waste storage structures at PWMF and other preparatory activities are planned for 2010 to 2014. It is expected that the four reactors will be refurbished from 2012-2026 (see Section 2.6). Up to two reactors at a time may be taken out of service for refurbishment outages.

Continued Operation Phase

PNGS B will be returned to service and is anticipated to continue to the new end of life which has been conservatively assessed to be up to 2060 for the last of the four units.

Construction of an additional storage building at the PWMF for the interim storage of used nuclear fuel from extended operation will likely take place about 2025.

Decommissioning Phase

The Decommissioning Phase of PNGS B is expected to take place after 2060 in stages, beginning with a period of safe storage of approximately 30 years after the last of the four units is shut down. Decommissioning activities for PWMF have been addressed in the PWMF Phase II Final EA Study Report (OPG 2003a).

3.2.3 Spatial Boundaries

Spatial boundaries define the geographical extent(s) within which likely or potential environmental effects will be considered. As such, these boundaries become the study areas adopted for the EA study.

The EA Guidelines (CNSC 2007) require that the study areas considered in the assessment encompass the areas of the environment that can reasonably be expected to be directly or indirectly affected by the project, or which may be relevant to the assessment of cumulative effects. Each study area encompasses all relevant components of the environment including people, non-human biota, land, water, air and other aspects of the natural and human environment. Study boundaries have been defined taking into account ecological, technical and social/political considerations. Study boundaries may be modified during the assessment for the different environmental components to allow consideration of the extent of likely environmental effects. The three general study areas selected for the EA are described in the EA study Guidelines and presented below.

3.2.3.1 Site Study Area

The Site Study Area includes the facilities, buildings and infrastructure at the PNGS B facility and the area within the 914 metre exclusion zone for the site which encompasses both land surface and part of Lake Ontario water surface. This area is illustrated on Figure 3.2-1.

3.2.3.2 Local Study Area

The Local Study Area is composed of an area which lies outside of the Site Study Area and extends approximately 10 km from PNGS. It is defined as an area which includes lands within the City of Pickering, the Town of Ajax, and the eastern part of the City of Toronto (Scarborough). This study area also includes a portion of Lake Ontario abutting the property and used by those communities for activities such as recreation and community water supply and waste water discharge. The spatial coverage of this study area is generally illustrated on Figure 3.2-2.

3.2.3.3 Regional Study Area

The Regional Study Area extends beyond the Local Study Area and can be defined as the area within which there is the potential for cumulative and socio-economic effects. This area generally extends approximately 20 km east of the Darlington Nuclear Generating Station (NGS) in the east (i.e. the eastern boundary of the Region of Durham), to the eastern part of the City of Toronto (Scarborough) in the west and includes the municipalities in the Regional Municipality of Durham north of the PN site. This area is shown on Figure 3.2-3.

The above study areas represent the general spatial framework for assessing environmental effects. The application of these study areas varies within each environmental component to allow the full extent of likely effects to be considered. Specific descriptions of any modifications to these study areas that were adopted for each of the environmental components are provided, including the rationale for their selection, in the individual sub-sections of Chapter 4.0.

3.2.4 Environmental Components

Section 2 of the *CEAA* defines the "Environment" to include:

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

For the purpose of this report, the environment comprises the following components that include the biophysical and social features that have the potential to be affected by the project.

- **Atmospheric Environment**: represents air quality with respect to non-radiological parameters, including noise, meteorology and climatic conditions;
- **Surface Water Resources:** represent surface water quantity and quality, lake temperature, lake circulation, shoreline processes, and sediment quality;
- **Aquatic Environment**: represents aquatic biota and habitat;
- **Terrestrial Environment**: represents terrestrial biota and habitat;
- **Geology, Hydrogeology and Seismicity**: represent geological and hydrogeological conditions (including soil quality, groundwater quality and groundwater flow) and seismic potential;
- **Radiation and Radioactivity**: represent environmental radiation and radioactivity, including radionuclide emissions and doses to humans and non-human biota;
- **Visual Setting and Transportation**: represent landscape and visual setting, transportation, and traffic analysis;
- **Physical and Cultural Heritage Resources**: represent pre-contact, historic, and cultural landscape heritage resources;
- **Socio-economic Conditions**: represent land use, population and economy, community infrastructure, community services, municipal finance and administration, residents and communities;
- **Aboriginal Interests**: represent aboriginal communities, treaty and aboriginal rights, and traditional use of lands and resources; and

- **Human Health**: represents the physical, mental and social well-being of humans (workers and members of the public). Human health comprises components of the atmospheric environment, surface water resources, hydrogeology, radiation and radioactivity, socio-economic conditions and aboriginal interests.

Each environmental component is further divided into sub-components that represent a potential pathway or mechanism for the transfer of an effect to a Valued Ecosystem Component (VEC) (see Section 3.3.2 for definition of VECs). The sub-components and VECs in each of the environmental components are identified and described in Chapter 4.0. These individual environmental components and sub-components provide the general framework for assessing the effects of the project on VECs.

3.3 ASSESSMENT OF LIKELY EFFECTS OF THE PROJECT

The methodology for the assessment of likely environmental effects of the project involves the following steps:

- Defining how each of the Project Works and Activities has the potential to affect the environment; namely, the project-environment interactions;
- Characterizing the components and sub-components of the existing environmental conditions (i.e. baseline environment) that are relevant in the specific context of the project;
- Identifying and describing VECs that are the focus of the EA study;
- Determining the measurable changes that are likely to occur as a result of implementing the project (the “likely effects”), identifying the associated VECs that may be affected, considering measures to mitigate any adverse effects, and identifying any residual adverse effects that remain following mitigation; and
- Evaluating the significance of any adverse residual effects.

3.3.1 Define the Project-Environment Interactions

For the purposes of the EA Study, it is necessary to define the project in terms of its potential to interact with and affect the environment. Accordingly, the project was broken out into its individual Project Works and Activities (see Sections 2.7 and 2.8). Each of the Project Works and Activities was screened to identify those that are judged to have a potential project-environment interaction. The screening approach allows the assessment to focus on the issues of key importance, thus avoiding unnecessarily large amounts of documentation where the potential interaction between the project and the various components of the environment are weak or remote in space and time.

All Project Works and Activities comprising the Refurbishment Phase and the Continued Operation Phase were described and analyzed individually to determine if there was a plausible mechanism for an effect on each environmental component. The analyses were based on professional judgement and experience of the technical specialists with regard for the physical and operational features of the project and their potential interactions with the environment.

The outcome of the screening was the identification of the Project Works and Activities that have a potential to affect the environment. These are summarized in Table 5.3-1 that denotes project–environment interactions with a potential to lead to environmental effects. These interactions are analyzed in subsequent sections to determine if they are likely to result in a measurable change in the environment, and if so, to describe the relevant environmental effect on the appropriate VEC.

3.3.2 Characterize the Existing Environment

The existing environment that may be affected by the project is described in Chapter 4.0. Descriptions for each of the eleven environmental components focused on specific aspects (i.e., sub-components) that are relevant to the project.

The existing environment was delineated as follows:

- Descriptions of the existing environment (i.e., baseline conditions) for each of the study areas (spatial boundaries) as appropriate;
- Selection of VECs or other valued features that represent important characteristics of the environment because of their ecological, social, cultural and economic value (see following Section 3.3.2.1).

3.3.2.1 Identify Valued Ecosystem Components

Valued Components (VCs) are features of the environment selected to be a focus of the EA Study because of their ecological, social, cultural or economic value, and their potential vulnerability to effects of the project.

VCs are referred to as **Valued Ecosystem Components** (VECs), **Valued Social Components** (VSCs), and **Valued Cultural Heritage Components** (VCHCs) depending on the component of the environment under investigation. VECs are usually individual valued species or represent important groups of species within food webs. VECs identified as relevant to the assessment include those that relate to the terrestrial and aquatic components of the environment and human health. Social aspects of the environment are identified with respect to their Valued Components termed VSCs or VCHCs. All other environmental components were assessed with respect to specific features of the natural environment (e.g., water quality or air quality) and their roles in providing pathways and mechanisms for effects on the VCs based on the inter-relationships of the environmental components.

For the purposes of this EA Study Report, all VCs are referred to as VECs.

VEC selection is based on the potential project-environment interactions and the discussion of the existing environment. The VEC selection considered:

- Abundance in the Site, Local and Regional Study Areas;
- Ecological importance - position in the food web; relative contribution to productivity;
- Baseline data availability - sufficient information should be available to allow a reasonable evaluation of effects;
- Native species;
- Exposure - the VEC should have some exposure to the “stressors” produced by the Project Works and Activities;
- Sensitivity - the VEC should be sensitive to the “stressors” produced by the Project Works and Activities;
- Ecological and human health - potential to affect the growth or sustainability of biota;
- Socio-economic importance - value as commercial, recreational or subsistence resource; inherent aesthetic value;
- Conservation status - specifically protected by law, designated as rare, threatened, or endangered;
- Traditional and current importance to Aboriginal people; and
- Cultural and heritage importance to society.

As the focal points of the EA Study, it is important that the selected VECs represent meaningful measures of the environmental changes and effects that may be caused by the project. In many cases, the identified potential changes to the VEC can be quantified. In other cases, indicators for the VEC provide a measurable endpoint for the assessment. Public and regulatory review of VECs is undertaken as part of the selection process.

3.3.3 Assess Effects of the Project

3.3.3.1 Linkages of Project Interactions and the Environment

Linkages represent the process whereby a project work or activity may interact with the environment to create a measurable change in the environment, which leads to a potential effect on a VEC. As such, linkages generally reflect the "source-pathway-receptor" concept typically considered in ecological and human health impact assessment models.

3.3.3.2 Identify and Assess Likely Effects on VECs

The assessment of effects of the project is an iterative process. Consistent with accepted practice, quantitative as well as qualitative methods, including professional expertise and judgement, are used to predict and describe the likely effects. Specific assessment criteria are applied to assess the importance of each effect in each environmental component. These criteria are identified in the appropriate sections of Chapter 5.0. For each identified effect, the predicted magnitude, duration, frequency, timing, probability of occurrence, ecological and social context, geographic extent, and the degree of reversibility are considered in determining if it is a likely adverse effect.

Project Works and Activities are assessed to identify those project-environment interactions that are likely to result in a measurable change in an environmental sub-component. For the purposes of the assessment, a **measurable change** is defined as a change in the environment that is real, observable, or detectable compared with existing conditions. For example, a predicted change, which is trivial, negligible or indistinguishable from background, is not considered to be measurable. Where a measurable change is identified, the effects of this change on VECs are assessed. Feasible mitigation measures are identified that may be applied to reduce, eliminate or control any likely adverse effects on the VECs. A further assessment is then made to determine whether or not there is a residual adverse effect (i.e., an effect that remains after mitigation). Finally, the significance of all residual adverse effects is determined. Where it is determined that the interactions of the project on the environment are unlikely to result in a measurable change in the environment, no further assessment of VECs is conducted.

Each project-environment interaction with a likely measurable effect is advanced for a detailed assessment of effects.

3.3.3.3 Consider Mitigation Measures

Possible measures that are technically and economically feasible to mitigate (i.e. to eliminate, reduce or control) each likely adverse effect are identified and considered. This step is carried out for all identified adverse effects of the project.

Section 2 of the *CEAA* defines "**mitigation**" as:

> *… the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or other means.*

3.3.3.4 Re-Assess Likely Effects and Describe Residual Effects

Based on the assumed implementation of feasible mitigation measures, each likely adverse effect is examined to identify whether or not it is a **residual effect**. The residual effect is that effect which remains after mitigation has been put into place, and would be measurable or observable on the selected VECs. Effects that are unlikely, are of no concern, or can be mitigated, are not identified as residual effects and thus are not considered further.

Residual effects also represent effects that have the potential to act cumulatively with those from other projects and activities. As such, this step accomplishes the first step of the Cumulative Effects Assessment (described in Section 3.6).

The likely effects are also assessed within the context of human health.

3.4 ASSESSMENT OF THE EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Potential conditions in the environment that are likely to affect the project are identified based on past experience at the PN site and professional judgement of the specialists conducting the EA Study. These are described in Chapter 6.0, and include such conditions as seismic activity, severe weather or climate change. For each potential environmental condition, the design and contingency measures incorporated into the project to mitigate the effect of the conditions are identified and their likely effectiveness judged.

Based on the evaluation of potential environmental conditions and the effectiveness of the feasible mitigation measures that can be reasonably expected, a determination of the significance of effects of the environment on the project is made.

3.5 ASSESSMENT OF CREDIBLE MALFUNCTION AND ACCIDENT SCENARIOS

The potential interactions between project works and activities, and the existing environment are also identified with respect to credible malfunction and accident scenarios. These scenarios include conventional (non-radiological), radiological and nuclear malfunctions and accidents. Each scenario is screened to determine whether an effect (an environmental consequence) is possible, and whether further assessment is required. From this screening bounding scenarios are determined; these are described in Chapter 7.0. The assessment of likely effects from malfunctions and accidents follows a similar methodology to that outlined in Section 3.3.3 for normal operations.

3.6 ASSESSMENT OF CUMULATIVE ENVIRONMENTAL EFFECTS

In addition to the assessment of likely effects of the project, the assessment methodology also provides for consideration of the likely cumulative environmental effects of the project in combination with those of other projects and activities that have been, or will be carried out, and which may overlap with the direct effects of the project. In considering these cumulative effects, all adverse residual effects (i.e., after mitigation) are characterized; other projects with likely similar effects occurring within the same temporal and spatial framework are identified, and the likely combined effects of the overlapping residual effects evaluated.

For purposes of this EA Study, cumulative effects are defined as those incremental residual adverse environmental effects of refurbishment activities and the continued operation of PNGS B, combined with effects associated with other operations and activities on and beyond the PN site.

Other past, existing or future projects relevant to the PNGS B project are identified and described in Chapter 8.0. To establish if the effects related to the proposed project have the potential to act cumulatively, they are considered with the likely effects of the other projects. To act cumulatively, the effects of the PNGS B project on the VECs identified for the project must overlap with the effects of other projects on those VECs.

Where there is a potential for a cumulative effect, it is evaluated in the context of each relevant environmental component and relevant VECs. Where there is a likely adverse cumulative effect, feasible mitigation measures are identified and the likely effect reconsidered to determine the residual condition. The significance of the adverse residual cumulative effects is assessed using the same significance criteria as for the project-related effects.

The overall methodology for assessing the identified likely cumulative effects, including consideration of mitigation measures, identification of residual effects, and determination of significance, is the same as that used for assessment of likely measurable effects.

3.7 EVALUATION OF SIGNIFICANCE OF RESIDUAL ENVIRONMENTAL EFFECTS

The **significance** of each adverse residual effect of the project on the environment; of the environment on the project; of project malfunctions and accidents; and of other projects and activities that could cause cumulative effects is established within a framework of significance criteria and effect levels. Significance criteria include magnitude, duration, frequency, probability of occurrence, ecological and social context, geographic extent, degree of reversibility, and effect on physical and psychosocial human health. Existing regulatory and industry standards and guidelines are used as points of reference. In addition, professional expertise and judgement are also applied. The definitions of the level of effect within each criterion vary by environmental component to recognize that the units and range of measurement are distinct for each. The evaluation of significance is presented in Chapter 9.0.

3.8 CONSIDERATION OF COMMUNITY AND STAKEHOLDER COMMENTS

The assessment includes notification of, and consultation with, the potentially affected stakeholders, including the local public. Various stakeholders, including interested parties from the federal, provincial and local governments; First Nations and Aboriginal groups; established communities and neighbouring residents; OPG employees; and local businesses, as well as non-governmental organizations and interest groups, were provided information on the project and given the opportunity to comment. The stakeholder consultation process is described in Chapter 10.0. Also indicated are a summary review of comments received from stakeholders and how the issues identified have been considered in the EA study. Key inputs from the public are also included in applicable sections of the EA Study Report.

3.9 FOLLOW-UP AND MONITORING PROGRAM

A follow-up and monitoring program is required to assist in determining if the environmental and cumulative effects of the project are as predicted in the EA Study Report. It is also used to ensure that the feasible mitigation measures taken are effective and to determine if there is a need for additional measures and/or strategies.

A preliminary plan for a follow-up and monitoring program is provided in Chapter 11.0. The design of the program is appropriate to the scale of the PNGS B project and the issues addressed in the EA Study.