OPG's DEEP GEOLOGIC

REPOSITORY

FOR LOW & INTERMEDIATE LEVEL WASTE

Aquatic Environment Technical Support Document

March 2011

Prepared by: Golder Associates Ltd.

NWMO DGR-TR-2011-01

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Document History

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

Ontario Power Generation (OPG) is undergoing a multi-year planning and regulatory approvals process for a deep geologic repository (DGR) for the long-term management of low and intermediate level waste (L&ILW). Currently, the L&ILW produced as a result of the operation of OPG's nuclear reactors is stored centrally at OPG's Western Waste Management Facility (WWMF) located at the Bruce nuclear site. Although current storage practices are safe and could be continued safely for many decades, OPG's long-term plan is to manage these wastes in a long-term management facility. Throughout this report, OPG's proposal is referred to as the "DGR Project".

The DGR Project includes the site preparation and construction, operations, decommissioning, and abandonment and long-term performance of the DGR. The DGR will be constructed in competent sedimentary bedrock beneath the Bruce nuclear site near the existing WWMF. The underground facilities will include access-ways (shafts and tunnels), emplacement rooms and various underground service areas and installations. The surface facilities include the underground access and ventilation buildings, Waste Package Receiving Building (WPRB) and related infrastructure.

An environmental assessment (EA) of the proposed DGR Project is required under the provisions of the *Canadian Environmental Assessment Act* (CEAA) because the proponent (OPG) will be required to obtain a licence from the Canadian Nuclear Safety Commission (CNSC) to allow the project to proceed. The findings of the EA are presented in the Environmental Impact Statement (EIS) and Technical Support Documents (TSDs).

ES.2 APPROACH

The approach used for assessing effects of the DGR Project supports the philosophy of EA as a planning tool and decision-making process. The assessment characterizes and assesses the effects of the DGR Project in a thorough, traceable, step-wise manner. The approach used in the assessment includes the following steps:

- describe the project;
- describe the existing environment;
- screen potential project-environment interactions to focus the assessment;
- predict and assess effects, apply mitigation measures to reduce or eliminate the effects and identify residual adverse effects;
- determine significance of residual adverse effects; and
- propose a follow-up program to confirm mitigation measures are effective and the DGR Project effects are as predicted.

The assessment of effects considers direct and indirect effects of the DGR Project, effects of the environment on the project, climate change considerations, and effects of the project on renewable and non-renewable resources. An assessment of the cumulative effects associated with the DGR Project in association with past, existing and planned projects is presented in Section 10 of the EIS. Effects are predicted in the context of temporal and spatial boundaries.

The temporal boundaries for the EIS establish the timeframes for which the effects are assessed. Four temporal phases were identified for the DGR Project:

- site preparation and construction phase;
- operations phase;
- decommissioning phase; and
- abandonment and long-term performance phase.

The abandonment and long-term performance phase is discussed in Section 9 of the EIS. Spatial boundaries define the geographical extents within which environmental effects are considered. As such, these boundaries become the study areas adopted for the EA. Four study areas were selected for the assessment of the aquatic environment: the Regional Study Area, Local Study Area, Site Study Area and Project Area. Each study area includes the smaller study areas (i.e., they are not geographically separate).

ES.3 VALUED ECOSYSTEM COMPONENTS

While all components of the environment are important, it is neither practicable nor necessary to assess every potential effect of a project on every component. The EA focuses on the components that have the greatest relevance in terms of value and sensitivity, and which are likely to be affected by the project. To achieve this focus, specific Valued Ecosystem Components (VECs) are identified. A VEC is considered to be the 'receptor' for both project-specific effects and cumulative effects. A VEC can be represented by a number of 'indicators', which are features of the VEC that may be affected by the DGR Project (e.g., fish habitat). Each indicator requires specific 'measures' that can be quantified and assessed (e.g., changes in fish habitat). In essence, the nature and magnitude of the effects of the DGR Project on these VECs has been studied and their significance determined.

The following VECs are used in assessing the effects of the DGR Project on the aquatic environment:

- redbelly dace;
- creek chub;
- brook trout;
- variable leaf pondweed;
- burrowing crayfish;
- lake whitefish;
- spottail shiner;
- smallmouth bass; and
- benthic invertebrates.

ES.4 RESULTS

Project-environment interactions are identified and assessed for their potential to measurably change the VECs. The Hydrology and Surface Water Quality TSD predicts a measurable decrease in flow in the North Railway Ditch. This is not expected to result in a measurable change in the aquatic habitat or the associated VECs, or in a measurable change in Stream C. The DGR Project incorporates a stormwater management pond; the release from which will meet water quality permitting requirements. Therefore, no measurable changes to water quality in MacPherson Bay and no measurable change to its associated VECs is expected.

Measurable changes were identified to the habitat within the South Railway Ditch and other habitat in the Project Area during the site preparation and construction of surface facilites. These identified measurable changes are then assessed to determine whether they are adverse. The following residual adverse effects are identified on the aquatic environment after taking mitigation measures into consideration:

- a small amount of burrowing crayfish habitat will be lost during site preparation and construction of the crossing over the abandoned rail bed, which results in a residual adverse effect on burrowing crayfish; and
- the construction of the crossing over the abandoned rail bed will have a direct effect on the South Railway Ditch, resulting in a residual adverse effect on the associated VECs (creek chub, redbelly dace, variable leaf pondweed and benthic invertebrates).

After further evaluation described in Section 11, these two residual adverse effects are determined to be not significant.

Although residual adverse effects on VECs in the South Railway Ditch are identified, these effects do not represent an adverse effect on renewable resources. Climate change is not expected to change the conclusions of the assessment relating to the effects of the DGR Project on the aquatic environment VECs.

ES.5 PRELIMINARY FOLLOW-UP PROGRAM

Follow-up monitoring programs are required to:

- verify the key predictions of the EA studies; or
- confirm the effectiveness of mitigation measures, and in so doing, determine if alternate mitigation strategies are required.

The follow-up monitoring recommended for the aquatic environment includes monitoring:

- dewatering in marsh habitat used by burrowing crayfish;
- habitat re-growth in ditches; and
- bank stability in ditches.

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1. INTRODUCTION

Ontario Power Generation (OPG) is undergoing a multi-year planning and regulatory approvals process for a deep geologic repository (DGR) for the long-term management of low and intermediate level waste (L&ILW). Currently, the L&ILW produced as a result of the operation of OPG-owned nuclear reactors is stored centrally at OPG's Western Waste Management Facility (WWMF) located at the Bruce nuclear site. Although current storage practices are safe and could be continued safely for many decades, OPG's long-term plan is to manage these wastes in a long-term management facility.

A key element of the regulatory approvals process is an environmental assessment (EA), the findings of which are presented in an Environmental Impact Statement (EIS). The EA considers the long-term management of L&ILW currently in interim storage at the WWMF, as well as that produced by OPG-owned or operated nuclear generating stations, in a DGR at the Bruce nuclear site in the Municipality of Kincardine, Ontario. The project location is shown on Figure 1-1. Throughout this report, OPG's proposal is referred to as the "DGR Project". The DGR Project includes the site preparation and construction, operations, decommissioning, and abandonment and long-term performance of the DGR.

The DGR will be constructed in competent sedimentary bedrock beneath the Bruce nuclear site near the existing WWMF. The underground facilities will include access-ways (shafts and tunnels), emplacement rooms and various underground service areas and installations. The surface facilities include the underground access and ventilation buildings, Waste Package Receiving Building (WPRB) and related infrastructure. All surface and underground facilities will be located within the boundaries of the OPG-retained lands near the WWMF at the Bruce nuclear site.

OPG is the proponent for the DGR Project. OPG will own, operate and be the licensee for the DGR. The regulatory approvals phase of the DGR Project, including the EA process and the site preparation and construction licensing, has been contracted to the Nuclear Waste Management Organization (NWMO). The NWMO is responsible, with support from OPG, for completing the EA, preparing the EIS and obtaining the site preparation and construction licences.

1.1 EA PROCESS AND REGULATORY CONTEXT

The EA process was initiated by the submission of a Project Description for the DGR by OPG to the Canadian Nuclear Safety Commission (CNSC) on December 2, 2005. The site preparation and construction licence application for the DGR was submitted by OPG to the CNSC on August 13, 2007. An EA of the proposed DGR Project is required under the provisions of the *Canadian Environmental Assessment Act* (CEAA) because the proponent (OPG) will require a licence from the CNSC to allow the project to proceed. Under the CEAA, the CNSC is identified as the Responsible Authority (RA); however, the Canadian Environmental Assessment Agency also has statutory responsibilities.

Under the CEAA, this type of project is identified in the Comprehensive Study List Regulations. The CNSC issued draft guidelines for a comprehensive study EA of the DGR Project, which were the subject of a public hearing held in Kincardine on October 23, 2006. Following the hearing, CNSC Commission members recommended to the Minister of the Environment that the

DGR Project be referred to a review panel given the public concerns, possibility of adverse environmental effects, the first-of-a-kind nature of the project and concerns regarding the comprehensive study's ability to address all the questions raised [1].

The Minister of the Environment referred the EA of the DGR Project to a joint review panel on June 29, 2007. Draft guidelines for the preparation of the EIS were issued by the Canadian Environmental Assessment Agency and the CNSC for public review on April 4, 2008. The guidelines, a copy of which is included in the EIS as Appendix A, were finalized on January 26, 2009. The scope of the EA for the DGR Project includes the site preparation, construction, operations and decommissioning of the above- and below-ground facilities for the long-term management of L&ILW. The EA also addresses the abandonment and long-term performance of the DGR Project.

An EA is a tool to provide an effective means of integrating environmental factors into the planning and decision-making processes in a manner that promotes sustainable development and minimizes the overall effect of a project. The methods used in the EA and presented in the EIS are consistent with the final guidelines, and are based on systematic and detailed consideration of the systems, works, activities and events comprising the DGR Project.

1.2 EA REPORTING STRUCTURE

The EA for the DGR Project is documented in an EIS, which is based on the final guidelines and the work detailed in a series of technical support documents (TSDs). In addition, there are parallel technical studies, information from which is also used in preparing the EIS and TSDs. Finally, the findings are summarized in the EIS Summary. Figure 1.2-1 illustrates the relationships between the EIS and summary report, its supporting documents, and the independent technical studies for the DGR Project.

The EIS comprises the following volumes:

- **Volume 1** consolidates and summarizes all aspects of the EIS studies. It includes a description of the EA methods, a description of the DGR Project, a description of the existing environment, an assessment of likely environmental effects, including cumulative effects, a discussion of the proposed follow-up program, and a discussion of the communication and consultation program.
- **Volume 2** contains a series of appendices that support the material in Volume 1, including a copy of the guidelines and human health assessment. It also contains a summary of the community engagement and consultation program along with copies of supporting materials.

The TSDs present information on the existing environment and describe the process used to assess the direct and indirect effects of the DGR Project on the environment. The TSDs, on which the EIS is based, are as follows:

- Atmospheric Environment;
- Hydrology and Surface Water Quality;
- Geology;
- Aquatic Environment;
- Terrestrial Environment;

- Socio-economic Environment;
- Aboriginal Interests;
- Radiation and Radioactivity; and
- Malfunctions, Accidents and Malevolent Acts.

These TSDs are also interconnected with one another. Each respective report focuses on the effects of the DGR Project on that particular aspect of the environment, be it through a direct interaction with the DGR Project or through a change identified in another TSD (i.e., an indirect interaction). Cross-references are provided throughout the TSD where it relies on information from another report.

The TSDs assess the direct and indirect effects of the DGR Project as a result of normal conditions, with the exception of the Malfunctions, Accidents and Malevolent Acts TSD. The EIS guidelines require an identification of credible malfunctions and accidents, and an evaluation of the effects of the DGR Project in the event that these accidents or malfunctions occur. All of these effects are discussed and assessed in the Malfunctions, Accidents and Malevolent Acts TSD regardless of the element of the environment that is affected. The reasoning for this is that a single accident is likely to affect multiple elements of the environment.

It is also important to note that the assessment of potential radiation and radioactivity effects of the DGR Project are documented in the Radiation and Radioactivity TSD, regardless of the physical media through which they are transported (e.g., air or water). This was done because of the special importance placed on radiation and radioactivity, and the combined effects to the receiving environment regardless of the path of exposure.

The independent parallel technical study reports used in preparing the EIS include the following:

- Postclosure Safety Assessment [2];
- Geosynthesis [3]; and
- Preliminary Safety Report [4].

This Aquatic Environment TSD evaluates the non-radiological effects of the site preparation and construction, operations and decommissioning of the DGR Project on aquatic habitat and biota. The abandonment and long-term performance phase is considered in Section 9 of the EIS. To facilitate this assessment, a description of the existing aquatic environmental features is also included.

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LEGEND

- City
- Highway
- Provincial Highway
- Secondary Highway

0 5 10 20 30 40 50

Kilometres

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v7.3 2003
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2005
Datum: NAD 83 Projection: UTM Zone 17N

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

LOCATION OF THE DGR PROJECT

Golder Associates
Mississauga, Ontario

PROJECT NO. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct. 2007	**FIGURE 1-1**	
GIS	BC	14 Apr. 2010		
CHECK	BC	14 Apr. 2010		
REVIEW	MAR	14 Apr. 2010		

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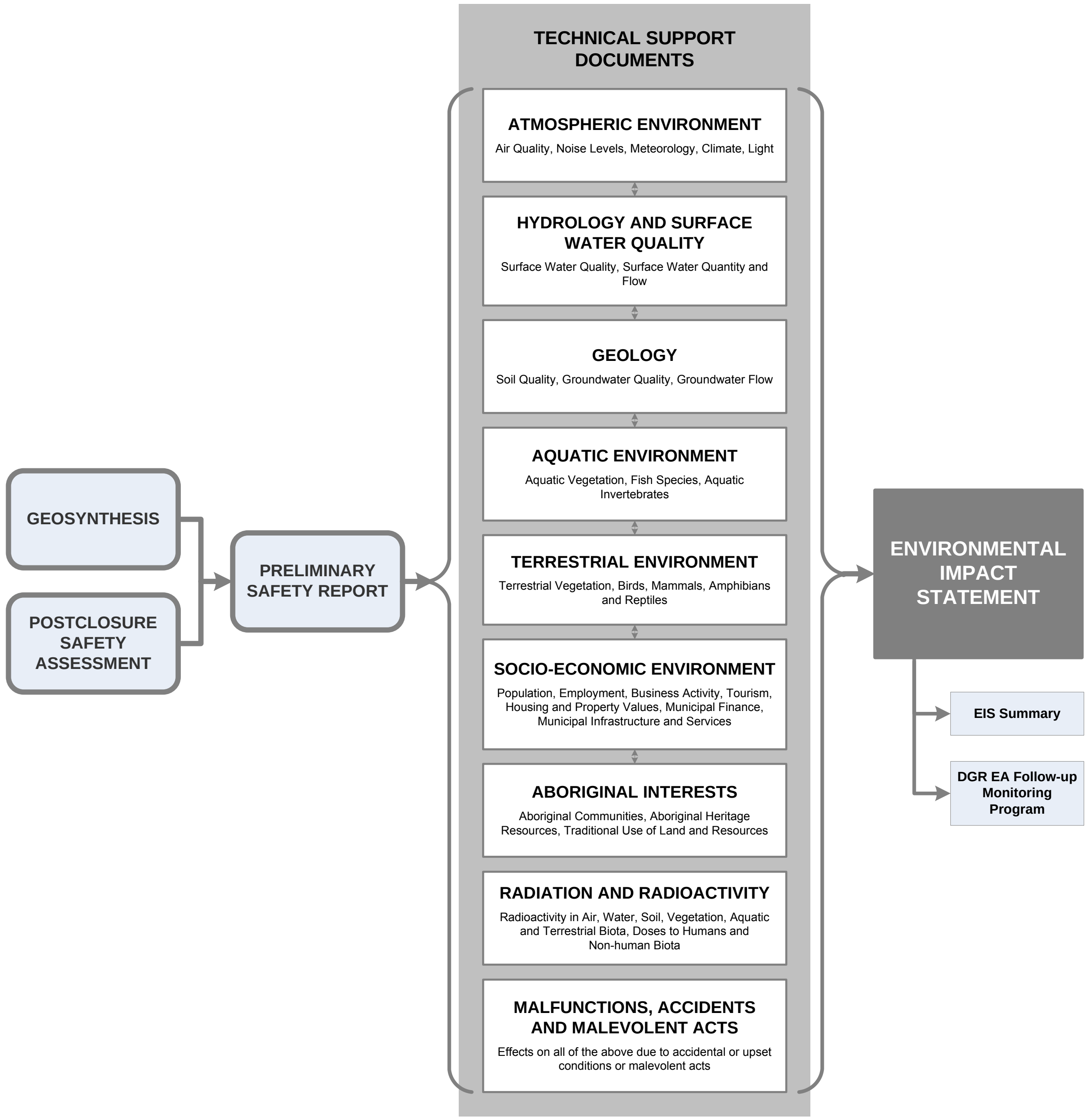

Figure 1.2-1: Organization of EA Documentation

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2. APPROACH

2.1 GENERAL SUMMARY OF EA APPROACH

The approach used for assessing the DGR Project, and documented in this TSD, supports the philosophy of EA as a planning and decision-making process. The assessment characterizes and assesses the effects of the DGR Project in a thorough, traceable, step-wise manner. The approach used in the assessment is illustrated on Figure 2.1-1, and includes the following steps.

- **Describe the Project.** As summarized in Section 3, the project is described as a number of works and activities that could affect the surrounding environment.
- **Describe the Existing Environment.** The existing environment is characterized using available information and field studies, as described in Section 5. The description of the existing environment reflects the cumulative effects of past and existing projects on the environment.
- **Screen to Focus the Assessment.** Two screening steps, first for potential interactions and secondly for measurable change, allow the assessment to focus on where effects are likely to occur. These steps are completed using professional judgement; if there is uncertainty, the interaction is advanced for assessment. The screening steps are completed in Sections 6 and 7.
- **Assess Effects.** Where there is likely to be a measurable change, the effects on the environment are predicted and assessed as to whether or not they are adverse, as described in Section 8. If adverse effects are predicted, mitigation measures to reduce or eliminate the effect are proposed, and residual adverse effects, if any, are identified. Any residual adverse effects are then assessed in Section 10 of the EIS to determine whether they are likely to combine with the effects of other past, present or reasonably foreseeable future projects and activities in the surrounding region to produce cumulative effects.
- **Determine Significance.** All residual adverse effects are then assessed in Section 11 to determine whether the effect is significant, or not, taking into account the magnitude, extent, duration, frequency and irreversibility of the effect.
- **Propose Follow-up Programs.** Finally, follow-up monitoring is proposed to confirm that mitigation measures are effective and the effects are as predicted. Monitoring activities are described in Section 13.

The assessment of effects of the DGR Project focuses on Valued Ecosystem Components (VECs), which are elements of the environment considered to be important for cultural or scientific reasons. Aquatic VECs are defined and described in detail in Section 4. The detailed methods for each of these steps, including how they are applied to this particular TSD, are described at the beginning of each of the respective sections.

The screening and assessment steps described above follow a source-pathway-receptor approach. The DGR Project works and activities represent the source of a change, a measurable change to the environment represents a pathway and the VEC represents the receptor. In some cases, VECs may act as both pathways and receptors.

Effects from the DGR Project may occur either directly or indirectly. A direct interaction occurs when the VEC is affected by a change resulting from a project work and activity. An indirect interaction occurs when the VEC is affected by a change in another VEC (e.g., a project-related change in surface water quality [a VEC in the Hydrology and Surface Water Quality TSD] could affect redbelly dace).

There are many linkages and connections between aspects of the physical, biophysical and socio-economic environments in an integrated EA. The linkages relevant to this TSD are illustrated using an information flow diagram. Figure 2.1-2 presents the flow of information related to the aquatic VECs and where potential indirect effects are evaluated. Multi-feature VECs are evaluated in Section 7 of the EIS (e.g., Lake Huron, human health). An assessment of the cumulative effects associated with the DGR Project is presented in Section 10 of the EIS.

The assessment is completed within the framework of defined temporal and spatial boundaries, and takes into account a precautionary approach and Aboriginal traditional knowledge, where available. These are described in further detail in the following sections.

2.2 PRECAUTIONARY APPROACH

The EA, as a forward-looking planning tool used in the early stages of project development, is based on a precautionary approach. This approach is guided by judgement, based on values and intended to address uncertainties in the assessment. This approach is consistent with Principle 15[1] of the 1992 Rio Declaration on Environment and Development and the Canadian government's framework for applying precaution in decision-making processes [5].

Throughout the EA, the DGR Project has been conservatively considered in a thorough and traceable manner. For example, at each of the screening stages, potential project-related effects are advanced if they cannot be systematically removed from consideration through application of rigorous, sound and credible scientific evidence. In addition, with the exception of malfunctions, accidents and malevolent acts, all identified residual adverse effects are assumed to occur (i.e., probability of occurrence is assumed to be 1.0), and are assessed for significance.

A further precautionary feature incorporated into the assessment method is that the evaluation of potential effects is based on changes to the existing environment and not solely on regulatory compliance. This captures and assesses changes to the existing environment that may fall outside or below applicable regulatory frameworks.

The precautionary approach adopted for the EA of the DGR Project is described further in Section 1 of the EIS, and a summary of how precaution has been taken into account in the assessment of the aquatic environment is provided at the end of the assessment section (Section 8).

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[1] Principle 15 of the 1992 Rio Declaration on Environment and Development states that "Where there are threats of serious or irreversible damage, lack of full scientific certainty must not be used as a reason for postponing cost-effective measures to prevent environmental degradation".

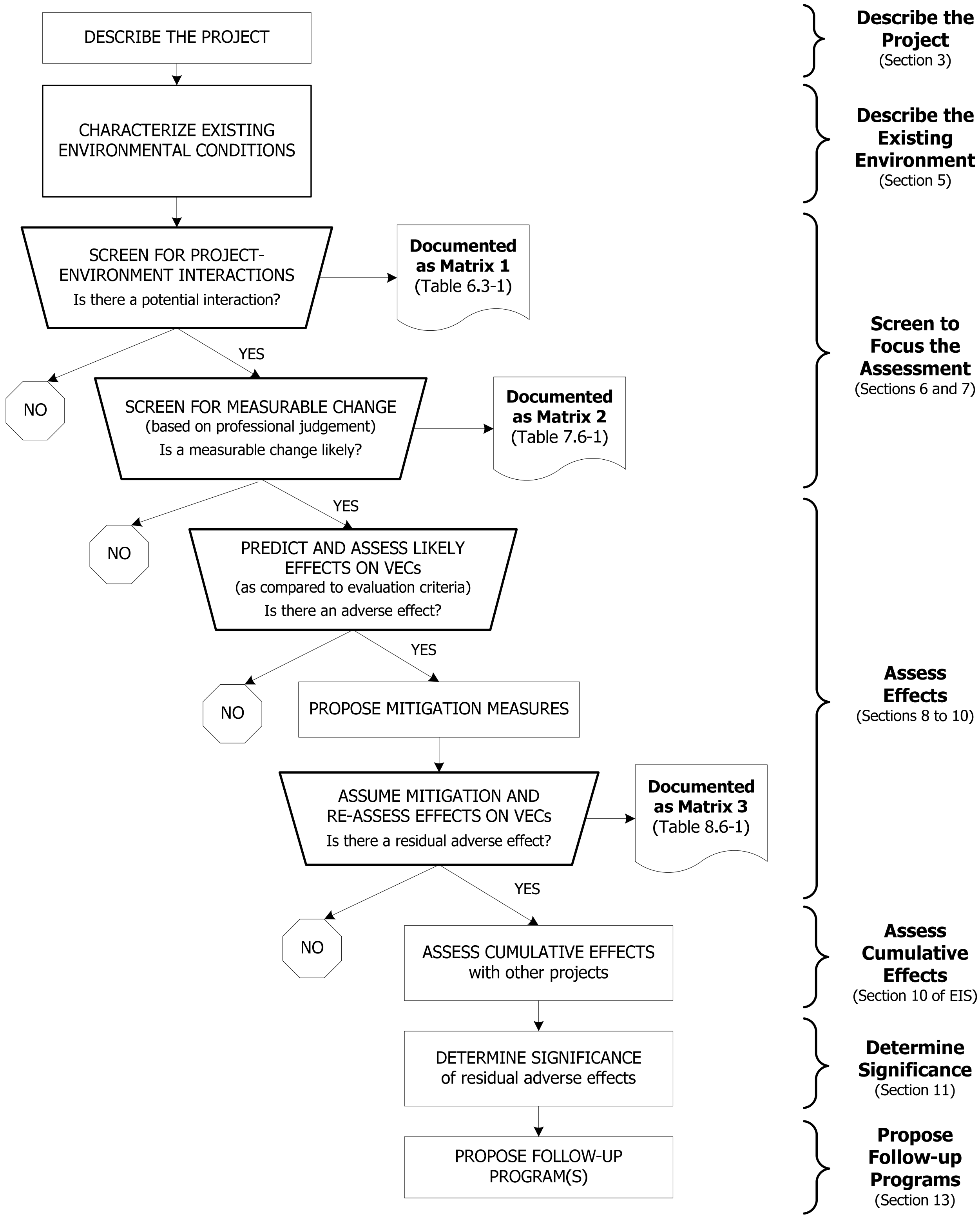

Figure 2.1-1: Methodology for Assessment of Effects

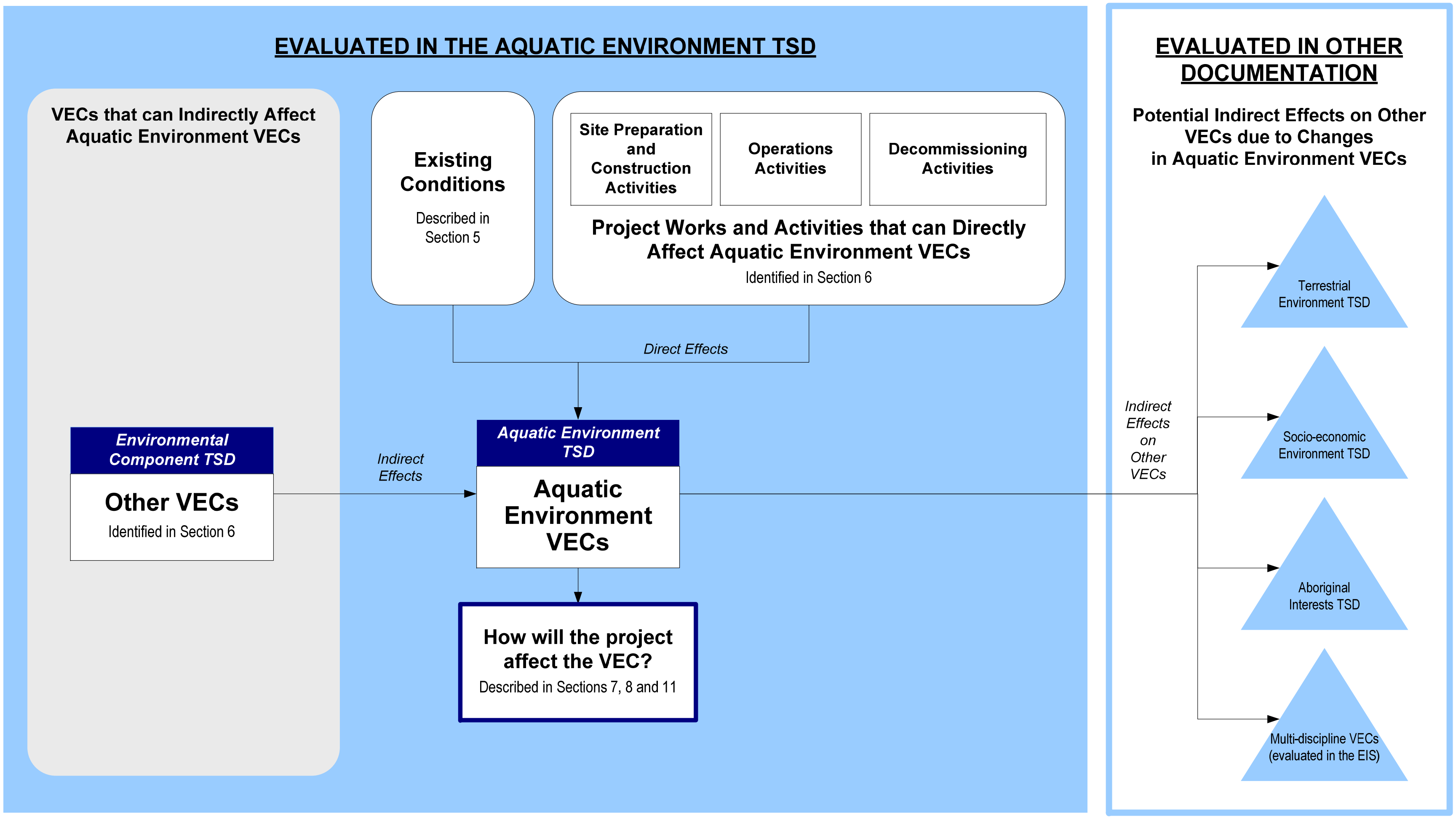

Figure 2.1-2: Information Flow Diagram for the Aquatic Environment VECs

2.3 ABORIGINAL TRADITIONAL KNOWLEDGE

This EA considers both western science and traditional and local knowledge, where that information is available. Guidance provided by the Canadian Environmental Assessment Agency describes Aboriginal traditional knowledge as knowledge that is held by, and unique to, Aboriginal peoples [6]. Aboriginal traditional knowledge is a body of knowledge built up by a group of people through generations of living in close contact with nature. It is cumulative and dynamic and builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.

Traditional ecological knowledge is a subset of Aboriginal traditional knowledge. Traditional ecological knowledge “refers specifically to all types of knowledge about the environment derived from the experience and traditions of a particular group of people” [7]. There are four traditional ecological knowledge categories:

- knowledge about the environment;
- knowledge about the use of the environment;
- values about the environment; and
- the foundation of the knowledge system.

In this EA, specific traditional knowledge, where available, is incorporated through the characterization of the existing environment and assessment of effects. Issues of importance to Aboriginal communities were identified as part of the Aboriginal Interests TSD through examination of available information pertaining to general ecological, socio-economic and cultural heritage interests for Ojibway and Métis peoples in Ontario. This examination identified a range of interests raised by Aboriginal communities that can be used to focus this EA relative to potential effects on residents of the Aboriginal communities in the study areas. This examination included the following:

- interests raised by Aboriginal communities according to previous studies;
- interests raised by Aboriginal communities in the context of dialogue for the DGR Project; and
- insight into traditional knowledge, and interests of general importance to Ojibway and Métis peoples.

Throughout this TSD, it is highlighted where Aboriginal traditional knowledge and traditional ecological knowledge was available, and has influenced the assessment.

2.4 TEMPORAL AND SPATIAL BOUNDARIES

The assessment of the DGR Project works and activities on the environment is conducted within the framework of temporal and spatial boundaries that are common to all of the environmental components (with some modifications). The particular temporal and spatial boundaries used in the assessment of the aquatic environment are described in the following sections.

2.4.1 Temporal Boundaries

The temporal boundaries for the EA establish the timeframes for which the direct, indirect and cumulative effects are assessed. Four temporal phases were identified for the DGR Project:

- **Site Preparation and Construction Phase**, which includes site preparation and all activities associated with the construction of the DGR Project, up until operations commence with the placement of waste. All of the construction activities at the DGR Project will occur during this phase. The site preparation and construction phase is expected to last approximately five to seven years.
- **Operations Phase**, which covers the period during which waste is emplaced in the DGR, as well as a period of monitoring prior to the start of decommissioning. Activities include receipt and on-site handling of waste packages, transfer underground and emplacement of L&ILW in rooms in the DGR, and activities necessary to support and monitor operations. The operations phase is expected to last approximately 40 to 45 years with waste being emplaced for the first 35 to 40 years. The length of the monitoring period would be decided at some future time in consultation with the regulator.
- **Decommissioning Phase**, which begins immediately after the operations phase for the DGR. Activities include preparation for decommissioning, decommissioning and may include monitoring following decommissioning. The decommissioning activities, including dismantling surface facilities and sealing the shaft, are expected to take five to six years.
- **Abandonment and Long-term Performance Phase**, which begins once decommissioning activities are completed. This period will include institutional controls for a period up to three hundred years.

These timeframes are intended to be sufficiently flexible to capture the effects of the DGR Project. The assessment of the aquatic environment focuses on the first three phases as there are no activities during the abandonment and long-term performance phase that would interact with the aquatic environment VECs. The effects of the DGR Project during the abandonment and long-term performance phase are discussed in Section 9 of the EIS.

2.4.2 Spatial Boundaries

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

The guidelines require that the study areas defined therein, and described below, encompass the environment that can reasonably be expected to be affected by the DGR Project, or which may be relevant to the assessment of cumulative effects. Specific study areas are defined by the boundaries to encompass all relevant components of the environment including the people, land, water, air and other aspects of the natural environment.

Four study areas were selected for the assessment of the aquatic environment: the Regional Study Area, Local Study Area, the Site Study Area, and Project Area. The Project Area, although not specified in the guidelines, was defined to help describe the potential site-specific effects of the DGR Project. Each study area includes the smaller study areas (i.e., they are not geographically separate). These areas are described in the following sections.

2.4.2.1 Regional Study Area

The Regional Study Area (Figure 2.4.2-1) includes the lands bound by regional watersheds and extends 4 km offshore. To be consistent with the hydrological analysis of the DGR Project (presented in the Hydrology and Surface Water Quality TSD), the northern and southern limits of the Regional Study Area have been selected to include municipal Water Supply Plant intakes at Southampton and Kincardine. The Regional Study Area encompasses larger-scale aquatic biological resources and systems potentially affected by the DGR Project because of their interconnections, and consider its associations with biological resources and systems in the Site Study Area and Local Study Area.

2.4.2.2 Local Study Area

The Local Study Area (Figure 2.4.2-2) corresponds to the Stream C and Underwood Creek watersheds for the on-land (non-lake) portion. The Local Study Area also extends approximately 2 km offshore into Lake Huron, from MacGregor Point Provincial Park in the north and approaches McRae Point in the south.

2.4.2.3 Site Study Area

The Site Study Area (Figure 2.4.2-3) corresponds to the property boundary of the Bruce nuclear site, including the exclusion zones associated with Bruce nuclear generating stations A and B on land and over water. The Site Study Area includes the nearshore waters of Lake Huron (small embayment immediately south of Bruce A known as MacPherson Bay), which receive the surface water runoff from catchment areas draining water from portions of the Project Area (described below). The Site Study Area also includes the lower section of the Stream C watershed, which drains the remainder of the Project Area.

Effects at the Site Study Area level are focused on the individual species and habitats within the Bruce nuclear site and the potential receiving waterbodies (e.g., on-site ditches, Stream C).

2.4.2.4 Project Area

The Project Area (see Figure 2.4.2-3) corresponds to the boundary of the OPG-retained lands at the centre of the Bruce nuclear site where the DGR Project is being proposed. The Project Area is the particular area of focus for the aquatic environment assessment, as this is where the physical footprint of the project occurs. A small portion of the Project Area drains south and east towards the North Railway Ditch and Stream C and the other portion drains north toward MacPherson Bay.

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LEGEND

- Site Study Area [1]
- Local Study Area
- Regional Study Area

NOTES

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

REFERENCE

Base Data Provided by 4DM, November 2007.
Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m, Datum: NAD 83 Projection: UTM Zone 17N

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

REGIONAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT No. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct 2007	**FIGURE 2.4.2-1**	
GIS	BC	22 Apr. 2010		
CHECK	AB	22 Apr. 2010		
REVIEW	MAR	22 Apr. 2010		

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LEGEND

- Site Study Area [1]
- Local Study Area

NOTES

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

REFERENCE

Base Data Provided by 4DM, November 2007.
Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m, Datum: NAD 83 Projection: UTM Zone 17N

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

LOCAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT No. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct 2007		
GIS	BC	22 Apr. 2010		
CHECK	AB	22 Apr. 2010		
REVIEW	MAR	22 Apr. 2010		

FIGURE 2.4.2-2

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LEGEND

- Project Area (OPG-retained lands that encompass the DGR Project)
- Site Study Area [1]

NOTES

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

REFERENCE

Base Data Provided by 4DM, November 2007.
Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m, Datum: NAD 83 Projection: UTM Zone 17N

0 0.5 1 2
Kilometres

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

SITE STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT No. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct. 2007		
GIS	BC	22 Apr. 2010		
CHECK	AB	22 Apr. 2010		
REVIEW	MAR	22 Apr. 2010		

FIGURE 2.4.2-3

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3. PROJECT DESCRIPTION

The assessment of effects requires a detailed description of the DGR Project. The individual works and activities are the physical structures, buildings, systems, components, activities and events comprising the DGR Project. These are collectively referred to as the project works and activities. This section provides an overview of the DGR Project. The specific works and activities required for the DGR Project are summarized in the Basis for EA in Appendix B. Further details on the DGR Project design can be found in Section 4 of the EIS and in Chapter 6 of the Preliminary Safety Report [4].

3.1 OVERVIEW

The DGR Project will receive L&ILW currently stored in interim facilities at the WWMF, as well as that produced from OPG-owned or operated nuclear generating stations. Low level waste consists of industrial items and materials such as clothing, tools, equipment, and occasional large objects such as heat exchangers, which have become contaminated with low levels of radioactivity. Intermediate level waste consists primarily of used reactor components and resins used to clean the reactor water circuits. The capacity of the DGR is a nominal 200,000 m^3 of "as-disposed" waste.

The DGR Project comprises two shafts, a number of emplacement rooms, and support facilities for the long-term management of L&ILW (Figure 3.1-1). The DGR will be constructed over a period of 5 to 7 years. The DGR Project design is the result of a thorough comparison and evaluation of different alternative methods of implementing the project. This includes considerations such as the layout of the DGR and construction methods. The evaluation compared each of the alternative means using technical, safety, environmental and economic factors to identify a preferred mean. This evaluation is presented in Section 3 of the EIS. This TSD assesses the effects of the preferred alternative (i.e., the project) on the aquatic environment.

3.2 SITE DESCRIPTION AND PROJECT LAYOUT

3.2.1 Surface Facilities

The surface DGR facilities will be located on vacant OPG-retained land to the north of the existing WWMF. A new crossing will be constructed over the abandoned rail bed to provide access to the proposed DGR Project site from the WWMF (Figure 3.2.1-1). The surface structures will be grouped in relatively close proximity to facilitate operations and maintenance activities, and provide a compact footprint.

The Waste Package Receiving Building (WPRB) will receive all radioactive waste packages and transfer them to the main shaft cage for transfer underground. A maintenance workshop and stores for essential shaft-related spares and materials will be attached to the WPRB. An office, main control room and amenities building will also form part of the main shaft complex for administrative purposes, control and monitoring of the DGR, and receiving visitors to the DGR. An electrical sub-station will provide power to the entire facility, both surface and underground, and an emergency power supply system will maintain critical equipment in the event of an outage.

Waste rock piles for the complete excavated volume of rock will be accommodated to the north-east of the two shafts. A stormwater management system of ditches and a pond will be provided to control the outflow of surface runoff and sump discharge water from the site before release into an existing network of ditches at the Bruce nuclear site, and ultimately Lake Huron (Figure 3.2.1-1). The discharge will also be monitored to confirm it meets certificate of approval water quality requirements.

3.2.2 Underground Facilities

The underground DGR facilities will be constructed in limestone bedrock (Cobourg Formation) at a nominal depth of 680 m beneath the OPG-retained lands in the centre of Bruce nuclear site (Figure 3.1-1). The overall underground arrangement enables infrastructure to be kept in close proximity to the main shaft, while keeping the L&ILW emplacement areas away from normally occupied and high use areas.

The DGR will have two vertical shafts (main and ventilation shafts) in an islanded arrangement with a services area in which offices, a workshop, wash bay, refuge stations, lunch room and geotechnical laboratory will be provided. From this centralized area, the two panels of emplacement rooms are connected via access tunnels. A main access tunnel will be driven from the main shaft station to the east, passing the ventilation shaft and then proceeding towards the emplacement room panels. The main access tunnel will continue straight into the Panel 1 access tunnel, while a branch tunnel to the south will lead to the Panel 2 access tunnel. The length of the rooms is nominally 250 m. End walls may be erected once the rooms are filled.

The emplacement rooms will all be aligned with the assumed east-north-east direction of the major principal horizontal stresses of the rock mass to minimize the risks of any rock fall in the emplacement rooms.

A ventilation supply system will supply air at a controlled range of temperatures to ensure that freezing does not occur in the main shaft and the atmosphere is kept in a reasonably steady and dry state, which is suitable for workers and limits corrosion of structures and waste packages.

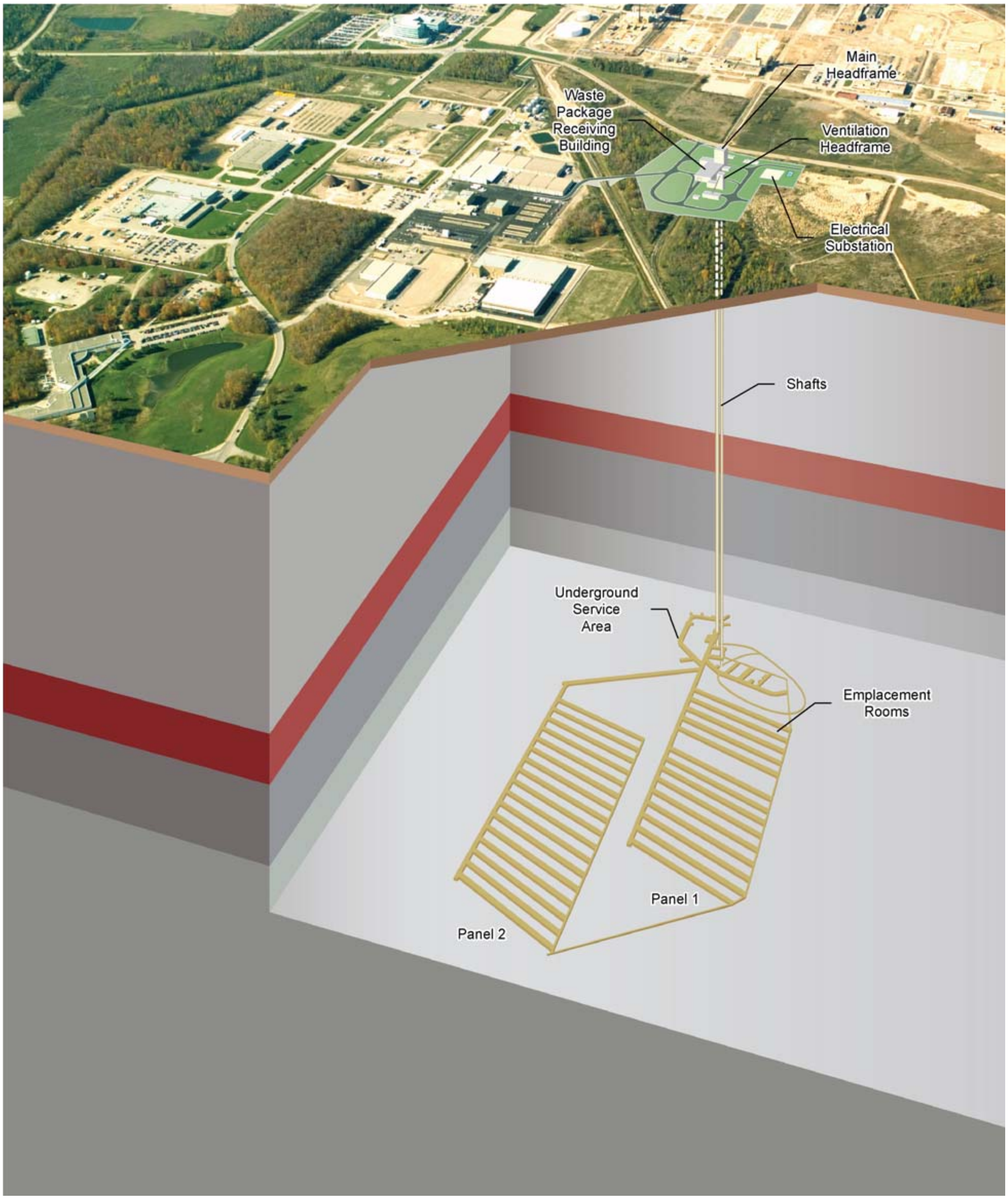

Figure 3.1-1: Schematic of the DGR Project

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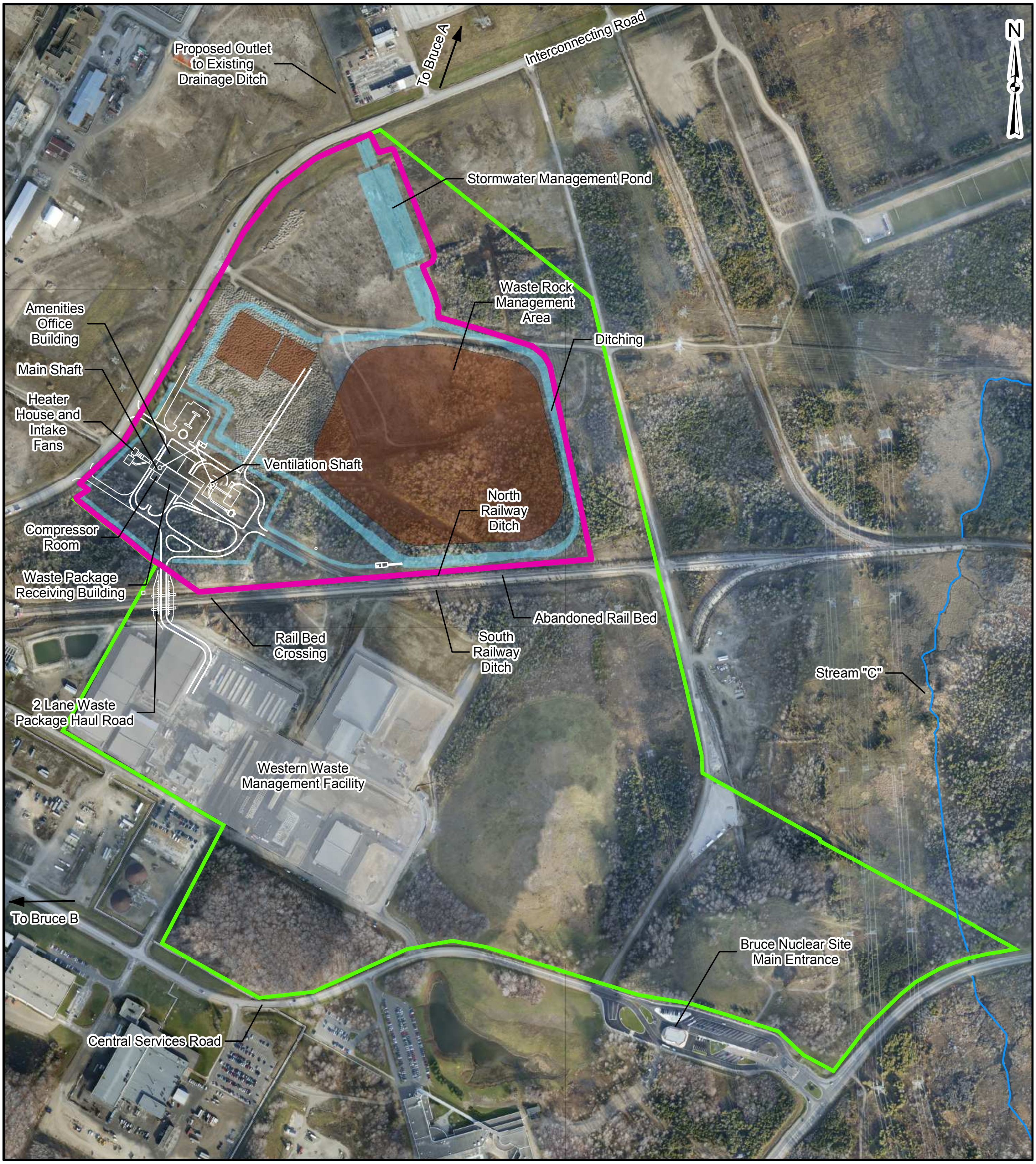

LEGEND

- DGR Project Site
- Project Area (OPG-retained lands that encompass the DGR Project)
- Soils and Rock Stockpile
- Stormwater Management System

0 125 250 500

Metres

REFERENCE

Base Data Provided by 4DM, Nov 2007.
Imagery and Topo Collected and Processed by Terrapoint Canada Inc.,
Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m,
Datum: NAD 83 Projection: UTM Zone 17N

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

LAYOUT OF DGR SURFACE INFRASTRUCTURE

Golder Associates
Mississauga, Ontario

PROJECT NO. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	AB	16 Mar. 2010		
GIS	BC	25 Nov. 2010	**FIGURE 3.2.1-1**	
CHECK	KC	25 Nov. 2010		
REVIEW	AB	25 Nov. 2010		

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4. SELECTION OF VECS

While all components of the environment are important, it is neither practicable nor necessary to assess every potential effect of a project on every component of the environment. An EA focuses on the components that have the greatest relevance in terms of value and sensitivity, and which are likely to be affected by the project. To achieve this focus, specific Valued Ecosystem Components (VECs) are identified. The Canadian Environmental Assessment Agency states that VECs are "*Any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process*" [8]. Importance may be determined on the basis of cultural values or scientific concerns. VECs can be an individually valued component of the environment or species or a collection of components that represent one aspect of the environment.

From an ecological perspective, VECs can represent features or elements of the natural environment (e.g., a local wetland or stream) considered to be culturally or scientifically important. Such features may be complex, comprising several ecological aspects and affected by a range of pathways (i.e., routes of effect). In essence, these ecological feature VECs could encompass a number of individual VECs such as:

- an aspect of the physical environment (e.g., water quality);
- an individual species (e.g., lake whitefish, creek chub);
- a range of species that serve as a surrogate aquatic community (e.g., aquatic and riparian vegetation, benthic invertebrates); or
- a particular type of habitat (e.g., coldwater streams).

A VEC is considered to be the receptor for both project-specific effects and cumulative effects. A VEC can be represented by a number of indicators. Indicators are features of the VEC that may be affected by the DGR Project (e.g., aquatic habitat). Each indicator requires specific 'measures' that can be quantified and assessed (e.g., changes in habitat quality and quantity).

VECs are identified using the expertise of the technical specialists with input from regulators, and members of the public. The VECs for the DGR Project were available for discussion and comment at the open houses held in October of 2007, November 2008, November 2009 and summer/fall 2010. The public was encouraged to add VECs to the list and to identify the VECs that were most important to them. The public also had the opportunity to provide input on the list of VECs during the public review of the draft guidelines.

Nine VECs are used in assessing the effects of the DGR Project on the aquatic environment. These VECs were selected to be representative of the aquatic environment likely to be important and susceptible to effects within the spatial context of the DGR Project. The rationale for selection of the VECs and the indicators used in the assessment are described in the following sections and summarized in Table 4-1.

Table 4-1: VECs Selected for the Aquatic Environment

VEC	Rationale for Selection	Indicators	Measures
Redbelly Dace (*Chrosmus eos*[2])	• Inhabits quiet, slow flowing/sluggish creeks and ponds over a bottom of organic muck or vegetation • A common fish species in the South Railway Ditch and also inhabits Stream C • A valuable food resource for predatory fish and wildlife • May be affected by changes in surface water quality, quantity or flow	Habitat	• Change in habitat quality and quantity
Creek Chub (*Semotilus atromaculatus*)	• Inhabits small, clear streams • A common fish species in the South Railway Ditch and Stream C • A valuable food resource for predatory fish and wildlife • May be affected by changes in surface water quality, quantity or flow	Habitat	• Change in habitat quality and quantity
Brook Trout (*Salvelinus fontinalis*)	• Inhabits cold, well-oxygenated waters of streams, rivers and lakes • Present in Stream C • May be affected by changes in surface water quality, quantity or flow	Habitat	• Change in habitat quality and quantity
Variable Leaf Pondweed (*Potamogeton gramineus*)	• Found in shallow, non-flowing water such as the South Railway Ditch and Baie du Dore • An important cover for fishes, supports and shelters many aquatic invertebrates • An indicator of habitat type/quality	Habitat	• Change in habitat quality and quantity

[2] All scientific nomenclature and common names used in this TSD are from the Integrated Taxonomic Information Systems [9]

Table 4-1: VECs Selected for the Aquatic Environment (continued)

VEC	Rationale for Selection	Indicators	Measures
Burrowing Crayfish (*Fallicambarus fodiens* and *Orconectes immunis*)	• Inhabit marshy fields, drainage ditches, marshes, ponds, and shallow, slow moving streams with muddy substrates and rooted aquatic vegetation • Inhabits the marsh, swamp and drainage ditches, including the North and South Railway Ditches, and along the abandoned railway spur within the Project Area • Both species build burrows to escape drying habitats associated with seasonal water level fluctuations • Require clayey soils for burrow construction • May be affected by changes in water quality, quantity or flow	Habitat	• Change in habitat quality and quantity
Lake Whitefish (*Coregonus clupeaformis*)	• • Focus of concern in EAs of projects at the Bruce nuclear site • Utilizes shoals north of Baie du Doré and areas off Gunn Point for spawning and rearing • May be affected by changes in surface water quality • Historically identified as an important species for Aboriginal interests • Currently important species for Aboriginal commercial fishery around Lake Huron	Habitat	• Change in habitat quality and quantity
Spottail Shiner (*Notropis hudsonius*)	• Inhabits large rivers and lakes, in sandy or rocky shallows with sparse vegetation • A common fish species that utilizes MacPherson Bay, Baie du Doré and Stream C • An important prey species for other fish and birds, as well as an important bait fish for anglers • May be affected by changes in surface water quality, quantity or flow	Habitat	• Change in habitat quality and quantity
Smallmouth Bass (*Micropterus dolomieui*)	• Important sport fish, which reproduces in the Baie du Doré coastal wetland, and Bruce A and B discharges • May be affected by changes in surface water quality, quantity or flow	Habitat	• Change in habitat quality and quantity

Table 4-1: VECs Selected for the Aquatic Environment (continued)

VEC	Rationale for Selection	Indicators	Measures
Benthic Invertebrates	• Valuable food resource for higher trophic levels • Inhabit a wide variety of permanent, intermittent and ephemeral aquatic habitats • Remain in a localized area and may therefore respond to localized changes in the aquatic environment • May be affected by changes in water quality, quantity or flow	Habitat	• Change in habitat quality and quantity

Note:
This TSD considers only potential effects of the project on the aquatic environment associated with conventional (i.e., non-radiological) parameters. The potential effects of radioactivity on the aquatic environment are considered in the Radiation and Radioactivity TSD. In addition, overall effects of the project on Lake Huron are considered in the EIS.

4.1 RATIONALE FOR SELECTION OF VECS, INDICATORS AND MEASURES

The following sections identify and justify the selection of VECs for assessing the effects of the DGR Project on the aquatic environment.

4.1.1 Valued Ecosystem Components

Redbelly Dace

Redbelly dace is the most common fish species found in the South Railway Ditch and Stream C in the Site Study Area[3]. This species is a food source for higher trophic levels such as piscivorous fish, birds, reptiles and mammals. They are an important food item for brook trout in many waters [10]. This fish feeds mainly on algae with some consumption of aquatic invertebrates. They are used to indicate changes to stream substrate habitat since they tend to feed more on benthic organisms. They are also relatively easy to sample and tend to remain in the localized area they are found in (as opposed to species that migrate or range over a wider area). For these reasons, redbelly dace are important in the assessment of potential project effects on the quality and quantity of aquatic habitat in the Site Study Area.

Creek Chub

Creek chub is a common species that inhabits the South Railway Ditch and Stream C in the Site Study Area and is likely the most common stream minnow in eastern North America [10]. It is an omnivore, feeding on both plant and animal matter. Aquatic and terrestrial insect larvae and adults are an important part of their diet. In turn, creek chub form a component of the diet of higher trophic levels such as piscivorous fish, birds, reptiles and mammals. Creek chub are important in the assessment of project effects because, although relatively resilient, their abundance could be affected by changes in water quality, they remain in the local area, and are easily sampled and identified.

[3] Existing conditions, including field data collection carried out in support of this assessment, are described in Section 5.

Brook Trout

Brook trout inhabit cold, clear, well-oxygenated waters of streams, rivers and lakes and are present in Stream C. They are important in the assessment of potential project effects related to habitat impairment as they are relatively sensitive to changes in water quality, and do not tolerate turbidity and changes to thermal conditions. They feed on aquatic insects and other invertebrates as well as fish. Their presence in Stream C is a key indication of the good quality of that aquatic habitat.

Variable Leaf Pondweed

Variable leaf pondweed is important in assessing potential project effects because it is a common aquatic macrophyte in the South Railway Ditch in the Site Study Area, it is affected by changes in habitat quality, and has several key functions in the aquatic system. This plant grows submerged and provides cover for fish, attachment sites for invertebrates and is a potential food source for both.

Burrowing Crayfish

Two species of burrowing crayfish (*Fallicambarus fodiens* and *Orconectes immunis*) occur in the ditches and temporary and permanent wetland areas in the Site Study Area. These are identified as a VEC because they are a valuable food resource for higher trophic levels such as fish, birds and mammals. These crayfish construct burrows through clay or silty clay soils into the groundwater table. These burrows extend above the ground surface in distinctive shapes so their presence is easily detected. Burrowing crayfish are important in assessing potential project effects on the habitat available in the Site Study Area as their territory is localized (i.e., they can provide insight into local effects).

Lake Whitefish

Lake Whitefish utilize shoals in the vicinity of Douglas Point for spawning activity. Aquatic insect larvae, molluscs and amphipods are their primary food sources. Lake whitefish has historically been identified as an important species for Aboriginal interests, and is currently important to the Aboriginal commercial fishery in Lake Huron. This species could be affected by changes in water quality and thus has been the focus of concern for other EAs associated with projects at the Bruce nuclear site.

Spottail Shiner

Spottail shiner is a common species that inhabits the nearshore areas of the bays of Lake Huron in the Local Study Area, including MacPherson Bay and Baie du Doré. Spottail shiner is an important forage fish species as it is eaten by almost all predaceous fish [10]. It is also an important baitfish for recreational anglers. Spottail shiner feeds mainly on plants (algae) and aquatic invertebrates. In addition, this species is sensitive to changes in water quality, contaminant discharges and alterations in flow velocities.

Smallmouth Bass

Smallmouth bass is a warmwater fish that inhabits nearshore areas of Lake Huron. Extensive data has been collected regarding their spawning activities in Baie du Doré. This species prefers shallow waters in rocky or sandy areas of lakes. Smallmouth bass feed on aquatic insects, crayfish and fish. Since they are sensitive to changes in nearshore habitat quality including water chemistry and temperature, and are valued as part of the local sport fishery, they are important in the assessment of potential project effects.

Benthic Invertebrates

Benthic invertebrates exist in all permanent, intermittent and ephemeral aquatic habitats. Benthic invertebrate (e.g., slugs, leeches) communities are accepted as providing an indication of the overall quality of aquatic environments. Overall, these organisms can be considered sessile organisms and are therefore directly exposed to an effect. Furthermore, they are short-lived so changes are expressed rapidly. They are important in assessing the effect of changes to water and habitat quality. They are also an important food source for higher trophic levels such as fish, birds, reptiles and amphibians. A benthic invertebrate community survey was completed for MacPherson Bay and these data provide basis for an assessment of the water quality from the stormwater management system.

4.1.2 Indicators

The indicator selected for the VECs is habitat. Habitat encompasses all the physical, chemical and ecological conditions upon which these species depend in the aquatic environment. In this assessment, habitat is divided into two broad categories, namely non-critical and critical. Changes to habitat conditions such as water quality, channel morphology, sedimentation, flow, refuge and availability of forage have the potential to affect the habitat suitability for VEC species.

4.1.3 Measures

The measures for aquatic habitat are changes in either habitat quality and/or habitat quantity. Habitat quality is the suitability of the habitat to the requirements of each VEC. This can be measured as the availability of suitable spawning substrates, cover and food resources. Habitat quantity is the amount of suitable habitat (area).

5. DESCRIPTION OF THE EXISTING ENVIRONMENT

This section provides a description of the existing environmental conditions in the study areas for the aquatic environment component of the EA, focused on the VECs identified in Section 4. For the purposes of this TSD, "existing conditions" are defined as those generally present at the site and may reflect effects of the Bruce A and B nuclear generating stations, activities at the WWMF, Douglas Point generating station, Hydro One transmission activities and previous activities within the Site Study Area. The characterization of the existing environment serves as the baseline condition for which the environmental effects of the DGR Project are predicted and assessed.

For the purpose of this report, aquatic ecosystems are considered those that provide habitat for fish and crayfish. There is limited discussion relating to upland areas, such as riparian zones, as context to aquatic habitats. Upland habitats and associated biological communities are addressed in the Terrestrial Environment TSD.

5.1 EXISTING ENVIRONMENT METHODS

As noted above, the description of the existing environment focuses on VECs identified in Section 4. Information is presented for the study areas with emphasis placed on the areal extents most likely to be affected by the DGR Project. The description of the existing environment for the aquatic environment presents:

- a compilation and review of existing information; and
- details and results of the field programs undertaken to update existing information and fill data gaps.

The aquatic environment component of the EA uses the Regional, Local and Site Study Areas and Project Area (defined in Section 2.4.2) to characterize the existing conditions. The Project Area is the portion of the Bruce nuclear site that is being proposed as the location for the DGR Project. The Project Area specifically includes the WWMF because of its proximity to the DGR Project and shared drainage pathways.

The effects assessment (Section 8) evaluates the potential effects of the DGR Project on the existing environment. The methods used to gather information on which to base the description of the aquatic environment are explained in the following sections.

5.1.1 Sources of Existing Data

For the purposes of characterizing the aquatic environment, the following documents were included in the compilation and review of existing information:

- Bruce A Refurbishment for Life Extension and Continued Operations Project Environmental Assessment [11];
- Western Waste Management Facility Refurbishment Waste Storage Project Environmental Assessment and TSDs [12;13];
- Bruce Nuclear Power Development Ecological Effects Review [14];

- Bruce A Refurbishment for Life Extension and Continued Operations Project – Technical Support Document: Aquatic Environment [15];
- Assessment of the Crayfish Species and Populations Offsite and at the Western Waste Management Facility [16]; and
- Bruce Nuclear Power Development Bioinventory Study [17].

5.1.2 Field Studies

Available site specific information was supplemented with field surveys of Stream C, drainage ditches and the nearshore area of Lake Huron conducted in 2007 and 2009. On July 9, 2007 samples were taken from the South Railway Ditch, a man-made ditch, from the sections adjacent to the proposed DGR Project to the confluence with Stream C, as shown on Figure 5.1.2-1. Fish sampling was completed using a Smith Root backpack electro-fisher following the Ontario Ministry of Natural Resources single pass electro-fishing procedure outlined in the Ontario Stream Assessment Protocol [18]. Fish collection effort was concentrated in areas of suitable habitat for both juvenile and adult fish. Captured fish were enumerated and fork and total length (as applicable) were measured and recorded (Table C-3 in Appendix C). All captured fish were released after handling. The estimated length of the surveyed reach was 1,100 m with 5,560 seconds of electro-fishing conducted. Observations of fish habitat and aquatic vegetation were recorded.

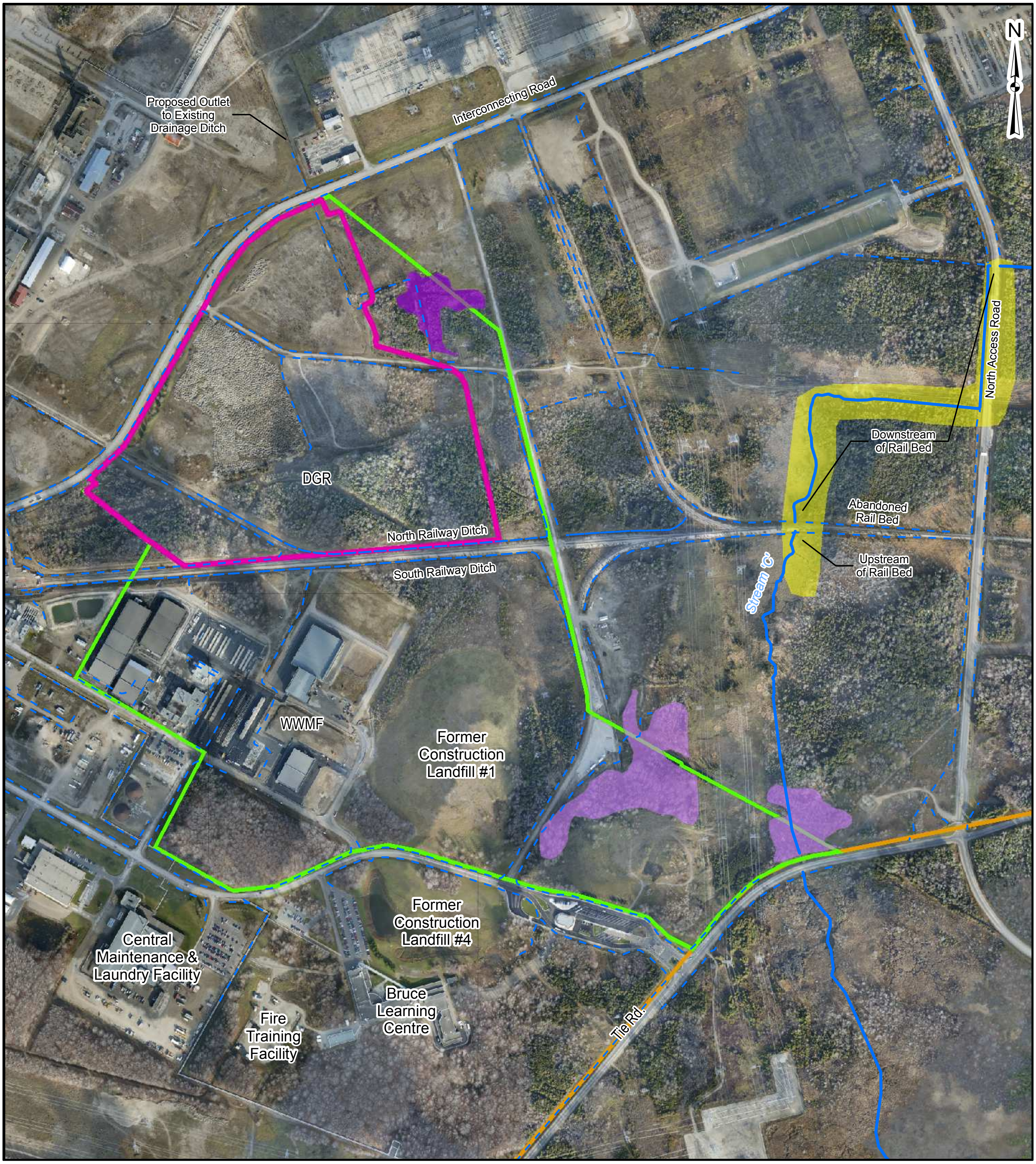
On July 21 and 22, 2007, the nearshore waters of Lake Huron were fished with seines and minnow traps, in the area known as MacPherson Bay (Tables C-1 and C-2 in Appendix C). Seining was completed using a 30 m long beach seine with a mesh size of 1/8 of an inch. Seine nets were deployed ten times and six minnow traps set overnight. Depth range of surveyed areas was 0.3 to 1.2 m. Substrate in the bay was predominantly cobble and boulders. Water temperature at the time of the survey ranged from 15.5 to 17.0 °C. Captured fish were enumerated and lengths (fork and total) were recorded. All captured fish were released after handling.

Surveys [16;19] for burrowing crayfish were conducted previously throughout the Project Area and adjacent lands in June 2006, and in the Site and Local Study Areas in July 2006. Field work in May 2009 provided an update to those studies in the Project Area. This work consisted of a repeat visit to areas surveyed in 2006 to conduct a visual survey and confirm the continued presence of burrowing crayfish in this area based on visual observations of burrows (i.e., chimneys).

Additionally, a habitat survey of Stream C was conducted on August 12, 2009. Visual assessments were conducted along the following reaches of Stream C:

- upstream of the abandoned rail bed for approximately 50 m; and
- downstream of the abandoned rail bed to North Access Road.

Habitat parameters such as channel morphology, presence of groundwater indicators (seeps, watercress) and fish habitat conditions were recorded. The reaches covered by the visual assessment are depicted on Figure 5.1.2-1. The results of the field studies are included in Section 5.3.



0 125 250 500

Metres

LEGEND

- Ephemeral/Intermittent Drainage Ditch
- Stream C Habitat Survey
- DGR Project Site
- Project Area (OPG-retained lands that encompass the DGR Project)
- Site Study Area [1]

ELC Group

- Marsh
- Swamp

NOTE

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

REFERENCE

Base Data Provided by 4DM, November 2007.
Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m, Datum: NAD 83 Projection: UTM Zone 17N

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

AQUATIC FEATURES ON THE SITE

Golder Associates
Mississauga, Ontario

PROJECT No. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct. 2007		
GIS	BC	22 Apr. 2010	**FIGURE 5.1.2-1**	
CHECK	AB	22 Apr. 2010		
REVIEW	MAR	22 Apr. 2010		

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5.2 TRADITIONAL KNOWLEDGE AND ABORIGINAL SHARING

As described in the Aboriginal Interests TSD, local Aboriginal communities have historically identified a number of issues relating to the DGR Project and Bruce nuclear site. Those issues that relate to the aquatic environment include:

- traditional lands, waters, and resources are a fundamental part of Aboriginal cultures;
- treaty rights in the waters surrounding the Bruce Peninsula, including fishing rights and lake bed;
- long-term use of lands and waters, including use of traditional territory for hunting, gathering and fishing;
- the importance to the cultural and economic health of the Aboriginal communities of the traditional fisheries of Lake Huron and Georgian Bay, particularly lake whitefish harvest; and
- level of contaminants in fish.

The description of the existing aquatic environment includes discussion of fish communities in Lake Huron, Stream C and drainage ditches in the Site Study Area. In addition, the overall effects of DGR Project on Lake Huron are considered in Section 7 of the EIS. Finally, Aboriginal observers from the Saugeen Objiway Nation were present during the visual habitat survey of Stream C conducted on August 12, 2009 (see Section 5.1.2).

5.3 AQUATIC HABITAT AND BIOTA

At the regional scale, the major watersheds are the Saugeen River watershed and the Sauble River watershed. These watersheds are naturally diverse, supporting a variety of both natural and anthropogenic (man-made) habitats, including wetlands, warm and coldwater streams, springs, ponds and inland lakes. All watercourses and waterbodies ultimately empty into Lake Huron.

The Local Study Area includes both the Stream C and Underwood Creek drainage areas. The Site Study Area includes MacPherson Bay, a portion of Stream C and a portion of Baie du Doré. Stream C is a diverted drainage channel which has become naturalized over time. Stream C crosses through the southeastern portion of the Project Area; however, the DGR Project site does not have any natural aquatic habitat. A detailed illustration of the location of all these aquatic features is provided on Figures 2.4.2-2, 2.4.2-3 and 5.1.2-1. General aquatic habitat features are illustrated on Figure D-2 in Appendix D.

Surface runoff in the Site Study Area is through a network of constructed ditches, which either directly drain to Lake Huron, or to the Stream C catchment. Surface runoff from most of the DGR Project site is carried through a drainage ditch to Lake Huron via MacPherson Bay. This is a constructed ditch that is dry for most of the year, is heavily vegetated and does not provide fish habitat. The remainder of the Project Area drains to Baie du Doré via the North Railway Ditch and Stream C.

The North Railway Ditch drains a very small portion (approximately 26 ha) of the Site Study Area, mainly the southwestern portion of the DGR Project site (Figure 7.2.1-1 in the Hydrology and Surface Water Quality TSD). The North Railway Ditch is frequently dry within the Project Area and does not contain fish habitat. The South Railway Ditch is described in Section 5.3.1.

As shown on Figure 5.1.2-1, at the Project Area boundary, the North Railway Ditch makes a 90 degree turn to the north and the South Railway Ditch makes a 90 degree turn to the south and both continue a short distance in their respective directions before emptying into culverts under the road. The ditches then migrate back (i.e., North Railway Ditch turns south and South Railway Ditch turns north) toward the abandoned rail bed. Once at the abandoned rail bed, they both turn 90 degrees to drain in an easterly direction and eventually drain into Stream C approximately 500 m west of the Project Area. The location of all these aquatic features is illustrated on Figure 5.1.2-1.

It was noted during field investigations that the North Railway Ditch does not contain enough water for any length of time to support fish or fish habitat. Previous studies by the Saugeen Valley Conservation Authority (SVCA) did not classify this ditch as fish habitat [17]. However, the South Railway Ditch appears to be intermittent (certain sections are choked with cattail and do not contain water), with enough water contained in remnant pools during low flow periods to maintain fish habitat. Therefore, in regards to the aquatic environment, it is the South Railway Ditch that will be discussed herein, as it provides habitat for aquatic VECs.

5.3.1 South Railway Ditch

The South Railway Ditch receives surface water from the WWMF site as well as three discharge pipes from the facilities on the WWMF site. The SVCA classified the South Railway Ditch as fish habitat [17].

Historical aquatic habitat investigations of the South Railway Ditch were conducted by Ontario Hydro in August 1996 and in June/July 1997 [20]. Additional site reconnaissance was carried out in November 1999, and a fish community survey of the South Railway Ditch was undertaken in June 2000. As part of an EA Follow-up Program at the WWMF in 2004 [21], biological surveys, including aquatic community surveys, were conducted along the South Railway Ditch. On July 9, 2007, a habitat reconnaissance and fish collection in the South Railway Ditch was completed in support of this EA. The DGR Project field survey results provided in Appendices C and D are consistent with past aquatic habitat investigations. From these various site investigations, the following characterization of the South Railway Ditch was formulated.

The South Railway Ditch is straight with a channel width of approximately 5 m at the top of the bank throughout the reaches within the Project Area. During the habitat reconnaissance and fish collection conducted in 2007, flow was stagnant in the ditch. Historical investigations of the ditch documented a wetted channel width of 3 m and a mean water depth of 0.15 m [13]. The channel is choked with thick stands of cattail in some places, which serves to reduce water velocity, thus minimizing erosion and increasing the rate of settling for sediments that may enter the ditch system.

There were also open channel sections that appear to have been subjected to clean-out/dredging in the past. Fish were caught in 2007 in these open channel sections in water depths of 0.2 to 0.25 m. The banks are stabilized with a mix of grasses and other herbaceous species, shrub species and trees.

Aquatic invertebrate life in the South Railway Ditch includes leeches (*Macrodbella decora* and *Placobdella ornata*) and snails (*Helisoma spp*., *Lymnaea spp*., and *Physidae physa*) [22]. Aquatic crayfish are also common [12;22]. These aquatic crayfish are species different than the burrowing crayfish species. The dominant aquatic macrophyte in the South Railway Ditch is cattail (*Typha spp*.). In areas of the ditch that appeared to have been recently dredged, five other macrophyte species occur: muskgrass (*Chara sp.*), variable leaf pondweed, sago pondweed (*Stuckenia pectinata*), floating leaf pondweed (*Potamogeton natans*) and water plantain (*Alisma plantago-aquatica*). All the aquatic macrophyte species observed are common and widespread throughout southern Ontario.

The South Railway Ditch supports a warmwater baitfish community. The water temperatures recorded during the 2007 and 2009 surveys and reported in the Hydrology and Surface Water Quality TSD confirmed the warmwater habitat status. The temperatures ranged from 10°C in October to 21°C in June. Six fish species were identified in the South Railway Ditch during the 2007 field studies (see Appendix C), including brassy minnow (*Hybognathus hankinsoni*), brook stickleback (*Culaea inconstans*), central mudminnow (*Umbra limi*), creek chub, fathead minnow (*Pimephales promelas*), and redbelly dace. These fish represent a mix of species that are typical of warmwater creeks and wetland conditions, and are tolerant of a wide range of environmental conditions. These species are common and wide-spread throughout central and southern Ontario.

The terrestrial burrowing crayfish species *Orconectes immunis* and *Fallicambarus fodiens* are found in and adjacent to the South Railway Ditch, as well as other suitable habitats, as evidenced by the observations of crayfish chimneys in the Project Area during 2006, 2007 and 2009 field investigations (Figure 5.3.1-1). The burrows of these species of crayfish are typically found in wetlands (marshes and swamps), roadside ditches and creek banks in moist clay soils. The burrows are excavated to the groundwater table.

The presence of burrowing crayfish in the Project Area was first recorded in 2006 during studies for the WWMF [19;16]. During the 2006 work, burrowing crayfish were documented within the Site, Local and Regional Study Areas (Bruce nuclear site, Baie du Doré and MacGregor Point Provincial Park) [16]. During the 2007 aquatic field program (and re-confirmed during the 2009 field work), chimneys of burrowing crayfish were documented within the Project Area.

The locations of all the burrows, based on from combined studies within the Project Area, are shown on Figure 5.3.1-1. Crayfish chimneys were observed in all drainage ditches in the Project Area including the North and South Railway Ditches and the abandoned railway spur. They were also found in the marsh and the swamp community identified in the Project Area.

The two burrowing crayfish species (*O. immunis* and *F. fodiens*) are ranked S4 by the Natural Heritage Information Centre (NHIC), which is a section of the Ontario Ministry of Natural Resources (OMNR) [23]. A rank of S4 indicates that they are secure species in Ontario and the NHIC describes them as common species in Ontario. The World Wildlife Fund and the Canadian Nature Federation have offered the opinion that they feel *F. fodiens* is threatened in Ontario [24].

5.3.2 Stream C

Stream C is located to the east and generally outside of the Project Area[4]. It is a former tributary of the Little Sauble River that was diverted to Baie du Doré during the initial

[4] A very small (approximately 50 m) portion of Stream C traverses the south-easterly tip of the Project Area, upstream of the DGR Project site, as shown on Figure 5.1.2-1.

development of the Bruce nuclear site in the 1960s. It is the largest stream entering Baie du Doré.

5.3.2.1 Upstream of Abandoned Rail Bed

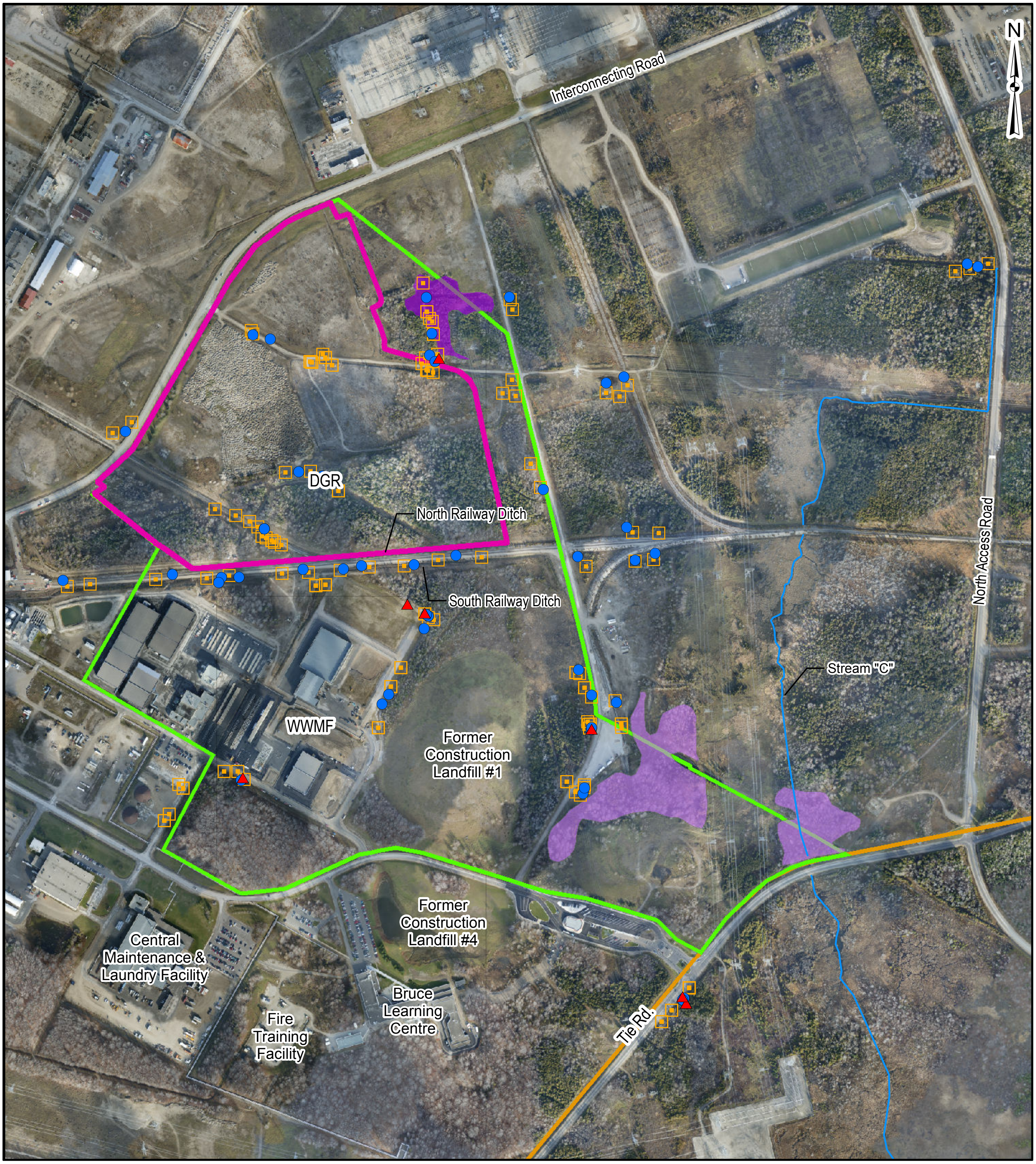
The reach upstream of the abandoned rail bed (see Figure 5.1.2-1) consists of a shallow, braided channel through low-lying areas dominated by cedar and cattails. The main channel that enters the approximately 1.2 m wide culvert under the abandoned rail bed is shallow (11 to 20 cm deep) and averaged 2 m wetted width at the time of the survey (August 12, 2009). The channel has approximately 20% shading by herbaceous wetland vegetation in this reach. Substrates are a mix of cobble, gravel, silt and sand. Watercress was observed in-stream at the culvert, which may indicate groundwater seeps.

5.3.2.2 Downstream of Abandoned Rail Bed to North Access Road

Downstream of the abandoned rail bed, there is an approximately 15 m long, 1.5 m deep outlet pool. This pool contained schools of minnows, and some were identified as northern redbelly dace. The main channel downstream of the outlet pool ranges from 3 to 4 m wide (wetted) and consists mostly of flats with some pools and riffles. The majority of this section of Stream C consists of a straight, constructed channel that flows along the transmission line right-of-way and the North Access Road. The channel is uniform with banks approximately 50 cm high. The riparian cover is good (some reaches have 60 to 100% overhead shading) in this section and watercress is abundant. The substrates are a mixture of boulders, cobble, gravel, silt and clay. The slower flowing areas at the margins of the channel support the growth of arrowhead (*Sagittaria latifolia*), water arum (*Calla palustris*) and pondweed. The riparian zone in this section consists of eastern white cedar, balsam poplar, tamarack and various common herbaceous old field species.

5.3.2.3 Stream C Downstream of Bruce Nuclear Site

Stream C flows through an approximately 2.5 m wide culvert under the North Access Road, where it exits the Bruce nuclear site. Stream C downstream of the road is shallow and the riparian zone is forested before it enters the Baie du Doré wetland. Substrates are relatively consistent with those in the upstream reaches described above. Flow velocity and water depth within this reach of Stream C are likely influenced by the backwater effect from Baie du Doré/Lake Huron.



0 125 250 500
Metres

LEGEND

- Trap
- Chimney
- Crayfish Caught
- DGR Project Site
- Project Area (OPG-retained lands that encompass the DGR Project)
- Site Study Area [1]

ELC Group

- Marsh
- Swamp

NOTE

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

REFERENCE

Base Data Provided by 4DM, Nov 2007. Chimmney & Trap: Source [16]
Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m, Datum: NAD 83 Projection: UTM Zone 17N

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

LOCATION OF BURROWING CRAYFISH CHIMNEYS AND BAITED TRAPS

Golder Associates
Mississauga, Ontario

PROJECT NO. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct. 2007	**FIGURE 5.3.1-1**	
GIS	BC	15 Apr. 2010		
CHECK	AB	15 Apr. 2010		
REVIEW	MAR	15 Apr. 2010		

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5.3.2.4 Fish Community

Stream C is designated by Fisheries and Oceans Canada (DFO) as coldwater fish habitat, as the fish community includes brook trout, rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*). Spawning activity of brook trout, rainbow trout, brown trout and chinook salmon (*Onchorynchus tshawytscha*) has been documented in this stream [25]. Various sucker (*Castostomus spp.*) and cyprinid species including spottail shiner are also known to inhabit or have been observed in Stream C [26].

In July 2007, the pools located immediately downstream of the abandoned rail bed and immediately upstream of the North Access Road were sampled for fish. Given the warm surface water temperatures recorded (20°C), these locations appeared to be providing coldwater refugia. A total of 14 different fish species were captured including spottail shiner, rainbow darter, creek chub and central mudminnow. During the 2007 study, brook trout, both adults and juveniles, were captured only in the pool immediately upstream of the North Access Road. However, previous studies have documented the presence of rainbow trout, brown trout and brook trout in the pool immediately downstream of the abandoned rail bed [25]. There were no barriers to fish migration noted in the reaches downstream of the abandoned rail bed during the 2009 aquatic habitat assessment.

5.3.3 Lake Huron and the Embayments

Within Lake Huron, near the Bruce nuclear site, there are two main habitats: the nearshore and offshore. The nearshore habitat consists mainly of rocky areas that are exposed to the wind and wave action of the Lake Huron shoreline (e.g., MacPherson Bay, Figure D-1 in Appendix D) and sheltered bays such as Baie du Doré, which provide a more constant environment, protected from wave and current action. Offshore habitat consists of the deep, cool, open waters of Lake Huron.

In the open waters of Lake Huron, the species encountered are those that are well adapted to the cold water and utilize open lake or deeper coastal habitats for the majority of their life cycles or the majority of the year. Species included in this category are round whitefish (*Prosopium cylindraceum*), lake whitefish, lake trout (*Salvelinus namaycush*) and deepwater sculpin (*Myoxocephalus thompsoni*). Most make use of the nearshore areas only during spawning and prefer offshore deeper waters, particularly during the warmer summer months. Studies focusing on lake whitefish and round whitefish spawning in the vicinity of the Bruce nuclear site indicated that larvae of both species are present in the spring, but in lower numbers than at reference sampling sites located north of the Bruce nuclear site, where extensive spawning shoals exist [26].

The exposed nearshore environment of MacPherson Bay is continually being swept out by wave action allowing for large coarse substrates to persist and fine substrates to be transported out of the bay to open water. By comparison, Baie du Doré is a calmer environment with depositional areas in the inner portion where fine sediments (sand) accumulate. The deposition of fine sediments allows for an increase in productivity because of the establishment of primary producers (e.g. aquatic macrophytes such as variable leaf pondweed) in Baie du Doré and a more stable/productive temperature regime for many species. It has been previously noted that Baie du Doré is the most important rearing and nursery area in the Local Study Area, and is used by many fish species. Some small streams (e.g., Stream C) and creeks enter the inner portion of Baie du Doré, providing additional habitat.

Fish found in the nearshore areas such as the inner, protected portion of the Baie du Doré are generally warmwater species. Shallow shoal areas within Baie du Doré provide spawning, nesting, rearing and feeding habitats for fish. Species known to use this habitat are smallmouth bass, northern pike (*Esox lucius*), spottail shiner and bowfin (*Amia calva*) [26;27;28]. Smallmouth bass are common in the Bruce A and B discharge channels and Baie du Doré, and have been observed spawning in these areas [26;27;28] (Figure D-3 in Appendix D).

Because MacPherson Bay is not sheltered from coastal effects, its function as fish habitat is restricted. The coarse substrates in the bay limit primary production (growth of aquatic macrophytes) and offer little cover for fish in its clear shallow waters. MacPherson Bay is unsuitable for critical life history functions of many fish species (e.g., spawning/nursery areas for many species including smallmouth bass and pike), and likely offers minimal foraging opportunities for some species. The bay may provide very limited spawning and nursery habitat for a small proportion of the populations of a few coastal species like the invasive round goby (*Neogobius melanostomus*) and bluntnose minnow. During the 2007 aquatic field program, 14 species of fish were caught in the shallow nearshore waters of MacPherson Bay, seven of which are generally regarded as nearshore species. These were round goby, spottail shiner, white sucker (*Catostomus commersoni*), longnose gar (*Lepisosteus osseus*), emerald shiner (*Notropis atherinoides*), spotfin shiner (*Notropis spilopterus*) and bluntnose minnow. Round goby accounted for 78% of the catch by numbers.

The continual wave and current action along the shoreline creates unstable substrates and promotes continual removal of fine substrates (prohibits deposition) and rapid dilution of suspended sediments. Prior to commissioning of Bruce A, the benthic invertebrate community was observed to be characteristic of the unstable, relatively severe conditions typically found on exposed coastlines in the Great Lakes [29;28]. Several studies since then have shown that the benthic invertebrate communities in the wave-washed nearshore zone are reduced in both density and diversity of organisms, and that only a few species are able to colonize this hostile habitat [29;28]. No organisms were observed on the exposed bedrock surfaces, which is evidence that physical conditions or exposure to predation may render these areas too harsh for colonization by most benthic organisms. Similarly, it was found that the abundance and diversity of benthic invertebrates was limited in sandy depositional areas; however, it was noted that, in general, diversity and abundance of benthic invertebrates is highest within Baie du Doré.

There are several drainage ditch/stormwater conduits to MacPherson Bay that drain the Bruce nuclear site. The majority (41.3 ha) of the northern portion of the Project Area is drained by a ditch that runs alongside Bruce A and outlets into MacPherson Bay. The SVCA did not categorize this ditch as providing fish habitat [17].

Overall, Baie du Doré and its largest tributary (i.e., Stream C) are considered more diverse, sensitive and productive than MacPherson Bay and its man-made, drainage ditch tributaries.

5.3.4 Other Potential Aquatic Habitat

Other potential aquatic habitats include those areas of the Project Area that may support aquatic VECs (e.g., burrowing crayfish) that are not designated by the SVCA. This includes the marsh and swamp in the Project Area, the North Railway Ditch, and other drainage ditches at the Bruce nuclear site.

As noted, there are two wetland features (i.e., marsh and swamp) within the Project Area. The vegetation communities within the Site Study Area have been classified according to Ecological Land Classification for Southern Ontario (ELC) as discussed and illustrated in the Terrestrial Environment TSD. One of the wetland communities is a seasonal swamp that is approximately 3.1 ha and is located in the southeast portion of the Project Area. The other wetland community is a marsh, approximately 0.9 ha in size and is located in the northeast portion of the Project Area. These communities are illustrated on Figure 5.1.2-1.

Burrowing crayfish species were observed within the Project Area (Figure 5.3.1-1) in both wetland communities, the North and South Railway Ditches, other drainage ditches in the Project Area, and the abandoned railway spur as previously discussed. Field study results also indicate that burrowing crayfish populations are present within the Local and Regional Study Areas in areas where suitable wetland and soil conditions exist.

5.4 SUMMARY OF EXISTING ENVIRONMENT

Table 5.4-1 provides a summary of the existing Aquatic Environment by VEC.

Table 5.4-1: Summary of Existing Aquatic Environment

VEC	Existing Environment	Aquatic Habitats			
		South Railway Ditch	Stream C	Lake Huron and Embayments	Other Aquatic Habitats
Redbelly Dace	• Inhabits the South Railway Ditch and Stream C • Warmwater species common in wetland conditions, and tolerant of a wide range of environmental conditions	✓	✓		
Creek Chub	• Inhabits the South Railway Ditch and Stream C • Warmwater species common in wetland conditions, and tolerant of a wide range of environmental conditions	✓	✓		
Brook Trout	• Inhabits Stream C; spawning behaviour in Stream C observed • Coldwater fish species intolerant of turbidity		✓	✓	
Variable Leaf Pondweed	• Grows in the South Railway Ditch in the open areas that are regularly dredged for drainage purposes • Previous studies recorded it growing in the Baie du Doré wetland	✓		✓	
Burrowing Crayfish	• In the Project Area, burrowing crayfish are found along the North and South Railway Ditch, within the marsh and the swamp and along the abandoned rail spur in the Project Area • Inhabits areas within the Regional, Local and Site Study Areas as well	✓			✓
Lake Whitefish	• Benthic-oriented species which spend most of the spring, summer and fall offshore in deeper, cooler water beyond the influence of the Bruce nuclear site • Spawn at sites with cobble, boulder and gravel substrates at depths greater than 2 m, outside the shallow nearshore littoral zone			✓	

Table 5.4-1: Summary of Existing Aquatic Environment (continued)

VEC	Existing Environment	Aquatic Habitats			
		South Railway Ditch	Stream C	Lake Huron and Embayments	Other Aquatic Habitats
Spottail Shiner	• Forage fish species that inhabits Baie du Doré, MacPherson Bay and Stream C • Warmwater species that inhabits the nearshore of Lake Huron		✓	✓	
Smallmouth Bass	• Common in Baie du Doré; observed spawning in this area • Warmwater species that prefers a temperature of 20 °C and inhabits shallow, nearshore areas of Lake Huron • They spawn in the spring/early summer in bays and other protected areas			✓	
Benthic Invertebrates	• Higher density and diversity of benthic invertebrates occurs in Baie du Doré, which offers protection from waves and currents, while lower density and diversity occurs along the exposed shoreline in MacPherson Bay • Benthic invertebrates in Stream C, South Railway Ditch and other aquatic habitats also provide valuable food source for other aquatic and terrestrial species	✓	✓	✓	✓

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6. INITIAL SCREENING OF PROJECT-ENVIRONMENT INTERACTIONS

6.1 INITIAL SCREENING METHODS

The first screening considers whether there is potential for the DGR Project to interact with the aquatic environment VECs.

6.1.1 Identification of Project-Environment Interactions

Following the description of the project, identification of VECs, and description of the existing environment, the project works and activities are screened to determine those with the potential to interact with the VECs in the aquatic environment. The screening is conducted based on the general understanding of the existing environmental conditions. This allows the assessment to focus on issues of key importance where potential interactions between the DGR Project and the aquatic environment are likely. The analyses are based on the experience of the technical specialists supported by information collected from field studies and information from earlier EAs carried out for projects at the Bruce nuclear site. This screening is conducted by habitat (and associated VECs) for the site preparation and construction, operations and decommissioning phases of the DGR Project. Some VECs are found in more than one habitat (see Table 5.4-1), and therefore may be considered more than once.

Aquatic environment VECs interact with the DGR Project directly (e.g., removal of habitat) and indirectly (e.g., effects on fish attributed to changes in surface water quality [a VEC in the Hydrology and Surface Water Quality TSD]). Both direct and indirect interactions are carried forward through this assessment. Where a mechanism for interaction is identified, the individual project work or activity is advanced for further consideration of measurable changes. Where no potential interaction is identified, no further assessment is conducted. The analyses at this stage are based on qualitative data, as well as the professional judgement and experience of the EA team with regard to the physical and operational features of the project and their potential interactions with the environment.

The results of the screening are documented in an interaction matrix. A potential project-VEC interaction is marked with a '•' on Matrix 1 (Section 6.3).

If, following the evaluation of project-environment interactions, there are no potential interactions between a VEC and any project work and activity or other VECs, the VEC may not be considered further.

6.2 IDENTIFICATION OF DGR PROJECT-ENVIRONMENT INTERACTIONS

In the initial screening, all works and activities associated with the DGR Project are identified and analyzed for possible interactions with the aquatic environment VECs. Both direct and indirect interactions are considered. As shown in the Basis for the EA (Appendix B), the DGR Project includes the following project works and activities:

- site preparation;
- construction of surface facilities;
- excavation and construction of underground facilities;

- above-ground transfer of waste;
- underground transfer of waste;
- decommissioning of the DGR Project;
- abandonment of the DGR facility;
- presence of the DGR Project;
- waste management;
- support and monitoring of DGR life cycle; and
- workers, payroll and purchasing.

The abandonment of the DGR facility work and activity is considered in this TSD as being at the end of the decommissioning phase. The abandonment and long-term performance phase is not considered in the assessment as no activities are expected to occur during this phase. It is considered in Section 9 of the EIS. This TSD considers normal operations and non-radiological effects. Abnormal conditions are considered in the Malfunctions, Accidents and Malevolent Acts TSD. Radiological effects are considered in the Radiation and Radioactivity TSD.

6.2.1 Direct Interactions

The works and activities associated with the DGR Project are not expected to have direct interactions with the aquatic environment VECs in Lake Huron, MacPherson Bay or Baie du Doré (i.e., spottail shiner, smallmouth bass, lake whitefish, benthic invertebrates, variable leaf pondweed) as the Project Area is located inland from these habitats. Similarly, Stream C, and its associated VECs (redbelly dace, creek chub, brook trout, spottail shiner and benthic invertebrates), is located at least 500 m from all disturbances associated with the works and activities of the DGR Project. Therefore, no potential direct interactions with the aquatic VECs in these habitats are possible and they are not considered further.

6.2.1.1 Site Preparation

VECs in the South Railway Ditch

Site preparation activities will include the clearing and grubbing of vegetation on approximately 30 ha of the Project Area north of the abandoned rail bed. Soil will be stripped to remove topsoil, and grading and compaction will be completed, as required, in the vicinity of surface facilities, roadways and the Waste Rock Management Area. The riparian vegetation along the banks of the South Railway Ditch will not be removed during site preparation activities according to the construction schedule. The rail bed crossing from the WWMF to the DGR Project will be constructed in the latter stages of the site preparation and construction phase during the construction of surface facilities. Therefore, the site preparation work is not expected to interact with the VECs in the South Railway Ditch (redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish and benthic invertebrates) and is not considered further.

VECs in Other Aquatic Habitats

The proposed DGR Project location and site preparation activities occur within the north half of the Project Area and therefore, the swamp in the southeast portion and the marsh located on the northern portion of the site will be protected from this disturbance. Thus, no direct interaction is anticipated with these wetland areas and their associated VECs (burrowing crayfish and benthic invertebrates). Wetland vegetation and wildlife are assessed in the Terrestrial Environment TSD.

The roadside drainage ditches in the Project Area and the ditches along the abandoned railway spur, which serve as marginal or secondary aquatic habitat for burrowing crayfish and benthic invertebrates, could be disturbed/altered during site preparation activities. Therefore, this direct interaction is forwarded for further consideration in Section 7.

6.2.1.2 Construction of Surface Facilities

VECs in the South Railway Ditch

The surface buildings and infrastructure to be constructed for the DGR Project include the Waste Package Receiving Building, ancillary buildings, the main shaft, the ventilation shaft and the access road. The proposed locations for the buildings are removed from the aquatic features in the Project Area and, therefore, the construction of surface facilities will not directly interact with the VECs associated with the South Railway Ditch.

The rail bed crossing will cross a portion of the South Railway Ditch adjacent to the WWMF (Figure 3.2.1-1). Removal of some riparian vegetation and alteration of the banks of the South Railway Ditch will occur during the construction of the crossing. Therefore, this work and activity will have a direct interaction with the habitat within and adjacent to the South Railway Ditch and the associated VEC fish species (i.e., redbelly dace, creek chub, benthic invertebrates and variable-leaf pondweed). Additionally, there is a potential interaction with the habitat of burrowing crayfish in the South Railway Ditch. These project-environment interactions are carried forward to the second screening.

VECs in Other Aquatic Habitats

The roadside drainage ditches in the Project Area, the North Railway Ditch and the ditches along the abandoned railway spur, which serve as marginal or secondary aquatic habitat for burrowing crayfish and benthic invertebrates, could be disturbed/altered during the construction of surface facilities. These activities will likely occur within areas previously disturbed during site preparation (see Section 6.2.1.1); however, there remains a potential for interaction. These project-environment interactions are carried forward to the second screening.

6.2.1.3 Excavation and Construction of Underground Facilities

VECs in the South Railway Ditch

During excavation and construction of the underground facilities, the stockpiled excavated materials will be located in the northern portion of the Project Area, which is geographically separated from the South Railway Ditch by the surface buildings and infrastructure associated with the DGR Project. Therefore, there will be no direct interaction with the aquatic habitat within the South Railway Ditch and its VECs (redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish, benthic invertebrates). Therefore, no potential interaction is identified, and this is not considered further.

VECs in Other Aquatic Habitats

The excavation and construction of underground facilities will be geographically separated from the swamp and marsh areas found in the Project Area. Other drainage ditches will not be altered during the excavation and construction of underground facilities. Accordingly, no direct interaction is identified for burrowing crayfish or benthic invertebrates in other aquatic habitats. Therefore, further consideration is not warranted.

6.2.1.4 Above-ground Transfer of Waste

VECs in the South Railway Ditch

The transfer of waste from the WWMF to the DGR will not have a direct interaction with the South Railway Ditch or the associated VECs (redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish, benthic invertebrates) since it does not involve the alteration or degradation of aquatic habitat or destruction of biota. Therefore, no further consideration is warranted.

VECs in Other Aquatic Habitats

The waste transfer activities are within the northwest half of the Project Area and thus the other aquatic habitats (i.e. swamp in the southeast portion, marsh in the northeastern portion of the Project Area, and existing drainage ditches) will not be directly affected. Thus the habitat of the burrowing crayfish and benthic invertebrates will not be affected. No potential interactions are identified, and this is not considered further.

6.2.1.5 Underground Transfer of Waste

The underground transfer of waste is not expected to have a direct interaction with the aquatic habitats or the associated VECs, as all activities will be carried out nominally 680 m below ground. No potential interactions are identified, and this is not considered further.

6.2.1.6 Decommissioning of the DGR Project

VECs in the South Railway Ditch

The decommissioning of the DGR Project includes the removal of all surface facilities, sealing the two shafts, and finally, the rehabilitation of the surface landscape of the DGR Project site. During shaft sealing, materials will be brought on-site, mixed and then placed in the shafts. The crossing over the abandoned rail bed will remain in place. The removal of the surface facilities and sealing of the shafts are not expected to directly affect the VECs in the South Railway Ditch and no further consideration is warranted.

VECs in Other Aquatic Habitats

The decommissioning of the DGR Project includes the removal of all surface facilities and the re-vegetation of the DGR Project site. The re-vegetated/re-naturalized site has the potential to interact with habitat for the burrowing crayfish in other aquatic habitats on-site, particularly in low lying areas that are utilized by burrowing crayfish under existing conditions. This interaction is advanced for further consideration.

6.2.1.7 Abandonment of DGR Facility

Abandonment may include removal of access controls. There are no physical works and activities associated with abandonment of the DGR facility that have the potential to interact with aquatic environment VECs. Therefore, no further consideration is warranted.

6.2.1.8 Presence of the DGR Project

The presence of the DGR Project work and activity is associated with the meaning people may attach to the existence of the facility in their community, and therefore, cannot directly interact with the aquatic environment VECs. Accordingly, no further consideration is warranted.

6.2.1.9 Waste Management

Waste management includes all activities required to manage waste throughout the DGR Project. During site preparation and construction, waste management will include managing the waste rock along with conventional and hazardous waste. During operations, waste management would include management of conventional and hazardous wastes, along with small amounts of radiological wastes from the underground and above-ground waste transfer activities. Decommissioning waste management may include management of conventional and construction wastes, along with very small quantities of hazardous and radioactive wastes.

This work and activity would not directly interact with the aquatic environment VECs as it does not involve any direct alteration of aquatic habitat and its associated plant and fish species. Therefore, waste management is not considered further.

6.2.1.10 Support and Monitoring of DGR Life Cycle

The support and monitoring of the DGR life cycle work and activity includes activities to support the safe construction, operation and decommissioning of the DGR Project. Drainage ditch maintenance activities (e.g., cleaning out culverts) could potentially affect the VECs in the South Railway Ditch (redbelly dace, creek chub, burrowing crayfish, benthic invertebrates and variable leaf pondweed). Therefore, support and monitoring of the DGR life cycle is carried forward to the second screening.

6.2.1.11 Workers, Payroll and Purchasing

Workers, payroll and purchasing encompasses all workers required during each phase of the DGR Project, including the vehicles used to access the Bruce nuclear site and delivery vehicles entering and leaving the site. The activities associated with workers, payroll and purchasing are not expected to have a direct interaction with the aquatic environment or the associated VECs, since they do not involve destruction of aquatic habitats or biota. No further consideration is warranted.

6.2.2 Indirect Interactions

6.2.2.1 Changes in Air Quality

Dust and atmospheric emissions generated during site preparation and construction, operations and decommissioning may be deposited on the aquatic habitat within the Site Study Area. This deposition could, in turn, affect surface water quality, which has the potential to affect the VECs within the South Railway Ditch and Stream C. This process is captured as an indirect interaction through changes in surface water quality (see Section 6.2.2.4).

6.2.2.2 Changes in Noise and Vibration Levels

The change in noise level during construction and operations from equipment, trucks, fans, and emergency power system is not expected to affect any of the aquatic VECs as there will not be any underwater works and activities. Additionally, no works or activities are expected to produce sufficient vibration to penetrate the aquatic environment during operations. However, changes in vibration levels associated with the blasting that will occur during construction activities and could affect fish VECs associated with the South Railway Ditch, Stream C and/or MacPherson Bay (redbelly dace, creek chub, brook trout, spottail shiner, lake whitefish and smallmouth bass). Therefore, this indirect interaction is advanced for further consideration in Section 7.

6.2.2.3 Changes in Surface Water Quantity and Flow

Site drainage that flows into the Stream C catchment under existing conditions will be diverted into the MacPherson Bay catchment. This diversion will occur during the site preparation and construction phase and continue through the life of the DGR Project. The change in flow to the North Railway Ditch and Stream C has the potential to interact with brook trout, creek chub, redbelly dace, spottail shiner and benthic invertebrates. Therefore, this interaction is advanced to Section 7 for further consideration.

The South Railway Ditch drains the WWMF site and thus there is no interaction between the VECs in the South Railway Ditch and changes to surface water quantity and flow.

Burrowing crayfish rely on suitable soil and groundwater conditions, but they occur in open surface waters a few weeks each year for reproductive activities. The diversion of surface run-off from the North Railway Ditch has the potential to indirectly interact with burrowing crayfish and is advanced for further consideration.

The areal extent of the DGR Project Area draining to MacPherson Bay through the existing drainage ditch at Interconnecting Road will increase. Therefore, the potential interaction of increased surface water flow to MacPherson Bay and its VECs (lake whitefish, spottail shiner, smallmouth bass and benthic invertebrates) will be carried forward for further consideration.

6.2.2.4 Changes in Surface Water Quality

Various DGR Project activities have the potential to interact with surface water quality, including the deposition of air emissions (as discussed in Section 6.2.2.1). How they affect surface water quality, either directly or indirectly, are described in the Hydrology and Surface Water Quality TSD. This indirect interaction is therefore, considered further in Section 7 for the VECs in the South Railway Ditch and Stream C (i.e., redbelly dace, creek chub, brook trout, variable leaf pondweed and benthic invertebrates).

Burrowing crayfish use surface water for reproduction and as such could be affected by a change in surface water quality, thus this indirect interaction is forwarded for further consideration.

All of the developed areas within the Project Area will drain to MacPherson Bay so there is the potential for changes to surface water quality in MacPherson Bay and its VECs (i.e., lake whitefish, spottail shiner, smallmouth bass and benthic invertebrates). Therefore, this indirect interaction is advance for further consideration in Section 7.

6.2.2.5 Changes in Soil Quality

A change in soil quality[5] could affect burrowing crayfish and thus this potential interaction is carried forward for further consideration. There are no other potential interactions between soil quality and the aquatic VECs.

6.2.2.6 Changes in Groundwater Quality

Burrowing crayfish dig burrows to reach the groundwater table. A change in groundwater quality could affect burrowing crayfish and thus this potential interaction is carried forward for further discussion. Changes in groundwater quality can, in turn, affect surface water quality, which has the potential to affect the VECs within the South Railway Ditch and Stream C. This process is captured as an indirect interaction through changes in surface water quality (see Section 6.2.2.4).

6.2.2.7 Changes in Groundwater Flow

Burrowing crayfish dig burrows to reach the groundwater table. Changes to the groundwater level could indirectly interact with burrowing crayfish and this interaction is carried forward to Section 7.

6.3 SUMMARY OF FIRST SCREENING

Table 6.3-1 provides a summary of the initial screening for aquatic environment-DGR Project interactions. Small dots (•) on this matrix represent potential DGR Project-environment interactions involving VECs. These interactions are advanced to Section 7 for a second screening to determine those interactions that may result in a measurable change to the VECs identified for the aquatic environment.

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[5] For the purposes of evaluating the effects of the DGR Project on the aquatic environment, "soil quality" refers collectively to sediment and soil quality.

Table 6.3-1: Matrix 1 – Summary of the First Screening for Potential Interactions with VECs

Project Work and Activity	Redbelly Dace			Creek Chub			Brook Trout		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation		—	—		—	—		—	—
Construction of Surface Facilities	•	—	—	•	—	—		—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—		—	—		—	—	
Abandonment of the DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle	•	•	•	•	•	•			
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibration Levels	•			•			•		
Changes in Surface Water Quantity and Flow	•	•	•	•	•	•	•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality									
Changes in Groundwater Quality									
Changes in Groundwater Flow									

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as no activities that have the potential to interact with the aquatic environment VECs occur during this phase. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
— Activity does not occur during this phase
Blank No potential interaction

Table 6.3-1: Matrix 1 – Summary of the First Screening for Potential Interactions with VECs (continued)

Project Work and Activity	Burrowing Crayfish			Variable Leaf Pondweed			Lake Whitefish		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation	•	—	—		—	—		—	—
Construction of Surface Facilities	•	—	—	•	—	—		—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—	•	—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle	•	•	•	•	•	•			
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibration Levels							•		
Changes in Surface Water Quantity and Flow	•	•	•				•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality	•	•	•						
Changes in Groundwater Quality	•	•	•						
Changes in Groundwater Flow	•	•	•						

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as no activities that have the potential to interact with the aquatic environment VECs occur during this phase. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
— Activity does not occur during this phase
Blank No potential interaction

Table 6.3-1: Matrix 1 – Summary of the First Screening for Potential Interactions with VECs (continued)

Project Work and Activity	Spottail Shiner			Smallmouth Bass			Benthic Invertebrates		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation		—	—		—	—	•	—	—
Construction of Surface Facilities		—	—		—	—	•	—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—		—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle							•	•	•
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibration Levels	•			•					
Changes in Surface Water Quantity and Flow	•	•	•	•	•	•	•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality									
Changes in Groundwater Quality									
Changes in Groundwater Flow									

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as no activities that have the potential to interact with the aquatic environment VECs occur during this phase. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
— Activity does not occur during this phase
Blank No potential interaction

Following the screening of potential DGR Project-environment interactions, it is determined that all VECs have a potential interaction with the DGR Project. Therefore, as summarized in Table 6.3-2, all of the VECs proposed in Table 4-1 are carried forward for further assessment.

Table 6.3-2: Advancement of Aquatic Environment VECs

VEC	Retained?	Rationale
Redbelly Dace	Yes	• Potential change to habitat within the South Railway Ditch • Potential indirect interaction resulting from changes in water quality, and surface water quantity and flow, as well as potential vibration effects as a result of blasting
Creek Chub	Yes	• Potential change to habitat within the South Railway Ditch • Potential indirect interaction resulting from changes in water quality, and surface water quantity and flow, as well as potential vibration effects as a result of blasting
Brook Trout	Yes	• Potential indirect interaction resulting from changes in surface water quality and surface water quantity and flow in Stream C, as well as potential vibration effects as a result of blasting
Variable Leaf Pondweed	Yes	• Potential change to habitat within the South Railway Ditch • Potential indirect interaction resulting from changes in surface water quality
Burrowing Crayfish	Yes	• Potential change to habitat within North and South Railway Ditch and other parts of the Project Area • Potential indirect interaction attributed to change in surface water quantity and flow, surface water quality, groundwater flow, groundwater quality, and soil quality
Lake Whitefish	Yes	• Potential indirect interaction attributed to change in surface water quality and surface water quantity and flow input to MacPherson Bay, as well as potential vibration effects as a result of blasting
Spottail Shiner	Yes	• Potential indirect interaction attributed to change in water quality and surface water quantity and flow input to MacPherson Bay • Potential indirect interaction resulting from changes in surface water quantity and flow in Stream C • Potential indirect interaction resulting from potential vibration effects as a result of blasting

Table 6.3-2: Advancement of Aquatic Environment VECs (continued)

VEC	Retained?	Rationale
Smallmouth Bass	Yes	• Potential indirect interaction attributed to change in surface water quality and surface water quantity and flow input to MacPherson Bay, as well as potential vibration effects as a result of blasting
Benthic Invertebrates	Yes	• Potential interaction with habitat in the North and South Railway Ditches, and other locations within the Project Area • Potential indirect interaction attributed to change in surface water quality and surface water quantity and flow

7. SECOND SCREENING OF PROJECT-ENVIRONMENT INTERACTIONS

The second screening considers the DGR Project works and activities advanced from Section 6 to determine if the identified interactions are likely to cause a measurable change to the aquatic environment VECs.

7.1 SECOND SCREENING METHODS

Each of the potential interactions identified in the first screening is evaluated to determine those likely to result in a measurable change in the environment. For the purposes of the assessment, a measurable change in the environment is defined as a change that is real, observable or detectable compared with existing conditions.

To determine likely direct measurable changes, a judgement is made using qualitative and quantitative information, as available.

For potential indirect changes, a measurable change is considered possible if there is a likely adverse effect identified on the other VEC in question (e.g., there could be a measurable change on brook trout if there is a likely adverse effect on surface water quality [a VEC in the Hydrology and Surface Water Quality TSD] in Stream C). In turn, if an adverse effect is likely for an aquatic VEC, that effect may indirectly interact with VECs in other TSDs (e.g. adverse effect on redbelly dace may affect midland painted turtle as fish are part of their diet).

For the purposes of the aquatic environment assessment, each of the DGR Project works and activities found to have potential interactions with the VECs are screened further by reviewing the likelihood of measurable changes to VECs associated with each of the DGR Project phases considered in this assessment. Where DGR Project-environment interactions are considered likely to result in measurable changes, they are advanced for detailed assessment in Section 8.

A predicted change that is trivial, negligible or indistinguishable from baseline conditions is not considered measurable. A likely measurable change to a VEC is marked with a '■' on Matrix 2 (Section 7.6).

7.2 VECS IN THE SOUTH RAILWAY DITCH

7.2.1 Direct Changes

The following works and activities are screened to determine likely measurable changes in relation to the VECs in the South Railway Ditch:

- construction of surface facilities; and
- support and monitoring of DGR life cycle.

A crossing will be built across the North and South Railway Ditches to allow for access from the WWMF to the DGR Project as part of the construction of surface facilities activity. The proposed crossing will be situated on a fill embankment over the ditches and abandoned rail bed. Culverts will be used to accommodate the existing water flow in the railway ditches. There will be removal of some riparian vegetation from the banks of the South Railway Ditch during the construction of the rail bed crossing. The construction of the crossing will disturb an area of approximately 100 m² in the South Railway Ditch. The removal of riparian vegetation causes a measurable change to the habitat in the South Railway Ditch and, therefore, to its associated VECs (redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish and benthic invertebrates).

The regular maintenance of the drainage ditches (support and monitoring of the DGR life cycle) will include dredging to extract plant materials from the ditches to permit efficient flow. This activity will occur within ditches constructed as part of the DGR Project stormwater management system only and thus will not produce a measurable change to the habitat of any of the aquatic VECs in the South Railway Ditch. No further consideration is warranted.

Based on the above screening, direct measurable changes to habitat in the South Railway Ditch are predicted and, in turn, measurable changes to redbelly dace, creek chub, burrowing crayfish, variable leaf pondweed and benthic invertebrates are predicted. These likely measurable changes are advanced for further consideration.

7.2.2 Indirect Changes

7.2.2.1 Changes in Vibration Levels

As described in Section 6.2.2, aquatic VECs may be affected by blasting activities during construction. Appendix I of the Atmospheric Environment TSD includes predictions of vibration levels at locations in the Site Study Area. Controlled blasting will be used for shaft sinking and underground development. The DFO Guidelines state that the no explosive may be used that produces or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during egg incubation [30]. These guidelines apply to blasting in water; however, it can be assumed that they can be applied conservatively in this situation. The South Railway Ditch is the aquatic habitat nearest where blasting will occur and is located 150 m or more from both the ventilation shaft and the main shaft (main areas of blasting). The predicted maximum ground vibration during shaft sinking is predicted to be 8.4 mm/s. Therefore, no measurable change to the aquatic habitat and VEC species supported in the South Railway Ditch from blasting are predicted. Accordingly, no further consideration is warranted.

7.2.2.2 Changes in Surface Water Quality

Surface runoff and underground sump water from the DGR Project will be directed to the stormwater management pond. The stormwater pond will discharge via a controlled output into the existing drainage ditch network, which drains northwest under Interconnecting Road to MacPherson Bay. No changes in surface water quality in the South Railway Ditch are identified in the Hydrology and Surface Water Quality TSD. Therefore, there is no indirect effect resulting in measurable changes to aquatic environment VECs.

7.3 VECS IN STREAM C

7.3.1 Direct Changes

There are no potential direct interactions identified with Stream C and its associated VECs as a result of the DGR Project. Accordingly, no further consideration is warranted.

7.3.2 Indirect Changes

7.3.2.1 Changes in Vibrations

As described in Section 7.2.2.1, aquatic VECs may be affected by blasting activities during construction. Stream C is located 1.2 km or more from the ventilation and main shafts (main areas of blasting). Therefore, even with a charge of 20 kg, the setback distance between the blasting and the aquatic habitat within Stream C is far enough to protect aquatic life. Therefore, no measurable change to the aquatic habitat and VEC species supported in Stream C from blasting are predicted. Accordingly, no further consideration is warranted.

7.3.2.2 Changes in Surface Water Quantity and Flow

Changes in surface water quantity and flow were identified as a potential interaction with the VECs in Stream C. As described in the Hydrology and Surface Water Quality TSD, there will be a diversion of flow from the Stream C catchment to MacPherson Bay. The purpose of this diversion is to avoid the discharge of potentially contaminated stormwater into the more sensitive coldwater habitat of the Stream C catchment and to ensure the collection of the surface runoff and drainage from the DGR Project in a stormwater management pond prior to discharge to an existing ditch that outlets to MacPherson Bay.

The change in drainage area will affect flow in Stream C. Based on the hydrological analysis presented in the Hydrology and Surface Water Quality TSD, the predicted decrease in flow in Stream C is 0.8%. This predicted change in flow in Stream C is difficult to distinguish from natural variability and is not considered to be measurable from an ecological perspective (i.e., no change in aquatic habitat in Stream C). Therefore, this indirect interaction is not considered further.

7.3.2.3 Changes in Surface Water Quality

Changes in surface water quality were identified as a potential interaction with the VECs in Stream C. As described in the Hydrology and Surface Water Quality TSD predicted changes in surface water quality in Stream C for total suspended solids and nitrates. Increases in total suspended solids are predicted to be less than the method detection limit. Increases in nitrate in Stream C are predicted to be less than 0.05 μg/L, which is well below the Canadian Water Qaulity Guidelines for the Protection of Aqautic Life for nitrate of 13 mg/L [31]. Therefore, there are no likely measurable changes on aquatic VECs in Stream C.

7.4 VECS IN LAKE HURON AND THE EMBAYMENTS

7.4.1 Direct Changes

No project works or activities are planned in these areas; therefore, there are no direct interactions between VECs within Lake Huron or the embayments and the DGR Project works and activities. This screening is documented in Section 6.

7.4.2 Indirect Changes

Previously in this report, potential effects have been discussed in relation to the broad habitat area called Lake Huron and the embayments, including MacPherson Bay, Baie du Doré and Lake Huron in general. However, it is important to clarify that the discussion of indirect effects is focussed on MacPherson Bay as it is the immediate receiving environment. If an environmental change is not measurable in MacPherson Bay, it will not be measurable in Lake Huron. While Stream C discharges to Baie du Doré, as noted in Section 7.3, no measurable changes to Stream C are likely to occur as a result of the DGR Project.

7.4.2.1 Changes in Vibrations

As described in Section 7.2.2.1, aquatic VECs may be affected by blasting activities during construction. MacPherson Bay is located at least 1 km from the ventilation and main shafts (main areas of blasting). Therefore, even with a charge of 20 kg, the setback distance between the blasting and the aquatic habitat within MacPherson Bay is far enough to protect aquatic life. Therefore, no measurable change to the aquatic habitat and VEC species supported in MacPherson Bay (and Lake Huron) from blasting are predicted. Accordingly, no further consideration is warranted.

7.4.2.2 Changes in Surface Water Quality

Changes in surface water quality are predicted in the Hydrology and Surface Water Quality TSD. The stormwater management system will discharge to Lake Huron, via an existing drainage ditch at Interconnecting Road. Stormwater pond discharge water will be sampled and compared against predetermined criteria (as described in the Hydrology and Surface Water Quality TSD). Provided that the criteria are met, no measurable changes to surface water quality are expected from the DGR Project in MacPherson Bay. Therefore, no changes to the aquatic VECs in MacPherson Bay are likely and no further consideration is warranted.

7.4.2.3 Changes in Surface Water Quantity and Flow

As described in the Hydrology and Surface Water Quality TSD, there will be a diversion of flow from the Stream C catchment to MacPherson Bay. Flow in the drainage ditch at Interconnecting Road (see Figure 5.1.2-1) is predicted to increase by 114% during construction and 61% during operations. This increase in flow is not likely to be measurable at the discharge to MacPherson Bay. Because of the nature of the habitat within MacPherson Bay (exposed to wind and wave action and therefore mixes readily with lake water) and its extent (approximately 40 ha), the increase in surface flows is not expected to result in a detectable alteration in the habitat.

Therefore, a measurable change to the VECs within MacPherson Bay is not likely, and no further consideration is warranted.

7.5 VECs IN OTHER AQUATIC HABITATS

7.5.1 Direct Changes

The site preparation and construction of surface facilities and decommissioning works and activities are screened for measurable changes in relation to the VECs in the other potential aquatic habitat in the Project Area (i.e.,. burrowing crayfish, benthic invertebrates).

The footprint of the surface facilities (DGR Project site) minimally encroaches upon burrowing crayfish habitat (Figure 5.3.1-1) and there will be a loss of a small area at the proposed abandoned rail bed crossing (area slightly wider than 20 m will be disturbed on either side of the North and South Railway Ditch). Burrowing crayfish were not found to be using the chimneys in this area when burrowing crayfish habitat use surveys were conducted (Section 5.1.2), so the construction is not expected to result in crayfish mortality [16]. Nonetheless, crayfish have used this area at some point and constructing the crossing from the WWMF to the DGR represents a direct measurable change to habitat in the North and South Railway Ditches and a loss of burrowing crayfish habitat. Therefore, there is a measurable change to burrowing crayfish, which is advanced for detailed assessment.

During decommissioning of the DGR Project, the surface facilities will be removed and the site re-vegetated. The re-vegetated/re-naturalized site will cause a likely measurable change to habitat for the burrowing crayfish at the DGR Project site, particularly in low lying areas. This measurable change is advanced for detailed assessment.

Site preparation and construction of the surface facilities will result in the loss of benthic invertebrate habitat in the North Railway Ditch and along the abandoned rail spur in the western portion of the Project Area. This loss represents a small portion of the benthic invertebrate habitat available within the Project Area. It is likely that this change would not be measurable and would be bound by the measurable change in the South Railway Ditch (see Section 7.2). Therefore, this interaction is not considered further.

7.5.2 Indirect Changes

7.5.2.1 Changes in Surface Water Quantity and Flow

Burrowing crayfish reproduce in open surface waters and as such may be using the North Railway Ditch for this purpose. The Hydrology and Surface Water Quality TSD predicts a 31% decrease in flow in the North Railway Ditch. However, the North Railway Ditch is often dry and does not provide high quality or quantity breeding habitat for crayfish. Therefore, a change in the quantity of surface water in marginal crayfish habitat is not expected to produce a measurable change in the burrowing crayfish population and is not considered further.

7.5.2.2 Changes in Surface Water Quality

No changes in surface water quality in the marsh or North Railway Ditch are identified in the Hydrology and Surface Water Quality TSD, thus there is no indirect effect that could measurably change burrowing crayfish and benthic invertebrates.

7.5.2.3 Changes in Soil Quality

As burrowing crayfish spend the majority of their life stages in contact with the soil, a change in the soil could affect them. As described in the Geology TSD, no adverse effects are identified for soil quality. Similarly, no adverse effects were identified to sediments in the Hydrology and Surface Water Quality TSD. Therefore, no further consideration of this pathway is warranted.

7.5.2.4 Changes in Groundwater Quality

The first screening for indirect project-environment interactions identified that a change in groundwater quality could interact with the habitat of burrowing crayfish. Analysis completed in the Geology TSD indicates that the change in groundwater quality resulting from the DGR Project would not be measurable at any of the aquatic habitats in the Site Study Area. As a result, a measurable change in groundwater quality at the burrowing crayfish habitats in the Site Study Area is not expected. No measurable change to the VECs is identified, and no further consideration is warranted.

7.5.2.5 Changes in Groundwater Flow

Changes in groundwater flow could indirectly interact with burrowing crayfish by changing the groundwater levels. Analysis completed in the Geology TSD indicates that the change in groundwater level caused by the excavation and construction of the underground facilities would not be measurable at any of the aquatic habitats in the Site Study Area. Therefore, no measurable changes to burrowing crayfish are identified through this pathway and no further consideration is warranted.

7.6 SUMMARY OF THE SECOND SCREENING

Table 7.6-1 provides a summary of the second screening for the DGR Project. Squares (■) on this matrix represent DGR Project-environment interactions that are predicted to result in a likely measurable change to VECs identified for the aquatic environment. These measurable changes are advanced to Section 8 for detailed assessment.

Table 7.6-1: Matrix 2 – Summary of the Second Screening for Measurable Change to VECs

Project Work and Activity	Redbelly Dace			Creek Chub			Brook Trout		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation		—	—		—	—		—	—
Construction of Surface Facilities	■	—	—	■	—	—		—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—		—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle	•	•	•	•	•	•			
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibrations	•			•			•		
Changes in Surface Water Quantity and Flow	•	•	•	•	•	•	•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality									
Changes in Groundwater Quality									
Changes in Groundwater Flow									

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as there are no activities during this phase that have the potential to interact with the aquatic environment VECs. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
■ Measurable change
— Activity does not occur during this phase
Blank No potential interaction

Table 7.6-1: Matrix 2 – Summary of the Second Screening for Measurable Change to VECs (continued)

Project Work and Activity	Burrowing Crayfish			Variable Leaf Pondweed			Lake Whitefish		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation	■	—	—		—	—		—	—
Construction of Surface Facilities	■	—	—	■	—	—		—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—	■	—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle	•	•	•	•	•	•			
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibrations							•		
Changes in Surface Water Quantity and Flow	•	•	•				•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality	•	•	•						
Changes in Groundwater Quality	•	•	•						
Changes in Groundwater Flow	•	•	•						

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as there are no activities during this phase that have the potential to interact with the aquatic environment VECs. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
■ Measurable change
— Activity does not occur during this phase
Blank No potential interaction

Table 7.6-1: Matrix 2 – Summary of the Second Screening for Measurable Change to VECs (continued)

Project Work and Activity	Spottail Shiner			Smallmouth Bass			Benthic Invertebrates		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation		—	—		—	—	•	—	—
Construction of Surface Facilities		—	—		—	—	■	—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—		—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle							•	•	•
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibrations	•			•					
Changes in Surface Water Quantity and Flow	•	•	•	•	•	•	•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality									
Changes in Groundwater Quality									
Changes in Groundwater Flow									

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as there are no activities during this phase that have the potential to interact with the aquatic environment VECs. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
■ Measurable change
— Activity does not occur during this phase
Blank No potential interaction

Table 7.6-2 summarizes the results of the second screening by VEC. Only VECs present in the South Railway Ditch were carried forward for assessment.

Table 7.6-2: Advancement of Aquatic Environment VECs Following Second Screening

VEC	Retained?	Rationale
Redbelly Dace	Yes	• Measurable change to habitat in South Railway Ditch during construction of surface facilities
Creek Chub	Yes	• Measurable change to habitat in South Railway Ditch during construction of surface facilities
Brook Trout	No	• No measurable changes identified; not considered further
Variable Leaf Pondweed	Yes	• Measurable change to habitat within the South Railway Ditch during construction of surface facilities
Burrowing Crayfish	Yes	• Measurable change to habitat in South Railway Ditch and other habitat in the Project Area during site preparation and construction of surface facilities • Measurable change to habitat for the burrowing crayfish in the Project Area during decommissioning of the DGR Project
Lake Whitefish	No	• No measurable changes identified; not considered further
Spottail Shiner	No	• No measurable changes identified; not considered further
Smallmouth Bass	No	• No measurable changes identified; not considered further
Benthic Invertebrates	Yes	• Measurable change to habitat of South Railway Ditch during construction of surface facilities

8. IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL EFFECTS

The assessment of effects predicts and describes the likely environmental effects, mitigation measures and residual adverse effects on the aquatic environment VECs that could reasonably be expected as a result of the DGR Project.

8.1 ASSESSMENT METHODS

8.1.1 Identify Likely Environmental Effects

All measurable changes identified in the second screening (Section 7) are advanced for assessment, within the framework of the applicable VECs. Consistent with accepted EA practice, quantitative and qualitative methods, including professional expertise and judgement, are used to predict and describe the project-specific effects.

If a likely environmental effect is identified, the effect is assessed as either beneficial or adverse. Any adverse effects on VECs attributable to the DGR Project are advanced for consideration of possible mitigation measures. Beneficial effects, if any, are also identified during this step and marked with a '+' on the matrix, but are not considered further. The results of the assessment are recorded in Matrix 3 (Section 8.6).

The threshold used for aquatic environment interactions to determine whether the change is an adverse effect is whether the change results in the loss or degradation of habitat available to the VEC.

8.1.2 Consider Mitigation Measures

When the assessment indicates that an adverse effect on one of the aquatic environment VECs is likely, technically and economically feasible mitigation measures are proposed to address the identified effect.

8.1.3 Identify Residual Effects

Once mitigation measures are proposed, the likely adverse effect is re-evaluated with the mitigation measures in place to identify any residual adverse effects. If a residual adverse effect on a VEC is identified, it is marked with a '◆' on Matrix 3 (Section 8.6). Residual adverse effects, if any, are advanced to Section 11 for an assessment of significance.

8.2 VECS IN THE SOUTH RAILWAY DITCH

8.2.1 Linkage Analysis

The evaluation of the effects of the DGR Project on VECs in the South Railway Ditch (redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish, benthic invertebrates) uses changes in habitat to measure direct and indirect project effects.

The construction of the crossing over the abandoned rail bed (construction of surface facilities) was identified as resulting in direct measurable changes to the VECs in the South Railway Ditch during the site preparation and construction phase of the Project. No indirect effects were advanced from the second screening.

The aquatic environment VECs may affect other environmental components (Figure 2.1-2). These are assessed as indirect effects in the Terrestrial Environment, Socio-economic Environment and Aboriginal Interests TSDs and the EIS.

8.2.2 In-design Mitigation

The rail bed crossing will minimize effects on the South Railway Ditch through incorporation of appropriate design features (e.g., embedded culvert for fish passage), specific mitigation measures (e.g., management of surface water runoff) and best management practices (e.g. erosion and sediment control) both during and after construction. Timing of the construction of the abandoned rail bed crossing will take place according to the DFO Operational Statement-Timing Windows. This ensures that critical life history stages such as spawning activities are protected by restricting the conduct of works or undertakings in and around water at certain times of the year. The South Railway Ditch contains a warm water fish community and generally, the warm water timing window begins July 1 and ends March 31. However, the Saugeen Valley Conservation Authority has made a specific recommendation for this particular construction work of an ‘in-water’ timing window of July 1 to September 30 [32].

8.2.3 Direct Effects

The crossing over the South Railway Ditch will cause a change in habitat in a localized area. The abandoned rail bed crossing consists of the placement of a 20 m long culvert in-stream, which will cover approximately 100 m^2 of in-stream habitat. There will be an increase in channel shading in a localized area and elimination of the riparian vegetation for a 20 m section of the banks. Although the culvert will allow for fish passage, it will lack organic inputs from riparian vegetative sources and will not contain much aquatic plant growth because of the low light conditions. Therefore, this will no longer be a productive reach of the South Railway Ditch. Consequently, the construction of the rail bed crossing across the South Railway Ditch will adversely affect the habitat of redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish and benthic invertebrates in that there is a degradation of their non-critical habitat (does not contain spawning or rearing/nursery areas). Mitigation is discussed, below.

8.2.4 Additional Mitigation Measures

The application of standard measures to protect fish and fish habitat in the South Railway Ditch during the construction of the crossing is recommended. These mitigation measures include:

- Install effective sediment and erosion control measures before starting work to prevent silt/sediment laden runoff from directly entering the water in the South Railway Ditch. Inspect them regularly during the course of construction and make necessary repairs if damage occurs.
- Operate machinery on land and in a manner that minimizes disturbance to the banks of the South Railway Ditch. Machinery should arrive on-site in a clean condition and should be maintained free of fluid leaks. Wash, refuel and service machinery and store fuel and

other materials for the machinery away from the water to prevent any deleterious substance from entering the water. Keep an emergency spill kit on-site in case of fluid leaks or spills from machinery.

- Use measures to prevent deleterious substances such as new concrete (i.e., it is pre-cast, cured and dried before use near the watercourse), grout, paint and preservatives from entering the watercourse.
- Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the disturbed area should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring.
- Isolate and dewater the section of the South Railway Ditch wherein the culvert will be placed. Prior to dewatering the work area, fish salvage and relocation will be conducted so as to avoid harming any fish during construction.

8.2.5 Residual Adverse Effects

The standard mitigation measures recommended above will be applied to the construction works and activities within the South Railway Ditch to limit adverse effects to the aquatic environment in the South Railway Ditch and further downstream. However, the alteration of the habitat within the South Railway Ditch because of the placement of the instream culvert and its associated effects described in Section 7.2.1 is a permanent change to the habitat of redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish and benthic invertebrates. Accordingly, there is a residual adverse effect to these VECs in the South Railway Ditch. These residual adverse effects are evaluated for significance in Section 11.

8.3 VECS IN STREAM C

No measurable changes to VECs in Stream C were identified in Section 7. Therefore, no further consideration is warranted.

8.4 VECS IN LAKE HURON AND EMBAYMENTS

No measurable changes to VECs in Lake Huron and the embayments were identified in Section 7. Therefore, no further consideration is warranted.

8.5 VECS IN OTHER AQUATIC HABITAT

8.5.1 Linkage Analysis

The evaluation of the effects of the DGR Project on VECs in other potential aquatic habitat in the Project Area (i.e., burrowing crayfish) used changes in habitat to identify likely direct and indirect project-related effects.

Site preparation activities and construction of the rail bed crossing are identified as resulting in a measurable change to the burrowing crayfish VEC. Decommissioning is also identified as having a likely measurable change on burrowing crayfish. No indirect effects were identified that could affect burrowing crayfish.

8.5.2 In-design Mitigation

Burrowing crayfish species included as VECs require clay soils for the construction of chimneys, in which they can burrow down to the groundwater table. Conditions appear to be suitable for burrowing crayfish in most of the moist, low-lying portions of the Project Area and Site Study Area. Therefore, although the design of the project successfully avoids most of the identified crayfish habitat in the Project Area, including protection of the marsh in the northeast portion of the Project Area, some burrowing crayfish could be disturbed. Since the majority of the existing burrowing crayfish habitat will be unchanged by the DGR Project, affected individuals may relocate to more favourable conditions.

8.5.3 Direct Effects

The construction of the crossing over the abandoned rail bed and other surface infrastructure will result in the loss of a small portion of burrowing crayfish habitat (approximately 100 m^2 along the North Railway Ditch), as well as other ditches and the abandoned railway spur in the western portion of the Project Area. This loss represents approximately 0.01% of the burrowing crayfish habitat available within the Project Area under the existing conditions. Although chimneys are located in this area, crayfish were not captured in the traps at these locations (Figure 5.3.1-1) [16]. Because burrowing crayfish were not found to be using the chimneys in the DGR Project site during the field studies conducted in both 2006 and 2009, the construction is not expected to result in crayfish mortality.

Re-vegetation of the DGR Project site during decommissioning may have a beneficial effect on the burrowing crayfish through a potential increase in available habitat. However, no credit has been assumed for this change, and it is not considered further in this TSD.

8.5.4 Additional Mitigation Measures

There are no additional feasible mitigation measures beyond those in-design measures identified in Section 8.5.2.

8.5.5 Residual Adverse Effects

Since burrowing crayfish habitat will be lost as part of the site preparation and the construction of surface facilities works and activities, a residual adverse effect on this VEC is identified. This effect on burrowing crayfish is advanced for an evaluation of its significance in Section 11.

8.6 SUMMARY OF ASSESSMENT

Table 8.6-1 provides a summary of the third screening for the DGR Project. Diamonds (◆) on this matrix represent likely DGR Project-environment interactions resulting in a residual adverse effect on VECs. These interactions are advanced to Section 11 for an evaluation of their significance.

8.6.1 Application of Precautionary Approach in the Assessment

Aquatic species depend on the conditions within their aquatic habitats albeit they have different tolerances to changes in those conditions. For the aquatic assessment, conservatism is built in using a bounding assessment approach, grouping the VECs by habitat and using the assumption that effects are likely to occur to all VECs in a particular habitat.

8.6.2 Application of Traditional Knowledge in the Assessment

In the Aquatic Environment TSD, Aboriginal traditional knowledge and traditional ecological knowledge has been built into the assessment, where available. Some of the VECs chosen (e.g., lake whitefish) are important to Aboriginal communities and were considered explicitly in the effects assessment. No other input from Aboriginal peoples was available relative to the aquatic environment at the time this report was prepared.

8.6.3 Cumulative Effects

Effects of the DGR Project have the potential to act cumulatively with those of other projects. The EIS Guidelines require that the EA considers the cumulative effects of past, present and reasonably foreseeable future projects. The description of the existing environmental conditions presented in Section 5 includes the cumulative effects of past and existing projects. The assessment completed in Section 8 considers the effects of the DGR Project in combination with those of past and present projects.

Residual adverse effects on burrowing crayfish, creek chub, redbelly dace, benthic invertebrates and variable leaf pondweed are expected to occur during the site preparation and construction phase. The potential for cumulative effects associated with the residual adverse effect on aquatic environment VECs with past, present and reasonably foreseeable future projects is presented in Section 10 of the EIS.

Table 8.6-1: Matrix 3 – Summary of the Third Screening for Residual Adverse Effects on VECs

Project Work and Activity	Redbelly Dace			Creek Chub			Brook Trout		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation		—	—		—	—		—	—
Construction of Surface Facilities	◆	—	—	◆	—	—		—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—		—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle	•	•	•	•	•	•			
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibrations	•			•			•		
Changes in Surface Water Quantity and Flow	•	•	•	•	•	•	•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality									
Changes in Groundwater Quality									
Changes in Groundwater Flow									

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning and Abandonment Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as there are no activities during this phase that have the potential to interact with the aquatic environment VECs. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
■ Measurable change
◆ Residual adverse effect
— Activity does not occur during this phase
Blank No potential interaction

Table 8.6-1: Matrix 3 – Summary of the Third Screening for Residual Adverse Effects on VECs (continued)

Project Work and Activity	Burrowing Crayfish			Variable Leaf Pondweed			Lake Whitefish		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation	◆	—	—		—	—		—	—
Construction of Surface Facilities	◆	—	—	◆	—	—		—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—	■	—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle	•	•	•	•	•	•			
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibrations							•		
Changes in Surface Water Quantity and Flow	•	•	•				•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality	•	•	•						
Changes in Groundwater Quality	•	•	•						
Changes in Groundwater Flow	•	•	•						

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning and Abandonment Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.

The abandonment and long-term performance phase is not included in the matrix as there are no activities during this phase that have the potential to interact with the aquatic environment VECs. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
■ Measurable change
◆ Residual adverse effect
— Activity does not occur during this phase
Blank No potential interaction

Table 8.6-1: Matrix 3 – Summary of the Third Screening for Residual Adverse Effects on VECs (continued)

Project Work and Activity	Spottail Shiner			Smallmouth Bass			Benthic Invertebrates		
	C	O	D	C	O	D	C	O	D
Direct Effects									
Site Preparation		—	—		—	—	■	—	—
Construction of Surface Facilities		—	—		—	—	◆	—	—
Excavation and Construction of Underground Facilities		—	—		—	—		—	—
Above-ground Transfer of Waste	—		—	—		—	—		—
Underground Transfer of Waste	—		—	—		—	—		—
Decommissioning of the DGR Project	—	—		—	—		—	—	
Abandonment of DGR Facility	—	—		—	—		—	—	
Presence of the DGR Project									
Waste Management									
Support and Monitoring of DGR Life Cycle							•	•	•
Workers, Payroll and Purchasing									
Indirect Effects									
Changes in Air Quality									
Changes in Vibrations	•			•					
Changes in Surface Water Quantity and Flow	•	•	•	•	•	•	•	•	•
Changes in Surface Water Quality	•	•	•	•	•	•	•	•	•
Changes in Soil Quality									
Changes in Groundwater Quality									
Changes in Groundwater Flow									

Notes:
C = Site Preparation and Construction Phase
O = Operations Phase
D = Decommissioning and Abandonment Phase
The matrices are meant to indicate when the effect occurs and do not imply how long the effect will last. The duration of the effect is assessed in Section 11.
The abandonment and long-term performance phase is not included in the matrix as there are no activities during this phase that have the potential to interact with the aquatic environment VECs. The abandonment of the DGR facility work and activity occurs immediately following decommissioning within the decommissioning phase and does not encompass the entirety of the abandonment and long-term performance phase.

• Potential project-environment interaction
■ Measurable change
◆ Residual adverse effect
— Activity does not occur during this phase
Blank No potential interaction

9. EFFECTS OF THE ENVIRONMENT ON THE PROJECT

9.1 ASSESSMENT METHODS

The EA must include a consideration of how the environment could adversely affect the DGR Project. For example, the EA evaluates how hazards such as flooding are likely to affect the DGR Project. This assessment was accomplished using the method illustrated on Figure 9.1-1. First, potential conditions in the environment that may affect the DGR Project are identified. Then, the level of effect these environmental conditions could have on the DGR Project is evaluated based on past experience at the site and professional judgement of the study team. The assessment of effects of the environment on the DGR Project focuses on those conditions associated with the aquatic environment. For each environmental condition that could potentially affect the DGR Project, the mitigation measures incorporated into the project design are identified and evaluated for effectiveness. This evaluation is based on the available data, and the experience and judgement of the study team.

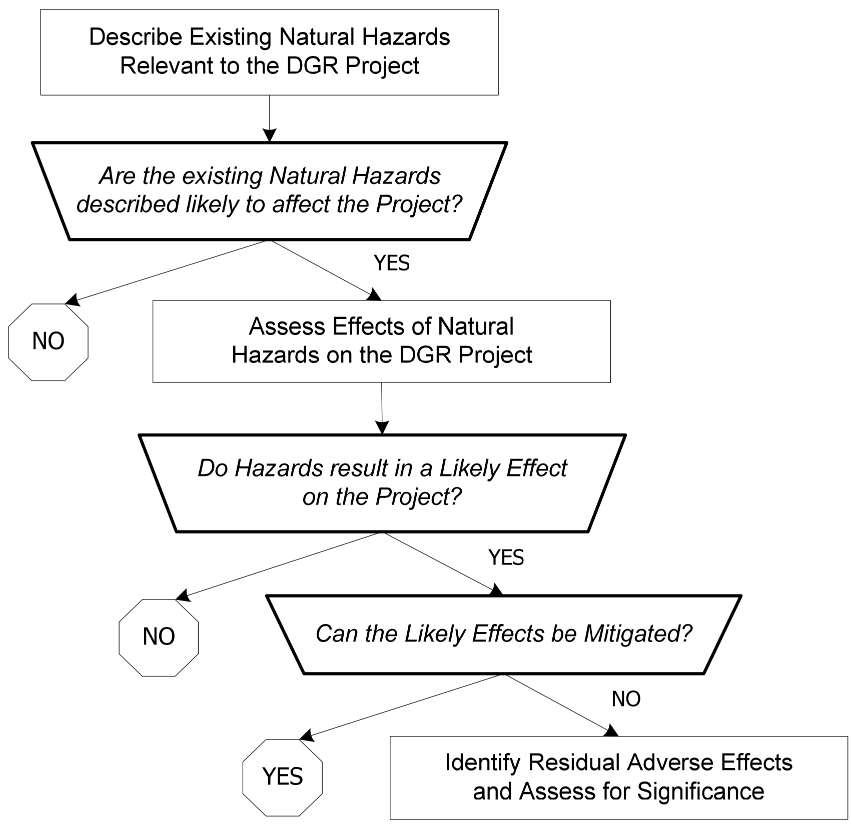

Figure 9.1-1: Method to Assess Effects of the Environment on the DGR Project

Identified residual adverse effects, if any, are then advanced to Section 11 for an assessment of significance.

9.2 ASSESSMENT OF EFFECTS OF THE CURRENT AQUATIC ENVIRONMENT ON THE DGR PROJECT

The DGR Project will not be affected by the aquatic environment VECs as there are no possible pathways or mechanisms through which aquatic species can interact with the works and activities of DGR Project. In addition, the timing windows that the Saugeen Valley Conservation Authority has proposed for 'in-water' work (i.e., construction of the crossing from the WWMF to the DGR Project site) are not sufficiently restrictive to adversely affect the project schedule.

9.3 SUMMARY

No effects of the aquatic environment on the DGR Project are identified, and no further consideration is warranted.

10. CLIMATE CHANGE CONSIDERATIONS

The guidelines require a consideration of whether the DGR Project and EA conclusions are sensitive to changes in climatic conditions. In this TSD, climate change is considered over the life of the DGR Project spanning the site preparation and construction, operations, and decommissioning phases only. Shifts in climate that occur from one epoch to the next have been considered as part of the Postclosure Safety Assessment [2], and their effects on the DGR Project are described in Section 9 of the EIS.

The requirement of the guidelines to consider climate change is addressed through the following considerations:

1: How will the future environment affect the DGR Project?
2: How will the DGR Project affect the future environment?
3: How will the DGR Project affect climate change (e.g., contribution to climate change by the emission of greenhouse gases)?

The methods used to consider the effects of climate change are described in the following sections. Establishing how the climate may change over the life of the DGR Project is an initial requirement for addressing the first two considerations. A determination of how climate has been changing and how it might change over the DGR Project life considered in this TSD is based on 30-year climate normals, literature review and the professional experience of the study team. The climate models used to predict high, medium and low climate change scenarios for the Regional Study Area are described in the Atmospheric Environment TSD. These predicted climate change scenarios are used by all environmental disciplines for the assessment of the consequences of climatic conditions in relation to the first two considerations identified above.

10.1 DESCRIPTION OF PREDICTED CHANGES IN CLIMATE

Climate represents the long-term expected values for parameters such as temperature, precipitation and winds. The climate of an area is described using normals, which are averages calculated over a 30 year period (the latest accepted normals period is from 1971 to 2000) [33]. It is now widely accepted that climate is changing; therefore, consideration of these changes needs to be incorporated in the EA carried out for the DGR Project through to the end of the decommissioning phase. Traditionally, scientists looked to past weather records to provide guidance for predicting future conditions. Historic climate trends for the DGR Project are determined using the temperature archives observed at Wiarton Airport over the period from 1971 through 2000. While past trends have traditionally been used to provide guidance to the future, reliance is shifting to global climate models, which incorporate accepted understandings of climate mechanisms and standardized scenarios reflecting potential human development in the future.

Tables 10.1-1 and 10.1-2 provide a summary of the past and future trends for temperature and precipitation, respectively. The tables describe how climate in the region has been changing, as well as how it is projected to change over the life of the DGR Project through to the end of the decommissioning phase. These data will be used to evaluate how climate change may affect the conclusions reached regarding the assessment of the effects of the DGR Project on the selected VECs. The Atmospheric Environment TSD provides further details on the predicted changes in climate.

Table 10.1-1: Historic and Future Temperature Trends

Criteria	1971-2000 Normals (°C)	1971-2000 Trend (°C/decade)	2011-2040 Forecast (°C/decade)			2041-2070 Forecast (°C/decade)			2071-2100 Forecast (°C/decade)		
			Low	Average	High	Low	Average	High	Low	Average	High
Annual	6.1	+0.31	+0.00	+0.41	+1.05	+0.15	+0.34	+0.66	+0.20	+0.33	+0.51
Spring	4.5	+0.50	+0.00	+0.45	+1.09	+0.14	+0.35	+0.69	+0.19	+0.34	+0.54
Summer	17.4	+0.26	+0.00	+0.43	+1.10	+0.15	+0.34	+0.69	+0.21	+0.34	+0.52
Fall	8.3	+0.05	+0.00	+0.36	+1.02	+0.12	+0.30	+0.63	+0.19	+0.32	+0.49
Winter	-5.7	+0.68	+0.00	+0.40	+0.99	+0.16	+0.33	+0.63	+0.21	+0.33	+0.50

Note:
The low and high data correspond to the forecasts for the scenario with the smallest and largest respective changes in temperature for each forecast horizon. The average represents the arithmetic average of the available forecasts. Refer to Appendix D of the Atmospheric Environment TSD for the derivation of climate data

Table 10.1-2: Historic and Future Precipitation Trends

Season	1971-2000 Normals (mm)	1971-2000 Trend (mm/decade)	2011-2040 Forecast (%/decade)			2041-2070 Forecast (%/decade)			2071-2100 Forecast (%/decade)		
			Low	Average	High	Low	Average	High	Low	Average	High
Annual	1,041.3	+0.13%	+0.00%	+1.44%	+3.57%	+0.36%	+1.11%	+2.09%	+1.39%	+1.30%	+2.25%
Spring	216.8	+3.23%	+0.00%	+2.59%	+5.39%	+0.62%	+1.51%	+2.72%	+1.88%	+2.24%	+4.05%
Summer	230.8	-0.51%	+0.00%	-1.65%	-3.40%	-0.95%	-1.13%	-0.42%	-0.68%	-0.85%	-0.61%
Fall	310.9	+4.41%	+0.00%	+2.09%	+4.35%	+2.28%	+1.67%	+2.75%	+2.11%	+1.65%	+1.85%
Winter	282.8	-4.65%	+0.00%	+2.39%	+7.30%	-0.27%	+1.82%	+3.08%	+2.05%	+1.92%	+3.32%

Note:
The low and high data correspond to the forecasts for the scenario with the smallest and largest respective changes in temperature for each forecast horizon. The average represents the arithmetic average of the available forecasts. Refer to Appendix D of the Atmospheric Environment TSD for the derivation of climate data

10.2 EFFECTS OF THE FUTURE ENVIRONMENT ON THE DGR PROJECT

10.2.1 Methods

Changes to the climate are predicted to occur over the lifetime of the DGR Project; therefore, it is also necessary to assess how the predicted future environment may affect the DGR Project. For example, climate change might result in new or more severe weather hazards. The method used to assess these changes is shown on Figure 10.2.1-1.

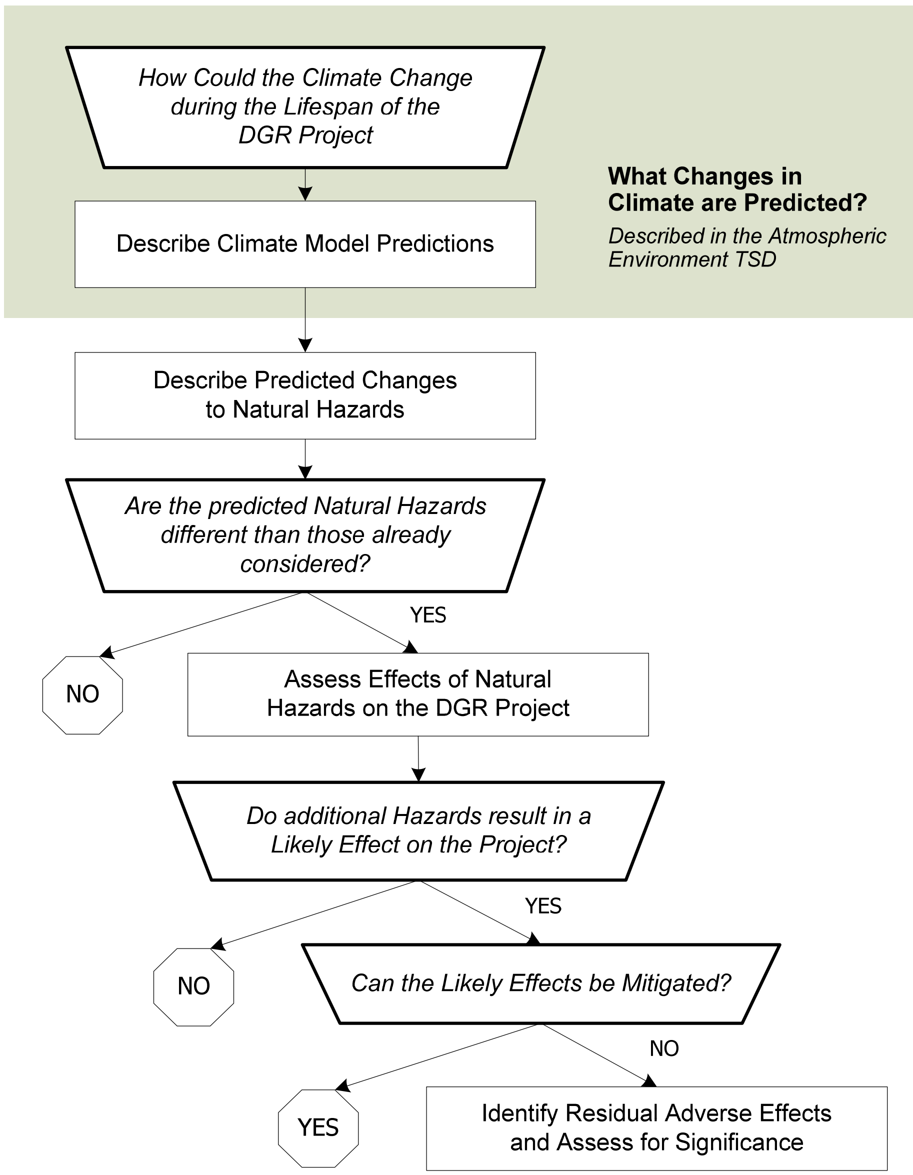

Figure 10.2.1-1: Method to Assess Effects of the Future Environment on the DGR Project

Once the future environment is established, the evaluation of changed and/or additional natural hazards on the DGR Project is carried out in a similar fashion to the assessment of effects of the current environment on the DGR Project (Section 9). The assessment addresses only predicted hazards that are different or in addition to those considered in the assessment of existing natural hazards. The EA predictions of future hazards as a result of a changing climate relies upon both qualitative and quantitative evaluations based on available data and technical experience, with consideration for the design and contingency measures incorporated into the DGR Project to mitigate likely effects. Identified residual adverse effects, if any, are advanced to Section 11 for an assessment of significance.

10.2.2 Assessment of Effects of the Future Aquatic Environment on the DGR Project

As discussed in Section 9.2, there are no potential pathways or mechanisms through which the future aquatic environment (habitat and biota) can affect the DGR Project.

10.3 EFFECTS OF THE DGR PROJECT ON THE FUTURE ENVIRONMENT

10.3.1 Methods

Climate change may result in an environment that is different from the current environment as less severe winters or increased precipitation might alter the habitat or behaviour of VECs. Climate-related changes to VECs may result in changed or additional effects of the DGR Project compared with those predicted on the current environment. The method used to assess these changes is shown on Figure 10.3.1-1.

The assessment of the effects of the DGR Project on VECs in a changed future environment begins with re-examining the EA predictions for the current environment by identifying whether or not the VECs might be altered as a result of climate change. The effects of the DGR Project on the altered VECs are then assessed to determine whether they are bounded by the predictions made for the effects assessment for the current environment (Section 8). All additional or different effects are fully assessed, using a similar method to that followed for assessing effects of the DGR Project on the current environment. Effects that cannot be fully mitigated result in residual adverse effects, which are forwarded for an assessment of significance in Section 11.

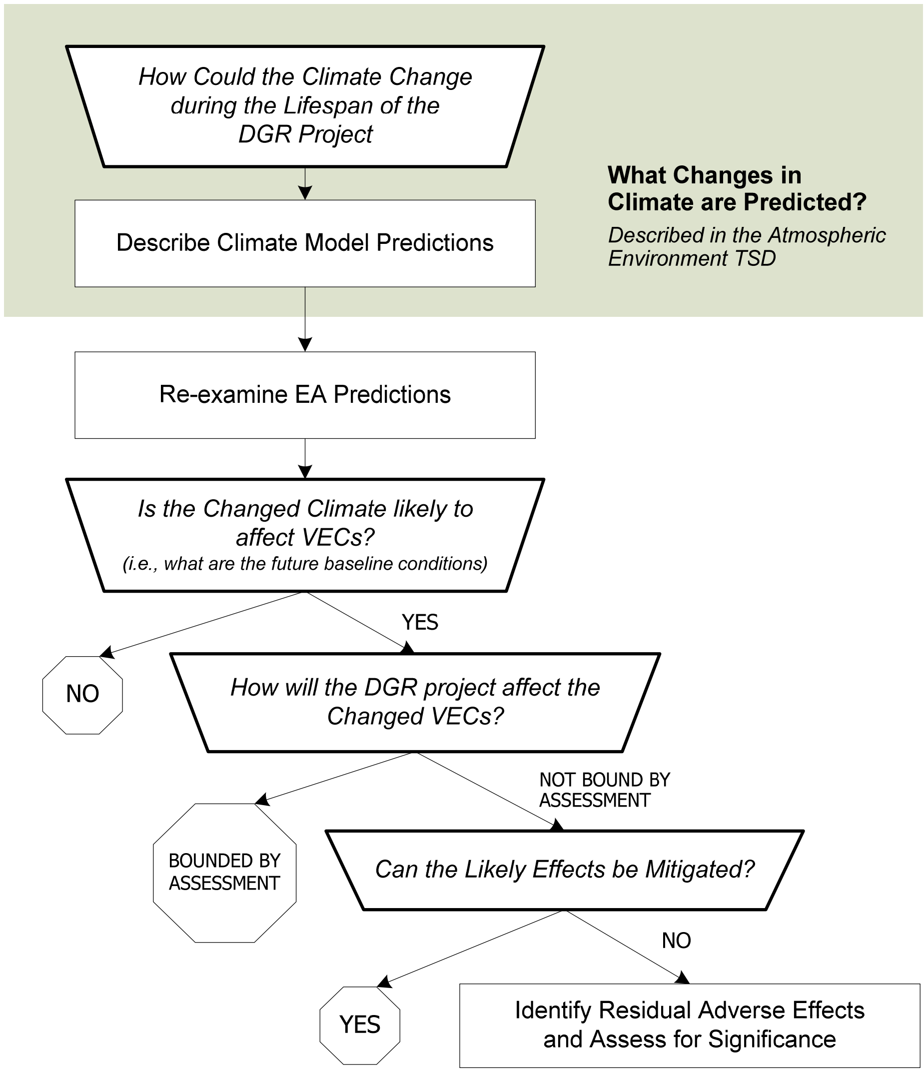

Figure 10.3.1-1: Method to Assess Effects of the DGR Project on the Future Environment

10.3.2 Assessment of the Future Effects of the DGR Project on Aquatic Environment VECs

Change in air temperature and precipitation could potentially change the flow in area streams and the amount of runoff from the DGR Project. An increase in annual precipitation as predicted in Table 10.1-2 would increase the potential amount of runoff from the DGR Project. Conversely, an increase in air temperature as predicted in Table 10.1-1 would increase the rate of evaporation and diminish the effect of increased precipitation. As described in the Hydrology and Surface Water Quality TSD, the changes in stream flow (runoff) are not expected to be adverse.

Changes in surface water quality could result from the effects of climate change, for example, increased volumes of runoff could decrease the overall concentration of contaminants in the runoff. Since the change in runoff is not expected to be measurable, no measurable changes to water quality are expected.

Table 10.3.2-1 summarizes the consideration of effects of the DGR Project taking into account the potential effects of climate change on aquatic environment VECs, and describes whether these changes could affect the conclusions of the assessment presented in Section 8.

Table 10.3.2-1: Effects of Climate Change on Aquatic Environment VECs

VECs	Potential Effects of Climate Change on VEC	Rationale	Change to EA Conclusion?
Redbelly Dace Creek Chub Brook Trout Variable Leaf Pondweed Benthic Invertebrates	• Change to frequency and magnitude of precipitation events	• Increases in runoff resulting from increased precipitation are offset by increased evaporation resulting from increased air temperature.	• Any possible changes in flow are predicted to be negligible in terms of aquatic habitat • No changes to the EA conclusions are warranted
Burrowing Crayfish	• Change to frequency and magnitude of precipitation events result in changes to surface and groundwater recharge	• Increased surface water and groundwater flow associated with extreme weather events could lead to flood conditions in crayfish burrows	• Predicted changes to annual precipitation amounts and atmospheric temperatures are relatively small through to the decommissioning phase of the DGR Project • These changes are not likely to result in measurable changes to aquatic habitat and accordingly to aquatic biota • No changes to the EA conclusions are warranted

Table 10.3.2-1: Effects of Climate Change on Aquatic Environment VECs (continued)

VECs	Potential Effects of Climate Change on VEC	Rationale	Change to EA Conclusion?
Lake Whitefish Spottail Shiner Smallmouth Bass Benthic Invertebrates	• Increased flow associated with extreme weather events could lead to changes in surface water quality entering Lake Huron from the tributaries	• Potential effects of increasing levels of suspended sediments entering the lake	• Predicted changes to annual precipitation amounts are relatively small through to the decommissioning phase of the DGR Project • Sediments entering MacPherson Bay from the Project Area will quickly disperse in Lake Huron waters • These changes are not likely to result in measurable changes to aquatic habitat and accordingly no measurable changes to aquatic biota • No changes to the EA conclusions are warranted

10.4 EFFECTS OF THE DGR PROJECT ON CLIMATE CHANGE

The DGR Project may also contribute to how the climate is changing (e.g., through changes in the levels of greenhouse gas emissions). The assessment, which considers the direct and indirect changes as a result of the DGR Project, is not relevant to the aquatic environment, and is described in the Atmospheric Environment TSD.

10.5 SUMMARY

It was determined that changes in climate will not alter the assessment of the DGR Project on the aquatic environment or the environment on the DGR Project because of the following conclusions:

- the future aquatic habitat and biota will not affect the DGR Project;
- the DGR Project will not have an effect on a climate changed aquatic environment; and
- the DGR Project will not affect the aquatic environment indirectly by influencing climate change.

Therefore, no adverse effects are identified, and further assessment is not warranted.

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11. SIGNIFICANCE OF RESIDUAL ADVERSE EFFECTS

This section includes an evaluation of the significance of the residual adverse effects identified for the DGR Project on the aquatic environment VECs. An assessment of the cumulative effects associated with the DGR Project is addressed in Section 10 of the EIS.

11.1 ASSESSMENT METHODS

The residual adverse effects identified in the assessment (Sections 8 through 10) are assessed to determine if they are significant. Significance is rated using criteria applicable to the aquatic environment. The criteria used for judging and describing the significance of effects are shown in Table 11.1-1. Only non-negligible (i.e., adverse) effects are carried forward for an assessment of significance.

Table 11.1-1: Effects Criteria and Levels for Determining Significance

Effects Criteria	Effects Level Definition		
Magnitude (of effect)	**Low**	**Medium**	**High**
	Non-critical habitat is removed or rendered non-usable	Critical habitat is removed or rendered non-usable, and there is comparable habitat available elsewhere in the watercourse	Critical habitat is removed or rendered non-useable, and there is no comparable habitat available elsewhere in the watercourse
Geographic Extent (of effect)	**Low**	**Medium**	**High**
	Effect is within the Site Study Area	Effect extends into the Local Study Area	Effect extends into the Regional Study Area
Timing and Duration (of conditions causing effect)	**Low**	**Medium**	**High**
	Conditions causing effect are evident during the site preparation and construction phase, or the decommissioning phase	Conditions causing effect are evident during the operations phase	Conditions causing effect extend beyond any one phase
Frequency (of effect)	**Low**	**Medium**	**High**
	Conditions or phenomena causing the effect occur infrequently (i.e., several times per year)	Conditions or phenomena causing the effect occur at regular, although infrequent intervals (i.e., several times per month)	Conditions or phenomena causing the effect occur at regular and frequent intervals (i.e., daily or continuously)
Degree of Irreversibility (of effect)	**Low**	**Medium**	**High**
	Effect is readily (i.e., immediately) reversible	Effect is reversible with time	Effect is not reversible (i.e., permanent)

Probability of occurrence was not explicitly included as a criterion for the assessment of significance of residual adverse effects. The assessment recognizes the widest, reasonable range of residual adverse effects without specific regard for their respective probability of occurrence[6]. The focus is on evaluating the possible impact of such effects on the environment and VECs and the consideration of feasible mitigation measures that can be incorporated to control, reduce or eliminate the effect.

The level of significance is assigned by using a decision tree model illustrated on Figure 11.1-1. First, magnitude, geographic extent, timing and duration, frequency, and degree of irreversibility are combined to identify an environmental consequence. Then the social and/or ecological importance of the VEC being affected is considered to determine the overall significance of the effect.

This decision tree is specific to the aquatic environment and the effects level criteria defined in Table 11.1-1. Some of the guiding principles are:

- effects associated with removal of non-critical habitat (i.e., low magnitude) would result in a low environmental consequence and are not considered significant;
- generally, if the effect is immediately reversible (i.e., low irreversibility) it would result in a low environmental consequence and is not considered significant; and
- effects with a high magnitude and extent and/or high irreversibility would result in a high environmental consequence and may be considered significant, taking social and/or ecological importance into consideration.

The residual adverse effect can be determined to be:

- not significant;
- may not be significant; or
- significant.

An effect that "may not be significant" is one that would not be significant in the professional judgement of the technical specialists; however, follow-up monitoring should be implemented to confirm that significant adverse effects do not occur as a result of the DGR Project.

6 As noted in Section 2.2 in regards to the application of the precautionary principle, all identified residual adverse effects, with the exception of malfunctions, accidents, and malevolent acts, are assumed to occur for the purposes of this assessment.

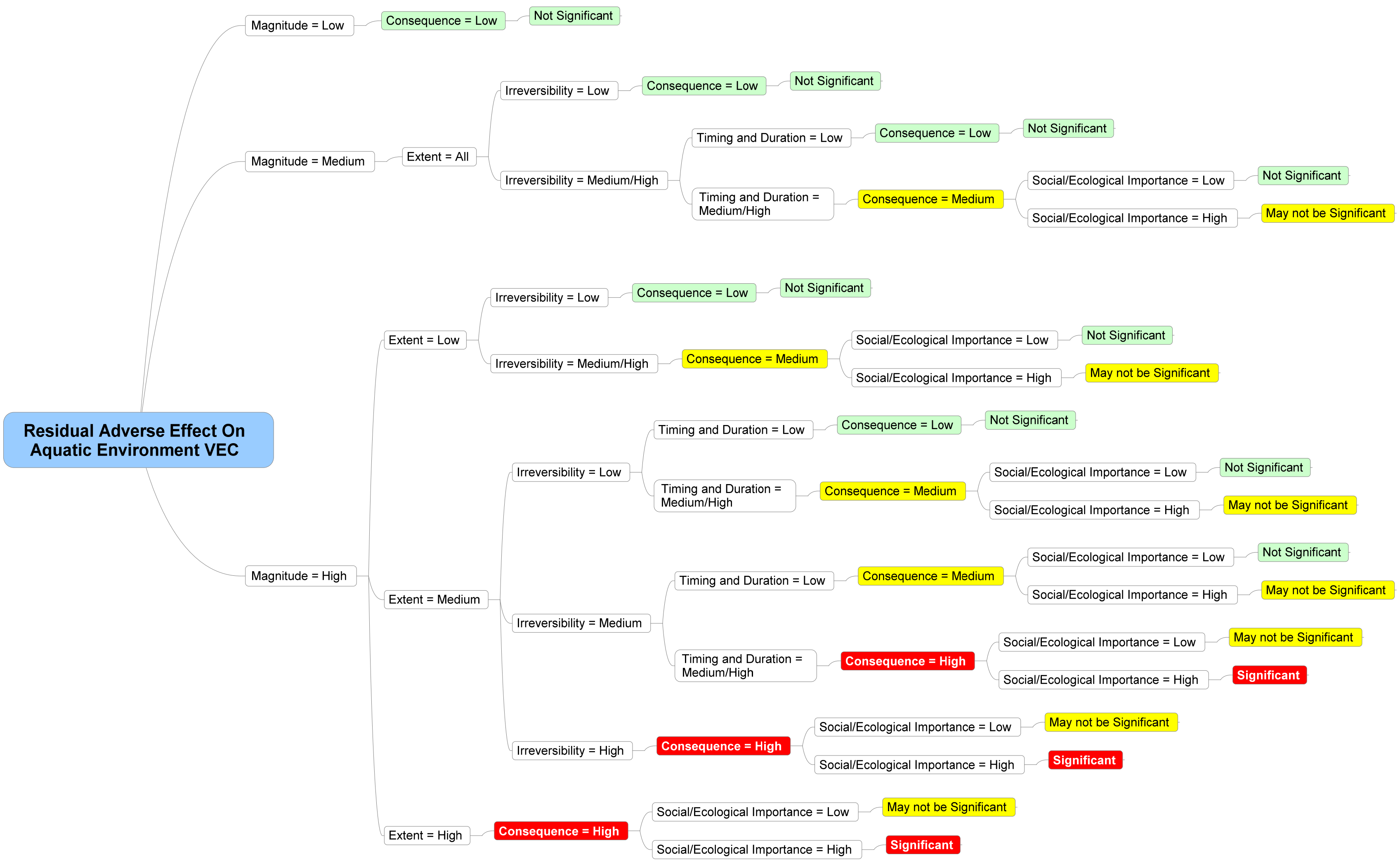

Figure 11.1-1: Determination of Significance of Residual Adverse Effects

11.2 SIGNIFICANCE OF RESIDUAL ADVERSE EFFECTS

As described in Section 8, residual adverse effects on five of the aquatic environment VECs are identified as a result of the DGR Project:

- burrowing crayfish habitat will be disturbed/removed during the site preparation activities and construction of the rail bed crossing; and
- habitat for redbelly dace, creek chub, variable leaf pondweed and benthic invertebrates within the South Railway Ditch will be altered during construction of the crossing over the abandoned rail bed.

As shown in Table 11.2-1, and based on the decision flow diagram illustrated on Figure 11.1-1, the residual adverse effects are assessed as not significant because they involve removal/alteration of only non-critical habitat over a very limited portion of the Project Area (i.e., low magnitude). Furthermore, from an ecological and social perspective, burrowing crayfish, benthic invertebrates, and the fish and plant species affected are tolerant of a broad range of environmental conditions, are considered common in freshwater systems in Ontario, and would not be considered keystone species.

Table 11.2-1: Summary of Residual Adverse Effects and Significance Levels

VEC	Magnitude	Geographic Extent	Timing and Duration	Frequency	Degree of Irreversibility	Overall Assessment
Burrowing Crayfish	**Low** No critical habitat is removed A portion (~0.01% of habitat in the Site Study Area) of non-critical habitat is removed	**Low** The effect is limited to the Site Study Area	**Low** The condition causing the effect occurs during the site preparation and construction phase	**High** The habitat loss is continuous	**High** Effect is not reversible (i.e., permanent)	**Not significant**
Redbelly Dace	**Low** No critical habitat is removed A portion (~1.6% of the length of the South Railway Ditch) of non-critical habitat is removed	**Low** The effect is limited to the Site Study Area	**Low** The condition causing the effect occurs during the site preparation and construction phase	**High** The habitat loss is continuous	**High** Effect is not reversible (i.e., permanent)	**Not significant**
Creek Chub	**Low** No critical habitat is removed. A portion (~1.6% of the length of the South Railway Ditch) of non-critical habitat is removed	**Low** The effect is limited to the Site Study Area	**Low** The condition causing the effect occurs during the site preparation and construction phase	**High** The habitat loss is continuous	**High** Effect is not reversible (i.e., permanent)	**Not significant**

Table 11.2-1: Summary of Residual Adverse Effects and Significance Levels (continued)

VEC	Magnitude	Geographic Extent	Timing and Duration	Frequency	Degree of Irreversibility	Overall Assessment
Variable Leaf Pondweed	**Low** No critical habitat is removed A portion (~1.6% of the length of the South Railway Ditch) of non-critical habitat is removed	**Low** The effect is limited to the Site Study Area	**Low** The condition causing the effect occurs during the construction phase	**High** The habitat loss is continuous	**High** Effect is not reversible (i.e., permanent)	**Not significant**
Benthic Invertebrates	**Low** No critical habitat is removed A portion (~1.6% of the length of the South Railway Ditch) of non-critical habitat is removed	**Low** The effect is limited to the Site Study Area	**Low** The condition causing the effect occurs during the construction phase	**High** The habitat loss is continuous	**High** Effect is not reversible (i.e., permanent).	**Not significant**

12. EFFECTS OF THE PROJECT ON RENEWABLE AND NON-RENEWABLE RESOURCES

The DGR Project EIS Guidelines (Appendix A of the EIS) require the EA to consider the effects of the DGR Project on resource sustainability. For context, non-renewable resources are also discussed in this section.

12.1 METHODS

Potential project-environment interactions (as identified by the assessment of effects of the DGR Project) are reconsidered in a context of their likelihood of affecting resource sustainability or availability through all time frames. Likely effects, if any, are predicted, described and their significance assessed by considering “renewable” and “non-renewable resources” as VECs. For example, lake whitefish is a commercially important species and the potential effects on this species as a renewable resource have been considered. In addition, the ability of the present generation and future generations to meet their own needs is evaluated, based on the professional judgement of the technical specialists.

One goal of the assessment is to determine whether renewable and non-renewable resources would be affected by the DGR Project to the point where they are not sustainable or become appreciably depleted. Sustainability is defined in a manner consistent with the United Nation’s definition of sustainable development as “*economic development that meets the needs of the present without compromising the ability of future generations to meet their own needs*”.

Potential DGR Project-environment interactions identified in the screening matrices were reviewed to determine the likelihood of interactions between the DGR Project and resource sustainability and availability. For example, fish are a renewable resource used by humans for consumption. For the purpose of this assessment, the likely residual adverse effects of the DGR Project’s physical works and activities on the environment were considered as having the potential to adversely affect the sustainability of associated resources.

12.2 LIKELY EFFECTS

12.2.1 Non-renewable Resources

Non-renewable resource use associated with the DGR Project is expected to include use of aggregate and fuels. However, the use of non-renewable resources is not applicable to the aquatic environment and is not considered further in this TSD.

12.2.2 Renewable Resources

The loss of fish or fish habitat would constitute an effect on a renewable resource; however, the residual adverse effects on fish using habitat in the South Railway Ditch was determined to be of low consequence (not significant) in the assessment carried out in Section 11. Additionally, the VECs in the South Railway Ditch and burrowing crayfish are not currently and likely will not be used as a source for human consumption (i.e., as a renewable resource). Therefore, the DGR Project is not expected to affect the sustainability of these resources.

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13. PRELIMINARY FOLLOW-UP PROGRAM

The guidelines stipulate that the need for, and the requirements of, any follow-up program for the DGR Project be identified. A follow-up program may be required to determine that the environmental and cumulative effects of the DGR Project are consistent with predictions reported in the EIS. It can also be used to verify that the identified mitigation measures are effective once implemented and determine whether there is a need for additional mitigation measures. A preliminary follow-up plan is provided below. The follow-up program is designed to be appropriate to the scale of the DGR Project and the effects identified through the EA process.

Follow-up monitoring programs are generally required to:

- verify the key predictions of the EA studies; or
- confirm the effectiveness of mitigation measures, and in so doing, determine if alternate mitigation strategies are required.

The CNSC will provide the regulatory oversight to ensure that OPG has implemented all appropriate mitigation measures and that follow-up monitoring is designed and carried out. The CNSC compliance program can be used as the mechanism for ensuring the final design and implementation of the follow-up program and reporting of the follow-up program results.

13.1 INITIAL SCOPE OF THE FOLLOW-UP PROGRAM

Table 13.1-1 summarizes the recommended follow-up monitoring program considerations for the aquatic environment assessment. The recommendations identify the general timeframe for follow-up and monitoring (site preparation and construction, operations and/or decommissioning phase). These recommendations should be reviewed and incorporated, as appropriate, into the formal follow-up program that would be developed prior to the initiation of the DGR Project. The preliminary follow-up monitoring program has been prepared and is submitted along with the EIS. Follow-up procedures to be carried out in the event of an accidental spill are described in the Malfunctions, Accidents and Malevolent Acts TSD.

Table 13.1-1: Potential Follow-up Monitoring for the Aquatic Environment

VEC	Phase	Program Objective	Suggested Frequency and Location of Monitoring
VECs in the South Railway Ditch (redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish, benthic invertebrates)	• Site preparation and construction phase • Operations phase	• Monitor re-growth of riparian vegetation following removal, note deficiencies in bank stability (i.e. erosion and slumping)	• Annually for three years following construction of abandoned rail bed crossing • Time period: during the growing season-summer • Location: disturbed areas; at abandoned rail bed crossing
		• Vibration monitoring	• As described in Appendix I of the Atmospheric Environment TSD
VECs in MacPherson Bay (spottail shiner, benthic invertebrates, lake whitefish, smallmouth bass)	• Site preparation and construction phase	• Monitor stability and re-vegetation of new ditches	• One time after construction of drainage ditches and stormwater management pond. • Time period: during the growing season-summer
Burrowing crayfish	• Site preparation and construction phase	• Monitor the on-site marsh (see Figure 5.1.2-1) for confirmation that excavation of underground facilities does not dewater marsh habitat utilized by burrowing crayfish	• Incorporate the results of shallow groundwater monitoring taking place in the Project Area on a monthly basis during excavation of the underground facilities • Compare the groundwater levels with a water level gauge located in the marsh to determine if there is any effect on water levels • Location: shallow groundwater monitoring well (to be installed in 2011) closest to the marsh located in the Project Area as discussed in the Geology TSD • Annual monitoring of the Project Area for three years to observe and document burrowing crayfish activity (visual observations of chimneys)

Monitoring results are used to verify the predictions of the EA. Corrective actions may be required in the event that monitoring results are not consistent with predictions. For example, replanting or stabilization of ditches and pond(s), or temporary supply of surface water to marsh (see Figure 5.1.2-1) to offset any ongoing dewatering effects, may be required.

The Hydrology and Surface Water Quality TSD includes follow up monitoring of water quality in the on-site stormwater management facilities (stormwater management pond, drainage ditches) to ensure site discharge meets criteria and to characterize site runoff. This will confirm that there are no adverse effects on the receiving environment (MacPherson Bay).

13.2 PERMITTING REQUIREMENTS

The follow-up program described above may be a requirement of the CNSC licence. In addition, it is expected that the DGR Project will be subject to a number of permitting requirements.

OPG will apply to the SVCA for a permit under O. Reg. 169/06 (Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses Regulation) for construction of the crossing over the abandoned rail bed. Although OPG is not subject to this Regulation, it has been their past practice to proceed through the SCVA permitting process.

All wetlands plus an adjacent land distance are also subject to O. Reg. 169/06. For wetlands that are not classified as Provincially Significant, the regulated area includes the wetland plus 30 m from the wetland boundary. The DGR Project will maintain a 30 m setback from the marsh area in the northeast portion of the Project Area. Therefore, it is not expected that a permit will be necessary for these project activities.

SVCA has reviewed the DGR Project relative to the *Fisheries Act* and does not expect that a Section 35(2) authorization will be required for the crossing. Therefore, DFO is not expected to be involved in this project.

If fish salvage is required prior to the construction of the crossing over the abandoned rail bed, a Fish Collection Permit will be obtained from the OMNR.

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14. CONCLUSIONS

The assessment predicts residual adverse effects on burrowing crayfish, creek chub, redbelly dace, benthic invertebrates and variable leaf pondweed as a result of the construction of the rail bed crossing over the North and South Railway Ditches. Burrowing crayfish habitat will also be lost as a result of site preparation activities. These effects were assessed to be not significant. It is expected that these effects will be limited to within the Project Area.

A small amount of burrowing crayfish habitat, which is approximately 0.01% of the habitat available in the Site Study Area and consists of chimneys that were not confirmed as habitat being used by the crayfish at the time of monitoring, will be lost during site preparation and construction. This loss will be offset by the colonization of new areas in the Site Study Area by burrowing crayfish.

For the construction of the crossing from the WWMF to the DGR Project, an approximately 100 m^2 section of the South Railway Ditch will be altered during the installation of culverts. The culverts will change the habitat available to redbelly dace, creek chub, variable leaf pondweed, burrowing crayfish and benthic invertebrates in the immediate vicinity of the crossing. However, this alteration takes place in a section of the ditch that amounts to less than 1.6% of similar habitat available along the entire length of the drainage ditch. These effects on fish, burrowing crayfish and aquatic plant VECs in the South Railway Ditch were assessed as not significant.

Based on the results of the assessment documented in this TSD, the following additional conclusions are reached:

- although a measurable decrease in flow in the North Railway Ditch is predicted in the Hydrology and Surface Water Quality TSD, it is not expected to result in a measurable change to the aquatic habitat or the associated VECs (burrowing crayfish, benthic invertebrates);
- as an appropriate stormwater management pond will be implemented to meet stormwater discharge criteria, there are no predicted measurable changes to water quality in MacPherson Bay and thus no adverse effects on associated VECs (benthic invertebrates, smallmouth bass, lake whitefish and spottail shiner);
- climate change over the site preparation and construction, operations, and decommissioning phases is not expected to affect the conclusions of the assessment of effects of the project on the aquatic environment VECs; and
- although residual adverse effects on VECs in the South Railway Ditch are identified, these effects do not represent an adverse effect on renewable resources.

In summary, no significant effects to aquatic environment VECs are identified as a result of the DGR Project.

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APPENDIX A: LIST OF ACRONYMS, UNITS AND TERMS

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LIST OF ACRONYMS

Acronym	Descriptive Term
CEAA	Canadian Environmental Assessment Act
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CNSC	Canadian Nuclear Safety Commission
DFO	Fisheries and Oceans Canada
DGR	Deep Geologic Repository
EA	Environmental Assessment
EIS	Environmental Impact Study
ELC	Ecological Land Classification
ILW	Intermediate Level Waste
LLW	Low Level Waste
L&ILW	Low and Intermediate Level Waste
NWMO	Nuclear Waste Management Organization
OMNR	Ontario Ministry of Natural Resources
OPG	Ontario Power Generation Inc.
RA	Responsible Authority
SARA	Species At Risk Act
SVCA	Saugeen Valley Conservation Authority
TSD	Technical Support Document
TSS	Total Suspended Solids
VEC	Valued Ecosystem Component
WPRB	Waste Package Receiving Building
WWMF	Western Waste Management Facility

LIST OF UNITS

Symbol	Units
%	Percent
°C	Degrees Celsius
cm	Centimetre
g/L	Grams per Litre
kg	Kilograms
km	Kilometres
km^2	Square Kilometres
m	Metres
m^3	Cubic Metres (volume)
mASL	Metres above sea level
mBGS	Metres below ground surface
mg/L	Milligrams per Litre
mm	Millimetres

GLOSSARY OF TERMS

Aboriginal traditional knowledge – Knowledge that is held by, and unique to, Aboriginal peoples. Aboriginal traditional knowledge is a body of knowledge built up by a group of people through generations of living in close contact with nature. It is cumulative and dynamic and builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.

Bruce nuclear site – The 932 hectare (9.32 km^2) parcel of land located within the administrative boundaries of the Municipality of Kincardine in Bruce County. Two operating nuclear stations are located on the site. The site is owned by OPG but has been leased to Bruce Power since May 2001. However, parts of the site, including land on which the WWMF is located, have been retained by OPG. See also *OPG-retained lands*.

Bruce Power – The licensed operator of the Bruce A and Bruce B nuclear generating stations.

Canadian Environmental Assessment Agency (CEAA) – The federal body accountable to the Minister of the Environment. The Agency works to provide Canadians with high-quality environmental assessments that contribute to informed decision making, in support of sustainable development.

Canadian Nuclear Safety Commission (CNSC) – The Canadian federal agency responsible for regulating nuclear facilities and materials, including management of all radioactive waste in Canada.

Decommissioning – Those actions taken, in the interest of health, safety, security and protection of the environment, to retire a licensed activity/facility permanently from service and render it to a predetermined end-state condition.

Deep Geologic Repository (or DGR, or Repository) – The underground portion of the deep geologic repository facility for low- and intermediate-level waste. Initially, the repository includes the access-ways (shafts, ramps and/or tunnels), underground service areas and installations, and emplacement rooms. In the postclosure phase it also includes the engineered barrier systems. The repository includes the waste emplaced within the rooms and excludes the excavation damage zone.

DGR Project Site – The portion of the Project Area that will be affected by the site preparation and construction of surface facilities (i.e., the surface footprint).

Direct Effect – A direct effect occurs when the VEC is affected by a change that results from a project work and activity.

Geosynthesis – The assembly of all the geologically-based evidence relevant to the repository safety case; the integration of multi-disciplinary geoscientific data relevant to the development of a descriptive conceptual geosphere model; explanation of a site-specific descriptive conceptual geosphere model within a systematic and structured framework.

Indirect Effect – An indirect effect occurs when the VEC is affected by a change in another VEC.

Intermediate-Level Waste (ILW) – Radioactive non-fuel waste, containing significant quantities of long-lived radionuclides (generally refers to half-lives greater than 30 years).

Low-Level Waste (LLW) – Radioactive waste in which the concentration or quantity of radionuclides is above the clearance levels established by the regulatory body (CNSC), and which contains primarily short-lived radionuclides (half-lives shorter than or equal to 30-years).

OPG-retained Land – The parcels of land on the Bruce nuclear site for which control has been retained by OPG. This includes the WWMF, certain landfills, and the Heavy Water Plant Lands.

Precautionary Approach – The precautionary approach is ultimately guided by judgement, based on values and is intended to address uncertainties in the assessment. This approach is consistent with Principle 15 of the 1992 Rio Declaration on Environment and Development. Principle 15 of 1992 Rio Declaration on Environment and Development and the Canadian government's framework for applying precaution in decision-making processes.

Receptor – Any person or environmental entity that is exposed to radiation, or a hazardous substance, or both. A receptor is usually an organism or a population, but it could also be an abiotic entity such as surface water or sediment.

Risk – A multi-attribute quantity expressing hazard, danger or chance of harmful or injurious consequences associated with actual or potential exposures. It relates to quantities such as the probability that specific deleterious consequences may arise and the magnitude and character of such consequences.

Safety Report – A key licensing document which provides an overview of the facility design and operations, summarizes the integrated results of individual safety assessments, and demonstrates that a facility can be constructed, operated, or continue to be operated, without undue risk to health and safety of the workers and the public, and the environment.

Preliminary Safety Report (PSR) is the Safety Report submitted to CNSC in support of an application for a Site Preparation/Construction Licence.

Final Safety Report (FSR) is the Safety Report submitted to CNSC in support of an application for a Licence to Operate.

Traditional ecological knowledge – Traditional ecological knowledge is a subset of Aboriginal traditional knowledge. Traditional ecological knowledge refers specifically to all types of knowledge about the environment derived from the experience and traditions of a particular group of people. There are four traditional ecological knowledge categories:

knowledge about the environment; knowledge about the use of the environment; values about the environment; and the foundation of the knowledge system.

Valued Ecosystem Component (VEC) – VECs are features of the environment selected to be a focus of the environmental assessment because of their ecological, social, or economic value, and their potential vulnerability to the effects of the DGR Project.

Waste Package – The waste material, the container, and any external barriers (e.g. shielding material), as prepared in accordance with requirements for handling, transfer and emplacement in the repository. It is a discrete unit that can be individually identified and handled at the repository facility.

Waste Package Receiving Building (WPRB) –The building at the DGR surface where waste packages arrive for transfer underground.

Western Waste Management Facility (WWMF) – The centralized processing and storage facility on the Bruce nuclear site for OPG's L&ILW and for the dry storage of used fuel from Bruce nuclear generating stations.

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APPENDIX B: BASIS FOR THE EA

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Table B-1: Basis for the EA

Project Works and Activities	**Description**
Site Preparation	Site preparation would begin after receipt of a Site Preparation Licence and would include clearing approximately 30 ha of the DGR Project site and preparing the construction laydown areas. Activities would include: • Removal of brush and trees and transfer by truck to on-site storage; • Excavation for removal and stockpiling of topsoil and truck transfer of soil to stockpile on-site; • Grading of sites, including roads, construction laydown areas, stormwater management area, ditches; • Receipt of materials including gravel, concrete, and steel; • Installation of construction roads and fencing; • Receipt and installation of construction trailers and associated temporary services; and • Install and operate fuel depot for construction equipment.
Construction of Surface Facilities	Construction of surface facilities will include the construction of the waste transfer, material handling, shaft headframes and all other temporary and permanent facilities at the site. Activities would include: • establish a concrete batch plant; • receipt of construction materials, including supplies for concrete, gravel, and steel by road transportation; • excavation for and construction of footings for permanent buildings, and for site services such as domestic water, sewage, electrical; • construction of permanent buildings, including headframe buildings associated with main and ventilation shafts; • receipt and set up of equipment for shaft sinking; • construction of abandoned rail bed crossing between WWMF and the DGR site; • fuelling of vehicles; and • construction of electrical substation and receipt and installation of standby generators.
Excavation and Construction of Underground Facilities	Excavation and construction of underground facilities will include excavation of the shafts, installation of the shaft and underground infrastructure (e.g., ventilation system) and the underground excavation of the emplacement and non-storage rooms. Activities will include: • drilling and blasting (use of explosives) for construction of main and ventilation shafts, and access tunnels and emplacement rooms; • receipt and placement of grout and concrete, steel and equipment; • dewatering of the shaft construction area by pumping and transfer to the above-ground stormwater management facility; • temporary storage of explosives underground for construction of emplacement rooms and tunnels; • receipt and installation of rock bolts and services; and • installation of shotcrete.

Table B-1: Basis for the EA (continued)

Project Works and Activities	Description
Above-ground Transfer and Receipt of Waste	Above-ground handling of wastes will occur during the operations phase of the DGR Project and will include receipt of L&ILW from the WWMF at the staging area in the DGR Waste Package Receiving Building (WPRB) and on-site transfer to shaft. Above-ground handling of wastes includes: • receipt of disposal-ready waste packages from the WWMF by forklift or truck • offloading of waste packages at the WPRB; • transfer of waste packages within the WPRB by forklift or rail cart; • temporary storage of waste packages inside the WPRB.
Underground Transfer of Waste	Underground handling of wastes will take place during the operations phase of the DGR Project and will include: • receipt of waste packages at the the main shaft station; • offloading from cage and transfer of waste packages by forklift to emplacement rooms; • rail cart transfer of some large packages (Heat Exchangers/Shield Plug Containers) to emplacement rooms; • installation of end walls on full emplacement rooms; • remedial rock bolting and rock wall scaling; • fuelling and maintenance of underground vehicles and equipment; • receipt and storage of fuel for underground vehicles. Emplacement activities will be followed by a period of monitoring to ensure that the DGR facility is performing as expected prior to decommissioning.
Decommissioning of the DGR Project	Decommissioning of the DGR Project will require a separate environmental assessment before any activities can begin. Decommissioning of the DGR Project will include all activities required to seal shafts and remove surface facilities including: • removal of fuels from underground equipment; • removal of surface buildings, including foundations and equipment; • receipt and placement of materials, including concrete, asphalt, sand, bentonite for sealing the shaft; • construction of concrete monolith at base of two shafts, removal of shaft infrastructure and concrete liners, and reaming of some rock from the shafts and shaft stations; • sealing the shaft; and • grading of the site. The waste rock pile (limestones) will be covered and remain on-site.
Abandonment of the DGR Facility	Timing of abandonment of the DGR facility will be based on discussion with the regulator. Activities may include removal of access controls.
Presence of the DGR Project	Presence of the DGR Project represents the meaning people may attach to the existence of the DGR Project in their community and the influence its operations may have on their sense of health, safety and personal security over the life cycle of the DGR Project. This includes the aesthetics and vista of the DGR facility.

Table B-1: Basis for the EA (continued)

Project Works and Activities	Description
Waste Management	Waste management represents all activities required to manage waste during the DGR Project. During construction waste management will include managing the waste rock along with conventional waste management. During operations, waste management would include managing conventional and radiological wastes from the underground and above-ground operations. Decommissioning waste management may include management of conventional and construction wastes. Activities include: • transfer of waste rock, by truck to the WRMA; • placement of waste rock on the storage pile; • collection and transfer of construction waste to on-site or licensed off-site facility; • collection and transfer of domestic waste to licensed facility; • collection, processing and management of any radioactive waste produced at the DGR facility; • collection, temporary storage and transfer of toxic/hazardous waste to licensed facility.
Support and Monitoring of DGR Life Cycle	Support and monitoring of DGR life cycle will include all activities to support the safe construction, operation, and decommissioning of the DGR Project. This includes: • operation and maintenance of the ventilation fans, heating system, electrical systems, fire protection system, communications services, sewage and potable water system and the standby generator; • collection, storage, and disposal of water from underground sumps, and of wastewater from above-and below ground facilities; • management of surface drainage in a stormwater management facility; • monitoring of air quality in the facility, exhaust from the facility, water quality of run-off from the developed area around the shafts and Waste Rock Management Area, water quality from underground shaft sumps and geotechnical monitoring of various underground openings; • maintenance and operation of fuel depots above-ground (construction only) and below-ground; and • administrative activities above- and below-ground involving office space, lunch room and amenities space.
Workers, Payroll and Purchasing	Workers, payroll and purchasing will include all workers required during each phase to implement the DGR Project. Activities include: • spending in commercial and industrial sectors; • transport of materials purchased to the site; and workers travelling to and from site.

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APPENDIX C: FISH SURVEY DATA

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Table C-1: Seine Netting Location and Effort Data, 2007

ID [a]	Start MMDDYY/Time	Location	Substrate
1	6/21/07 15:00	MacPherson Bay	—
2	6/21/07 15:00	MacPherson Bay	—
3	6/21/07 15:00	MacPherson Bay	—
4	6/21/07 15:00	MacPherson Bay	—
15	6/22/07 15:30	MacPherson Bay	—
16	6/22/07 15:45	MacPherson Bay	—
17	6/22/07 15:50	MacPherson Bay	—
18	6/22/07 16:00	MacPherson Bay	—
19	6/22/07 16:10	MacPherson Bay	—
20	6/22/07 16:15	MacPherson Bay	gravel/small cobble
32	8/15/07 15:55	MacPherson Bay	cobble/small boulder to silt and fine gravel
33	8/15/07 16:12	MacPherson Bay	silt/fine gravel
34	8/15/07 16:30	MacPherson Bay	small - large cobble, small boulder
35	8/15/07 16:40	MacPherson Bay	cobble/boulder
36	8/15/07 17:01	MacPherson Bay	—
37	8/15/07 17:11	MacPherson Bay	Large cobble/small boulder
38	8/15/07 17:20	MacPherson Bay	Large cobble/small boulder
39	8/15/07 17:31	MacPherson Bay	sand/gravel to gravel cobble boulder
40	8/15/07 17:45	MacPherson Bay	—
41	8/15/07 17:58	MacPherson Bay	—
42	8/15/07 18:08	MacPherson Bay	—
53	10/4/07 10:15	MacPherson Bay	gravel
54	10/4/07 10:25	MacPherson Bay	gravel
55	10/4/07 10:35	MacPherson Bay	gravel
56	10/4/07 10:45	MacPherson Bay	gravel
57	10/4/07 10:55	MacPherson Bay	gravel
58	10/4/07 11:25	MacPherson Bay	sand
59	10/4/07 11:30	MacPherson Bay	sand
60	10/4/07 11:40	MacPherson Bay	sand
61	10/4/07 11:45	MacPherson Bay	sand
62	10/4/07 12:01	MacPherson Bay	sand

Notes:

— No data available

a ID refers to the unique identifiers assigned to each seine netting location – only those locations in MacPherson Bay have been included in this table.

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Table C-2: Seine Netting Location and Catch Data, 2007

ID	Location	Spottail shiner	Spotfin shiner	Round goby	Longnose gar	White sucker	Bluntnose minnow	Banded killifish	Emerald shiner	Yoy shiner	Yellow perch	Sand shiner	Lake chub	Alewife	Rainbow smelt
1	MacPherson Bay	1	—	1	—	—	—	—	—	—	—	—	—	—	—
2	MacPherson Bay	—	—	1	—	—	—	—	3	—	—	—	—	—	—
3	MacPherson Bay		—	4	—	—	—	—	—	—	—	—	—	—	—
4	MacPherson Bay	7	—	76	1	—	—	—	—	—	—	—	—	—	—
15	MacPherson Bay	10	—	—	—	5	—	—	—	—	—	—	—	—	—
16	MacPherson Bay	6	—	19	—	—	1	—	—	—	—	—	—	—	—
17	MacPherson Bay	8	—	1	—	1	—	—	2	—	—	—	—	—	—
18	MacPherson Bay	7	—	5	—	1	—	—	—	—	—	—	—	—	—
19	MacPherson Bay	4	—	32	—	—	—	—	—	—	—	—	—	—	—
20	MacPherson Bay	11	—	29	—	—	—	—	—	—	—	—	—	—	—
32	MacPherson Bay	80	—	3	—	—	—	1	—	15	1	—	—	—	—
33	MacPherson Bay	26	—	7	—	—	—	—	—	8	—	—	—	—	—
34	MacPherson Bay	2	—	9	—	—	—	1	—	—	—	—	—	—	—
35	MacPherson Bay	14	4	3	—	1	—	—	26	6	—	8	—	—	—
36	MacPherson Bay	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37	MacPherson Bay	—	—	1	—	—	—	—	—	—	—	1	—	—	—
38	MacPherson Bay	3	—	4	—	—	—	—	—	—	—	—	—	—	—
39	MacPherson Bay	1	4	2	—	1	1	—	2	—	—	7	—	—	—
40	MacPherson Bay	1	—	2	—	—	—	—	—	24	—	—	1	—	—
41	MacPherson Bay	4	—	2	—	—	—	—	—	1	—	—	—	—	—
42	MacPherson Bay	6	—	53	—	—	—	—	4	33	1	2	—	—	—
53	MacPherson Bay	3	—	—	—	—	—	—	—	—	—	—	—	—	—
54	MacPherson Bay	1	—	—	—	—	—	—	—	—	—	—	—	1	—
55	MacPherson Bay	1	—	—	—	—	—	—	—	—	—	—	—	—	—
56	MacPherson Bay		—	1	—	—	—	—	—	—	—	—	—	—	—
57	MacPherson Bay	—	—	—	—	—	—	—	—	—	—	—	—	—	—
58	MacPherson Bay	63	—	2	—	—	—	—	—	—	—	—	—	—	1
59	MacPherson Bay	10	—	1	—	—	—	—	—	—	—	—	—	—	—
60	MacPherson Bay	3	—	1	—	—	—	—	—	—	—	—	—	—	—
61	MacPherson Bay	41	—	2	—	—	—	—	—	—	—	—	—	—	—
62	MacPherson Bay	40	—	2	—	—	—	—	—	—	—	—	—	—	—

Note: — not captured

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Table C-3: Biological Data for Fish Captured during South Railway Ditch Backpack Electroshocking, 2007

Species	Total Length (mm)	Fork Length[a] (mm)	Weight (g)
Central Mudminnow	70	—	4
Central Mudminnow	23	—	<2
Central Mudminnow	23	—	n/a
Central Mudminnow	78	—	5.5
Central Mudminnow	65	—	3.75
Central Mudminnow	25	—	<2
Central Mudminnow	27	—	<2
Central Mudminnow	23	—	<2
Central Mudminnow	23	—	<2
Central Mudminnow	23	—	<2
Central Mudminnow	23	—	<2
Central Mudminnow	68	—	4.1
Central Mudminnow	63	—	3
Central Mudminnow	60	—	3
Central Mudminnow	22	—	<2
Central Mudminnow	22	—	<2
Central Mudminnow	75	—	6.5
Central Mudminnow	62	—	3.5
Central Mudminnow	80	—	8.5
Central Mudminnow	70	—	4
Central Mudminnow	73	—	5
Central Mudminnow	92	—	10
Central Mudminnow	70	—	3
Central Mudminnow	90	—	10
Central Mudminnow	78	—	7.5
Central Mudminnow	83	—	8
Central Mudminnow	75	—	7
Central Mudminnow	105	—	13.5
Central Mudminnow	68	—	3
Central Mudminnow	70	—	7

Table C-3: Biological Data for Fish Captured during South Railway Ditch Backpack Electroshocking, 2007 (continued)

Species	Total Length (mm)	Fork Length[a] (mm)	Weight (g)
Central Mudminnow	67	—	4
Central Mudminnow	68	—	4
Central Mudminnow	67	—	4
Central Mudminnow	74	—	5.5
Central Mudminnow	83	—	9
Central Mudminnow	78	—	7
Central Mudminnow	63	—	3.5
Central Mudminnow	75	—	5.5
Central Mudminnow	66	—	3.5
Central Mudminnow	68	—	5
Central Mudminnow	75	—	6.5
Central Mudminnow	55	—	3
Central Mudminnow	60	—	3.75
Central Mudminnow	77	—	8
Central Mudminnow	95	—	10
Central Mudminnow	97	—	11
Central Mudminnow	75	—	5
Central Mudminnow	65	—	5
Central Mudminnow	69	—	5
Central Mudminnow	73	—	5.5
Central Mudminnow	80	—	6.5
Northern Redbelly Dace	45	42	<2
Northern Redbelly Dace	46	42	<2
Northern Redbelly Dace	40	37	<2
Northern Redbelly Dace	42	38	<2
Northern Redbelly Dace	44	40	<2
Northern Redbelly Dace	45	41	<2
Northern Redbelly Dace	44	40	<2
Northern Redbelly Dace	44	40	<2
Northern Redbelly Dace	50	45	2

Table C-3: Biological Data for Fish Captured during South Railway Ditch Backpack Electroshocking, 2007 (continued)

Species	Total Length (mm)	Fork Length[a] (mm)	Weight (g)
Northern Redbelly Dace	40	37	<2
Northern Redbelly Dace	45	41	<2
Northern Redbelly Dace	45	41	<2
Northern Redbelly Dace	45	41	<2
Northern Redbelly Dace	36	33	<2
Northern Redbelly Dace	50	45	2
Northern Redbelly Dace	46	40	<2
Northern Redbelly Dace	45	n/a	tail eroded
Northern Redbelly Dace	35	33	<2
Northern Redbelly Dace	37	34	<2
Northern Redbelly Dace	44	40	<2
Northern Redbelly Dace	39	36	<2
Northern Redbelly Dace	25	n/a	tail eroded
Northern Redbelly Dace	47	43	<2
Northern Redbelly Dace	47	43	<2
Northern Redbelly Dace	47	43	<2
Northern Redbelly Dace	45	42	<2
Northern Redbelly Dace	45	42	<2
Northern Redbelly Dace	47	44	<2
Northern Redbelly Dace	45	42	<2
Northern Redbelly Dace	45	42	<2
Northern Redbelly Dace	53	50	2.5
Northern Redbelly Dace	47	45	<2
Northern Redbelly Dace	43	40	<2
Northern Redbelly Dace	45	42	<2
Northern Redbelly Dace	52	49	2.5
Northern Redbelly Dace	43	40	<2
Northern Redbelly Dace	35	32	<2
Northern Redbelly Dace	46	42	<2
Northern Redbelly Dace	45	42	<2

Table C-3: Biological Data for Fish Captured during South Railway Ditch Backpack Electroshocking, 2007 (continued)

Species	Total Length (mm)	Fork Length[a] (mm)	Weight (g)
Northern Redbelly Dace	48	45	2
Northern Redbelly Dace	45	42	<2
Northern Redbelly Dace	41	37	<2
Northern Redbelly Dace	53	49	<2
Northern Redbelly Dace	48	45	<2
Brook Stickleback	43	—	<2
Brook Stickleback	25	—	<2
Brook Stickleback	25	—	<2
Brook Stickleback	25	—	<2
Brook Stickleback	25	—	<2
Brook Stickleback	26	—	<2
Brook Stickleback	26	—	<2
Brook Stickleback	22	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	33	—	<2
Brook Stickleback	32	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	26	—	<2
Brook Stickleback	23	—	<2
Brook Stickleback	23	—	<2
Brook Stickleback	18	—	<2
Brook Stickleback	18	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	36	—	<2

Table C-3: Biological Data for Fish Captured during South Railway Ditch Backpack Electroshocking, 2007 (continued)

Species	Total Length (mm)	Fork Length[a] (mm)	Weight (g)
Brook Stickleback	24	—	<2
Brook Stickleback	55	—	<2
Brook Stickleback	33	—	<2
Brook Stickleback	31	—	<2
Brook Stickleback	30	—	<2
Brook Stickleback	29	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	31	—	<2
Brook Stickleback	33	—	<2
Brook Stickleback	41	—	<2
Brook Stickleback	32	—	<2
Brook Stickleback	25	—	<2
Brook Stickleback	32	—	<2
Brook Stickleback	18	—	<2
Brook Stickleback	34	—	<2
Brook Stickleback	27	—	<2
Brook Stickleback	28	—	<2
Brook Stickleback	28	—	<2
Brook Stickleback	29	—	<2
Brook Stickleback	20	—	<2
Brook Stickleback	26	—	<2
Brook Stickleback	33	—	<2
Brook Stickleback	28	—	<2
Brook Stickleback	23	—	<2
Brook Stickleback	24	—	<2
Brook Stickleback	38	—	<2
Creek Chub	112	105	15
Creek Chub	115	100	15
Creek Chub	100	95	10.5
Creek Chub	132	125	22

Table C-3: Biological Data for Fish Captured during South Railway Ditch Backpack Electroshocking, 2007 (continued)

Species	Total Length (mm)	Fork Length[a] (mm)	Weight (g)
Creek Chub	95	92	10
Creek Chub	135	130	25
Creek Chub	137	130	25
Creek Chub	50	45	10
Creek Chub	153	146	35
Creek Chub	84	79	6.5
Creek Chub	100	90	9.5
Creek Chub	105	97	9.5
Creek Chub	95	90	8.5
Creek Chub	143	135	30
Creek Chub	110	100	16
Creek Chub	110	103	13
Creek Chub	150	140	36
Creek Chub	130	122	23
Creek Chub	115	110	18.5
Creek Chub	87	83	7.5
Creek Chub	92	85	8
Creek Chub	120	111	19
Creek Chub	87	82	6
Creek Chub	108	100	12
Creek Chub	120	114	16
Creek Chub	144	135	28
Creek Chub	131	124	24
Creek Chub	81	78	6
Creek Chub	102	96	10
Creek Chub	161	153	42
Creek Chub	87	81	8
Creek Chub	106	99	12
Creek Chub	104	96	10
Creek Chub	113	105	12

Table C-3: Biological Data for Fish Captured during South Railway Ditch Backpack Electroshocking, 2007 (continued)

Species	Total Length (mm)	Fork Length[a] (mm)	Weight (g)
Creek Chub	90	84	8
Creek Chub	108	102	12
Creek Chub	136	127	26
Creek Chub	145	139	32
Creek Chub	120	112	18
Creek Chub	114	105	14
Fathead Minnow	63	57	4
Fathead Minnow	73	67	5
Fathead Minnow	59	54	3
Fathead Minnow	63	59	4
Fathead Minnow	65	61	4
Fathead Minnow	57	54	3
Fathead Minnow	59	56	3
Brassy Minnow	55	50	2
Brassy Minnow	57	53	4
Brassy Minnow	67	54	2

Notes:
a Fork length not recorded for species that do not have fork (e.g., central mudminnow).
— Not applicable
n/a Not available

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APPENDIX D: AQUATIC HABITAT MAPPING

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LEGEND

- Proposed Stormwater Discharge Ditch
- Boundary of Substrate Survey
- Local Bathymetry (m)
- Project Area (OPG-retained lands that encompass the DGR Project)
- Bedrock
- Boulder (>250mm)
- Cobble (64-250mm)
- Gravel (2-64mm)
- Sand (<2mm)
- Site Study Area [1]

NOTES

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

REFERENCE

Bruce Power, 2008. Bruce New Nuclear Power Plant Project Environmental Assessment Aquatic Environment TSD. Base Data Provided by 4DM, November 2007. Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m, Datum: NAD 83 Projection: UTM Zone 17N

0 125 250 500

Metres

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

MACPHERSON BAY HABITAT ASSESSMENT

Golder Associates
Mississauga, Ontario

PROJECT NO. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct. 2007		
GIS	BC	11 Nov. 2010	**FIGURE D-1**	
CHECK	AB	11 Nov. 2010		
REVIEW	MAR	11 Nov. 2010		

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LEGEND

- Aquatic Macrophyte Bed
- Exposed/Marginal Spawning/Nursery Habitat
- Recreational Fishing Area
- Sheltered Spawning/Nursery Habitat
- Fish Migration Route
- Local Bathymetry (m)
- Fish Migration Barrier
- Shoal
- Site Study Area [1]
- Project Area (OPG-retained lands that encompass the DGR Project)

NOTES

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

The ELC data within the Site Study Area was collected during 2007. The ELC data within Project Area was updated during 2009 survey.

REFERENCE

Bruce Power, 2008. Bruce New Nuclear Power Plant Project Environmental Assessment Aquatic Environment TSD.
Base Data Provided by 4DM, November 2007.
Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m,
Datum: NAD 83 Projection: UTM Zone 17N

0 500 1,000 2,000
Metres

PROJECT
AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE
GENERAL AQUATIC HABITAT FEATURES
SITE STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 6-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	03 Aug. 2006	**FIGURE D-2**	
GIS	BC	11 Nov. 2010		
CHECK	KC	11 Nov. 2010		
REVIEW	AB	11 Nov. 2010		

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0 250 500 1,000

Metres

LEGEND

- Aquatic Vegetation
- Smallmouth Bass Nesting Locations
- Local Bathymetry (m)
- Site Study Area [1]
- Project Area (OPG-retained lands that encompass the DGR Project)

NOTES

1. Site Study Area is defined by EIS Guidelines as: "includes the facilities, buildings and infrastructure at the Bruce nuclear site, including the existing licensed exclusion zone for the site on land and within Lake Huron, and particularly the property where the Deep Geologic Repository is proposed.

REFERENCE

Bruce Power, 2008. Bruce New Nuclear Power Plant Project Environmental Assessment Aquatic Environment TSD. Base Data Provided by 4DM, November 2007. Imagery and Topo Collected and Processed by Terrapoint Canada Inc., Acquisition Date: Nov. 12, 14, and 15, 2006, Ground Resolution: 0.25m, Datum: NAD 83 Projection: UTM Zone 17N

PROJECT

AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT

TITLE

SMALLMOUTH BASS NESTING LOCATIONS AND AREAS OF DENSE AQUATIC VEGETATION

Golder Associates
Mississauga, Ontario

PROJECT NO. 06-1112-037			SCALE: AS SHOWN	R000
DESIGN	ASB	17 Oct. 2007		
GIS	BC	11 Nov. 2010		
CHECK	AB	11 Nov. 2010		
REVIEW	MAR	11 Nov. 2010		

FIGURE D-3

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