PMD 13-P1.80

File / dossier : 8.01.07
Date: 2013-08-12
Edocs: 4184183

Oral intervention from

The Canadian Environmental Law Association

In the Matter of

Ontario Power Generation Inc.

Proposed Environmental Impact Statement for OPG's Deep Geological Repository (DGR) Project for Low and Intermediate Level Waste

Joint Review Panel

September 16 to October 12, 2013

Intervention orale par

The Canadian Environmental Law Association

À l'égard de

Ontario Power Generation Inc.

Étude proposée pour l'énoncé des incidences environnementales pour l'Installation de stockage de déchets radioactifs à faible et moyenne activité dans des couches géologiques profondes

Commission d'examen conjoint

16 septembre au 12 octobre 2013

Canada

Panel Member Document:

DGR Joint Review Panel Hearing - Written Submission in Support of an Oral Intervention

Final comments to the Joint Review Panel for the Deep Geologic Repository Project for Low and Intermediate Level Radioactive Waste Project – Environmental Impact Statement and Licence to Prepare Site and Construct Application

Prepared for Canadian Environmental Law Association

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August 2013

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Glossary

CEA – Cumulative effects assessment
CEAA – Canadian Environmental Assessment Agency
CELA – Canadian Environmental Law Association
CNSC – Canadian Nuclear Safety Commission
DGR – Deep geological repository
EIS – Environmental Impact Statement
IAS – Golder Associates' independent assessment study
ILW – Intermediate level nuclear waste
IR – Information request
IWTS – Integrated waste tracking system
JRP – Joint review panel
L&ILW – Low and intermediate level nuclear waste
LLW – Low level nuclear waste
OPG – Ontario Power Generation
PAR – Public attitudinal research
VEC – Valued ecosystem component
WWMF – Western Waste Management Facility

Author Bios

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Kyrke Gaudreau recently completed his PhD in social and ecological sustainability at the University of Waterloo where his research focused on the sustainability assessment of energy systems. Kyrke has consulted on various strategic and environmental assessments of energy systems in Canada, and has researched energy systems sustainability in several different countries. Kyrke serves on the editorial board of Alternatives Journal, where he writes for a popular audience on a variety of environmental, social and technical issues.

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Robert Gibson is a tenured Professor and Associate Chair, Graduate Studies, in the Department of Environment and Resource Studies at the University of Waterloo. Bob has worked mostly on environmental and sustainability policy issues. His research and writing have centred on decision-making successes and failures in environmental planning, assessment and regulation in various Canadian jurisdictions and on the emerging design and practice of sustainability assessment. Since 1984, he has been co-editor or editor or (now) editorial board chair of the Canadian environmental journal, Alternatives Journal.

Before coming to Waterloo in the early 1980s, Bob worked for a variety of government agencies and native and environmental groups. Since then he has continued to work with a variety of such organizations on the design and application of environmental law and policy. This collaborative work also informs his academic research on how best to integrate broad sustainability considerations in a wide range of decision-making venues including urban growth management, in corporate greening, and in environmental assessments at the project and strategic levels.

His book on *Sustainability Assessment* was published by Earthscan in 2005.

1. Introduction

The purpose of this report is to provide a final commentary to the Joint Review Panel (JRP) on behalf of the Canadian Environmental Law Association (CELA) regarding whether and if so how the proposed Deep Geological Repository (DGR) proposed by Ontario Power Generation (OPG) promotes sustainable development in general, and may lead to a long-term positive outcome for the municipality of Kincardine, and the government and citizens of Ontario.

This report focuses primarily upon deficiencies in the Environmental Impact Statement (EIS) provided by OPG, as well as OPG's responses to information requests submitted by the JRP on matters raised by CELA. These deficiencies relate primarily to the following four themes:

1. Section 2 – Justification for the proposed DGR project;
2. Section 3 – Consideration of alternative means of carrying out the project; and
3. Section 4 – Consideration of the extent to which the project will contribute to sustainable development, particularly with respect to
    a. the cumulative effects of the project; and
    b. the perpetual care and monitoring of the DGR.
4. Section 5 – Consideration of the precautionary principle.

2. Justification for the Proposed DGR Project

OPG is obliged by the JRP Agreement, Terms of Reference for the Review (Appendix, Part IV) and the EIS Guidelines (s.7.1-7.3) to clearly describe the need for and purpose of the proposed DGR project and to determine the most appropriate option from a range of options for the management of long-lived radioactive waste. In light of this basic concern to determine the most appropriate option, OPG's description of need should have

- clearly defined the problem/opportunity that the proposed DGR project intends to solve/satisfy; and
- established the fundamental rationale for the proposed project based on a demonstration that the proposed DGR is the most appropriate option, among a range of options (including "alternatives to" and "alternative means"), to solve/satisfy the problem/opportunity.

2.1 Consideration of Need

OPG's description of need and purpose should have provided an adequate context for the identification and consideration of alternatives to and alternative means of carrying out the DGR (s.7.1 EIS Guidelines). In sections 2.1 – 2.2, below, we provide notes to the JRP on the inadequacy of OPG's consideration of need for and purpose of the proposed DGR project.

OPG considers the need for the DGR primarily in sections 3.2 (Need for the Project) and 4.5 (Waste to be Placed in the DGR) of the EIS. These subsections describe the need for the DGR in relation to

i) OPG's legislated responsibility for managing L&ILW (s. 3.2.1),
ii) OPG's long-term financial planning (s. 3.2.2),
iii) OPG's Independent Assessment Study (IAS) (s. 3.2.3),
iv) the Municipality of Kincardine Council endorsement of the Deep Rock Vault option as the preferred course of study in regards to the management of L&ILW (s. 3.2.4),
v) a community poll to guage public opinion of the DGR (s. 3.2.7), and
vi) existing and future L&ILW (s. 4.5).

The above points provide some relevant information about OPG's legal responsibilities, capacity to achieve them, and the local context within which the proposed project may be undertaken. But they fail to establish the fundamental rationale for the proposed DGR and provide a precise description of the problem/opportunity to be solved/satisfied.

Consider point (i), OPG's description of its legislated responsibility for managing L&ILW. These regulatory requirements constitute, in part, the legislative framework that governs the management of long-term radioactive wastes. They do not define the problem/opportunity to be solved/satisfied by the proposed DGR. Nor do they provide an adequate rationale for the proposed DGR project, specifically speaking. In fact, there is no legal basis for the DGR project, per se. In other words, CNSC rules and regulations do not explicitly point to the DGR as the preferred option for managing long-term radioactive waste.

Point (ii) refers to OPG's long-term financial planning. OPG describes the amount of funds that it has set aside solely for the long-term management of waste and for the decommissioning of its generating stations. The amount of money in OPG's financial coffers is, however, not a problem/opportunity or a rationale for the proposed DGR project. OPG's coffers should be considered in light of the full range of costs and capabilities associated with planned and potential future nuclear waste management undertakings, including construction, operation, maintenance, refurbishment, decommissioning and abandonment; and costs and capabilities associated with potential contingencies (e.g., costs of accidents, as demonstrated by Japan's Fukushima accident; economic recessions and depressions, etc.), among other costs.

Point (iii) relates to the IAS undertaken by Golder Associates Ltd., under the terms of a MOU between OPG and the Municipality of Kincardine. The IAS examined the costs, impacts and benefits of constructing and operating each of three long-term management concepts at the Western Waste Management Facility (WWMF): Enhanced Processing and Storage; Surface Concrete Vaults; and Deep Rock Vaults. OPG asserts that the Municipality of Kincardine showed a preference for the Deep Rock Vault option based on the findings of the IAS. But the IAS was completed in 2004, before the CNSC determined the type of EA required for the proposed DGR project and before the EIS Guidelines were drafted and the applications of CEAA requirements were confirmed. While Golder's IAS document includes information relevant to the JRP review, it rests on an agenda and scope far narrower than what is required for the present process. Most significantly, the IAS considers only a set of options at the WWMF site. Its examination of the WWMF site options did not extend around decommissioning and abandonment stages (as per section 4 of the EIS Guidelines), among many other requirements set out in the EIS Guidelines. Furthermore, Golder did not explicitly consider ILW in the Engineering Feasibility and Safety and Licensibility components of the IAS. Only LLW was considered. The results of the IAS, therefore, cannot provide a sound rationale for the DGR project as the preferred alternative.

Points (iv) and (v) refer to the “willing host” criterion, which is an integral requirement for such nuclear waste management projects as the DGR. While the willing host criterion is admirable in its consideration of community acceptance, it fails to address the full range of social, economic, and ecological concerns required under CEAA and the EIS Guidelines. Moreover, there are no grounds for assuming that the Municipality of Kincardine represents the only current or potential willing host for a L&ILW undertaking. Indeed, the on-going deliberations on options for long-term disposal of high-level radioactive waste indicate that there may be several already self-identified potential willing host communities in Ontario.

Point (vi) refers to the tables provided in section 4.5 of the EIS, which describe the operational and refurbishment wastes to be emplaced in the DGR, and include information on waste sources, inventories, and the physical, radiological and chemical characteristics of the wastes. OPG also projects the amount of waste and number of packages that will be sent to the DGR over the life of OPG’s nuclear program. In presenting this information, however, OPG does not establish a rationale for the DGR project specifically. At best, subsection 4.5 of the EIS establishes initial grounds for OPG to consider how best to manage these long-lived radioactive wastes. The possible options clearly extend well beyond those at the WWMF site.

Furthermore, OPG’s projections are too uncertain to clearly define the problem/opportunity that the project aims to solve/satisfy. As OPG explains, the amount of waste and number of packages projected over the life of OPG’s nuclear program are calculated based on the existing inventory tracked in an electronic records system called the Integrated Waste Tracking System (IWTS), and a future waste receipt projection. The receipt forecast is based on the planning assumption of refurbishment of all reactor units at or near their mid-life, and then operating for a further 25 to 30 years after refurbishment. As OPG admits, however, the waste volume forecast is subject to changes to the nuclear operating and refurbishment program; standardization across stations; improvements to waste processing technology; and changes to repository storage technology. OPG also admits that the forecast does not take into account OPG’s decision not to refurbish Pickering B. Even fully reliable projections would not justify any particular option for dealing with the wastes involved. Uncertain projections of the sort provided so far, however, make it difficult to determine long-term capacity needs, which represent one of the parameters for selection among possible options. OPG’s projections would therefore seem to be, if anything, a barrier to justification of any particular option.

Finally, OPG has not been transparent and precise about the amount of L&ILW that it receives at the WWMF from Darlington, Pickering, and Bruce, respectively. Missing are precise volumes per facility per year or other aggregate sums; precise data related to the current projected lifetimes of each reactor unit, and details about the assumptions made with respect to refurbishment of each reactor unit.

Again, OPG’s justification for the DGR project should have emerged from a clear description of the problem and a comprehensive and transparent assessment of options, as required by CEAA, for the management of long-lived radioactive waste. None of the above points provided by OPG demonstrates that this was the case. Below, we discuss how OPG's need and purpose descriptions do not provide an adequate context for consideration of alternatives, which would be a prerequisite for establishing that any one option (including the current proposed project) is to be preferred.

2.2 Consideration of Purpose and Context for Alternatives

OPG provides a description of the purpose of the proposed DGR project in section 1.2 (Project Overview and Purpose) of the EIS: "The DGR will receive L&ILW currently stored at the WWMF on the Bruce nuclear site, as well as that produced from OPG-owned or operated generating stations. The DGR Project would provide safe long-term management of L&ILW in Ontario" (p. 40). This, however, is a statement of the anticipated *function* of the proposed DGR project. It is not an appropriate statement of the *purpose* of a project that, in the environmental assessment process, must be justified in comparison with reasonable alternatives.

Additionally, OPG's purpose statement fails to provide an adequate context for the consideration of alternatives (as required in the EIS Guidelines, s.7.1) because it is too narrowly focused on the DGR specifically. Similarly, OPG's description of need is entirely focused on the DGR as opposed to building a strong case for identifying the most appropriate option for managing long-lived radioactive waste. The IAS provides some indication that OPG considered a very narrow range of other options. As previously mentioned, however, the IAS does not cover options in other potential locations or provide a comprehensive assessment of the WWMF options. It consequently does not support an assumption that the DGR would emerge as the preferred option. The EIS presently before the JRP does not demonstrate that OPG undertook a comprehensive and transparent assessment of alternatives as required by the terms of reference for the review (Terms of Reference, Appendix Part IV and the EIS Guidelines 7.1-7.3) in order to determine what project or set of projects would be the most appropriate option for managing long-lived low and intermediate level radioactive waste.

In sections 3 and 4, below, we discuss some specific problems in OPG's assessment of alternatives. Then, we discuss OPG's inadequate consideration of sustainability under CEAA.

3. Consideration of Alternative Locations for the DGR

Siting is a fundamentally important activity in the geological disposal of long-lived radioactive waste. One critical issue concerning OPG's consideration of alternative means is that a systematic comparative evaluation of alternative sites was not undertaken. OPG's rationale for not evaluating other sites rests on the 'willing host' criterion, OPG's assumption that Bruce geology is most likely highly suited, and the higher transportation costs associated with other locations, among other considerations (see OPG's EIS, section 3.2.5). These concerns are relevant but clearly insufficient. It is possible and currently seems likely that there may be several willing host communities and that at least some of these may offer siting attributes equal or superior to those of the WWMF site. CELA submitted an IR to the panel making the following request:

Provide a rationale for the lack of systematic comparative evaluation of alternative sites. The rationale must explain why OPG selected the Bruce site as opposed to other sites with suitable geologic attributes. Provide detailed information about the suitability of the Bruce site relative to other sites with different suitable geological attributes.

This IR was forwarded by the JRP to OPG in Panel request EIS-02-40. The requests and an excerpt from OPG's response are shown in 3.1-1, below.

Table 3.1-1 – Panel IR EIS-02-40 – Alternative locations considered for the DGR

Related Panel Request EIS-02-40	Provide further information on the location, salient features, evaluation criteria used, and a summary presentation of the comparison and selection process for alternative locations considered for the DGR. **Context:** The EIS Guidelines directs the proponent to consider the siting of the DGR in a location outside the existing site as an alternative mean. A brief reference is made to this matter in Table 3.4.2-1 and in Section 3.2.5 - "…the possibility of pursuing a Greenfield site at a location other than Kincardine was considered." No supporting information is provided as to what off-site locations were considered and to what extent.
OPG Response	OPG's response to EIS-02-40 stated that the Memorandum of Understanding signed with the Municipality of Kincardine in 2002 intended that longterm management options for OPG's L&ILW be studied for implementation at the Bruce nuclear site, hence, the technical and socio-economic studies documented in the Independent Assessment Study (GOLDER 2004) considered only alternatives on the Bruce nuclear site. OPG continues to describe, "Subsequent to this study, and as stated in Section 3.2.5 of the EIS '…the possibility of pursuing a Greenfield site at a location other than Kincardine was considered'. This was not intended to imply that one or more specific greenfield sites were identified and assessed. Rather it refers to the approach that was taken to the assessment of alternative sites. This is described in the EIS; that is, looking conceptually at the alternative of locating the DGR Project on the Bruce nuclear site versus seeking a greenfield site off the Bruce nuclear site."

OPG's response indicates that no additional analysis was undertaken to provide evidence that the

Bruce nuclear site should be the preferred alternative. Rather, OPG simply reiterated the 'willing host' criterion and the information provided in the EIS. Given the characteristics of the proposed DGR, it is unacceptable for OPG to offer only a broad conceptual rejection of alternative locations. The glaring omission is that there has been no *real* comparison of alternative sites for the DGR.

International standards for siting geological disposal facilities recommend the following:

"In site selection, one or more candidate sites are selected after the investigation of a large region, the rejection of unsuitable sites and the screening and comparison of the remaining sites. From several, possibly many, prospective sites identified at the start of a siting process, a selection is made of one or more preferred sites on the basis of geological setting and with account taken of other factors" (IAEA, 2011, p. 55).

As the above quote reveals, many authorities hold that the most important issue with respect to siting is the long-term safety of the site in relation to the geosphere, especially given the thousands of years over which the repository will house potentially harmful radioactive waste (OECD, 1999; OECD, 2009; Wallace, 2010; IAEA, 2011).

Moreover, international EA experience in relation to the geological disposal of radioactive waste has emphasized the importance of performing detailed analyses of the differences between and among alternative sites in terms of their radiation safety (e.g., Swedish Radiation Safety Authority, 2011, p.12). Similarly, EU EIA legislation emphasizes the integral role of EA in selecting a preferred site for development: "The EIA Report should incorporate information on the assessed performance of the preferred site for development together with comparative information for alternative sites" (O'Sullivan et al., 1999, p. 5)

OPG must provide additional information about the suitability of the Bruce site relative to other sites in order to present a sound rationale for the proposed DGR project. In particular, OPG must provide detailed information on alternative sites with different geological attributes. Sykes (2003) notes that one required attribute of the geosphere for a deep disposal system for radioactive waste is stagnant or sluggish groundwater flow at repository depths. The plutonic rock of the Canadian Shield has this attribute:

"The characteristics of plutonic rock have been studied at the Whiteshell Research Area (WRA) near Lac du Bonnet Manitoba…The hydrogeochemical data indicate that below 500 m at the Underground Research Laboratory, groundwaters are very saline, reducing, and old. The groundwater can be considered as essentially stagnant over the period of concern for a waste facility (1,000,000 years). The very low permeability of the rock supports this conclusion" (Sykes, 2003).

In fact, historically speaking, the preferred host medium for long-lived nuclear waste in Canada has been the plutonic rocks in the Canadian Shield (Dormuth et al., 1989). As Sykes (2003) notes, Ontario has significant quantities of plutonic rock for such projects as deep geologic repositories. In light of this obvious potential for other suitable sites, it is difficult to see how OPG might justify its lack of analyses of alternative sites. OPG's justification for the current proposal must present a strong case for selecting the Bruce site as opposed to sites with other suitable geologic attributes.

4. Consideration of Sustainable Development

4.1 Contributions to sustainability of the alternative means

Section 2.4 of the EIS Guidelines obliges OPG to consider the extent to which the proposed DGR project contributes to sustainable development. The basic steps for adequate attention to this obligation are quite simple (see Gibson, 2000, 2005, 2006). OPG's description of need and purpose should have rested, in part, on a recognition that the proposed project must, in comparison with other options, contribute to sustainability while avoiding significant adverse effects.

CELA submitted an IR to the panel posing the following request:

Provide the following additional information to clarify how OPG considered the extent to which the proposed DGR project will contribute to sustainability:

a) Describe the sustainability-based criteria that OPG adopted to evaluate and compare the effects of the proposed DGR project, alternatives to the project, and alternative means of carrying out the project.
b) Describe the relative contributions to sustainability of the alternative means of carrying out the project.

This IR was forwarded by the JRP to OPG in Panel request EIS-06-273. The requests and an excerpt from OPG's response are shown in 4.1-1, below.

Table 4.1-1 – Panel IR EIS-06-273 – Contributions to sustainability of the alternative means

Related Panel Request EIS-06-273	Provide a description of the sustainability-based criteria that OPG adopted to evaluate and compare the alternative means of carrying out the project, and a description of the relative contributions to sustainability of the alternative means of carrying out the project. **Context:** In Section 2.4 of the EIS Guidelines states that "The project, including its alternative means, must take into account the relations and interactions among the various components of the ecosystems and meeting the needs of the population. The proponent must include in the EIS consideration of the extent to which the Project contributes to sustainable development."
OPG Response	OPG asserts that it applied sustainability concepts (consumption of energy resources, impact on ecosystems, production of wastes, and impact on economy) in its evaluation of alternative means. A table is provided that shows how OPG applied these concepts to a range of alternative means.

It is clear that OPG did not incorporate throughout the EIS consideration of the relative contributions to sustainability of the alternative means. One remaining inadequacy is that the alternative means analysis did not extend to the matters addressed in Sections 7 (Effects Prediction, Mitigation Measures and Significance of Residual Effects), 8 (Malfunctions, Accidents and Malevolent Acts), and 9 (Long-Term Safety of the DGR). OPG should have applied a comprehensive set of sustainability criteria throughout the EIS process (including how all of the alternative means would perform in all stages of the project and in relation to all potential impacts) in order to provide a basis for determining the most appropriate option.

Specifically, OPG should have

- set out a comprehensive set of sustainability-based evaluation criteria that combine the generic requirements for progress towards sustainability with particular attention to the key considerations surrounding selection among options for best management of low and intermediate level radioactive wastes;
- shown how these criteria were applied in the comparative evaluation of the options throughout the decision making process, in relation to all project phases, mitigation of adverse effects, and potential impacts; and
- showed how the preferred alternatives have been selected, in light of the criteria, and with clear justifications for any trade-offs among the criteria that may be entailed by proceeding with the proposed project.

Instead, OPG decided on the preferred alternative means based on a partial analysis of their sustainability performance.

4.2 Cumulative effects

Chapter 10 of the EIS presents OPG's approach to cumulative effects assessment (CEA). CEA is a critical component of sustainability-based assessment and informed decision-making due to the concerns for crossing critical thresholds and encountering negative synergy, as well as the potential for achieving mutually reinforcing positive gains. As Duinker and Greig (2006) note, "cumulative effects are the only real effects worth assessing in most EIAs." This section describes various concerns with OPG's CEA.

4.2.1 OPG's determination of 'significance' of effects

Section 11.3 of the EIS guidelines states that "the EIS must clearly explain the method and definitions used to describe the level of the adverse effect (e.g., low, medium, high) for each of the above categories and how these levels were combined to produce an overall conclusion on the significance of adverse effects for each VEC."

OPG claims its CEA was consistent with the CEAA Cumulative Effects Practitioners Guide. Section 3.1 of the Practitioners Guide provides the following three 'fundamental' tasks of CEA:

a) Determine if the project will have an effect on a VEC.
b) If such an effect can be demonstrated, determine if the incremental effect acts cumulatively with the effects of other actions, either past, existing or future.
c) Determine if the effect of the project, in combination with the other effects, may cause a significant change now or in the future in the characteristics of the VEC after the application of mitigation for that project.

As can be seen, significance as addressed in Step 3 of the guide implies that it is necessary to consider all effects on the VECs, not simply those effects that are individually considered significant. To this end, we note the CEA Practitioners Guide is very clear on this subject, as in Section 3.5.2 they note a "cumulative effect on a VEC may be significant even though each individual project-specific assessment of that same VEC concludes that the effects are insignificant. This is a fundamental principle in the understanding of cumulative effects". Later the Guide notes, "an insignificant local effect may still contribute to a significant cumulative effect!" (exclamation included in original).

Despite the point noted above, it appears OPG's approach to CEA only considered effects that were significant at the individual level, as opposed to potentially significant at the cumulative level. For example, the CEA method outlined by OPG in Figure 10.2-1 does not seem to include residual adverse effects of the DGR project that are insignificant themselves, but may contribute to significant cumulative effects. For these reasons, CELA submitted an IR to the panel with the following request.

Please provide the following information with respect to the significance of cumulative effects of the proposed DGR Project:

a) Describe how significance was included in the assessment of cumulative effects.
b) Explain why OPG chose not to assess effects that may not be significant on their own, but may still be significant at the cumulative effects level.

This IR was forwarded by the JRP to OPG in Panel request EIS-08-361. The requests and an excerpt from OPG's response are shown in 4.2-1, below.

Table 4.2-1 – Panel IR EIS-08-361 - Determining significance of cumulative effects

Related Panel Request EIS-08-361	Explain the rationale for not assessing effects that may not be significant on their own, but that may still be significant at the cumulative effects level; i.e., interactive effects via processes such as trophic cascades or changes caused by alteration in a habitat-related VEC Describe the logic used to assess the significance of cumulative effects, including significance over the entire spatial and temporal scale of the proposed project. **Context:** This IR follows from EIS-08-358. In Section 11.3 of the EIS guidelines, it is stated that "the EIS must clearly explain the method and definitions used to describe the level of the adverse effect (e.g., low, medium, high) for each of the above categories and how these levels were combined to produce an overall conclusion on the significance of adverse effects for each VEC." Section 3.1 of the CEAA Cumulative Effects Practitioners Guide provides the following fundamental direction for cumulative effects assessment: • Determine if the project will have an effect on a VEC. • If such an effect can be demonstrated, determine if the incremental effect acts cumulatively with the effects of other actions, either past, existing or future. • Determine if the effect of the project, in combination with the other effects, may cause a significant change now or in the future in the characteristics of the VEC after the application of mitigation for that project. In Section 3.5.2 it is noted that a "cumulative effect on a VEC may be significant even though each individual project- specific assessment of that same VEC concludes that the effects are insignificant. This is a fundamental principle in the understanding of cumulative effects". It is also noted that "an insignificant local effect may still contribute to a significant cumulative effect."
OPG Response	As discussed in OPG's response to EIS-08-360, cumulative effects are assessed for residual adverse effects of the proposed project, in combination with the effects of other projects that may overlap temporally or geographically. All residual adverse effects are carried forward for consideration in the cumulative effects assessment, whether or not they have been assessed as significant. Table 1

	summarizes the components of the environment for which residual adverse effects were identified, and references the section of the Environmental Impact Statement (EIS) (OPG 2011) where the assessment of cumulative effects of each residual adverse effect is considered. The EIS (OPG 2011, Section 10.2) describes the method used to assess the cumulative effects of the DGR Project. The method used is consistent with the guidance provided by Hegmann et al. (1999). Section 7.1 (OPG 2011) describes the method used to determine significance. As no residual adverse cumulative effects were identified, assessment of significance was not warranted. [Embedded Table not shown here] Residual adverse effects on the Aboriginal interests, socio-economic environment and human health environmental components were identified in Sections 7.9.3, 7.10.3 and 7.11.6 of the EIS (OPG 2011), respectively. These residual adverse effects are due to changes in other environmental component valued ecosystem components (i.e., indirect effects). Therefore, potential cumulative effects associated with these residual adverse effects were considered through the assessment of other environmental components. For example, a potential cumulative effect on the residual adverse effect to human health from exposure to acrolein in air was considered through the assessment of air quality (OPG 2011, Section 10.5.1.4).

OPG's response ties in with a further information request relating to the determination of significance. An overall commentary will be provided following the presentation of the IR relating to significance.

Section 11.3 of the EIS guidelines states that "the EIS must clearly explain the method and definitions used to describe the level of the adverse effect (e.g., low, medium, high) for each of the above categories and how these levels were combined to produce an overall conclusion on the significance of adverse effects for each VEC."

In various instances in Section 7, the significance of the environmental effects on the various VECs is determined based on the following concerns (quoting from EIS Section 7.8.3) "magnitude, geographic extent, timing and duration, frequency, and degree of irreversibility are combined to identify an environmental consequence." In each instance, a figure is provided that shows the decision-making procedure for determining significance amongst these concerns (e.g. EIS Figure 7.8.3-1).

In all instances, OPG does not sufficiently detail how the decision-making tree was followed through, or who was undertaking the decision-making process. OPG appears to limit itself to simply arguing for the 'professional judgment' of the project team. For example, in Section 3.4 of the EIS, OPG notes, "The criteria and assessment were based on the professional judgment of the DGR Project team, which includes OPG and NWMO personnel, members of independent review groups, engineering consultants, and EA professionals. Economic feasibility was also determined based on the professional judgment of the project team. Environmental effects criteria used to assess the alternative means are described and were evaluated based on the professional judgment of the project team." Given the EIS's bias towards quantitative and measurable impacts, this reliance on professional judgment must be justified.

Within the decision-making procedure itself, OPG bases significance upon the "social/ecological importance" of the VEC, without explanation of how importance was determined. For these reasons, CELA submitted an IR to the panel making the following requests:

Please provide the following information with respect to the significance of adverse environmental effects of the proposed DGR Project:

a) Justify how decision-making procedure for determining significance of adverse effects was developed.
b) Describe the characteristics of the project team that indicate their professional judgment is sufficient, given that many of the decisions are either qualitative or the chosen magnitudes are based solely upon the professional judgment of the project team.
c) Provide details on where the reported professional judgment was unanimous, and where the presented conclusion represents a compromise (or synthesis or averaging, etc.) among a range of professional positions.
d) Justify the choice of magnitudes for significant (e.g. Table 7.5.3-1, relating to magnitude level definition for Aquatic Environment VECs).
e) Define 'Social/Ecological importance', and describe how it was determined (e.g. based upon attitudinal research, ecological modeling, resilience assessment) and by whom.
f) Describe how the level of irreversibility may be determined for effects on the individual VECs.
g) Justify why more complex effects (e.g. synergistic, interactive) are not included in the decision-making procedure.

This IR was forwarded by the JRP to OPG in Panel request EIS-08-362. The request and OPG's response are shown in Table 4.2-2, below.

Table 4.2-2 – Panel IR EIS-08-362 - Determination of significance for adverse effects

Related Panel Request EIS-08-362	Describe the professional qualifications of the members of the project team in order to demonstrate that their professional judgment is sufficient, given that many aspects of the assessment of significance of residual effects are either qualitative or the chosen magnitudes are based solely upon the professional judgment of the project team. Provide details on the process used to come to a consensus among professionals involved in the evaluation of significance. Indicate where the reported professional judgment was unanimous, and where the presented conclusion represents a compromise (or synthesis or averaging, etc.) among a range of professional positions. Provide justification for the choice of magnitudes for levels of significance (e.g., Table 7.5.3-1, relating to magnitude level definition for Aquatic Environment VECs). Define 'Social/Ecological importance', and explain how it was determined and by whom. Describe how the level of irreversibility may be determined for effects on the individual VECs. **Context:** Section 11.3 of the EIS guidelines states that "the EIS must clearly explain the method and definitions used to describe the level of the adverse effect (e.g., low, medium, high) for each of the above categories and how these levels were combined to produce an overall conclusion on the significance of adverse effects for each VEC." In various instances in Section 7 of the EIS, the significance of the environmental effects on the various VECs is determined based on the following concerns (quoting from EIS Section 7.8.3) "magnitude, geographic extent, timing and duration, frequency, and degree of irreversibility are combined to identify an environmental consequence." In each instance, a figure is provided that shows the decision-making procedure for determining significance amongst these concerns (e.g. EIS Figure 7.8.3-1). OPG has not detailed how the decision-making tree was followed through, or who was undertaking the decision-making process. Within the decision-making procedure itself, OPG bases significance upon the "social/ecological importance" of the VEC, without explanation of how importance was determined.
OPG Response	The contract for completion of the environmental assessment of OPG's Deep Geologic Repository was awarded to Golder Associates Ltd. following a competitive process. The process included a review of each submitted proposal relative to criteria, which included qualifications of project staff. Following award of contract, the contractor is required to provide (to OPG and subsequently

	to NWMO) notification of changes to key project personnel in advance of substitution. Each of Golder's discipline-specific project teams includes a Senior Reviewer, and an Intermediate Professional at a minimum; other personnel may have been involved depending on the discipline. The Senior Reviewer is a professional, educated and experienced in the discipline; the Intermediate Professional is a professional, educated in the discipline but with fewer years of experience. The Project Manager and Deputy Project Manager participated in the assessment of significance for all components of the environment to ensure the approach was applied consistently across the disciplines. Table 1 lists the academic qualifications, years of experience and other designations for each of the participants. [Embedded Table not shown here] Significance was assessed by a technical specialist(s) for each environmental component. The technical specialist's evaluation was reviewed by and discussed with the technical lead and/or senior reviewer. Finally, the significance evaluation was reviewed by the project manager/deputy project manager. The evaluation of significance considered all of these professional positions and was conducted using a precautionary approach. Where there was a potential for uncertainty, or the technical specialist(s) and reviewers differed in their professional judgment, the most conservative judgment formed the conclusion. Thus, none of the conclusions presented in the Environmental Impact Statement (EIS) for evaluation of significance are representative of compromise, synthesis or averaging of a range of professional positions. As discussed in OPG's response to Information Request (IR) EIS-03-44 (OPG 2012), sustainability (as a guiding principle for the assessment as described in the EIS Guidelines (CEAA and CNSC 2009)) was considered when defining magnitude levels to evaluate the significance of residual adverse effects on Aquatic VECs. The assessment of potential effects of the DGR Project on the Aquatic Environment considered the availability and importance of habitat critical to the sustainability of the VECs. Any loss of habitat was considered an adverse effect, with the loss of non-critical habitat considered to be of low magnitude. Medium magnitudes were assigned when critical habitat is lost but there is comparable habitat elsewhere within the watercourse. For critical habitat that is lost but not available elsewhere in the watercourse, high magnitudes were assigned. 'Social/ecological importance' was based on characteristics of the VEC, such as its importance to the ecosystem, abundance, tolerance and the value or importance it holds within an affected community in terms of economic and social benefits. It was determined using the professional judgment of the technical specialists responsible for each environmental component who used

	knowledge of local populations, habitat availability, Aboriginal traditional knowledge and information gained through stakeholder consultation. As discussed in OPG's response to IR-EIS-03-44 (OPG 2012), guiding principles for the assessment as described in the EIS Guidelines (CEAA and CNSC 2009) were applied to assign a level of significance rating to the degree of irreversibility effects criterion. The precautionary principle and the guiding principle of sustainable development were applied in assessing irreversibility. Only effects that are immediately reversible were considered to be of "low" significance. Such effects would have no impact beyond the life of the project. The degree of irreversibility was considered to be "high" if the effect is permanent. If the effect is reversible with time, the degree of irreversibility was considered to be "medium". These effects have the potential to affect the environment beyond the life of the project. For example, increased off-site noise levels during the site preparation and construction and decommissioning phases was assessed to result in a residual adverse effect on the use and enjoyment of personal property. Since the increased noise levels will cease once these phases are complete but will take some time for people's enjoyment of their property to recover, the degree of reversibility was deemed "medium".

OPG's responses to the requests on the determination of significance help put the CEA into better perspective. Unfortunately, given time and resource constraints, it is impossible at this point to verify OPG's response with a detailed reassessment of the determination of significance and adverse effects. OPG should have been more explicit when originally describing the decision-making tree so as to allow for a better assessment of its approach. This is something we believe the Panel should consider in its evaluation of the proposed project.

4.2.2 OPG's consideration of synergistic and interactive cumulative effects

The assessment of synergistic cumulative effects are an important part of a CEA, and must be deeply considered and addressed for the purpose of promoting sustainable development. Duinker and Greig (2006) note that "it is patently wrong to assume that the cumulative effects of all the stressors… are simply sums of the individual effects of each stressor analyzed separately."

The EIS guidelines recognize the importance of synergistic and additive effects. Notably, Section 14 of the EIS guidelines states that OPG should address effects that "would act in *combination* with the residual effects of the project" (emphasis added), and further on states that OPG must include "different forms of effects (e.g. *synergistic, additive*, induced, spatial, or temporal and identify impact pathways and trends" (emphasis added). Likewise, Section 11 of the EIS guidelines states that "specific attention must be given to *interactions* between the project and the identified VECs" (emphasis added). These guidelines provide sufficient justification for assessing effects beyond a simple linear addition of effects onto specific VECs.

In Section 10.2 of the EIS, OPG claims its approach to cumulative effects assessment is consistent with the guidelines provided in the CEAA Cumulative Effects Assessment (CEA)

Practitioners Guide. However, Section 1.1 of CEAA Cumulative Effects Practitioner's Guide states "the incremental additive effects of the proposed action on the VECs are assessed. *If the nature of the effects interaction is more complex (e.g., synergistic)*, then the effect is assessed on that basis, or why that is not reasonable or possible is explained" (emphasis added).

As can be seen, there is substantial justification for considering cumulative effects in a manner that recognizes the complex nature of such effects, and the many possible direct, indirect and induced effects. Unfortunately, OPG's approach to CEA, as is found in Section 10 of the EIS provides only a simple and incomplete approach of adding up effects on various VECs, and does not provide any mention of how more complex effects (e.g. synergistic, interactive) were considered, or whether they were even considered at all. For these reasons, CELA submitted an IR to the panel posing the following request.

Please provide the following information with respect to the cumulative effects of the proposed DGR Project:

a) Describe how OPG considered more complex effects (e.g. interactive and synergistic effects) during the cumulative effects assessment.

This IR was forwarded by the JRP to OPG in Panel request EIS-08-358. The requests and an excerpt from OPG's response are shown in 4.2-3, below.

Table 4.2-3 – Panel IR EIS-08-358 - Assessing synergistic and interactive cumulative effects

Related Panel Request EIS-08-358	Describe in more detail than is provided in the EIS the conceptual model used for the assessment of cumulative effects, including the screening arguments used to eliminate synergistic effects from further analysis. Further, provide the screening arguments used to eliminate interactions among VEC and multiple stressors. **Context:** In Section 14 of the EIS guidelines it is stated that the "EIS must include different forms of effects (e.g., synergistic, additive, induced, spatial or temporal) and identify impact pathways and trends." It is stated in Section 11 of the EIS guidelines that "specific attention must be given to interactions between the project and the identified VECs." In Section 10 of the EIS, OPG does not describe if or how complex effects (e.g., synergistic, interactive) were considered. It is stated in Section 1.1 of the CEAA Cumulative Effects Practitioner's Guide that "the incremental additive effects of the proposed action on the VECs are assessed. If the nature of the effects interaction is more complex (e.g., synergistic), then the effect is assessed on that basis, or why that is not reasonable or possible is explained." The use of an incremental, VEC-by-VEC approach does not produce an integrated cumulative effects assessment. Integration of multiple stressors from all relevant human activities within the temporal and

	spatial boundaries for the assessment should be considered, at least at a conceptual level, and then examined for their potential to produce significant adverse effects.
OPG Response	For a cumulative effect to occur, the project in question has to have caused an effect. In this environmental assessment, all non-trivial effects that remain after mitigation (i.e., residual adverse effects) were carried forward and considered in the cumulative effects assessment. In identifying the residual adverse effects of the project, both direct and indirect effects on the identified valued ecosystem components (VECs) were considered. Direct effects were those that occurred when VECs are affected by project work and activities (e.g., clearing of land during the construction phase resulting in the loss of eastern white cedar). Indirect effects are those where changes to another VEC as a result of the project could have a synergistic effect on the VEC in question. For example, changes in the groundwater quality VEC were also evaluated as an indirect (or synergistic) effect on the eastern white cedar. When residual adverse effects of the project were identified, they included the combined influence of both the direct and indirect (synergistic) effects of the project on the VEC in question. Therefore, the Environmental Impact Statement (OPG 2011) explicitly addressed interactions among VECs and multiple stressors among VECs. In the EIS (OPG 2011, Table 5.3.2-1), a number of multi-feature VECs were identified that inherently considered the combined effects of multiple stressors and the combined effect of individual VECs. This is another example where the EIS explicitly addressed interactions among VECs and multiple stressors among VECs. The residual adverse effects of the project were on the following VECs: surface water quantity and flow, eastern white cedar, VECs in the South Railway Ditch (burrowing crayfish, redbelly dace, creek chub, variable pondweed and benthic invertebrates), air quality, noise levels, other social assets within the socio-economic environment (changes in noise), overall health for both a local resident and member of an Aboriginal community from exposure to acrolein, and Aboriginal heritage resources (diminishment of quality or value of activities at the on-site burial ground). Human exposure to radiation and radiation dose to non-human biota were included for the purposes of cumulative effects assessment even though no residual adverse effect was identified. The residual adverse effect(s) on each of these VECs is summarized in Table 10.3-1 of the EIS (OPG 2011). Of those effects, only adverse effects to the air quality, noise levels, socio- economic environment and human health environmental component VECs extended beyond the Site Study Area. In the cumulative effects assessment, all reasonably foreseeable projects within

	the temporal and spatial boundaries were considered. For each of the residual adverse effects, the projects considered in the cumulative effects assessment were examined to determine whether there was potential for cumulative effects with those VECs. In the event that a cumulative effect was identified, both the direct and indirect (synergistic) cumulative effects would have been carried forward. As summarized in Section 10.8 of the EIS, no likely adverse cumulative effects were identified (OPG 2011).

OPG's response to the IR does not adequately address the substance or the spirit of the IR. In particular, OPG's response notes that "all non-trivial effects that remain after mitigation (i.e., residual adverse effects) were carried forward and considered in the cumulative effects assessment." This response misses the intent of CEA, which is premised upon the recognition that the accumulation of 'trivial' impacts may ultimately lead to significant effects; something known colloquially as "death by a thousand cuts". More importantly, OPG's answer seems to assume that indirect effects and synergistic effects are synonymous, which is a basic error that points to a fundamental failure to understand the original IR as well as the nature of cumulative effects. Unfortunately, given time and resource constraints, it is impossible at this point to verify OPG's response with a detailed reassessment of the determination of synergistic and additive effects.

4.2.3 Ensuring the VECs reflect the integrity of the broader ecosystem

Section 10 of the EIS guidelines states that "for the biological environment, baseline data in the form of inventories alone is not sufficient for the joint review panel to assess effects. The proponent must consider the resilience of species, communities, and their habitats." Likewise, Duinker and Greig (2006) note that "if the promise of CEA is to be fulfilled, it needs to be either well informed about the existence of such critical thresholds or conservative with regard to protecting VEC integrity."

Thresholds are clearly important for cumulative effects assessment, both at the level of individual VECs, and, more importantly, at the overall level of ecological and socio-ecological integrity and resilience. While the cumulative effects assessment provided by OPG in Section 10 provides a preliminary discussion of thresholds, it is not formulated in a way to allow the panel or other stakeholders to develop an informed and integrated understanding of the long-term health of the ecological system.

Beyond the question of thresholds is the concern of how VECs act as a proxy for the larger ecosystem. Section 10 of the EIS guidelines notes that while "emphasis must be on those species, communities and processes identified as VECs … the interrelations of these components and their relation to the entire ecosystem and communities of which they are a part must be indicated. The proponent must address issues such as habitat, nutrient and chemical cycles, food chains, productivity, as these may be appropriate to understanding the effect of the project on ecosystem health and integrity."

The statement above points to the importance of VECs, not as isolated factors, but rather as proxies for ensuring that the overall integrity and resilience of the local ecosystems are maintained and enhanced. In the cumulative effects assessment provided by OPG, no mention is made regarding how the overall integrity and resilience of the ecosystem will be maintained, including how ecosystem level thresholds will be identified and related effects managed through the measurement of VECs.

Furthermore, the follow up monitoring efforts described in Table 12.2-1 make no reference to how the individual monitoring efforts, each one highly specific in space, time and VEC, will be sufficient to describe the integrity and resilience of the local ecosystem over the long term. It would be beneficial for stakeholders and the panel if OPG were to provide a clearer overall picture of how these considerations will be integrated and what monitoring will accomplish. For these reasons, CELA forwarded two related sets of requests to the JRP:

1 - Please provide the following information with respect to the cumulative effects of the proposed DGR Project:

a) How individual thresholds were considered for the various VECs with regard to ensuring the overall integrity of the local ecosystem.
b) How the overall integrity and resilience of the local ecosystem is adequately represented through the choice of VECs, and how the monitoring and cumulative effects assessment may ensure that important thresholds at all scales are not crossed.

2 - Please provide the following information with respect to the cumulative effects of the proposed DGR Project:

a) How the overall integrity and resilience of the local ecosystem are adequately represented through the choice of VECs, and how the cumulative effects assessment, and subsequent monitoring and response, will ensure that important thresholds at all scales are not crossed.
b) How the monitoring of VECs over all project phases described in Table 12.2-1 will ensure the overall integrity and resilience of the local ecosystem are adequately maintained and enhanced. Please provide a figure showing how the various monitoring approaches inform one another in space, time and type of effect, and how they are linked to effective response capabilities.

These requests were forwarded by the JRP to OPG in IR EIS-08-359, provided in Table 4.2-4, below.

Table 4.2-4 – Panel IR EIS-08-359 - Relationship between individual VECs and overall ecological integrity

Related Panel Request EIS-08-359	Describe how the use of individual thresholds for each VEC can be confidently used to assess cumulative effects to local and regional terrestrial and aquatic ecosystems. Explain how the overall integrity and resilience of the local ecosystem is adequately represented by the selected VECs and how the monitoring and cumulative effects assessment may ensure that thresholds are not crossed. Provide a figure showing how the various monitoring approaches inform one another in space, time and type of effect, and how they are linked to effective response capabilities **Context:** This IR follows from EIS-08-358. Section 10 of the EIS guidelines states that "for the biological environment, baseline data in the form of inventories alone is not sufficient for the joint review panel to assess effects. The proponent must consider the resilience of species, communities, and their habitats." OPG provides a preliminary discussion of thresholds but does not assess the long-term integrity of the ecological system. OPG does not explain how the overall integrity and resilience of the ecosystem will be maintained, including how ecosystem-level thresholds will be identified and related effects managed through the measurement of VECs. The follow-up monitoring described in Table 12.2-1 of the EIS does not explain how the individual monitoring efforts will be sufficient to describe the integrity and resilience of the local ecosystem over the long term.
OPG Response	In selecting the valued ecosystem components (VECs), consideration was given to identifying species that are indicative of the ecosystem as a whole. While all components of the environment are important, it is neither practical nor necessary to assess every potential effect of a project on every component of the environment. The environmental assessment (EA) focuses on the components that have the greatest relevance in terms of value and sensitivity, and which are most likely to be affected by the project. To achieve this focus, VECs are identified and assessed. A VEC is considered to be the receptor for both project-specific effects and cumulative effects. A VEC is represented by a number of indicators, such as habitat use, which are features of the VEC that may be affected.

	In identifying the residual adverse effects of the project, both direct and indirect effects on the identified VECs were considered. Direct effects were those that occurred when a VEC is affected by one or more project works and activities (e.g., clearing of land during the construction phase resulting in the loss of eastern white cedar). Indirect effects are those where changes to another VEC as a result of the project could have a synergistic effect on the VEC in question. For example, changes in groundwater quality VECs were also evaluated as an indirect (or synergistic) effect on the eastern white cedar. When residual adverse effects of the project were identified, they included the combined influence of both the direct and indirect (synergistic) effects of the project on the VEC in question. Therefore, the Environmental Impact Statement (EIS) explicitly addressed interactions among VECs and multiple stressors between VECs. In this EA, all non-trivial effects that remain after mitigation (i.e., residual adverse effects) were carried forward and considered in the cumulative effects assessment. Thresholds, as mentioned in the question, were only used in defining magnitudes of residual adverse effects and contributed to the determination of whether an adverse effect was considered to be significant or not. Thresholds were not relied on for determining if an effect was advanced for consideration in the cumulative effects assessment. The thresholds, as well as the VECs, selected for use in the EIS gave consideration to both the individual species as well as the resilience of the ecosystem. A plan for a follow-up monitoring program to verify the accuracy of the assessment and to determine the effectiveness of the measures implemented to mitigate adverse effects is a requirement of the EIS Guidelines. The monitoring identified in Table 12.2-1 of the EIS will provide information regarding the actual magnitude of the identified adverse effects experienced by those VECs used to characterize the effects of the project on the ecosystem as a whole. The need for additional mitigation would be identified through reviewing the results of the monitoring program (i.e., where results differ from effects predictions) to ensure thresholds within the environment are not being exceeded. A more detailed description of the EA follow-up monitoring program, including a discussion of the program assessment, is provided in the EA Follow-up Monitoring Program (NWMO 2011). The environmental monitoring framework includes four groups of monitoring activities: EA follow-up monitoring, environmental management plan monitoring, radiological regulatory monitoring and conventional regulatory monitoring. Some elements of the groups will overlap with others at some times. In lieu of a figure, a tabular summary of the proposed follow-up monitoring program is provided as Table 1 of the DGR EA Follow-up Monitoring Program (NWMO 2011) consistent with the requirements of the EIS Guidelines (CEAA and CNSC 2009, Section 16). Table 1 provides a summary of all of the

	components of the monitoring programs, across all four groups of the framework, and also includes the baseline monitoring activities that are anticipated prior to the site preparation and construction phase. It presents the various environmental components, how each component is monitored in the different program groups and the timing and continuation of each activity described in Tables 2 through 6. Tables 2 through 6 present details of each monitoring activity, including location, timing and type of effect. Table 1 provides the linkages between the activities, both through the different phases of the DGR Project, and across the program groupings. The division of the program into four groups is, in part, an administrative tool to facilitate the reporting and review of the different aspects of the program. The monitoring program will be managed as a whole within the structure of an Environmental Management System (EMS). Planned environmental monitoring activities will be implemented, results will be reviewed and changes to the monitoring program identified if necessary, within the EMS and in accordance with the CSA standard "Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills" (CSA 2010). As described in OPG's response to EIS-06-276 (OPG 2012), adaptive management (effective response capabilities) has been incorporated into the EA follow-up monitoring program. **References:** CEAA and CNSC. 2009. Guidelines for the Preparation of the Environmental Impact Statement for the Deep Geologic Repository of Low- and Intermediate- Level Radioactive Wastes. (CEAA Registry Doc# 150) CSA. 2010. Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills. N288.4-10. NWMO. 2011. DGR EA Follow-up Monitoring Program. Nuclear Waste Management Organization report NWMO DGR- TR-2011-10 R000. Toronto, Canada. (CEAA Registry Doc# 299) OPG. 2012. OPG Letter, A. Sweetnam to S. Swanson, "Deep Geologic Repository Project for Low and Intermediate Level Waste – Submission of Responses to a Sub-set of Package #6 Information Requests", CD# 00216-CORR-00531- 00152, November 29, 2012. (CEAA Registry Doc# 823)

OPG provides a helpful response by highlighting the importance of VECs as indicator species (or 'proxies') for the overall health and integrity of the ecosystem. This is fair, and we recognize that it is both impossible and undesirable to monitor all species at all times. Unfortunately the problem noted earlier in section 4.2.2 arises here again – the apparent assumption that indirect effects and synergistic effects are synonymous, which is certainly incorrect.

Where OPG's response is lacking relates to what management actions will be undertaken if there are adverse effects on the VECs. As it stands, it appears that OPG's approach is to deal with the VEC in question, while neglecting that the impacts on the VEC may be indicative of deeper problems in the ecosystem. If for example, brook trout were a VEC and monitoring revealed a population decline, it is possible to restock the river with trout. However, although the restocking addresses the declining population of trout, it may well do nothing to address the underlying the ecosystem damage indicated by the trout decline.

Furthermore, while OPG provides a preliminary discussion of thresholds, it does not describe how it assesses or monitors the long-term integrity of the ecological system. OPG does not explain how the overall integrity and resilience of the ecosystem will be maintained, including how ecosystem-level thresholds will be identified and related effects managed through the measurement of VECs. Furthermore, the follow-up monitoring described in Table 12.2-1 of the EIS does not explain how the individual monitoring efforts will be sufficient to describe the integrity and resilience of the local ecosystem over the long term.

4.2.4 The relevance of cumulative effects assessment for assessing 'alternatives to' and 'alternative means'

Section 7.2 of the EIS guidelines state the EIS "must identify any alternatives to the DGR that are within the control and/or interests of the proponent; explain how the proponent developed the criteria to identify the major environmental, economic and technical costs and benefits of those alternatives; provide reasons for rejection of these alternatives; and identify the preferred alternative to the project based on the relative consideration of the environmental, economic and technical benefits and costs. This must be done to a level of detail which is sufficient to allow the joint review panel and the public to compare the project and its alternatives."

Clearly the identification and comparative evaluation of alternatives to and alternative means are important components of the assessment process, and must be addressed in a sufficient manner, including the assessment of cumulative effects. For example, O'Brien (2001) notes that "the assessment of the benefits and drawbacks of a full range of alternatives, not assessment of the acceptable level of a hazardous activity, is not only the heart of an environmental impact statement, it is the heart of wise decision-making in a democracy." Likewise, Duinker and Greig (2006) state that "cumulative effects are the only real effects worth assessing in most EIAs."

Cumulative effects assessment of alternatives to and alternative means is necessary to ensure that OPG has chosen the most appropriate option for the long-term storage of LILW. The reported OPG cumulative effects assessment, as presented in Section 10 of the EIS, does not provide attention to alternatives to and alternative means. Therefore, it is unclear how cumulative affects assessment informed the evaluation of alternatives. For these reasons, CELA forwarded the following requests to the JRP:

Please provide the following information with respect to the significance of cumulative effects of the proposed DGR Project:

a) Describe how cumulative effects assessment helped inform the decision to choose among the options including the project as proposed and the ‘alternatives to’ and ‘alternatives means’ of undertaking the long-term storage of LILW
b) Describe how cumulative effects were included as specific criteria for the comparative evaluation of the options (including ‘alternatives to’ and ‘alternative means’).

These requests were forwarded by the JRP to OPG in IR EIS-08-360.

Table 4.2-5 – Panel IR EIS-08-360 - Relevance of cumulative effects for ‘alternatives to’ and ‘alternative means’

Related Panel Request EIS-08-360	Explain how the cumulative effects assessment informed the evaluation of alternative means of carrying out the Project, as well as the selection of the preferred alternative. Context: In Section 7.3 of the EIS, it is stated that the EIS “must also describe the environmental effects of each alternative means. In describing the preferred means, the EIS should identify the relative consideration of environmental effects, and technical and economic feasibility. The criteria used to identify alternative means as unacceptable, and how these criteria were applied, must be described, as must the criteria used to examine the environmental effects of each remaining alternative means to identify a preferred alternative.“ It is unclear how cumulative affects assessment informed the evaluation of alternative means.
OPG Response	Section 7.3 of the Environmental Impact Statement (EIS) (OPG 2011) discusses the assessment of effects of the DGR Project on the Hydrology and Surface Water Quality environment. Section 7.3 of the EIS Guidelines (CEAA and CNSC 2009) presents the requirements for Alternative Means of Carrying Out the Project. The EIS (OPG 2011, Sections 3.3 and 3.4) presents the consideration of environmental effects, and technical and economic feasibility of the alternatives to the project and alternative means of carrying out the project. OPG’s response to Information Request (IR) EIS-03-49 (OPG 2012) provides additional information on the evaluation of alternative means of carrying out the project. The EIS Guidelines (CEAA and CNSC 2009, Section 14) state that “the proponent must identify and evaluate the cumulative adverse effects of the project in combination with other past, present or reasonably foreseeable projects and/or activities within the study area”. OPG presents the cumulative effects assessment in Section 10 of the EIS. The ‘project’ that is assessed in combination with other projects is identified through the evaluation of alternatives to and alternative means of carrying out the project. The cumulative effects assessment did not inform the evaluation of alternative means of carrying out the project or the selection of the preferred project. The Canadian Environmental Assessment Agency (CEAA 1999, Section 3.1) states

	that the substantive work in a cumulative effects assessment (CEA) is often done after the initial identification of effects have been completed in an EIS. In this way, the early identification of direct project effects "paves the way" for cumulative effects to be assessed. If the cumulative effects assessment for the DGR project had identified significant adverse impacts, then looking at alternative means of carrying out the project could have been considered to mitigate those impacts, but this situation did not arise.

OPG's response confirms that the analysis and decision making concerning its choice among alternatives to or alternative means and identification of the preferred alternative, was not informed by attention to cumulative effects. Instead, the response indicates that OPG started with its preferred option, concluded that it would not have significant adverse effects, and decided that a careful examination of alternatives was not needed. That approach is, in our view, not appropriate.

The requirement for consideration of alternatives, as set out in the EIS Guidelines for the DGR assessment (section 7.2), emphasizes identification of the preferred alternative on the basis of a comparative evaluation addressing a comprehensive range of considerations and explicit criteria. These considerations clearly include environmental effects and cumulative environmental effects are, as noted above with reference to Duinker and Greig (2006), clearly the most important environmental effects to address. In environmental assessment generally, comparative evaluation of alternatives is meant to identify the most desirable option. OPG's approach, in contrast, would aim only to identify a project that is, in its view, acceptable. That is not consistent with the evident intent of the legislation, with the specific expectations in the EIS guidelines, or the general philosophy of environmental assessment where comparative evaluation of alternatives is required.

The OGS approach here seems also to be inconsistent with OPG's own policy commitments. As noted in Section 4.15, OPG claims it will "strive to continually improve its environmental performance" and committed to seven requirements, including (Page 4-92):

- Meet or Exceed Legal Requirements: Meet all legal requirements and OPG's voluntary commitments, with the objective of exceeding those standards where appropriate and feasible.
- Integrate Environment in Decision-Making: Integrate environmental factors and stakeholder considerations into our planning, decision-making and business practices.

In sum, OPG did not give due attention to cumulative effects in the evaluation of and choice among alternatives to and alternative means, and should be required to correct this deficiency.

4.2.5 Miscellaneous concerns relating to cumulative effects assessment

Beyond the deeper concerns described above, two other issues relating to CEA arose. First, OPG's CEA did not appear to provide sufficient detail relating to the cumulative effects of transporting hazardous wastes to the proposed site for the DGR. Likewise, the CEA did not include any discussion of potential long-term storage of high level nuclear wastes. Table 10.4-3 of the EIS states that the NWMO has "initiated a process to seek an informed, willing host community for all of Canada's nuclear waste." While OPG states the DGR is not the planned repository for used fuel, it has argued extensively in the EIS (e.g. in the Background) that Kincardine and the surrounding area are an informed and willing host community for LILW.

Given that there is no reason provided for why Kincardine would not be willing to accept Canada's high level nuclear waste, that nearby communities have formally expressed some initial level of willingness to accept nuclear waste (McLaren 2012), and that the fuel is already being stored at the Western Used Fuel Dry Storage Facility located on the Bruce site, it would be imprudent for OPG to neglect the possibility of this site for future fuel storage in a cumulative effects assessment. Therefore, planning for the proposed DGR should have included consideration of a separate high level waste storage facility on site or nearby.

To the best of our knowledge, neither request was forwarded by the JRP to OPG, although such issues may have been addressed in other panel IRs in response to requests from other concerned parties.

4.3 Care in perpetuity

A second important theme relating to sustainable development and the DGR relates to care in perpetuity. OPG recognizes that the proposed DGR represents a project requiring several decades of active monitoring, several centuries of passive monitoring, and which carries the potential for important negative impacts for millennia. Such a situation imposes a lasting burden for future generations, requires long-term planning and demands preparations now to ensure appropriate resources for the future. This is especially the case given the nascency of long-term storage of nuclear waste, as well as the tremendous uncertainties involved with planning for hundreds of years into the future. This section discusses some of the concerns related to OPG's proposal for care in perpetuity.

4.3.1 Ensuring resources for long-term monitoring and response

It is well acknowledged that intergenerational equity is a fundamental tenet of sustainable development, and this implies that future generations should not be bearing the costs of current benefits or current mistakes. Given that the DGR will include a large amount of present waste as well as both certain and uncertain future quantities (subject to the future nuclear activities), it is both good financial planning and ethically necessary for OPG to ensure that the cost of all phases of the project (including 300+ years of passive monitoring) are not borne by future generations who are not responsible for, or beneficiaries of, generation of the nuclear waste. One complicating factor in costing is the unique nature of each DGR.

OPG notes in Table 2.6.1-3 that an existing segregated fund (the Decommissioning Fund) was established by OPG and has been accumulating funds in order to pay for the DGR. Given that OPG will have other substantial long-term concerns, including the storage of used nuclear fuel and the decommissioning of Douglas Point nuclear plant (co-located with Bruce Power in Kincardine) – and Darlington and Pickering at some point – it is crucial that proper financing already be in place.

Currently, the costs calculations outlined in the EIS and the IAS do not sufficiently address the cost of care in perpetuity. The IAS costing provided in section 2.6.4 of the IAS does not extend beyond the decommissioning phase of the DGR. At this point, it is unclear how OPG updated the cost calculations from the original IAS to ensure that sufficient capacity will be available for long-term monitoring and response, and to ensure that the cost of this capacity will not be borne by future generations.

Finally, given that the nuclear waste will still be highly radioactive for much longer than 300 years, but rather tens of thousands of years, it is important for OPG to ensure both adequate institutional control and the resources to respond effectively in perpetuity. Otherwise the burden is once again placed upon future generations who are not responsible for the nuclear waste and its associated hazards.

For these reasons, CELA forwarded two sets of requests to the JRP:

1 - Please provide the following information with respect to the care in perpetuity of the proposed DGR Project:

a) Describe how OPG has ensured that sufficient resources are currently present so that the DGR will not place any burden (financial or otherwise) on future generations.
b) Describe what funds OPG will set aside to cover anticipated and unanticipated occurrences during the 300+ years of passive monitoring.
c) Justify why OPG has chosen to limit the timeframe of passive monitoring and control to 300 years, given the exceptionally long time-frame of the project, and that some of the more insidious hazards relating to radiation may become important long after 300 years.

These requests were forwarded by the JRP to OPG in IR EIS-08-363 shown below in Table 4.3-1.

2 - Please provide the following information with respect to the care in perpetuity of the proposed DGR Project:

a) Describe how OPG determined the costs of 300+ years of passive monitoring, including the resources required to respond to events that arise during passive monitoring.
b) Describe how OPG updated the cost estimate from the original Independent Assessment Study.

This second set of requests was not forwarded by the JRP to the best of our knowledge.

Table 4.3-1 – Panel IR EIS-08-363 - Perpetual care of the DGR – Resources for long-term monitoring and response

Related Panel Request EIS-08-363	Explain the rationale for the 300-year timeframe for passive monitoring, given the long time-frame of the project. **Context:** The L&ILW in the proposed DGR will be radioactive beyond 300 years.
OPG Response	The 300-year timeframe is the period of institutional control, following DGR closure, assumed for postclosure safety assessment purposes. As is explained in OPG's response to Information Request EIS-05-181 (OPG 2012), as part of the discussion on institutional controls, an assumed period of institutional control of 300 years is consistent with international practice. Given that institutional controls are assumed not to be in place after 300 years, it is conservatively postulated for safety assessment purposes that there could be inadvertent intrusion into the repository by drilling after 300 years. The period of monitoring following DGR closure will be determined in consultation with the community and regulatory authorities many decades from now.

This response addresses only the third component of the IR. No information is provided concerning funding or other resources to avoid burdens on future generations. Moreover, while the 300-year time limit for monitoring may be "consistent with international practice" it is not evident how this might be consistent with proper recognition of responsibility. Logically, monitoring should continue so long as there is some potential of effects to identify and address. In this case some potential for effects would seem to continue so long as any of the waste is highly radioactive, which is many thousands of years beyond the 300 years of passive monitoring. Finally, while it is no doubt the case that community and regulatory authorities in the future will need to make decisions about monitoring and other activities, merely recognizing this will be of no comfort for those authorities unless accompanied by provision of the needed resources.

Given that the JRP did not make the requests regarding financial concerns, OPG was not required to respond to those issues, although we argue this does not make the underlying concerns any less valid. The long-term financing question and its impact on future ratepayers remains something the JRP needs to consider seriously when it weight the relative merits of the DGR.

4.3.2 Ensuring proper requirements for abandonment and passive control

There are further concerns relating to abandonment and passive control under the theme of care in perpetuity. In Table 2.6.1-1 of the EIS, OPG mentions "at this time there are no specific plans [for passive control]. Control mechanisms aren't required for another 50 to 100 years. At that time, it is expected several countries will be in the same position, and that a solution will be developed with international consensus."

While it is laudable that OPG is honest about its current lack of planning for passive control, it is unclear how OPG's stance is not simply to displace the risk of passive control onto future generations. As has been previously mentioned, sustainability and equity considerations demand that OPG does not place burdens on future generations resulting for current actions. Furthermore, placing faith in future technological achievements appears a risky gambit, in part because of the uncertain future of nuclear power in the world (e.g. Schneider et al. 2012).

For these reasons, CELA forwarded the following requests to the JRP:

Please provide the following information with respect to the care in perpetuity of the proposed DGR Project:

a) How OPG is planning for passive control, including ensuring sufficient resources (financial and otherwise) are available.
b) Given that there are no safe grounds for assuming the licence to abandon that will be issued 50 years from now will be similar to present licences to abandon, what, in OPG's view, is the reasonably anticipated range of possible requirements.

These requests were forwarded by the JRP to OPG in IR EIS-08-364.

Table 4.3-2 – Panel IR EIS-08-364 - Perpetual care of the DGR – Requirements for passive control and abandonment

Related Panel Requests EIS-08-364	Explain how OPG's plans for operating the DGR anticipate requirements for future passive control. Include reference adaptive management plans and processes. Describe OPG's reasonably anticipated range of possible requirements for abandonment. **Context:** In Table 2.6.1-1 of the EIS, OPG mentions "at this time there are no specific plans [for passive control]. Control mechanisms aren't required for another 50 to 100 years. At that time, it is expected several countries will be in the same position, and that a solution will be developed with international consensus."
OPG	

Response	OPG's response to Information Request (IR) EIS-05-181 (OPG 2012) provides a conceptual abandonment plan and discusses postclosure institutional control. Anticipated requirements for abandonment and future passive control are included in the response to this IR. OPG's plans for the operational phase of the DGR facilitate, and do not preclude, a range of passive controls. For example, documentation of design and operational information useful for the postclosure phase will be maintained in a secure records management system to ensure knowledge preservation. Also, the possible use of location markers is not precluded and can be resolved during the decommissioning phase and as part of the planning for abandonment, as can the details of land use restrictions. In the Context section of this IR, a quote is provided from Table 2.6.1-1 (Item 16) of the Environmental Impact Statement (OPG 2011). This quote deals with a question related to location markers that came up in a DGR Open House, and does not deal with passive controls in general.

OPG's response helps to contextualize the quote provided in the IR. However, the general response still indicates exactly what the quote implies, namely that the long-term planning for abandonment and institutional control is still to be completed. While we do not disagree with OPG insofar as it may well be that little of the planning can be undertaken at this time, we argue that this represents an important risk placed upon future generations and ratepayers because of the uncertainty. It is important to consider this uncertainty, both with regards to the proposed project, as well as possible alternatives to the DGR.

4.3.3 Definitions of 'possible', 'unlikely' and 'non-credible' events

Determining the long-term safety of the DGR requires having a clear idea of what events may occur and how likely these events are to occur. In Section 8.1 of the EIS, OPG outlines three categories that describe the likelihood of impacts:

- possible events: annual frequency greater than 10^{-2};
- unlikely events: annual frequency between 10^{-2} and 10^{-7}; and
- non-credible events: annual frequency of 10^{-7}.

Of particular concern for the EIS is the unlikely events category. While the annual frequency appears quite low, for the purpose of a project that will span up to 1 million years, what is most important is the potential likelihood of occurrence over the relevant time. Effectively, the 'unlikely events' category spans an expected return frequency of 100 years all the way to 10 million years. Over a 1 million year period, some 'unlikely' events may be expected to occur 10,000 times, implying that labeling these events as 'unlikely' is misleading and inhibits an appreciation of the actual likelihood of events over the long term.

For these reasons, CELA forwarded the following requests to the JRP:
Please provide the following information with respect to the care in perpetuity of the proposed

DGR Project:

a) Justify OPG's rationale for determining how 'possible events', 'unlikely events', and 'non-credible' events were delineated in terms of annual frequency.
b) Provide reasoned estimates of the overall likelihood of occurrence of possible, unlikely and non-credible events over the period when the project could have adverse effects.

These requests were forwarded by the JRP to OPG in IR EIS-08-365.

Table 4.3-3 –Panel IR EIS-08-365 - Definitions of 'possible', 'unlikely' and 'non-credible' events

Related Panel Request EIS-08-365	Elaborate on the response to EIS 01-03. Provide specific definitions for "possible" events, "unlikely" events, and "non- credible" events for each of the initiating events. Support the definitions with references or detailed justification to supplement the reference supplied in the response to EIS 01-03. **Context:** In Section 8.1 of the EIS, OPG outlines three categories that describe the likelihood of impacts: · possible events: annual frequency greater than 10^{-2}; · unlikely events: annual frequency between 10^{-2} and 10^{-7}; and · non-credible events: annual frequency of 10-7. The above general definitions may not be appropriate for specific initiating events. Labeling certain events as 'unlikely' may be misleading, given the long timeframe of the Project and the likelihood of these events over the long term. It is anticipated that the definitions will vary with each initiating event.
OPG Response	The definitions are as noted in the Environmental Impact Statement (EIS) (OPG 2011a, Section 8.1) and repeated in the above Context. The categories were based on the likelihood of events occurring that could lead to radiological releases during the planned operational period of about 50 years. They were not used for assessing accidents in the postclosure period. The three categories therefore correspond respectively to events that would have a high probability of occurring during the operational period ("possible events"), a low probability of occurring during the operational period ("unlikely events"), and a very low probability of occurring during the operational period ("non-credible events"). However, as discussed in the EIS (OPG 2011a, Section 8.1) and the Preliminary Safety Report (OPG 2011b, Section 7.5.1.2), and in OPG's response to Information Request (IR) EIS-01-03 (OPG 2012a), the precise distinction between "possible" and "unlikely" events is not important to the DGR safety

	assessment since all such events are considered in the subsequent bounding accident scenarios, and the same dose constraint was applied. Furthermore, the potential consequences of non-credible accidents such as explosion and tornado are further discussed in the OPG response to IR-EIS-06-270 (OPG 2012b).

OPG's response helps contextualize the choice of terminology. That said, we argue the use of language is important in conveying ideas and influencing thought, and would recommend that OPG be more careful in the future with its choice of definitions.

4.3.4 Drawing from international experience in planning for care in perpetuity

In Section 7.10.2.11 of the EIS, OPG notes that the DGR project introduces a new type of facility that is unique to North America. However, to counter the concerns of related to the uniqueness of the undertaking, Section 3.3.7 of the EIS and the Executive Summary of the IAS both mention considerable international experience with all three options (enhanced processing and storage, surface concrete vaults, and deep rock vaults) for the long-term storage of LILW. The two deep rock vaults noted in the IAS relate to one in Forsmark, Sweden (commissioned in 1988) and Loviisa, Finland (operating since 1997).

It is not clear how the operations of the two rock vaults constitute considerable international experience, or how these two operations can inform all project phases (including abandonment) given the long timeline of the DGR. At the same time, insights from international experience (both in terms of success and failure) could be invaluable to inform efforts to anticipate, avoid and provide capacity to meet burdens on future generations due to the storage of LILW. Unfortunately, the EIS does not provide any detail of these two facilities to indicate what insights have been gained, what uncertainties remain, and how the successes and failures experienced should influence decision making regarding the proposed DGR.

For these reasons, CELA forwarded the following requests to the JRP:
Please provide the following information with respect to the care in perpetuity of the proposed DGR Project:

a) Describe the 'considerable international experience' of other DGR projects sufficiently to establish how the success and failure of other DGR-type projects can inform the proposed DGR.

These requests were forwarded by the JRP to OPG in IR EIS-08-366.

Table 4.3-4 – Panel IR EIS-08-366 - Perpetual care of the DGR - Drawing from international experience

Related Panel Request EIS-08-366	Describe the 'considerable international experience' of other DGR projects sufficiently to establish how the success and failure of other DGR-type projects can inform the proposed DGR. a) Provide any detail of the facilities in Forsmark, Sweden (commissioned in 1988) and Loviisa, Finland (operating since 1997) to indicate what insights have been gained, what uncertainties remain, and how the operating experience should be applied for the proposed DGR. **Context:** In Section 7.10.2.11 of the EIS, OPG notes that the proposed DGR project introduces a new type of facility that is unique to North America. However, to counter the concerns of related to the uniqueness of the undertaking, Section 3.3.7 of the EIS and the Executive Summary of the IAS both mention considerable international experience with all three options (enhanced processing and storage, surface concrete vaults, and deep rock vaults) for the long-term storage of LILW. The two deep rock vaults noted in the IAS relate to one in Forsmark, Sweden (commissioned in 1988) and Loviisa, Finland (operating since 1997).
OPG Response	Utilization of international experience has been, and will continue to be, an important aspect in the development and future operation and decommissioning of the DGR. DGR project staff have visited repository sites in Finland, Germany, Sweden and the USA to gain and exchange experience in the areas of site characterization, design, operation, safety assessment, regulatory practices and public engagement. Information already on the DGR public registry (CEAA Registry Doc# 521) submitted by the Canadian Nuclear Safety Commission (CNSC 2012) provides technical details of the Forsmark and Loviisa repositories. Insights gained from international repository projects include: a) comprehensive public engagement programs are an important part of attaining public acceptance of repository projects; b) geological conditions as well as the roles of various natural and engineered barriers are unique at each repository site and strongly influence the safety case at each site; c) the efficacy of specific site characterization methods; d) the importance of ensuring no significant groundwater flow paths into a repository; e) concurrent room excavation and waste emplacement, versus having these activities sequential is an important design and operational consideration; f) the importance of maintaining the safety case consistent with actual waste inventories;

	g) approaches to preclosure and postclosure safety assessments; h) issues with certain waste conveyance methods, in shaft and underground; and i) plans for shaft seal design. Uncertainties are generally very repository-design specific; hence any uncertainties remaining relative to the operational Forsmark and Loviisa repositories are not necessarily pertinent to OPG's DGR.

OPG's response to the request is to highlight some insights gained, including:

- The importance of proper public engagement;
- The uniqueness of geological conditions
- The efficacy of site specific characterization methods

OPG also references a document by the CNSC (CEAA Registry Doc# 521) that compares the DGR to six other waste repositories, but does not describe the successes and failures to date of these repositories.

The insights provided by OPG all serve to highlight that each approach to nuclear waste storage is unique. This does not imply there is no international experience to draw from, but implies that there is a need to be far more humble and cautious that appears to be the case. Understandably but significantly, there is not yet enough international experience to determine what designs are truly successful, particularly over the long-term. Effectively, while the identified lessons include important items that have implications for current design efforts to mitigate risks, they do not include lessons to inform efforts to provide capacity to meet burdens on future generations due to the storage of LILW.

In effect, it is unreasonable to expect OPG to have knowledge of long-term successful applications of nuclear waste storage given the relatively short history of nuclear power and even shorter history of attempts to store nuclear waste. For this same reason, it is very reasonable to expect OPG to act with due caution and respect for the unknown.

OPG might further elaborate on the successes and failures to date, and provide some relevant substantive examples of where learning-by-doing has taken place.

A related topic to the issue of international experience is that of the state of the art of DGR technology. Section 3.3.5.2 of the EIS notes that "the engineering feasibility studies found that each of the long-term management options is technically feasible, uses internationally *proven* technology and is capable of accommodating all of the LLW currently stored and likely to be received in future" (emphasis added). Further on, Section 3.3.5.3 of the EIS notes that "the screening determined that, while each the options for the long-term waste management facility had the potential to cause effects on the environment, all the identified potential effects can be appropriately managed using *proven* mitigation and management methods" (emphasis added).

In both instances, OPG is arguing that the feasibility of the DGR has been proven despite the obvious uncertainties and long-term risks and hazards present with the proposed project. Furthermore, with regards to the EIS, the "proven" nature of the technologies is mentioned with regards to LLW, but does not mention IWL.

It would be unfair to expect OPG to be able to prove anything, given the inherent and irreducible complexity and uncertainty present in the analysis. Nevertheless, OPG has developed an argument for feasibility (and consequently for the sustainability) of the DGR based in the notion that the technologies have been proven. It would be helpful for OPG to elaborate on its definition of a proven technology, and provide justification for how both the technologies and mitigation and management methods have been proven for both LLW and ILW.

For these reasons, CELA forwarded the following requests to the JRP:

Please provide the following information with respect to the care in perpetuity of the proposed DGR Project:

a) Describe what OPG implies when it states that its technologies and mitigation and management methods have been *proven*.
b) Set out the criteria that OPG used to determine whether a technology or method is "proven".
c) Explain whether these "proven" technologies relate only to LLW, or also include ILW

These requests were forwarded by the JRP to OPG in IR EIS-08-367.

Table 4.3-5 – Panel IR EIS-08-367 - Perpetual care of the DGR - Drawing from international experience

Related Panel Request EIS-08-367	Explain how OPG's technologies and mitigation and management methods have been proven. Define the criteria used to determine whether a technology or method is "proven". Explain whether these "proven" technologies relate only to LLW, or also include ILW. **Context:** It is noted in Section 3.3.5.2 of the EIS that "the engineering feasibility studies found that each of the long-term management options is technically feasible, uses internationally proven technology and is capable of accommodating all of the LLW currently stored and likely to be received in future." In Section 3.3.5.3 of the EIS it is noted that "the screening determined that, while each the options for the long-term waste management facility had the potential to cause effects on the environment, all the identified potential effects can be appropriately managed using proven mitigation and management methods." OPG should elaborate on its definition of a proven technology, and provide

	justification for how both the technologies and mitigation and management methods have been proven for both LLW and ILW.
OPG Response	The "engineering feasibility studies" in the quote provided in the Context refers to the Independent Assessment Study (IAS) performed by Golder Associates in 2003/2004 on behalf of OPG and the Municipality of Kincardine (GOLDER 2004). The reference to "internationally proven technology" would have been made in the IAS in the context of the options studied in the IAS, namely: Enhanced Processing and Storage, Surface Concrete Vaults and Deep Rock Vaults. Section 2.4 in the IAS provides examples of where internationally there were facilities representing each of these options in operation at the time, hence 'proven'. It is OPG's intent to use proven technology whenever possible in the design, construction and operation of the proposed DGR facility. In this context 'proven' means that the use of the technology has been successfully demonstrated before, or is a small extension of proven technology such that there is a high level of assurance that its application will be successful. With this in mind, OPG's intentions in a number of areas of use of technology, mitigation methods and management methods are described below. **Mine Development, Operation and Closure Technology** The DGR shafts will be developed using conventional controlled drill and blast techniques, and the shaft workings (e.g., shaft headframes, collar, ground support, steel sets, liner, etc.) are common to the mining industry and use readily available ("off-the-shelf") technology and construction methodologies. The reference for lateral development is also conventional controlled drill and blast techniques. This is common in the mining industry, and is also the means of development in other international repository projects (e.g., Sweden and Finland). The shaft hoists, both the Koepe and Blair multi-rope configurations, have been selected to provide a level of safety (i.e., multi-rope configurations), as well as, having proven application tested and available in the market. The main shaft Koepe hoist is very similar in specification to that at the Waste Isolation Pilot Plant in Carlsbad, New Mexico, which transfers low and intermediate level waste safely and has been operating for over 20 years. The underground ventilation system consists of "off-the-shelf" equipment that is typical of underground facilities, both mining and operating waste repositories. As described in OPG's response to Information Request (IR) EIS-03-64 (OPG 2012a) the closure shaft seals consist of relatively simple and durable materials that are placed using proven application methods (i.e., placement of materials in lifts and compacted in-place). Refer to OPG's presentation and written submission for the Technical

	Information Session #1 (OPG 2012b) for more information on the mine development, operation and closure aspects of the DGR project. **Waste Transfer and Underground Placement** Waste container transfer processes and equipment, with the exception of transfer within the shaft, are similar to those that have been employed in the handling of waste at OPG's Western Waste Management Facility (WWMF) over the last 40 years. The majority of waste containers will be transferred from WWMF to the main shaft, and from the base of the main shaft to emplacement rooms, using forklifts, the primary means of waste container transfer and stacking at the WWMF. Transfer in the shaft, utilizes existing technology and safeguards to ensure stable and intact shipment. Refer to OPG's response to IR-EIS-08-344 (OPG 2013) for additional information on waste transfer. Mitigation Methods As part of design evolution, risk assessments are conducted to identify areas that could have an effect on conventional, preclosure or postclosure safety of the DGR. Where possible, the risk is mitigated through the design (e.g., multi-rope hoists, additional shielding, etc.). Where the risk is beyond the design basis or standard, additional contingency measures may be identified. Examples of this would include the identification of water treatment options for pre-treatment of stormwater discharge, or the identification of portable pumping equipment in the event of repository flooding (assuming failure of the redundant dewatering system that is sized for the shaft liner failure scenario). Such mitigation methods are being successfully utilized in many other mine-related applications, and hence are considered well proven. **Management Methods** The management methods employed on the DGR project are modeled on the best industry practices and the extensive experience of OPG. All of the above examples of 'proven' technologies, mitigation methods and management methods are applicable to whether the wastes to be handled and emplaced in the repository are low-level waste or intermediate-level waste. Different methods (e.g., provision of additional shielding) of handling higher-activity intermediate-level waste, compared to low-level waste may be required, but these methods have been in use at the WWMF for many years.

OPG's response provides some clarification to the question of proven technologies. However, at the very basic level, there is still disagreement on the use of the word, and its implications. Notably, OPG's response includes the following two quotes:

- "Section 2.4 in the IAS provides examples of where internationally there were facilities representing each of these options in operation at the time, hence 'proven'."
- "It is OPG's intent to use proven technology whenever possible in the design, construction and operation of the proposed DGR facility. In this context 'proven' means that the use of the technology has been successfully demonstrated before, or is

a small extension of proven technology such that there is a high level of assurance that its application will be successful."

The first quote seems purposely misleading. The presence of a technology in operation only proves that it is currently in operation. This proves nothing of long-term success of the technology, and for the purposes of care in perpetuity, and even basic due diligence, this is not the desired test of proof. Prior to March 11, 2011, the Fukushima reactor in Japan was *proven* to be properly designed and sited. After March 11, this was no longer the case. The intent here is not to critique the Fukushima reactor, but rather to argue that this interpretation of *proven* technology is inappropriate.

The second quote helps qualify OPG's interpretation in a positive manner. However, even the second quote includes an improper application of the concept of a proven technology. In this instance the concerns relate to the time frame involved. A DGR that has successfully operated for 20 years is not proven to last for the entire operational period, the 300 years of institutional control, or the millennia of abandonment. This is not to say the technology will not last successfully over those periods, but that there is clearly no proof at this point, and one should be guided by the precautionary principle.

4.4 Ensuring positive socio-economic outcomes

The third aspect of sustainable development addressed in this report relates to socio-economics, especially whether the DGR is being designed in a manner to provide lasting socio-economic gains and avoid boom and bust effects. A review of the socio-economic considerations in the EIS revealed that there is insufficient information to make an informed judgment at this point.

This section only discusses a select set of concerns relating to the socio-economic environment, particularly with regards to long-term collection of socio-economic data and the cumulative effects of boom and bust dynamics. This section does not address the adequacy of the baseline data provided by OPG, although we recognize this is an important concern as well.

4.4.1 The cumulative effects of boom and bust dynamics

Section 7.10.2 of the EIS discusses the benefits of job creation, and OPG notes that "the DGR Project is forecast to create 650 jobs in the Local and Regional Study Area during peak construction, 128 jobs per year on average during operations and 548 jobs per year on average during decommissioning." These averages appear somewhat misleading, given that Figure 7.10.2-2 indicates that the number of jobs in the region is expected to increase from less than 100 jobs in 2054, up to over 1,300 jobs in 2060, and then decrease down to 0 jobs by 2064. A smaller, but potentially still significant drop is expected to occur between 2016 and 2018.

While there may be potential for both economic benefits and disadvantages, it appears equally important to consider the potential for boom and bust effects, especially considering that in Section 6.10.4.2 of the EIS, it is noted that a few stakeholders "indicated that adverse effects on the local economy were evident after the Bruce A station was laid-up in 1998 and some indicated that the ’boom and bust’ cycle associated with the facility has made it difficult to plan for the future. Others indicated a need for the economy to be more diversified to avoid complete dependency on the jobs generated by the presence of the Bruce nuclear site.”

Given the concerns about economic boom and bust noted by stakeholders, and the potential for significant changes to employment with regards to other nuclear and non-nuclear related activities, it is necessary and prudent to consider boom and bust at the cumulative effects level, and describe how OPG may act differently in light of the cumulative level assessment on boom and bust.

For these reasons, CELA forwarded the following requests to the JRP:
Please provide the following information with respect to the significance of cumulative effects of the proposed DGR Project:

a) Describe why economic boom and bust effects were not considered at the level of cumulative effects assessment
b) If some cumulative boom and bust effects are reasonably anticipated, describe what steps will OPG take to mitigate them.
c) Critically evaluate and report on opportunities for increased long-term economic diversification to avoid negative socio-economic effects due to overreliance on the nuclear sector.

These requests were forwarded by the JRP to OPG in IR EIS-08-369.

Table 4.4-1 – Panel IR EIS-08-369 – Cumulative socio-economic effects of boom and bust

Related Panel Request EIS-08-369	Explain why economic boom and bust socioeconomic effects were not considered at the level of cumulative effects assessment. Describe the mitigation measures to be taken should cumulative boom and bust effects be reasonably anticipated. **Context:** Section 7.10.2 of the EIS discusses the benefits of job creation, and OPG notes that “the DGR Project is forecast to create 650 jobs in the Local and Regional Study Area during peak construction, 128 jobs per year on average during operations and 548 jobs per year on average during decommissioning.” Figure 7.10.2-2 indicates that the number of jobs in the region is expected to increase from less than 100 jobs in 2054, up to over 1,300 jobs in 2060, and then decrease down to 0 jobs by 2064. A smaller, but potentially still significant drop is expected to occur between 2016 and 2018. In Section 6.10.4.2 of the EIS, it is noted that a few stakeholders “indicated that adverse effects on the local economy were evident after the Bruce A station was laidup in 1998 and some indicated that the ’boom and bust’ cycle associated with

	the facility has made it difficult to plan for the future. Others indicated a need for the economy to be more diversified to avoid complete dependency on the jobs generated by the presence of the Bruce nuclear site.”
OPG Response	“Boom and bust” economic effects are generally observed before and after particularly intense periods of work featuring rapid expansion or development, followed by rapid decline, project closure or abandonment. Such effects are typically associated with large transient workforces entering and leaving small rural or remote communities that do not have the infrastructure, services or past experience to cope with such rapid change. This phenomenon is normally associated with development projects on a larger scale than the DGR Project. The DGR Project was not considered to be a major construction undertaking within the context of other projects that have taken place in the same vicinity (i.e., Bruce Restart, which was of a larger scale); consequently, boom and bust effects were not anticipated. One of the main issues that can influence boom and bust effects is the temporarily increase in local populations from transient workers. This can affect issues such as use of infrastructure, demand on housing and temporary accommodations, demands for emergency services, healthcare, and other facilities and services. With regard to the DGR Project, the site preparation and construction phase will require an on-site workforce of up to 200 workers for approximately six years. In absolute terms, this is a small labour force. When compared to the existing labour force on the Bruce nuclear site, the Local Study Area (LSA) and Regional Study Area (RSA), this is an extremely small labour force. Nevertheless, it is anticipated that some competition for temporary accommodation would occur but it is not expected to be of sufficient magnitude to affect the tourism accommodation industry in the LSA and RSA. Rather, the increased demand for accommodation is likely to help maintain the economic viability of these accommodation providers, particularly in the off-peak seasons. Regardless, this is not expected to be of sufficient magnitude to generate substantial reinvestment into these facilities by their owners. Therefore, no major growth or “boom” to tourist accommodations is anticipated because of the DGR Project, and thus no subsequent “bust” will follow. This has been the history and experience in the south Bruce area for decades. Similarly, since the increased population associated with the DGR Project is expected to be small and will not impose a noticeable increase in demand on housing stock, municipal infrastructure or health and safety facilities and services, it is also expected that the small population increase will not change the overall demand for the recreational opportunities. Again, because of the small size of the labour force associated with the site

	preparation and construction phase, it was not anticipated that adverse effects on health and safety facilities and services would occur. In fact, the results of the socio-economic assessment indicated that the population increase in this phase (associated not just with the increased labour force but with overall population increase) would result in the need for barely measureable increases in additional requirements for health and safety services. During construction, the DGR Project is predicted to result in an average annual requirement for additional capacity across the RSA of approximately: • 0.8 in-patient hospital beds; • 0.8 staff persons for both emergency medical and police services; and • 2 firefighters (AECOM 2011, Table 8.3.2-2). The additional 0.8 staff persons for both emergency medical and police services indicates that the additional requirements for these services are quite small. Stakeholder interviews with local and regional police services indicated that the DGR Project is not a major concern for these operations, and that the DGR Project would not change the activities of police services in the area. In fact, one representative stated that the DGR Project would change the image of the community by making it more self-reliant and more secure. However, none of the representatives from police services stated that transient workers and potential social problems associated with those workers were a concern. In conclusion, boom and bust effects were not anticipated due to the scale of the project; therefore, these effects were not carried forward to the assessment of cumulative effects. The DGR Project is not considered to be a major project and additional workers are not expected to merit significant changes or undue stresses on the socio-economic environment including tourist accommodations or health and safety facilities and services.

OPG's response helps contextualize some of the dynamics relating to boom and bust, particularly with regards to the demand for increased infrastructure and services. However, the response does not address the fluctuations in employment opportunities, and the impacts on workers and their families. This is arguably an equally important aspect of boom and bust dynamics, and one not sufficiently treated in the EIS, or OPG's response to the IR.

4.4.2 Ensuring proper socio-economic monitoring and follow-up based on a proper baseline

Building from the discussion of boom and bust dynamics above, one of the deeper concerns of the socio-economic environment is that the EIS does not outline a sufficiently robust program for tracking and responding to socio-economic dynamics in its follow-up program. Ensuring adequate follow up monitoring and response is essential for tracking the actual effects of the DGR project on the relevant socioeconomic as well as biophysical systems, and for preparing suitable responses to identified problems and emerging opportunities.

Table 12.2-1, which outlines the proposed monitoring for the socioeconomic environment, notes monitoring will take place via public attitude research in the following manner:

a) During the peak year of employment during the site preparation and construction phase.
b) Subsequent to any accidents or malfunctions of the DGR or associated operations resulting in a release of radioactive contamination to the environment.
c) With public attitude research during operations to be considered in conjunction with ongoing WWMF public attitude research.

This socioeconomic monitoring program (notably point 'a') does not appear to be designed in a manner to detect all likely important effects. Boom and bust effects, for example, are likely to be missed if the monitoring ignores periods of low employment, including after the constructions, as well as the final decommissioning (which, based on predictions in Figure 7.10.2-2 in the EIS, will experience a decrease of more than 1,300 jobs from the period of 2060 to 2064). Likewise, the impact on the tourism and cottaging sectors were insufficiently treated to fully inform decision-making.

Without representative baseline data regarding socioeconomic conditions, it is difficult to develop a clear picture of the long-term impact the DGR will have on the residents of Kincardine and surrounding regions, including residents yet to be born. Furthermore, public attitude research (PAR) appears entirely insufficient to characterize the socioeconomic system, and it is important to understand what other metrics (both quantitative and qualitative) will be used to inform current and future decision-makers. Furthermore, the reliance on PAR gives the impression that OPG is more concerned about attitudes to the project than about actual project effects on wellbeing.

For these reasons, CELA forwarded the following requests to the JRP:

Please provide the following information with respect to the follow up program of the proposed DGR Project:

a) Describe how OPG will ensure that its follow-up program will be sufficiently comprehensive to characterize adequately the socioeconomic system beyond the 2009 baseline.
b) Provide the reasoning behind the proposal to collect socioeconomic data only during site preparation and construction phases
c) Explain how public attitude research alone will be sufficient to characterize the socioeconomic environment
d) Critically evaluate the impacts of the DGR on the tourism and cottaging sectors due to the placement of the DGR so near the shores of Lake Huron

These requests were forwarded by the JRP to OPG in IR EIS-08-368.

Table 4.4-2 – Panel IR EIS-08-368 – Developing appropriate socio-economic baseline data

Related Panel Request **EIS-08-368**	Describe how OPG will ensure that its follow-up program will be sufficiently comprehensive to adequately characterize the socioeconomic system beyond the 2009 baseline. Provide additional rationale with respect to the effects of the DGR on the tourism and cottaging sectors due to the location of the DGR being near Lake Huron. **Context:** Table 12.2-1 in the EIS outlines the proposed monitoring for the socioeconomic environment. This socioeconomic monitoring program may not detect all likely effects. For example boom and bust effects may be missed if the monitoring ignores periods of low employment, such as following decommissioning. Further information is also required to assess the effects on the tourism and cottaging sectors
OPG Response	**Socio-economic Follow-up Activities** The Environmental Impact Statement (OPG 2011a) does not predict adverse socio-economic effects as a result of the DGR Project beyond a noise-related effect on the use and enjoyment of property near Baie du Doré. The EA Follow-up Monitoring Program (NWMO 2011, Table 12.2-1) indicates that public attitude research (PAR) will be completed during the peak year of employment, when the magnitude of effects of the site preparation and construction phase workers are predicted to be greatest, and subsequent to accidents or malfunctions resulting in a release of radioactive contamination to the environment. Subsequently, this activity will be integrated with the PAR activities conducted by OPG (in accordance with CNSC RD 393) for its operating facilities at the Western Waste Management Facility (WWMF). Through continuation of its engagement programs, described in the Preliminary Safety Report (OPG 2011b, Section 12), OPG will maintain an awareness of stakeholder and public concerns that might relate to effects on the socio-economic environment. **Effects on Tourism and the Cottaging Sector** In the Socio-economic Environment Technical Support Document (TSD) (AECOM 2011), likely effects on tourism were assessed using a variety of data sources including the results of stakeholder interviews and field surveys, past experience, case studies and professional judgment. The required on-site labour force during the site preparation and construction phase is estimated to be less than 200 workers. The number of on-site jobs by project phase is shown in Table 1. [Embedded table not pasted]

	During the site preparation and construction, and the decommissioning phases of the DGR Project, some competition for temporary accommodation is anticipated but is not expected to be of sufficient magnitude to affect the tourist accommodation industry. Interviews with tourist accommodation providers across the Regional and Local Study Areas (RSA and LSA) indicate that most operators attribute some of their business to the presence of the Bruce nuclear site and its employees or activities, and some indicated that up to 70% of their business can be attributed to site employees. The increased number of workers on-site because of the DGR Project, and increased number of corporate clients using local hotels and motels during the off-season, is likely to help maintain the economic viability of these businesses. However, it is not expected to be of sufficient magnitude to generate substantial re-investment in these facilities by their owners, nor encourage the improvement of the tourist accommodation stock over the long-term. During the operations phase the workforce is small and it is anticipated most workers and their families will seek long-term permanent housing rather than temporary accommodation, and therefore impose little demand on tourist facilities. Notwithstanding the above, should tourists and other visitors to the provincial parks, LSA hotels, motels and campgrounds "stop coming" or be "diverted elsewhere" as a result of increased competition, it is not likely that the overall tourism industry would suffer. This possible loss of visitation would not likely translate directly into a loss in revenues at all tourist establishments because DGR Project workers would act as a substitute source of revenue. Results of the air quality and noise assessment indicate that the DGR Project is not likely to result in noticeable increased dust or noise levels at Inverhuron Provincial Park, MacGregor Point Provincial Park or any other key tourist attraction areas. The surface water assessment also indicates that the DGR Project is not likely to measurably change the water quality at LSA or RSA beaches and near shore areas used by tourists and day users for outdoor leisure activities such as swimming, fishing and boating. Therefore, the DGR Project will not result in environmental effects to the provincial parks, affect their accessibility nor require park operators to modify their facilities or programs. Apart from the potential effects of dust, noise and traffic, it was hypothesized that adverse effects on the use and enjoyment of the provincial parks, and the tourism industry in general, within the LSA and RSA may occur if the DGR Project results in an adverse effect on community character (i.e., a physical asset), particularly if a stigma is attributed to the LSA and tourists take steps to avoid the area, and its tourism-related products and services. In addition to the information presented in the Socio-economic Environment TSD (AECOM 2011), studies have found that analogous nuclear facilities sited and operated near tourist destinations generally have not adversely affected

	tourism (SAIC 1985, Baker 1980 et al., Allison et al. 1992, Metz 1996). A review of nuclear power plant studies conducted by Science Applications International Corporation (SAIC 1985) cites Nutant et al. (1977) research evaluating the effects of land-based nuclear power plants on resort communities. In their study, Nutant et al. (1977) examined historical data to determine effects on tourism associated with the operation of Oyster Creek Nuclear Generating Station in Ocean County, New Jersey. In the five years subsequent to commencement of plant operations in 1969, Ocean County's total population grew by 42%. Nutant et al. (1977) interpreted this substantial population growth as an indication that the Oyster Creek power plant had not adversely affected the community's resort economy. Qualitative assessments of three additional nuclear facilities (Turkey Point, Florida; Maine Yankee, Maine; and San Onofre, California) also revealed no indication of adverse effects on the tourist economy of nearby communities (SAIC 1985). Baker et al. (1980) examined coastal sited nuclear plants in the vicinity of visible beaches with out-of-town commercial tourist activity. Four nuclear sites were selected for investigation, including: • San Onofre, California; • St. Lucie, Florida; • Millstone, Connecticut; and • Zion, Illinois. Research included analysis of attendance figures of beach state parks near three sites; interviews with beach visitors; and interviews with officials and operators of tourist establishments. The key findings are summarized below. • In the analysis of beach state park attendance, Baker et al. (1980) concluded that the data did "...not suggest that the beginning of construction or commercial operation of nuclear generating facilities has had a sizable impact on attendance at nearby beach state parks" (Metz 1996). • Interviews of beach visitors in the vicinity of coastal nuclear plants revealed that less than 5% of visitors were aware of anyone having been deterred by the plant from visiting the beach. • Interviews with officials and professionals in a position to observe the effects of nuclear plants on tourism at the four sites indicated that there has been no effect (Metz 1996). Allison et al. (1992) evaluated the effect on tourism of 11 nuclear facilities where disposal of nuclear waste is an important element of operations. Information regarding the facilities was collected during site visits and through interviews with plant personnel, officials of local and state agencies, and community activists in the hosting communities. Of the 11 facilities examined, six experienced incidences of environmental contamination. The key findings are summarized below. • In the communities studied, negative attitudes and perceptions of risk did not affect tourism and there was no evidence of any economic effect. The authors add the caveat; however, that the potential for nuclear facilities to affect

tourism was limited given that the majority of facilities examined were sited in rural areas and smaller cities (Allison et al. 1992).

- Two of the nuclear sites Allison et al. (1992) examined, Wilmington, North Carolina (commercial nuclear fuel production) and West Valley, New York (nuclear waste storage facility and site of contamination), are in close proximity to rapidly growing tourist and recreational destinations. At Wilmington, the area south of the city from Wrightsville to Cape Fear has become a popular recreational and tourist area. Moreover, the city itself possesses historical features that have attracted tourists. Near the West Valley facility, researchers reported a popular ski resort and significant development growth in the adjacent town of Ellicotville (Allison et al. 1992).

Metz (1996) examined the economic effects of the U.S. Department of Energy (DOE) Nuclear Weapons Complex (Weapons Complex) facilities affect, including effects on local tourism. The Weapons Complex consisted of 15 major facilities in 12 U.S. states. Metz (1996) suggested that the Weapons Complex was analogous to the proposed high level nuclear waste repository in Yucca Mountain, Nevada because of strong similarities (i.e., they are managed by the DOE, have radioactive waste present, and have been subject to high-profile discrete and cumulative risk-related events). The Weapons Complex facilities have been recipients of media coverage regarding on-site and off-site incidents including contamination, mismanagement, spills, releases, exposures, accidents and deaths, as well as heightened concerns about impending chemical explosions and radioactive releases. The key findings are summarized below.

- Metz's research found that tourism and recreational activities continued to grow in the vicinity of Weapons Complex facilities.
- Metz also noted that many of the facilities were near flourishing vacation areas (e.g., Hilton Head, Tampa, Colorado Rockies and Great Smoky Mountains) and annual national tournament sports events (Metz 1996).

In addition, reviews by SAIC (1985), Baker et al. (1980), Allison et al. (1993) and Metz (1996), suggest that there is little cause to expect adverse effects on tourism given routine operation.

In a study commissioned by the Nevada Nuclear Waste Project Office, Easterling (1997) asserts, "the primary lesson to draw from the case-study approach is that the impact of a nuclear facility on the local economy depends almost completely on the severity of the events that occur over the lifetime of the facility" (Jenkins-Smith 2001). Easterling's conclusions regarding the potential effect of the proposed high-level nuclear waste repository at Yucca Mountain for tourism in Nevada are considered particularly applicable to the DGR Project in Kincardine. He states, "Under a benign scenario...without incident and without undue publicity – the repository would likely have a benign impact on decision making. On the other hand, if one assumes a severe repository scenario – with a set of high-publicity accidents and controversies – there is a very real potential for significant visitor impacts..." (Jenkins-Smith 2001).

Therefore, should radioactive contamination occur as consequence of the DGR Project, it is possible that tourism would be adversely affected. However, it is unlikely that the DGR will pose any threat to tourism in the area under normal operating conditions.

Jenkins-Smith (2001) study of how individuals rely on images in development of preferences holds further insight regarding the potential effect of the DGR Project on tourism. Key findings from his research are:

- attractiveness attached to images about a place were very strong predictors of vacation preferences for that place;
- opinions that people attach to images of nuclear facilities vary considerably ranging from overly positive to overly negative; and
- nuclear images are part of a broader set of images regarding a destination, and the perceptions of nuclear images are correlated with the perceptions of other destination image categories (Jenkins-Smith 2001).

Given the established presence of the Bruce nuclear site and the WWMF, it can reasonably be assumed that these nuclear facilities are part of image sets for some Kincardine tourists. The fact that tourists continue to visit Kincardine in spite of its associated nuclear images suggests that the valences tourists attach to these nuclear images are not overtly negative and that nuclear images do not overwhelm the positive valences of other images that attract them to the area.

Jenkins-Smith (2001) concludes that sets of images that exist prior to the introduction of a potentially stigmatizing image play a critical role in determining people's overall perceptions of a place because images interact. He summarizes:

> "If a new and negative type image is widely introduced into the image sets of a place, the effect of that image on such activities as vacationing, relocating, and retiring will be in part dependent on how the new image is associated with images in the pre-existing image sets. If the new image (e.g., a nuclear image) is negatively associated with the valences of images that previously had served to attract people to the place..., then the nuclear image is likely to lead to greatest reduction in vacation preferences among precisely those people who used to be most attracted to the place... If, on the other hand, the new image (e.g., a nuclear image) is positively associated with the valences of those images that previously had attracted people to the place... then the nuclear image will be most positive (or least negative) for those who are most likely to vacation in that place. Those who were least likely to vacation in the place before... are the ones for whom the new images will be most negative. In that case, people who didn't want to vacation there before will now want to vacation there even less." (130-131)

Therefore, it is unlikely that the new image of the DGR Project will be negatively

	associated with the perceptions of images that previously had served to attract tourists to Kincardine given that the analogous images of Bruce nuclear site and WWMF have not repelled these tourists from the area. It is likely that the new image of the DGR Project will be least negative, if negative at all, for those people who currently vacation in Kincardine. On the other hand, those who currently choose not to vacation in Kincardine because they attach strong negative connotations to nuclear images of the Bruce nuclear site and WWMF, the DGR Project will exacerbate their negative perspective. The DGR Project is not expected to adversely affect the attractiveness of the LSA or RSA to tourists and cottagers for the following reasons: • no noticeable increases in dust or noise levels at the two provincial parks, downtown Kincardine or Port Elgin are anticipated during the DGR Project phases; • the DGR Project is not likely to change environmental conditions at the beaches and near shore areas used by tourists and day users; • increased traffic is not anticipated to be noticeable at the entrance to Inverhuron Provincial Park or on Highway 21, both of which are regularly used by tourists; • the DGR Project is not expected to substantially change the visual character of the LSA, nor block views of the lake from the provincial parks or the Bruce Power Visitors' Centre; • based on the results of the Inverhuron and MacGregor Point Provincial Park Survey, the DGR Project is not likely to affect the things or special features that instigate the use and enjoyment of the provincial parks by tourists (i.e., beaches, park amenities and atmosphere, surrounding environment and recreational opportunities); and • the DGR Project will be visible from Lake Huron, but its above-ground facilities will not be dominant as compared to the existing buildings and structures at the Bruce nuclear site. As part of the assessment, stakeholder interviews were conducted with representatives of cottage rental agencies and were intended to provide local knowledge on study area services, resources and community well-being. Five agencies were contacted for participation and one interview was completed in 2009. Overall, the results of the interview indicated that the presence of the site had a strong, positive effect on off-season cottage rentals and business has improved in years prior to the interview. The interviewee stated that transient workers are important to their business operations and the presence of the site is not considered a detriment to business. When asked about the DGR, it was felt that the project would have the potential to increase cottage rentals. The 2009 PAR (INTELLIPULSE 2010) did not separate out seasonal residents from year-round residents. Fourteen seasonal residents were interviewed (out of 809). This was considered to be too small a sample to allow for significance analysis of their attitudes in comparison to the total sample. However, the

	following information is taken from the responses from the 14 seasonal residents: • seasonal residents are mostly "somewhat" or "very satisfied" with living in the community (12 out of 14 respondents); • seasonal respondents are mostly "somewhat" or "very committed" to remaining in the community long term (12 out of 14 respondents); • when asked what the first thing or image that came to mind when thinking about the Municipality of Kincardine was, only 2 seasonal resident respondents mentioned Bruce Power; neither respondent felt that this was a negative image; all seasonal residents (14 out of 14) said that they considered the Municipality of Kincardine and southern portion of Bruce County to be "very" or "somewhat attractive"; • a small proportion of respondents (4 out of 14) said that they thought about living near the WWMF "very often" or "often"; • only one seasonal resident respondent said that the presence of the WWMF had any effect on their daily life; and • the majority (12 out of 14 respondents) said that the DGR Project would not affect their commitment to living in their community nor would it affect their use and enjoyment of their private property. Given that only a small number of respondents were seasonal residents, these responses should not be considered conclusive or entirely representative of all seasonal residents in the area. **References:** AECOM. 2011. Socio-economic Environment Technical Support Document. AECOM Canada Ltd. report for the Nuclear Waste Management Organization NWMO DGR-TR-2011-08 R000. Toronto, Canada. (CEAA Registry Doc# 299) Allison, T., S. Hunter and F.J. Calzonetti. 1992. Analysis of the formation, expression, and economic impacts of risk perceptions associated with nuclear facilities (No. ANL/EAIS/TM--88). Argonne National Lab., IL (United States). Environmental Assessment and Information Sciences Div. Baker, E.J., S.G. West, D.J. Moss and J.M. Weyant. 1980. Impact of Offshore Nuclear Power Plants Forecasting Visits to Nearby Beaches. Environment and Behavior, 12(3), pp.367-407. Easterling, D. 1997. The vulnerability of the Nevada Visitor Economy to a Repository at Yucca Mountain. Risk Analysis, 17(5), pp.635-647. INTELLIPULSE. 2010. Ontario Power Generation, Deep Geologic Repository – Public Attitude Research. Intellipulse Inc. report for AECOM Ltd. (CEAA Registry Doc# 611) Jenkins-Smith, H. 2001. Modeling stigma: An empirical analysis of nuclear waste images of Nevada. Risk, media, and stigma: Understanding public challenges to modern science and technology, pp.107-132. Metz, W.C. 1996. Historical application of a social amplification of risk model: economic impacts of risk events at nuclear weapons facilities. Risk Analysis, 16(2), pp.185-193.

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OPG's discussion of the effects on the cottaging industry are commendable and may help inform discussions of the socio-economic effects. By contrast, OPG's response about socio-economic monitoring did not address the original requests beyond simply repeating that OPG will not be collecting the relevant socio-economic data beyond the year of peak employment. While it is clear that the year of peak employment will include various positive and negative effects, these are not the only type of effects that matter. Particularly with regards to boom and bust effects, collecting data at a single point, and at the year of maximum employment, provides very little useful information for decision-making and action. These are important concerns that OPG should not be ignoring.

5. Consideration of the Precautionary Principle

The first listed purpose of the *Canadian Environmental Assessment Act* (s. 4(1)(b)) is to ensure that projects are considered in a careful and precautionary manner. This purpose evidently applies to all aspects of the assessment process. Section 2.5 of the EIS Guidelines reiterates the importance of precaution as one of the guiding principles for the assessment, and provides some illustrative minimum expectations related to how OPG ought to establish that it applies the precautionary principle in the design of the project. OPG is obliged by the EIS Guidelines to evaluate and compare the alternative means of carrying out the project in light of three generic criteria that are central to a precautionary approach to nuclear waste management: risk avoidance, adaptive management capacity, and preparation for surprise. Because the legislative purpose applies to the entire assessment, not only to the matter of project design, we assert that OPG should have adopted and applied the three generic precautionary criteria in all stages of the EIS, including evaluations and decision making related to "alternatives to" as well as "alternative means" in the design of the project. Below, we briefly describe how this should have been undertaken.

OPG's EIS should have involved five basic stages including

- establishment and delineation of the public interest purpose of and need for an undertaking for managing L&ILW in Ontario;
- comparative evaluation of the potentially reasonable broad options for meeting the need and purpose (the "alternatives to"), leading to selection of the preferred alternative as the proposed project for managing L&ILW;
- the design of the preferred alternative, including a comparative evaluation of alternative means;
- plans for monitoring project effects; and
- plans to respond to new and unexpected outcomes and understanding.

The JRP must ensure that OPG has explicitly adopted and applied the three generic criteria (by themselves or as components of a more comprehensive set of criteria for comparative evaluation) throughout these basic stages. The DGR project cannot be identified as the preferred option until this has been done. Using this evaluative framework OPG must demonstrate that

- the preferred alternatives pose the least likelihood and potential severity of risk while providing the greatest capacity to adapt to new information and conditions;
- risk avoidance, adaptive management capacity and preparation for surprise are inherent in the design of the preferred alternatives; and
- the monitoring and response programmes aim to address unanticipated events and new information and conditions, as well as verify predicted effects and confirm the effectiveness of mitigation measures.

To begin, OPG should have defined the three generic criteria. These definitions must be comprehensive of the widely recognized, basic requirements of a precautionary approach to the design, construction and management of, broadly speaking, complex technological systems and, more specifically, nuclear waste management programmes. A transparent discussion of these basic requirements should have been provided and, if needed, other supplementary generic criteria should have been identified and defined to provide the necessary detail of elaboration. At a minimum, the generic criteria should have covered the following basic requirements of a precautionary approach: reversibility and retrievability, and diversity and redundancy. We provide a brief description of these requirements later.

Once the three or more generic criteria have been defined, OPG should have specified them appropriately in preparation for the comparative evaluation of alternatives. Briefly, in the specification step OPG should have first described the potential (social, economic, ecological, short and long-term, multi-scalar, etc.) effects associated with each alternative to and means under a range of potential circumstances, including accidents, malfunctions and malevolent acts. Then, OPG should have evaluated and compared how each alternative would perform in relation to the generic criteria, at a minimum considering the basic requirements of reversibility and retrievability, and diversity and redundancy. In Sections 5.1 and 5.2, below, we provide a brief description of these basic requirements.

5.1 Reversibility and Retrievability

Many radioactive waste disposal and storage organizations now incorporate the concepts of reversibility and retrievability in their programmes (see OECD, 2001, 2012). This is to increase the level of flexibility and, thus, their ability to respond to changing information and conditions including, among others,

- technological innovations and/or advances in scientific understanding;
- new technical information regarding the design and operation of the facility;
- changes in social and political opinion;
- changes in policy and regulatory frameworks, including safety standards; and
- unforeseen events, including natural disasters, malfunctions, accidents and malevolent acts.

Briefly, reversibility is defined as the possibility of reversing one or a series of decisions taken during the lifetime of a particular nuclear waste management project. Reversal is the actual action of changing a previous decision. Thus, reversibility implies making design provisions for reversal should it be required (see OECD, 2012). Aside from the above listed flexibility benefits, designing for reversibility helps to ensure that the means for the safe, long-term disposal or storage of radioactive wastes are provided, while allowing future generations to modify or reverse the decisions if needed. It may also benefit public confidence in the long-term safety of a particular option in that it may alleviate concerns that particular decisions are irreversible.

Retrievability denotes the action of recovery of the waste packages (see OECD, 2012). Designing a nuclear waste management project so that waste can be deposited or stored in a retrievable manner enhances the reversibility of decisions by providing an additional degree of flexibility. Moreover, a demonstrated possibility to retrieve the waste at each stage after emplacement may increase public confidence in the long-term safety of a particular project. Indeed, people may consider a technology safer if they know that retrievability will be possible in the case of an accident, malfunction, or natural disaster, no matter how unlikely such events may be.

It may be that reversibility and retrievability also have potentially negative implications, for example concerning site security obligations. If so, trade-offs related to reversibility and retrievability options will need to be addressed as well.

5.2 Diversity and Redundancy

Diversity and redundancy are essential features of an approach to nuclear waste management that seeks to minimize risk. They are also major sources of adaptive management capacity (see Walker & Salt, 2009). In the context of managing long-lived radioactive waste, the diversity requirement seeks to ensure that decision makers evaluate and compare the (social, economic, and ecological) advantages and disadvantages of a range of different alternatives to and alternative means that could achieve the same objective or end. They also seek to ensure that backup options remain available. Thus, if the preferred option fails or proves to be problematic there should be sufficient knowledge about other options to make adaptation feasible. A precautionary approach to nuclear waste management, then, requires the maintenance of alternatives throughout the lifetime of a particular project (OECD, 2001). In other words, back-up options should be investigated and readily available if needed.

Redundancy pertains to the technological components of a particular alternative. The concept of redundancy has long been central to enhancing the safety and reliability of complex technologies. An element of a system is redundant if there are backups to do its work if it fails. This can mean that there are several elements that work simultaneously but are capable of preforming the same function by themselves if required, or it can mean having idle elements that perform when/if the system needs them.

The diversity and redundancy requirements also relate to important socioeconomic aspects of nuclear waste management systems. For instance, it is conceivable that the organizational-administrative arrangements that currently oversee Ontario's nuclear waste management programme will change over time in response to socioeconomic pressures. There should be diversity, then, with respect to the range of organizations that maintain scrutiny and that could assume responsibility over nuclear waste management in Ontario. Similarly, there should be redundancy in the way that knowledge, skills, decision-making power and responsibility are distributed among organizational-administrative units so that current capacities are maintained, protected and enhanced over the long term.

Section 5.3, below, presents our remaining questions with respect to OPG's consideration of the precautionary principle.

5.3 Remaining Inadequacies in OPG's Consideration of the Precautionary Principle

Pursuant to the above discussion, the following IRs regarding OPG's consideration of the precautionary principle have not been addressed:

OPG must describe how the alternatives to the proposed DGR project and the alternative means of carrying out the project were evaluated and compared in light of risk avoidance, adaptive management capacity, and preparation for surprise. OPG must provide the following information:

a) Define risk avoidance, adaptive management capacity, and preparation for surprise.

b) Describe how the three criteria were applied (by themselves or as components of a more comprehensive set of criteria for comparative evaluation) as a framework for evaluating and comparing the alternatives to and the alternative means, considering a range of plausible scenarios including accidents, malfunctions and malevolent acts.

c) Describe how each alternative performs in relation to the three criteria, considering a range of plausible scenarios including accidents, malfunctions and malevolent acts.

d) Describe why the DGR was selected as the preferred option, giving explicit attention to the three criteria.

6. Summary and Recommendations

In this section, we summarize our final comments to the JRP. Then, Table 5 presents our associated recommendations. Please note that this section provides a quick overview of some of the most glaring inadequacies in OPG's EIS. A more detailed discussion of these and other inadequacies are provided throughout the sections of this report.

From an environmental planning perspective, OPG has not met the obligations of the JRP Agreement, Terms of Reference for the Review and EIS Guidelines. In light of the deficiencies identified in the report, OPG has not satisfied the relevant provisions of CEAA. Remaining critical insufficiencies include the following:

a) **Justification for the proposed DGR project:** OPG used the findings of the IAS in order to establish the DGR as the preferred option for the management of long-lived radioactive waste in Ontario. But the IAS was completed in 2004, before the CNSC determined the type of EA required for the proposed DGR project and before the EIS Guidelines were drafted and the applications of CEAA requirements were confirmed. Clearly, the IAS rests on an agenda and scope far narrower than what is required for the present process. Most significantly, the IAS did not extend around decommissioning and abandonment. Nor did it explicitly consider ILW in the Engineering Feasibility and Safety and Licensibility analyses. Please see Table 5 for our recommendation to the panel in this regard.

b) **Consideration of alternative locations for the DGR**: OPG clearly states in its response to EIS IR 20-40 that its investigation of alternative sites (off the Bruce site) occurred only on a conceptual level. No additional analysis was undertaken to provide evidence that the Bruce nuclear site should be the preferred alternative. Rather, OPG's preference for the Bruce site rests primarily on the 'willing host' criterion. Given the characteristics of the proposed DGR, it is unacceptable for OPG to offer only a broad conceptual rejection of alternative locations. The glaring omission is that there has been no *real* comparison of alternative sites for the DGR. Please see Table 5 for our recommendation to the panel in this regard.

c) **Contributions to sustainability of the alternative means:** OPG did not incorporate throughout the EIS consideration of the relative contributions to sustainability of the alternative means. One remaining inadequacy is that the alternative means analysis did not extend to the matters addressed in Sections 7 (Effects Prediction, Mitigation Measures and Significance of Residual Effects), 8 (Malfunctions, Accidents and Malevolent Acts), and 9 (Long-Term Safety of the DGR). Instead, OPG decided on the preferred alternative means based on a partial analysis of their sustainability performance. Table 5 sets out our recommendation to the panel in this regard.

d) **Cumulative effects: determination of 'significance' of effects:** Contrary to the Cumulative Effects Practitioners Guide, OPG's approach to cumulative effects assessment only considered effects that were significant at the individual level, as opposed to potentially significant at the cumulative level. Moreover, contrary to the EIS guidelines, OPG has not clearly explained the method and definitions used to describe the level of the adverse effects (e.g., low, medium, high). Rather, OPG appears to limit itself to simply arguing for the 'professional judgment' of the project team. See Table 5 for our recommendation to the panel in this regard.

e) **Consideration of synergistic and interactive cumulative effects:** OPG provides only a simple and incomplete approach to adding up the effects on various VECs, and does not provide any mention of how more complex effects (e.g. synergistic, interactive) were considered, or whether they were even considered at all. OPG completely misses the intent of CEA, which is premised upon the recognition that the accumulation of 'trivial' impacts may ultimately lead to significant effects. More importantly, OPG assumes that indirect effects and synergistic effects are synonymous, which is a basic error that points to a fundamental failure to understand the nature of cumulative effects. See Table 5 for our recommendation to the panel in this regard.

f) **Ensuring the VECs reflect the integrity of the broader ecosystem:** OPG's discussion of thresholds is not formulated in a way to allow the panel to develop an informed and integrated understanding of the long-term health of the ecological system. No mention is made regarding how the overall integrity and resilience of the ecosystem will be maintained, including how ecosystem level thresholds will be identified and related effects managed. Furthermore, the follow up monitoring efforts described make no reference to how the individual monitoring efforts will be sufficient to describe the integrity and resilience of the local ecosystem over the long term. OPG's response is lacking with respect to what management actions will be undertaken if there are adverse effects on the VECs. OPG's inadequate approach is to deal with the VEC in question, while neglecting that impacts on the VEC may be indicative of deeper problems in the ecosystem. See Table 5 for our recommendation to the panel.

g) **Relevance of cumulative effects assessment for assessing 'alternatives to' and 'alternative means':** Clearly, OPG's analysis and decision making concerning its choice among alternatives to or alternative means and identification of the preferred alternative was not informed by attention to cumulative effects. Instead, OPG started with its preferred option, concluded that it would not have significant adverse effects, and decided that a careful examination of alternatives was not needed. See Table 5 for our recommendation to the panel.

h) **Miscellaneous concerns relating to cumulative effects assessment:** OPG's CEA did not include any discussion of the potential long-term storage of high level nuclear wastes. OPG has argued extensively in the EIS that Kincardine and the surrounding area are an informed and willing host community for LILW. Given that there is no reason provided for why Kincardine would not be willing to accept Canada's high level nuclear waste, that nearby communities have formally expressed some initial level of willingness to accept nuclear waste, and that the fuel is already being stored at the Western Used Fuel Dry Storage Facility located on the Bruce site, it would be imprudent for OPG to neglect the possibility of this site for future fuel storage in a cumulative effects assessment. See Table 5 for our recommendation to the panel.

i) **Care in perpetuity: ensuring resources for long-term monitoring and response:** OPG must ensure that the cost of all phases of the project (including 300+ years of passive monitoring) are not borne by future generations who are not responsible for, or beneficiaries of, generation of the nuclear waste. Currently, the costs calculations outlined in the EIS and the IAS do not sufficiently address the cost of care in perpetuity. The IAS costing provided in section 2.6.4 of the IAS does not extend beyond the decommissioning phase of the DGR. At this point, it is unclear how OPG updated the cost calculations from the original IAS to ensure that sufficient capacity will be available for long-term monitoring and response, and to ensure that the cost of this capacity will not be borne by future generations. See Table 5 for our recommendation to the panel.

j) **Care in perpetuity: ensuring proper requirements for abandonment and passive control:** In Table 2.6.1-1 of the EIS, OPG mentions, "at this time there are no specific plans [for passive control]. Control mechanisms aren't required for another 50 to 100 years. At that time, it is expected several countries will be in the same position, and that a solution will be developed with international consensus." It is laudable that OPG is honest about its current lack of planning for passive control; however, it is unclear how OPG's stance is not simply to displace the risk of passive control onto future generations. Sustainability and equity considerations demand that OPG does not place burdens on future generations resulting for current actions. Furthermore, placing faith in future technological achievements appears a risky gambit, in part because of the uncertain future of nuclear power in the world. See Table 5 for our recommendation to the panel.

k) **Care in perpetuity: drawing from international experience:** OPG notes that the DGR project introduces a new type of facility that is unique to North America. However, to counter the concerns related to the uniqueness of the undertaking, Section 3.3.7 of the EIS and the Executive Summary of the IAS both mention considerable international experience with all three options (enhanced processing and storage, surface concrete vaults, and deep rock vaults) for the long-term storage of LILW. To date, however, OPG has not provided sufficient detail to indicate what insights have been gained, what uncertainties remain, and how the successes and failures experienced should influence decision making regarding the proposed DGR. See Table 5 for our recommendation to the panel.

l) **Ensuring positive socio-economic outcomes: boom and bust dynamics:** Given the concerns about economic boom and bust noted by stakeholders, and the potential for significant changes to employment with regards to other nuclear and non-nuclear related activities, OPG must consider boom and bust at the cumulative effects level, and describe how it may act differently in light of the cumulative level assessment on boom and bust. To date, however, OPG has not addressed the fluctuations in employment opportunities, and the impacts on workers and their families. See Table 5 for our recommendation to the panel.

m) **Ensuring positive socio-economic outcomes: socio-economic monitoring and follow-up:** OPG has not outlined a sufficiently robust program for tracking and responding to socio-economic dynamics in its follow-up program. In particular, the lack of baseline data and OPG's reliance on public attitude research render the program incapable of detecting such important socioeconomic impacts as boom and bust effects, as well as other effects on tourism and cottaging sectors. Ensuring adequate follow up monitoring and response is essential for tracking the actual effects of the DGR project on the relevant socioeconomic as well as biophysical systems, and for preparing suitable responses to identified problems and emerging opportunities. Please see Table 5 for our recommendation to the panel.

n) **Consideration of the precautionary principle:** OPG has clearly failed to consider the precautionary principle throughout decision making. Specifically, OPG has not described how the alternatives to the proposed DGR and the alternative means of carrying out the project were evaluated and compared in light of risk avoidance, adaptive management capacity, and preparation for surprise. The JRP must ensure that OPG has explicitly adopted and applied the three generic criteria (by themselves or as components of a more comprehensive set of criteria for comparative evaluation) throughout the basic stages of planning and decision making. The DGR project cannot be identified as the preferred option until this has been done.

The JRP should not recommend approval of the DGR project, conditionally or otherwise, unless and until these EA deficiencies are satisfactorily addressed in an open and accountable manner, subject to meaningful public/agency review/comment. Table 5, below, presents our associated recommendations to the JRP.

Table 5 – CELA's Recommendations to the JRP

Remaining EIS Inadequacies	**Recommendations**
a) Justification for the proposed DGR project	OPG must establish the fundamental rationale for the proposed project based on a demonstration (the scope of which must be determined by the EIS Guidelines) that the proposed DGR is the most appropriate option, among a range of options (including "alternatives to" and "alternative means"), to solve/satisfy the problem/opportunity.
b) Consideration of alternative locations for the DGR	OPG must provide additional information about the suitability of the Bruce site relative to other sites in order to present a sound rationale for the proposed DGR project. In particular, OPG must provide detailed information on alternative sites with different geological attributes.
c) Contributions to sustainability of the alternative means	OPG must clearly demonstrate how it incorporated throughout the EIS consideration of the relative contributions to sustainability of the alternative means. This analysis must extend around the matters addressed in Sections 7 (Effects Prediction, Mitigation Measures and Significance of Residual

	Effects), 8 (Malfunctions, Accidents and Malevolent Acts), and 9 (Long-Term Safety of the DGR).
d) Cumulative effects: determination of 'significance'	OPG must provide an adequate explanation of the methods and definitions used to describe the level of adverse effects. OPG must describe the professional qualifications of the members of the project team in order to demonstrate that their professional judgment is sufficient. Provide details on the process used to come to a consensus among professionals involved in the evaluation of significance. Please see Table 4.2.2.
e) Consideration of synergistic and interactive cumulative effects	OPG must describe in detail the conceptual model used for the assessment of cumulative effects, including the screening arguments used to eliminate synergistic effects from further analysis. Further, OPG must provide the screening arguments used to eliminate interactions among VEC and multiple stressors. See Section 4.2.2.
f) Ensuring the VECs reflect the integrity of the broader ecosystem	OPG must adequately describe how the use of individual thresholds for each VEC can be confidently used to assess cumulative effects to local and regional terrestrial and aquatic ecosystems. OPG must further explain how the overall integrity and resilience of the local ecosystem is adequately represented by the selected VECs and how the monitoring and cumulative effects assessment may ensure that thresholds are not crossed. See Section 4.2.3.
g) Relevance of cumulative effects assessment for assessing alternatives to and alternative means	OPG must provide an adequate explanation of how the cumulative effects assessment informed the evaluation of alternative means of carrying out the Project, as well as the selection of the preferred alternative. See Section 4.2.4.
h) Miscellaneous concerns relating to cumulative effects assessment	OPG's cumulative effects assessment must provide sufficient detail on the cumulative effects of transporting hazardous wastes to the proposed site for the DGR. Furthermore, it must include a detailed discussion of the potential cumulative effects of long-term storage of high level nuclear wastes.
i) Care in perpetuity: ensuring resources for long-term monitoring and response	OPG must provide an adequate rationale for the 3000-year timeframe for passive monitoring, given the long time-frame of the project.
j) Care in perpetuity: ensuring proper requirements for abandonment and passive control	OPG must provide an adequate explanation of how OPG's plans for operating the DGR anticipate requirements for future passive control. Include reference to adaptive management plans and processes. Describe OPG's reasonably anticipated

	range of possible requirements for abandonment.
k) Care in perpetuity: drawing from international experience	OPG must provide an adequate description of the ‘considerable international experience’ of other DGR projects in order to establish how the success and failure of other DGR-type projects can inform the proposed DGR. Furthermore, OPG must explain how its technologies and mitigation and management methods have been proven. It must define the criteria used to determine whether a technology or method is “proven”, and explain whether these “proven” technologies relate only to LLW, or also include ILW.
l) Ensuring positive socio-economic outcomes: boom and bust dynamics	OPG must explain why economic boom and bust socioeconomic effects were not considered at the level of cumulative effects assessment. The explanation must consider fluctuations in employment opportunities and the impacts on workers and their families.
m) Ensuring positive socio-economic outcomes: socio-economic monitoring and follow-up	OPG must provide an adequate description of how OPG will ensure that its follow-up program will be sufficiently comprehensive to adequately characterize the socioeconomic system beyond the 2009 baseline. Provide additional rationale with respect to the effects of the DGR on the tourism and cottaging sectors due to the location of the DGR being near Lake Huron.
n) Consideration of the precautionary principle	OPG must describe how the alternatives to the proposed DGR project and the alternative means of carrying out the project were evaluated and compared in light of risk avoidance, adaptive management capacity, and preparation for surprise. OPG must define risk avoidance, adaptive management capacity, and preparation for surprise; describe how the three criteria were applied (by themselves or as components of a more comprehensive set of criteria for comparative evaluation) as a framework for evaluating and comparing the alternatives to and the alternative means, considering a range of plausible scenarios including accidents, malfunctions and malevolent acts; describe how each alternative performs in relation to the three criteria, considering a range of plausible scenarios including accidents, malfunctions and malevolent acts; and describe why the DGR was selected as the preferred option, giving explicit attention to the three criteria.

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<u>DGR JOINT REVIEW PANEL HEARING WRITTEN SUBMISSION</u>
<u>IN SUPPORT OF AN ORAL INTERVENTION</u>

Independent Review of Hydrogeological Issues Pertaining to the OPG Environmental Impact Statement for the Proposed Deep Geologic Repository Project

Prepared for:

The Canadian Environmental Law Association

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August 10th, 2013

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1) Introduction

I am a hydrogeologist and Professional Geoscientist, and I have worked as an environmental consultant for over 25 years (2 years for a major consulting firm in Germany, and 25+ years independently in Canada). I am a specialist in groundwater and surface water contamination issues, and have investigated many such issues over the course of my consulting career.

I have given testimony as an expert witness on hydrogeological issues before various boards, including the Canadian Nuclear Safety Commission, the Environmental Assessment Board, the Joint Board, the Ontario Municipal Board, the Ontario Environmental Review Tribunal, and the Niagara Escarpment Commission. A copy of my Curriculum Vitae is included in **Appendix 1** of this review.

I have been retained as an expert by the Canadian Environmental Law Association (CELA) to provide an independent review of the Environmental Impact Statement (EIS) for the proposed Deep Geologic Repository (DGR) Project. The DGR Project has been put forward by Ontario Power Generation (OPG), "the proponent" under the environment assessment process.

The focus of my review of the DGR proposal are the following:

- the overall merits of the proposal;
- the adequacy of the site investigation;
- potential groundwater quality impacts related to inorganic, organic, and radiological contaminants which may be associated with any aspect of the proposal; and
- potential surface water quality impacts related to inorganic, organic, and radiological contaminants which may be associated with any aspect of the proposal.

The adequacy of the EIS (from a hydrogeology perspective) can be measured by the degree to which the EIS provides:

- a comprehensive description of the local geology, hydrology and hydrogeology;
- a comprehensive assessment of potential water quality impacts at all stages of the project including site preparation and construction, DGR operation, closure, and the very long post-closure period;
- detailed proposals for mitigation of any foreseeable impacts;
- appropriate monitoring plans and realistic contingency plans.

In order to carry out this work, I have reviewed a series of documents and the most important of these are listed as references in **Appendix 2** of this review. I also toured the area of the proposed DGR Project on June 13, 2013, and discussed various aspects of the proposal with the proponent's representatives who were present on the day of the tour.

I was strongly assisted and advised during my work on the review of documents in relation to the DGR project and the preparation of this report by Dr. Chris Smart of the University of Western Ontario. Dr. Smart is an expert in the fields of karst hydrogeology and glacial erosion. I have experience and expertise in the field of karst hydrogeology (and have co-authored several papers with Dr. Smart on this topic), and those aspects of this report pertaining to karst and evaporite dissolution issues are based on a collaborative effort by Dr. Smart and myself.

We submitted (through CELA) a series of Information Requests (IRs) which were forwarded to the proponent. Due to problems with the IR process it was challenging to determine if many of our IRs were ever answered. The problems we encountered with the IR process and more generally with the environment assessment process are discussed in more detail in **Section 3** of this report.

This review outlines my findings, conclusions and recommendations regarding the EIS and the potential impacts of the proposed Deep Geologic Repository (DGR) Project.

2) Overview of the DGR Proposal

The DGR proposal consists of the following key aspects:

- the planned excavation (at 680 meters below the ground surface on the grounds of the Bruce Nuclear Plant) of a permanent, deep repository for Ontario's low- and intermediate-level radioactive wastes (L&ILW) in a DGR construction period of 5-7 years;
- the deposition of those radioactive wastes in the DGR, over an operational period which will last for decades;
- once the main and ventilation shaft are sealed, the entombment of the DGR beneath about 200 meters of thick and impermeable overlying shale bedrock;
- about 450 meters more of mainly carbonate and evaporite sedimentary rocks overlie the thick shales, and are in turn covered by a relatively thin layer of overburden;
- the proponent's proposed monitoring of the DGR facility is for about 300 years after closure, after which there is no intention to further monitor the facility; and
- the containment of radioactive wastes for hundreds of thousands of years.

I have carefully reviewed a number of Technical Support Documents (hereafter referred to as "TSDs") which describe various aspects of the investigation and impact assessment for the DGR site from the perspective of its impacts on the local groundwater and surface water flow systems.

Characterization of the proposed DGR site has been done through drilling of a total of 8 deep boreholes, with numerous tests done on the quality of the geological materials and the groundwater which were encountered in the boreholes. It should be noted that the possible benefits (in terms of improved site characterization) of further drilling are outweighed by the risks of overdrilling the site and potentially creating hydraulic connections from the surface to the DGR host formation.

The proposed DGR will be situated in low permeability and structurally sound shaley limestone formations, which will provide a suitable host formation for the DGR excavations. These shaley limestone host formations are overlain by very thick (200 meters) and even lower permeability shales, which provide the hydraulic containment of the site.

Overlying the 200 meters of shale bedrock are an additional 450 meters of various kinds of sedimentary rocks, which will provide the deep shales with protection from surface erosion over the million year timeframe in which the DGR will be required to contain the radioactive wastes.

The upper 170 meters of carbonate bedrock at the DGR site are considered a zone of active karst development. There is little evidence of karst activity or potential below this depth. However over the long term karstic enhancement and/or evaporite dissolution-related enhancement of formation permeabilities is a potential issue in the entire upper 450 meter thick sequence of mainly carbonate and evaporite bedrock, which could under various glaciation scenarios be vulnerable to significant permability increases.

The deep 200 meter thick and effectively impermeable shale bedrock layers which immediately overlie the DGR host horizon are not considered to be vulnerable to erosion or significant permeability increases over a million year timeframe.

The proposed disposal in the DGR of Ontario's low- and intermediate-level radioactive wastes (L&ILW) would replace the current temporary storage of these wastes at the nearby Western Waste Management Facility (WWMF) on the Bruce Nuclear Property.

This report identifies problems with the environmental assessment process, the site characterization, the impact assessment, the proposed monitoring programs, and with various aspects of DGR proposal itself. These problems are discussed in detail in the following sections of this review.

3) Problems with the Environmental Assessment Process

There were two significant environmental assessment process related problems which impacted our review of the EIS and related documentation:

a. The Information Request (IR) process has been dysfunctional, and was a major impediment to obtaining the necessary information to properly review and understand the DGR proposal.

b. New documents were still being submitted on behalf of the proponent a couple of weeks before the August 13, 2013 deadline by which intervenors were required to submit their final reports. There was not adequate time to thoroughly review and understand these new documents.

These issues are discussed in more detail below.

a) Dysfunctional Information Request (IR) Process and Organization

i) A significant problem with the IR process was that carefully formulated questions which we submitted were modified by the Panel before being submitted to the proponent. In some cases this meant that our questions were so altered that the proponent's responses were of no benefit in addressing our original questions. In other cases it also meant that it was difficult or impossible for us to determine if our questions were ever submitted or responded to by the proponent.

This concern was communicated to the Panel in letters from CELA dated April 19, 2013 and May 24, 2013. The letter on May 24, 2013 includes the following expression of our concern about this matter:

> *"In addition, CELA submitted a letter dated April 19, 2013 to the Panel expressing concern about the difficulty in determining whether the IRs had been responded to by OPG.*
> *Notwithstanding the responses from the Panel Secretariat to our letter, our hydrogeological experts have found it to be effectively impossible to track their IRs through the process to see if they have been adequately responded to – or even to see if they've been responded to at all. For this reason alone, we submit that the EIS should be found to be insufficient at this time. This is a matter of grave concern to us, and we request that the Panel respond to this concern."*

While we appreciate that there were responses from the Panel Secretariat to these letters, the responses were unsatisfactory in terms of actually addressing and fixing this problem.

ii) A second signifcant problem with the IR process pertained to the organization and presentation of the IRs. The IRs were ordered by date of receipt rather than by topic, and had only limited searchability. Our experience was that the IR information base was not managed effectively, to the detriment of critical reviewers of the DGR proposal.

b) Last-Minute Submission of Proponent's Documents

The Panel has set an August 13, 2013 deadline for submissions. This deadline falls in the middle of summer holidays for CELA experts and staff, making the writing, review, and coordination of the CELA submission extremely difficult in terms of scheduling. We have nonetheless done our best to work around these constraints, and plan and schedule our work to meet the August 13, 2013 deadline.

Our efforts were however undermined by the last-minute submissions of documents by the proponent. Last-minute document submissions include the following:

- Posted at http://www.ceaa.gc.ca/050/documents/p17520/91944E.pdf is CEAR # 1245, which is Panel Member Document (PMD) 13-P1.1, Ontario Power Generation's summary of their Request for a Decision Regarding their "Application for a Site Preparation and Construction Licence for a Deep Geologic Repository for Low and Intermediate Level Waste" (34 pages).

- Posted at http://www.ceaa.gc.ca/050/documents/p17520/91945E.pdf is CEAR #1246, which is PMD) 13-P1.1A, Ontario Power Generation's summary of their Request for a Decision Regarding their "Environmental Assessment for Ontario Power Generation's Application to Prepare a Site and Construct a Deep Geologic Repository for Low and Intermediate Level Waste" (56 pages).

- Posted at http://www.ceaa.gc.ca/050/documents/p17520/91309E.pdf is Ontario Power Generation's " Commitments Report" to the Joint Review Panel (over 170 pages).

This is simply poor process. The documents themselves are helpful in that they provide good overviews of the proponent's position and commitments in support of the project, but they have been completed and made public so late in the process that they are of only limited assistance because it was simply not possible to make proper use of them in the time available.

Recommendation 1

The Joint Review Panel should take the deficiencies in the environmental assessment process into account in its review and assessment of the viability of the DGR project. Furthermore, future Panels should take the deficiencies in the environmental assessment process into account and take all necessary steps to ensure that these do not occur in any new environmental assessment process under the Canadian Environmental Assessment Act.

4) Concerns about the Site Characterization

Although a site which is potentially suitable from a hydrogeological perspective has been found, there are a number of issues which could and should have been investigated or explained more thoroughly in the EIS documentation in order to provide further assurance about its viability.

The issues requiring further investigation/explanation include the following:

a. the high hydraulic heads in the Cambrian sandstone, and the lack of information about hydraulic heads in underlying Precambrian basement;
b. information on deep oil/gas exploration boreholes;
c. permeability of the Silurian "barrier" formations;
d. the existing groundwater and surface water quality in the vicinity of the DGR site (in particular the elevated tritium levels and the reasons for these).

These issues are discussed in more detail below.

a) Hydraulic Conditions in the Cambrian Sandstone and the Underlying Precambrian Basement

Section 5.6.1.3 of the Geology TSD provides a discussion of hydraulic conditions in the deep groundwater flow system. It is clear from a review of this section that the Cambrian sandstone formation (found at about 840 to 860 meters below ground surface (mbgs) is a significant aquifer, which is characterized by relatively high average hydraulic conductivities of about $3x10^{-6}$ m/s.

Rather unexpectedly - the Cambrian sandstone is overpressured (11,000 kPa) and has very high hydraulic heads of 165 meters above the ground surface. This is an unusual and difficult to understand condition, and I was not able to find any explanation for it in the EIS documentation. This condition may extend downward to the Precambrian unconformity (which may be a zone of higher permeability), or even into the underlying Precambrian bedrock.

The excavation of the DGR will result in a huge pressure gradient and hydraulic gradient being established between the Cambrian sandstone and the overlying DGR.

The implications for the DGR project are that if any hydraulic connection from the DGR down to the Cambrian sandstone exists or is established, then more - perhaps much more - water will need to be pumped from the DGR than has been planned for in the site design.

In addition, the overpressures and formation heads may be sufficient to push groundwater and DGR-related contaminants up to the ground surface - note that this could only occur in the event of both a hydraulic connection from the DGR to the ground surface (eg. via a failed shaft seal) <u>and</u> a hydraulic connection from the DGR to the underlying Cambrian sandstone (eg. via a fault).

In this context the plans to excavate the ventilation shaft to a depth of 746 mbgs (ie. to within about 100 meters above the Cambrian sandstone) are worth reexamining.

<u>Recommendation 2</u>

a) The proponent should provide information on the shut-in pressure and the water quality at the Precambrian unconformity.

b) The proponent should provide a discussion of whether the proposed excavation depth of 746 mbgs is needed for the ventilation shaft, given the overpressured high hydraulic conductivity and high hydraulic head Cambrian sandstones which underlie the DGR site.

<u>b) Information on Deep Oil/Gas Exploration Boreholes</u>

Page 27 of the Geology TSD states that:

> *"Of more than 21,000 documented wells drilled in Ontario, only 27 petroleum exploration wells have been drilled within a radius of 40 km of the proposed DGR.."*

We requested more information about the depths and locations of the 27 known wells within 40 km of the DGR site, and after a long search found the proponent's answer in IR response EIS-05-178. Review of the information in the IR response reveals that 11 of the boreholes were drilled from the ground surface through to beyond the depth of the proposed DGR host horizon, and the closest of these wells was drilled within 3.5 km of the DGR site. The 11 wells are listed as "abandoned", which is said to mean "officially plugged and abandoned" with no further information provided.

There is also a not-to-be-discounted possibility of undocumented oil exploration wells having been drilled in the vicinity of the DGR. Such boreholes (if they were not properly sealed) could provide very effective pathways for vertical groundwater flow and contaminant transport.

<u>Recommendation 3</u>

a) The proponent should provide a full description of the measures taken to secure each of the 11 deep "abandoned" wells within 40 km of the DGR site.

b) The worst-case scenario of undocumented oil exploration wells being present in the area of the proposed DGR should be considered and explicitly addressed by the proponent.

c) Permeability of the Silurian "Barrier" Formations

The proposed DGR facility will be overlain by about 650 meters of bedrock. The EIS has confirmed that the upper 170 meters of the bedrock is a zone of active groundwater flow and karst dissolution with enhanced bedrock permeabilities. Below that there is little evidence of active groundwater flow, and no evidence of karst development.

I have found that the EIS documents assume that below 170 meters, all of the bedrock formations are effectively impermeable and can be relied upon to prevent groundwater carrying contaminants from the radioactive wastes in the DGR from ever coming into contact with the active shallow groundwater flow system in the upper 170 meters of the bedrock.

For example, page 34 of the Geology TSD (in discussing the "Intermediate" bedrock formations between 170 meters below ground surface (mbgs) and 450 mbgs), states that:

> *"The intermediate bedrock grouping includes dominantly shale rock formations which can potentially provide a significant water and/or contaminant transport barrier between the DGR repository levels in the deep bedrock, and the shallow bedrock formations above."*

This is an inaccurate statement - the Silurian bedrock formations at the "Intermediate" depths between 170 and 450 mbgs are not shales, they are predominantly carbonates (limestones and dolostones) and evaporites. There is little in the way of shales in the Intermediate bedrock formations. Yet only shale can be considered an effective long-term barrier to groundwater movement.

Both carbonates and especially evaporites are vulnerable to dissolution in the presence of flowing groundwater, so their effectiveness as a barrier is at risk as soon as they are disturbed and exposed to flowing groundwater. In my opinion it is a mistake to be considering the Intermediate carbonate and evaporite bedrock formations as a hydraulic barrier, because they are vulnerable to significant increases in permeability due to dissolution. All that is needed for this to occur is a disturbance which facilitates groundwater flow, and the passage of sufficient time.

The excavation of the vertical tunnels for the main shaft and the ventilation shaft for the DGR represents a massive disturbance. Large tunnels will be blasted into the bedrock, and it is quite conceivable that there will be significant movement of groundwater from the shallow active flow system downward into the Intermediate bedrock formations via the area of disturbed bedrock around the shaft tunnels.

Another disturbance is present in the form of boreholes which were drilled for the DGR investigations. The proponent undertakes to seal these boreholes properly and effectively, but there is no way of ascertaining whether these efforts will prove effective for a period of hundreds of thousands of years.

Finally, there are signs that there is already a zone of vulnerability in the Intermediate depth Silurian bedrock formations. The Silurian Salina formation comprises a suite of evaporite and precipitate subformations that <u>currently</u> serve as a significant hydrogeological and physical barrier, but there is no assurance that it can continue to serve this function in the long term.

The remarkable hydraulic isolation of the proposed DGR is ensured by the presence of soluble minerals such as halite and anhydrite. Hydration locks water into the mineral lattice preventing migration directly and attendant swelling further restricts hydraulic conductivity. However, significant flows of water will dissolve and remove these mineral barriers resulting in much higher permeability. The effect of such flushing particularly on hydraulic conductivity, effective porosity and barrier performance has not been assessed. It should be noted that solutional erosion and collapse are characteristic features of much of the Salina with complete removal of the major Salina B halite (salt) facies having occurred regionally and locally.

Moreover the “Salina A1 Carbonate” exhibits high permeability and anomalous hydraulic head. High hydraulic conductivities are reported from this zone (please see Geosynthesis TSD, Figure 51 on page 194). The Geosynthesis TSD also has a series of figures which show anomalously dilute water quality indicating active groundwater movement, including the following:

- Figure 4.6 on page 161, showing a TDS anomaly;
- Figure 4.7 on page 163, showing a stable isotope anomaly;
- Figure 4.8 on page 164, showing a halide anomaly;
- Figure 4.9 on page 169, showing a halide ratio anomaly.

The relatively fresh water found in this zone is inferred to be a mix of modern and glacial water, which indicates relatively fast penetration of near-surface groundwater to considerable depth. Complementary flushing of deep water to the surface is implied. The mechanism for transport of this groundwater is unknown, but it substantially varies from the EIS site conceptual model and modelling results reported. There is a groundwater flow condition in the DGR subsurface that is much faster than has been estimated, and which computer simulations have failed to account for.

For the above reasons, it would be prudent to assume that the potential barrier function of the Intermediate bedrock formations will be compromised to some degree. Fortunately the underlying 200 meters of Ordovician shales will comprise a very effective hydraulic barrier.

Recommendation 4

a) Further work on the DGR project should be premised on a prudent assumption that the Silurian bedrock formations will not provide an effective hydraulic barrier over the long term.

b) The proponent should model DGR performance using worst-case permeabilities, based on leach testing of all “barrier” formations.

d) Existing Groundwater and Surface Water Quality near the DGR Site (and Tritium Levels)

The Bruce Nuclear facility has known areas of groundwater contamination. A superficial discussion of contamination in these areas is provided in Section 5.7.2.1 of the Geology TSD.

Radioactive tritium is present at high levels in groundwater throughout the vicinity of the Western Waste Management Facility (WWMF), which is where the radioactive wastes going into the DGR will be coming from. Our attempts to determine the extent and distribution and reasons for the tritium contamination through IRs and review of the EIS documentation were not successful. The extensive borehole and water quality monitoring information available to the proponent has not been compiled to provide a comprehensible overview of the distribution and migration of tritium on site.

It is of concern that whatever workplace management and operating conditions allowed the spread of tritiated water through the area of the WWMF may also prevail at the DGR site and allow significant contamination of groundwater and/or surface water in the DGR area.

If a decision is made to move the wastes to the DGR based on a review of all the evidence at the hearing, then this site from a hydrogeological perspective would provide a considerably more secure location for these wastes than their current situation can provide. However, I take no position on whether the proponent's EA work to date satisfies CEAA provisions, the JRP Agreement, or EIS Guidelines respecting the analysis of alternatives to and alternative sites.

Modeling by Sykes (2012) suggests that the DGR excavation and stormwater management pond (SWMP) are at minimal risk of potential tritium contamination. However, the primary aquifers at the DGR site are highly karstic shallow carbonate formations and highly heterogeneous quaternary glacial sediments. Both these media exhibit substantial preferential flow, making the model’s porous medium based characterization of contaminant distribution and migration problematic.

More accurate monitoring and modelling reports are needed to explore the likely heterogeneities in tritium distribution.

It is possible that construction activities will encounter high levels of tritium well outside the boundaries of the predicted plume. It should be noted that groundwater levels of tritium are observed to be either rising or falling less rapidly than might be expected from radioactive decay, indicating substantial contaminant mass in the subsurface.

The radioactive characterization of the DGR area's subsurface unexpectedly revealed tritium at considerable depth. This alarming result was attributed to accidental borehole contamination by tritiated local drilling fluid. It is of particular concern that the DGR Study Team were apparently not aware of the presence of radioactive tritium in the groundwater. Workers can not sense their exposure to tritium contamination, so due diligence requires appropriate information sharing and monitoring protocols.

<u>**Recommendation 5**</u>

a) The proponent should provide full disclosure on what combination of workplace practices and incidents led to the tritium contamination which is observed in groundwater throughout the area of the Western Waste Management Facility.

b) The distribution of tritium in the subsurface should be determined by integration of all monitoring data and communicated to site operators, regulators, and the public.

c) The migration of tritium in the subsurface should be modelled using values of effective porosity appropriate to the karstic host formations.

d) The proponent should provide a full description of what measures will be undertaken to ensure that the surface water management pond (SWMP) does not become contaminated by tritium (or other radiological contaminants) during construction and operation of the DGR.

e) The proponent's radiological surface water monitoring parameter list includes tritium, gross beta, and carbon 14. Proposed maximum target levels for each parameter should be proposed for the SWMP by the proponent, with a rationale provided for each parameter.

f) Field workers exposed to local groundwater should have appropriate briefings, operational protocols and monitoring appropriate to the potential tritium hazard.

5) Hydrogeological Impact Assessment

a) Introduction

Impacts on groundwater and/or surface water quality may arise during the construction and operation period, or after the DGR is closed and sealed off.

Considerable impact assessment work has been carried out, and is documented in various TSDs, reports and technical memoranda prepared by the proponent and the consultants retained by the proponent. Further improvements have been made to the impact assessment as a result of the IR process, such that some of the issues which we originally identified have now been addressed.

b) Groundwater Impacts during Construction and Operations

The proposed groundwater monitoring program is adequate for the construction and operation period. The DGR site is about 1 km from Lake Huron, and all groundwater from the area of the DGR project site is flowing towards Lake Huron.

The DGR construction and operation period should not be problematic from a groundwater quality perspective, assuming the site is reasonably well run and any spills are promptly reported and thoroughly addressed. The overburden deposits are lower permeability glacial tills, which will provide initial containment of any spills. But there is a need to respond quickly to any surface contamination issues, because the underlying shallow bedrock formations are high-permeability karstic carbonates which will rapidly transport any contaminants reaching them to the lake.

Any DGR construction and operations related impacts on groundwater quality will be significantly attenuated (mainly by dilution) once they reach the lake, and as a result I have no particular concerns about potential groundwater quality impacts during the DGR construction and operations period.

c) Post-Closure Impacts, and Implications for Groundwater Monitoring

The impact assessment concludes that there should not be any long-term groundwater impacts from the wastes being disposed of in the DGR - assuming the DGR facility and the bedrock strata in which it is entombed remain intact, and that the shaft seals and backfill are effective in eliminating vertical hydraulic connections along the vertical shaft tunnels.

The proponent's impact assessment is based on the above assumptions, however these assumptions do not, in my professional opinion, adequately consider a conceivable worst case scenario relating to the effectiveness of the shaft seals and backfill in preventing vertical groundwater movement.

The hydrogeological investigations carried out as part of the DGR site assessment have established that the proposed DGR facility will be situated within and below hundreds of meters of bedrock formations of extraordinarily low permeabilities.

The permeabilities of these formations are so low, that it is highly unlikely that the various seal and backfill materials proposed to be used to close off the main access shaft and ventilation shaft will achieve anywhere close to such low permeabilities. As a result, the sealed and backfilled shaft tunnels will represent permanent weaknesses in the long-term entombment of the radioactive wastes in the DGR. They will in fact be the weakest points in the proposed containment of the completed DGR facility.

At best it will be extremely difficult to effectively seal off these vertical shaft tunnels to the point where they - and the surrounding bedrock - form impermeable barriers to vertical groundwater movement. The excavation of the vertical tunnels for the main shaft and the ventilation shaft for the DGR represents a massive disturbance. Large tunnels are to be blasted into the bedrock. The walls of the tunnels will not be smooth - they will be rough, jagged and uneven and there will be a zone of disturbed bedrock extending outward from the bedrock openings which form the tunnel walls.

The shafts themselves are to be sealed off to prevent groundwater from flowing into them in a horizontal direction from any surrounding permeable bedrock formations during the construction and operations period. This sealing will likely be quite effective. It will be a much more significant challenge to try to also seal the disturbed areas external to the shaft tunnel openings to eliminate groundwater flow in a vertical direction. This is partly because unlike the horizontal seals (whose effectiveness is readily apparent by the intrusion of water into the shafts), there is no way of easily determining if there is vertical groundwater movement occurring in the disturbed areas around the tunnels or if efforts to seal the rock are effective.

There will very likely be vertical groundwater movement in the disturbed bedrock areas around the shaft tunnels from the time that the tunnels are excavated through to the closure of the DGR. During the closure period when the shaft tunnels are being backfilled and sealed will provide the best opportunity to try to also ensure that the surrounding disturbed bedrock areas around the tunnels are made effectively impermeable to vertical groundwater movement. But it will be tremendously challenging to create an effective seal that will last for hundreds of thousands of years.

Consideration of this critical issue is provided in various EIS reports (in particular the Excavation Damaged Zones Assessment) and in many IRs (including IR LPSC-03-62, which was particularly helpful). There is discussion of a Highly Damaged Zone (HDZ) which may be present at the tunnel excavation face, and the Excavation Damaged Zone (EDZ) which pertains to the broken rock at and behind behind the tunnel face where there have been significant changes in flow and contaminant transport properties.

It is fair to say that the study of Excavation Damaged Zone (EDZ) assessment and remediation is an emerging science. While I appreciate that the proponent is committed to minimizing the EDZ around the shaft tunnels and to effectively sealing these features, I see no sign that there is currently any capability to actually do so with confidence that the end result has recreated the permeability of the undisturbed bedrock.

Vertical permeabilities in the sealed and backfilled shafts are, in my opinion, likely to be a factor of 1000 or more higher than in the surrounding low-permeability bedrock formations. By implication it is a near certainty that if any contamination from the DGR facility migrates vertically then it will be coming up via the areas of disturbed bedrock around one or both of the former shafts.

Despite the proponent's acknowledgement that there is a risk of increased permeability adjacent to the backfilled and sealed shafts, there is no sign that this has been recognized in the development of proposals for long-term groundwater monitoring of the site. The locations for proposed monitoring wells do not appear to include the actual vertical tunnels of the sealed and backfilled shafts, even though these are almost certainly the pathways which any upward moving groundwater contamination will be following.

Recommendation 6

a) The proposed groundwater monitoring plans for the DGR facility should be amended to include monitoring well nests atop each of the vertical tunnels of the main access shaft and the ventilation shaft.

b) These wells should be installed after the shafts have been sealed and backfilled to ground surface.

c) The bottom well in each nest should be installed at the top of the low-permeability shaft seal/backfill materials, and wells should be installed in higher permeability units above that depth with a maximum spacing of 40 meters vertically.

6) Hydrogeological Concerns with respect to Site Design and Operations

a) General Comment

Detailed work has been carried out in terms of describing the proposed DGR site design and operations, and this work is documented in various reports and technical memoranda prepared by the proponent and the consultants retained by the proponent.

For the most part, the design and operations are well thought out and presented at an adequate level of detail for an environmental assessment. As with the impact assessment, the proposals for site design and operations have evolved and been clarified through the IR process. Earlier issues which we had identified have been resolved or explained to our satisfaction - with one notable exception.

b) The Stormwater Management Pond (SWMP)

At this point there is only one water quality related issue which I have identified as requiring some further work and consideration - the design and management of the stormwater management pond (SWMP).

All surface water run off from the DGR construction project, all groundwater from the DGR excavation, and all sump water pumped from the constructed DGR facility during the decades-long operational period will be feeding into the pond. **The SWMP is therefore the critical feature when it comes to water protection for the proposed DGR project.**

There are however several design and operational issues pertaining to the stormwater management pond (SWMP) which require further attention:

i. targets for discharge water quality;
ii. in-design mitigation and SWMP treatment proposals;
iii. pond capacity;
iv. proposal to hold back pond contents.

These issues are discussed in more detail below.

i) Targets for Discharge Water Quality

The SWMP will contain all runoff from the DGR construction site, the waste rock pile leachate, as well as all sump water from the DGR facility. The projected water quality of the SWMP is outlined in a report entitled "Water Quality Modelling Results for the Stormwater Management Pond" which is dated December 2012 and is hereafter referred to as the "Water Quality Modelling Report".

The Water Quality Modelling Report compares water quality in the SWMP to the Provincial Water Objectives (PWQO), which, in my opinion, establish the appropriate criteria for setting discharge water quality limits.

However it is clear from that Water Quality Modelling Report that there is a real possibility that water quality in the SWMP will not meet the PWQO for many of the parameters considered in the report. In addition other parameters which are likely to find their way into the SWMP (including various organic chemicals such as toluene) were not considered in the report.

Target discharge water quality limits for inorganic chemicals have been established for the SWMP, and are outlined in the DGR Follow Up Monitoring TSD. The limits which have been set are appropriate.

Target discharge water quality limits for organic chemicals have not been established for the SWMP. Given the scale of the DGR project, this is not a reasonable omission. BTEX parameters (benzene, toluene, ethylbenzene, and xylenes) and PAHs (polynuclear aromatic hydrocarbons) are contaminants which are likely to be present on the DGR site and which pose significant threats to downstream water quality if they are present in discharges from the pond.

Recommendation 7

a) The proponent should commit to using the PWQO as the basis for setting SWMP discharge water quality limits for selected organic chemicals, including BTEX parameters (benzene, toluene, ethylbenzene, and xylenes) and PAHs (polynuclear aromatic hydrocarbons).

b)Water in the SWMP which does not meet the PWQO for the selected organic chemicals should be held back for further treatment and testing.

ii) In-Design Mitigation and SWMP Treatment Proposals

A project of the magnitude of the proposed DGR brings with it the potential for significant water quality impacts. Testing is proposed to assess the degree of such impacts in the SWMP, and if such impacts are detected then they will need to be addressed by the proponent.

Several in-design mitigation and water treatment possibilities for the SWMP are mentioned in various documents (such as the Water Quality Modelling Report and the DGR Follow Up Monitoring TSD), including the following:
• grouting high-TDS bedrock formations to reduce groundwater inflow into the shafts;
• modification of normal blasting practices;
• separating out waste rock pile water and treating to reduce unionized ammonia levels;
• using an evaporator to concentrate high-TDS water (which would have to be collected and treated separately).

The proponent has not made a firm commitment to actually implement any of these in-design mitigation or treatment methods.

A firm commitment to implementing in-design mitigation would involve the proponent stating that in-design best management practices will be followed to reduce the concentrations of various parameters in the SWMP (such as ammonia, BTEX parameters, PAHs, metals, and salts) as much as possible. A firm commitment to providing necessary treatment would involve setting discharge criteria for such parameters, establishing a program of regular testing for those same parameters, and firmly committing to providing whatever treatment is necessary to keep SWMP water quality below the discharge criteria.

In my professional opinion the proponent should commit to in-design best management practices and to treating the pond water unless rigorous testing has confirmed that it meets the PWQO for all parameters of concern.

Recommendation 8

The proponent should commit to in-design best management practices, and to treating the SWMP discharge water unless a program of rigorous testing has confirmed that it meets the PWQO for all parameters of concern (including ammonia, BTEX parameters, PAHs, metals, and salts).

iii) Pond Capacity

Another issue of concern pertaining to the SWMP is the need for adequate capacity. Various TSDs indicate that the SWMP through which all surface water from the DGR facility and construction site will flow will have the design capacity to handle a 100 year storm event. Given the predicted and already-observed effects of global climate change on precipitation intensities, this may not be a conservative design.

Recent events from across Canada confirm that our climate is in the process of changing, and that in particular precipitation intensities are increasing during rain events. Severe flooding events are becoming more commonplace, and the conventional standard for engineering design (the “100-year storm”, statistically estimated based on historic data) is being exceeded with unsettling regularity in locations across the country.

Under these circumstances and in a time of global climate change, it would be prudent and proactive for the proponent to commit up front to designing and constructing the SWMP so that it can contain the “Regional Storm” event (ie. the equivalent of Hurricane Hazel).

Recommendation 9

> **The SWMP should be designed and constructed with sufficient capacity to contain the Regional Storm (ie. Hurricane Hazel).**

iv) Proposal to Hold Back Pond Contents

Increasing the design capacity of the SWMP is particularly important given the proponent's commitment to “close the gate” and hold back the pond water if it doesn’t meet discharge criteria. SWMP discharge water quality is proposed by the proponent to be tested on a regular basis, with the pond water being “held back” if it fails this testing.

The details of how this is to work in practice have not been provided to date by the proponent. It is clear that this proposal will only be workable if the SWMP has been designed with ample capacity, such that its contents can be held back in the event of adverse test results. (This would support the need for the increased SWMP capacity recommended in **Recommendation 9**.)

The optimal way for such a system to work would be to have two triggers for the pond contents to be held back:

- if the SWMP water discharge quality fails to meet detailed PWQO-based discharge criteria during a scheduled regular testing event (as discussed in **Section 6)b)i)** above);
- if the SWMP discharge water quality fails to meet a specified level of conductivity during ongoing, continuous monitoring.

Continuous monitoring of conductivity at the pond outlet is also recommended, and can be used to trigger a “closing of the gate” if a precautionary limit is exceeded. Electrical conductivity is an excellent surrogate parameter to use as a broad measure of water quality impairment - in essence, the higher the levels of contamination in the SWMP, the higher the conductivity will be. If conductivity exceeds a certain level, then this provides a broad indication that something has happened to affect the water quality in the SWMP. Closing the gate will then allow more detailed testing to be done to ascertain the reason(s) for the change in water quality.

It should be noted that what happens next if the SWMP contents have been held back (because of adverse water quality test results) has not been specified by the proponent. In some cases, further treatment could improve pond water quality such that it meets PWQO and can be discharged. In other cases, it may not be possible to effectively treat the water in the SWMP with the facilities on hand.

It would be advisable to have arrangements in place with a local wastewater treatment plant, so that the SWMP contents can be removed and trucked to the wastewater treatment plant if poor water quality in the SWMP can not be quickly improved following adverse test results.

Recommendation 10

a) There should be continuous measurement of SWMP discharge water quality (by measuring electrical conductivity), coupled with a program of regular more detailed testing for various discharge criteria.

b) If there are adverse water quality results exceeding the PWQO, then the SWMP contents should be held back to allow for more detailed testing and investigation to determine the reason(s) for the adverse test results.

c) Arrangements should be made with a local wastewater treatment plant to take the SWMP contents in the event that on-site treatment is not able to reduce pond contaminant levels to below discharge criteria.

7) Monitoring and Contingency Plans

The work which has been carried out to date on the DGR monitoring and contingency plans has in a number of areas not been consistent with what would be expected given the importance and scale of the DGR project and the potential it brings with it for unacceptable water contamination.

Some monitoring and contingency issues require further work by the proponent. A number of monitoring/contingency issues have already been addressed in previous sections of this report, with the recommendations being provided for improvement.

The additional monitoring issues requiring further consideration/description by the proponent include the following:

a. the duration of the proposed post-closure monitoring period (300 years) seems arbitrary and too short given the long-lived contaminants being disposed of in the DGR;
b. provision needs to be made for development of robust monitoring programs;
c. there is no provision in the EIS outlining how the proponent will respond in the event of adverse monitoring results, or what monitoring results might trigger a response from the proponent;
d. independent review (including adequate funding and public access to information) is needed for the DGR monitoring programs.

These issues are discussed in more detail below.

a) Arbitrary 300 Year Post Closure Monitoring Period

The proposed 300-year post-closure monitoring period is arbitrary, and seems far too short given the very long timeframe over which the DGR will be required to provide containment of the radioactive wastes in the repository.

If one assumes a target of one million years containment to be provided by the DGR, then 300 years marks 0.03% of the overall containment period. It is not clear why the commitment by the proponent to monitor the facility is not open-ended, or at least of a longer duration.

The proponent's proposed 300-year monitoring duration is inadequate. There is no reason to assume that a plausible DGR containment failure scenario would be detectable by the relatively shallow proposed groundwater monitoring program within 300 years. In fact, many if not most of the most plausible failure scenarios would require a considerably longer period of time for contaminants to make their way up to the shallow groundwater flow system.

Ontario's landfill operators are required to calculate the contaminating lifespan of their facility, and to make provision for continued monitoring throughout that contaminating lifespan. The contaminating lifespans of landfills are measured in centuries, and so are the monitoring commitments for these facilities.

To date the proponent has not provided a compelling argument in favour of their proposal to terminate their obligations for monitoring the DGR facility after only 300 years. It would appear prudent for the proponent to commit to monitoring as long as possible, and at a minimum for a period of at least 1000 years.

Recommendation 11

a) The proponent should commit to sustaining a longer-term monitoring effort for the DGR facility following closure.

b) The commitment should be open ended (ie. to monitor "as long as possible") with a minimum monitoring period of 1000 years.

b) Development of Robust Monitoring Programs

The DGR Follow Up Monitoring TSD provides conceptual outlines of proposed monitoring programs, but provides few of the details which are an integral part of a robust and effective monitoring program.

Components of monitoring programs which are generally missing from the TSD include the following:

- a list of monitoring locations, and a map showing those locations;
- a list of indicator parameters which will be used to determine if contamination is occurring;
- trigger levels for each of the monitoring parameters, which if exceeded will trigger action by the proponent;
- conceptual outlines of contingency plans which will be triggered if confirmed adverse monitoring results are obtained.

A major concern with the proponent's failure to develop these components is the fact that if they are developed after the EA process has concluded, then the proponent will effectively have avoided subjecting these details to independent and public scrutiny. It is recommended that the details of the necessary DGR monitoring programs be subject to the same level of scrutiny that the EA and EIS have been subject to.

Monitoring programs can provide insight into environmental conditions and processes, provided that a suitable critical analysis which facilitates understanding of the data that have been collected is undertaken. It is this *understanding* rather than the data itself that provides a baseline against which changes and stability can be assessed and interpreted.

Furthermore, critical data analysis also provides an ongoing review of the efficacy of the monitoring protocol. For example, it can reveal gaps in spatial monitoring locations, or critical sampling times that might be missed There is no evidence in the Follow Up Monitoring TSD that OPG is committed to ongoing analysis and critical review of its monitoring results and protocol. Instead, the impression is that the commitment is to simply collect the data as directed.

The ongoing development of environmental monitoring technologies over the long term needs to be planned and accounted for. Sampling a series of boreholes may well be considered quaintly antiquated within the monitoring period of this proposed facility. A commitment from the proponent to adaptively updating the monitoring programs in concert with technological advances is essential.

<u>Recommendation 12</u>

a) The full details of the necessary DGR monitoring programs should be developed by OPG, and made available to all EA stakeholders for review and comment.

b) An arm's length process for critical analysis and review of the data and the effectiveness of the DGR monitoring programs should be established by the proponent.

c) The DGR monitoring programs should undergo periodic review to consider adoption of contemporary best practices and technologies as these evolve.

<u>c) The Proponent's Contingency Responses to Adverse Monitoring Results</u>

The EIS and its supporting documentation (in particular the Follow-Up Monitoring TSD) provide conceptual descriptions of monitoring proposed for the DGR project. However, these documents in most instances fail to provide descriptions of what kind(s) of adverse results will trigger a contingency response from the proponent, and what sort of contingency response might be triggered.

Following are some examples of conceivable adverse monitoring scenarios:

- Excavation sump monitoring during the construction phase of the project which detects high levels of radioactive tritium contamination in groundwater flowing into the shaft excavation(s).

- Facility sump monitoring during the operations period which detects unexpectedly high amounts of groundwater flowing into the DGR facility through the floor of the facility.

- SWMP monitoring which detects adverse water quality during the construction or operations period which does not respond adequately to treatment, such that the pond remains contaminated. This situation becomes acute if the pond is close to being full with heavy rains pending.

- Post-closure groundwater monitoring which detects signs of upwelling contamination whose most likely source is the DGR facility.

Conceptual descriptions of contingency responses to these and other conceivable monitoring results should be provided by the proponent. Moreover, as with the monitoring programs, these contingency responses should be subject to broad public scrutiny.

<u>Recommendation 13</u>

The conceptual details of the necessary DGR contingency plans should be developed by the proponent, and made available to all EA stakeholders for review and comment.

<u>d) Independent Review and Public Dissemination of DGR Monitoring Results</u>

The proponent has committed to a decades-long monitoring period during the active site preparation, construction and operations phases of the proposed DGR facility and to a 300-year post-closure monitoring period.

While I firmly believe that the 300-year monitoring period is inadequate (as outlined above), the fact that the proponent has committed to a centuries-long monitoring period for the proposed DGR facility means that careful thought needs to be given to facilitation of independent review of that monitoring program.

Independent review of monitoring results is the surest way to ensure that the program remains focussed, effective, and up to date. It is in the public interest for the proponent to facilitate independent review of the monitoring for the proposed DGR facility.

Our experience in accessing results from existing monitoring programs proved instructive in this regard. Despite our diligent efforts it proved impossible to obtain an integrated, clear and explicit overview of current groundwater contamination at the Bruce Nuclear site, even though such an overview was important to improving our understanding of the site hydrogeology. Information requests to the proponent did not elicit much greater clarity. This sort of opacity is unacceptable, and feeds public distrust of the proponent and the proposal.

Missing from the EIS and its supporting documentation is a meaningful commitment by the proponent to subject its DGR monitoring program results to independent and proponent-funded review, and to make the full results of its monitoring programs readily available to the public for review.

Recommendation 14

a) The proponent should subject its DGR monitoring program results to independent non-governmental review, and should provide funding to facilitate this review process.

b) The proponent should make the full results of its monitoring programs readily available to the public for review.

8) Conclusions

1) The proposed DGR site is potentially suitable from a hydrogeological perspective. The proposed DGR is to be situated in low permeability and structurally sound shaley limestone formations, which will provide a suitable host formation for the DGR excavations. These shaley limestone host formation are overlain by very thick (200 meters) and even lower permeability shales, which provide the hydrauli containment of the site.

Overlying the 200 meters of shale bedrock are a further 450 meters of various kinds of sedimentary rocks, which will provide the deep shales with protection from surface erosion over the million year timeframe in which the DGR will be required to contain its radioactive wastes.

2) The upper 170 meters of carbonate bedrock at the DGR site are considered a zone of active karst development. There is little evidence of karst activity or potential below this depth. However over the long term karstic enhancement and/or evaporite dissolution-related enhancement of formation permeabilities is a potential issue in the upper 450 meters of sedimentary bedrock, which could under various glaciation scenarios could be vulnerable to significant permeability increases.

3) The deep 200 meter thick shale bedrock layers which immediately overlie the DGR host horizon are not considered to be vulnerable to erosion or significant permeability increases over a million year timeframe.

8) Conclusions - continued

4) The proposed disposal in the DGR of Ontario's low- and intermediate-level radioactive wastes (L&ILW) would replace the current temporary storage of these wastes at the nearby Western Waste Management Facility (WWMF) on the Bruce Nuclear Property. There is extensive tritium contamination in the area of the WWMF, but it has not been possible to determine the extent and distribution and reasons for this.

If a decision is made to move the wastes to the DGR based on a review of all the evidence at the hearing, then this site from a hydrogeological perspective would provide a considerably more secure location for these wastes than their current situation can provide. However, I take no position on whether the proponent's EA work to date satisfies CEAA provisions, the JRP Agreement, or EIS Guidelines respecting the analysis of alternatives to and alternative sites.

5) There were a significant number of problems with the environmental assessment process being administered by the Canadian Nuclear Safety Commission (CNSC) and the Canadian Environmental Assessment Agency (CEAA). These include problems with the IR process and the late production and disclosure of the documents by the proponent. These problems are described in detail in **Section 3** of this report.

6) There were a number of shortcomings in the characterization of the DGR site, and 4 major issues requiring further investigation/explanation were identified:

a. the high hydraulic heads in the Cambrian sandstone, and the lack of information about hydraulic heads in underlying Precambrian basement;
b. the inadequate information on deep oil/gas exploration boreholes;
c. the permeability of the Silurian "barrier" formations;
d. the existing groundwater and surface water quality in the vicinity of the DGR site (in particular the elevated groundwater tritium contamination levels and the reasons for these).

These issues are described in detail in **Section 4** of this report.

7) The DGR construction and operation period should not be problematic from a groundwater quality perspective, assuming the site is reasonably well run and any spills are reported and addressed promptly and thoroughly.

8) For the most part, the design and operations are well thought out and presented at an adequate level of detail for an environmental assessment. There are however several design and operational issues pertaining to the stormwater management pond (SWMP) which require further attention:

a. targets for discharge water quality;
b. lack of proponent commitments on in-design mitigation and SWMP treatment proposals;
c. inadequate pond capacity;
d. the proposal to hold back SWMP contents following adverse test results.

These issues are described in detail in **Section 6** of this report.

9) The weakest aspects of the DGR proposal are the monitoring and contingency plans, which are currently only developed at a conceptual level. Critical details are missing from the plans which have been presented, and there is a concern that these critical details will avoid public scrutiny if their development is put off until after the conclusion of the EA process. The proposed 300-year post closure monitoring period is not adequate. My concerns about the proposed monitoring and contingency plans are described in detail in **Section 7** of this report.

9) Recommendations

The EIS (with its supporting documentation) should not be approved in its current form. The proponent should be required to address and implement the recommendations provided in this report.

Recommendation 1)

The Joint Review Panel should take the deficiencies in the environmental assessment process into account in its review and assessment of the viability of the DGR project. Furthermore, future Panels should take the deficiencies in the environmental assessment process into account and take all necessary steps to ensure that these do not occur in any new environmental assessment process under the Canadian Environmental Assessment Act.

Recommendation 2)

a) The proponent should provide information on the shut-in pressure and the water quality at the Precambrian unconformity.

b) The proponent should provide a discussion of whether the proposed excavation depth of 746 mbgs is needed for the ventilation shaft, given the overpressured high hydraulic conductivity and high hydraulic head Cambrian sandstones which underlie the DGR site.

Recommendation 3)

a) The proponent should provide a full description of the measures taken to secure each of the 11 deep "abandoned" wells within 40 km of the DGR site.

b) The worst-case scenario of undocumented oil exploration wells being present in the area of the proposed DGR should be considered and explicitly addressed by the proponent.

Recommendation 4)

a) Further work on the DGR project should be premised on a prudent assumption that the Silurian bedrock formations will not provide an effective hydraulic barrier over the long term.

b) The proponent should model DGR performance using worst-case permeabilities, based on leach testing of all "barrier" formations.

Recommendation 5)

a) The proponent should provide full disclosure on what combination of workplace practices and incidents led to the tritium contamination which is observed in groundwater throughout the area of the Western Waste Management Facility.

b) The distribution of tritium in the subsurface should be determined by integration of all monitoring data and communicated to site operators, regulators, and the public.

c) The migration of tritium in the subsurface should be modelled using values of effective porosity appropriate to the karstic host formations.

d) The proponent should provide a full description of what measures will be undertaken to ensure that the surface water management pond (SWMP) does not become contaminated by tritium (or other radiological contaminants) during construction and operation of the DGR.

e) The proponent's radiological surface water monitoring parameter list includes tritium, gross beta, and carbon 14. Proposed maximum target levels for each parameter should be proposed for the SWMP by the proponent, with a rationale provided for each parameter.

f) Field workers exposed to local groundwater should have appropriate briefings, operational protocols and monitoring appropriate to the potential tritium hazard.

Recommendation 6)

a) The proposed groundwater monitoring plans for the DGR facility should be amended to include monitoring well nests atop each of the vertical tunnels of the main access shaft and the ventilation shaft.

b) These wells should be installed after the shafts have been sealed and backfilled to ground surface.

c) The bottom well in each nest should be installed at the top of the low-permeability shaft seal/backfill materials, and wells should be installed in higher permeability units above that depth with a maximum spacing of 40 meters vertically.

Recommendation 7)

a) The proponent should commit to using the PWQO as the basis for setting SWMP discharge water quality limits for selected organic chemicals, including BTEX parameters (benzene, toluene, ethylbenzene, and xylenes) and PAHs (polynuclear aromatic hydrocarbons).

b) Water in the SWMP which does not meet the PWQO for the selected organic chemicals should be held back for further treatment and testing.

Recommendation 8)

The proponent should commit to in-design best management practices, and to treating the SWMP discharge water unless a program of rigorous testing has confirmed that it meets the PWQO for all parameters of concern (including ammonia, BTEX parameters, PAHs, metals, and salts).

Recommendation 9)

The SWMP should be designed and constructed with sufficient capacity to contain the Regional Storm (ie. Hurricane Hazel).

9) Recommendations - continued

Recommendation 10)

a) There should be continuous measurement of SWMP water quality (by measuring electrical conductivity), coupled with a program of regular more detailed testing for various discharge criteria.

b) If there are adverse water quality results exceeding the PWQO, then the SWMP contents should be held back to allow for more detailed testing and investigation to determine the reason(s) for the adverse test results.

c) Arrangements should be made with a local wastewater treatment plant to take the SWMP contents in the event that on-site treatment is not able to reduce pond contaminant levels to below discharge criteria.

Recommendation 11)

a) The proponent should commit to sustaining a longer-term monitoring effort for the DGR facility following closure.

b) The commitment should be open ended (ie. to monitor "as long as possible") with a minimum monitoring period of 1000 years.

Recommendation 12)

a) The full details of the necessary DGR monitoring programs should be developed by OPG, and made available to all EA stakeholders for review and comment.

b) An arm's length process for critical analysis and review of the data and the effectiveness of the DGR monitoring programs should be established by the proponent.

c) The DGR monitoring programs should undergo periodic review to consider adoption of contemporary best practices and technologies as these evolve.

Recommendation 13)

The conceptual details of the necessary DGR contingency plans should be developed by the proponent, and made available to all EA stakeholders for review and comment.

Recommendation 14)

a) The proponent should subject its DGR monitoring program results to independent non-governmental review, and should provide funding to facilitate this review process.

b) The proponent should make the full results of its monitoring programs readily available to the public for review.

Appendix 1

Curriculum Vitae

of

Wilf Ruland (P. Geo.)

Curriculum Vitae of Wilf Ruland

(Professional Geoscientist)

Address: Wilf Ruland (P. Geo.)
766 Sulphur Springs Road
Dundas, Ontario
L9H 5E3
Tel: (905) 648-1296
E-mail: deerspring1@gmail.com

Education:

1988 Master of Sciences in Earth Sciences,
University of Waterloo.
Supervisor: Dr. John Cherry

Master's project focussed on the hydrogeological properties of fractured clay deposits in Lambton County. 15 courses provided a broad background in hydrogeology.

1982 Honours Bachelor of Science in Geography and Geology,
McMaster University.

30 courses provided a broad background in natural science, geography and geology.

Experience:

since 1988 Environmental Consultant, as head of own consulting firm
(Citizens' Environmental Consulting).

Active as advisor and consultant on issues related to groundwater or surface water contamination or depletion for private citizens, citizens' groups, environmental groups, First Nations, companies and public agencies from across Ontario.

Specialization in addressing landfill-related groundwater and surface water contamination problems through review of hydrogeological impact studies, field investigations, and participation in public meetings and hearings.
Ongoing contracts include investigations of water contamination at landfills near St. Catharines, Brockville, Kingston, Waterloo, and Windsor.

Other significant areas of work include review of pit and quarry proposals and applications for Permits to Take Water, investigations of well interference resulting from quarries, and groundwater contamination emanating from major industrial properties and gas stations.

Experience: continued

1988-1993 Research Associate, Waterloo Centre for Groundwater Research, University of Waterloo

Work included research into the hydrogeology of fractured clays and into the impacts of landfills on groundwater.

1983-1985 Hydrogeologist, Ingenieur-Geologisches Institut, Westheim, Germany.

Work included hydrogeological field work, supervision and evaluation of drilling programs, supervision and evaluation of pumping tests, research and preparation of hydrogeologic reports, and supervision of environmental monitoring for a major railway construction project.

Publications, Papers and Research Reports:

Worthington, S.R.H., Smart, C.C., and Ruland, W.W. 2012. Effective Porosity of a Carbonate Aquifer with Bacterial Contamination: Walkerton, Ontario, Canada. Published in the Journal of Hydrology, Vol. 464-465 (2012), p. 517-527.

Ruland, W.W. 2005. Presentation on Source Water Considerations and the Walkerton Setting. Presented at the Canadian Water Network's Walkerton Water and Public Health Training Workshop, May 28 - June 2, 2005.

Worthington, S.R.H., Smart, C.C., and Ruland, W.W. 2002. Assessment of Groundwater Velocities to the Municipal Wells at Walkerton. Paper presented at the 3rd Joint IAH-CNC/CGS Conference, October 20 - 23, 2002 in Niagara Falls, Ontario.

Worthington, S.R.H., Smart, C.C., and Ruland, W. 2001. Karst Hydrogeological Investigations at Walkerton. Report prepared for and submitted as evidence at the Walkerton Inquiry.

Ruland, W.W., Schellenberg, S.S., and Farquhar, G. 1993. The Fate of Landfill Leachate in Waste Water Treatment Plants and in Groundwater at Attenuation Landfills. Report prepared for the Ontario Ministry of Environment and Energy.

Ruland, W.W., Cherry, J.A., and Feenstra, S. 1991. The Depth of Fractures and Active Ground Water Flow in a Clayey Till Plain in Southwestern Ontario. Published in the Journal of Ground Water, Vol. 29, No. 3, p. 405-417.

D'Astous, A.Y., Ruland, W.W., Bruce, R.J., Cherry, J.A., and Gillham, R.W. 1989. Fracture Effects in the Shallow Groundwater Zone in Weathered Sarnia Area Clay. Published in the Canadian Geotechnical Journal, Vol. 26, No. 1, p. 43-56.

Fracture Depths and Active Groundwater Flow in a Clayey Till in Lambton County, Ontario. 1988. Unpublished M.Sc.Project, University of Waterloo.

Cherry, J.A., MacQuarrie, K.T.B., and Ruland, W.W. 1987. Hydrogeologic Aspects of Landfill Impacts on Groundwater and Some Regulatory Implications. Paper presented at the PCAO/MOE Seminar on Landfill Regulations May 13, 1987.

Wilf Ruland (P. Geo.) - Partial List of Consulting Experience:

1) Investigations/Reviews of Landfill-Related Water Contamination:

Niagara Road 12 Landfill, near Grimsby, Ontario.
- Peer Review for the Niagara Road 12 Litizen Liaison Committee (2008-2010).

Humberstone Landfill in Welland, Ontario.
- Peer Review for the Humberstone Public Liaison Committee (since 2007).

City of Owen Sound's Derby Landfill site, near Owen Sound, Ontario.
- investigation and review for the Ledingham family (2004-2006)

Town of Northeastern Manitoulin and the Islands Landfill, near Little Current, Ontario;
- investigation and review for Mr. Raeburn Smith and Mrs. Virginia Smith (since 2004).

Rennie and Brampton Street Landfill Sites, Hamilton, Ontario;
- Peer Review for the Rennie/Brampton Citizens' Liaison Committee (2001-2005).

Town of Thessalon Landfill Site, near Thessalon, Ontario;
- investigation for Mr. Mark Petingalo and Mrs. Wendy Petingalo (in 2000).

City of Brockville Landfill Site, Brockville, Ontario;
- review for Brockville Public Liaison and Monitoring Group (since 1997).

Fletcher Tile Landfill Site, near Chatham, Ontario;
- investigation for Citizens Opposed to Landfill Development (1996-1997).

Bracebridge Landfill Site, Bracebridge, Ontario;
- investigation for Dr. David Kent (1995-1996).

Waterloo Sanitary Landfill Site, Waterloo, Ontario;
- review for Waterloo Waste and Water Watchers (since 1995).

Innisfil Landfill Site, Innisville, Ontario; investigation for Mrs. Helen Hodgson (1995 - 1999).

Tom Howe Landfill Site, near Hagersville, Ontario;
- review for the Mississaugas of the New Credit First Nation (since 1994).

Wolfe Island Waste Disposal Site, Wolfe Island, Ontario;
- investigation for Ms. Theresa James (since 1994).

Bensfort Road Landfill, near Peterborough, Ontario;
- investigation for Mr. Gary McCarrell and Mrs. Lori McCarrell (1991-1993).

Orillia Landfill Site, in Orillia, Ontario; investigation for Citizens Acting Now (1991).

Storrington Landfill near Kingston, Ontario;
- investigation for Storrington Committee Against Trash (1990-1997).

Glenridge Quarry Landfill in St. Catharines, Ontario;
- review for Glenridge Landfill Citizens' Committee (since 1989).

Warwick Landfill near Watford, Ontario;
- investigation for Watford Warwick Landfill Committee (1989-1996).

Brow Quarry Landfill near Dundas, Ontario;
- investigation for Greensville Against Serious Pollution (1988-1989).

Essex County Landfill No. 3 in Maidstone Township, Ontario;
- reviews for Maidstone Against Dumping and Maidstone Township (1988-2008).

Town of Cobourg Landfill, in Haldimand Township, Ontario;
- investigation for Mr. Joe Sherman (1988-1991).

2) Reviews of Proposals to Site New or Expand Existing Landfills

Proposal to massively expand the Richmond Landfill near Napanee, Ontario;
- review for the Concerned Citizens Committee of Tyendinaga Twp. (2004 - 2006, and since 2010).

Proposal to expand and significantly alter the Edwards Landfill
(including excavation of hazardous wastes, and relocation of other wastes) near Cayuga, Ontario;
- review for Haldimand Against Landfill Transfers (2004 - 2006)

Proposal to massively expand the Warwick Landfill near Watford, Ontario;
- Peer Review for the Township of Warwick (1998-2008).

Proposal to site a landfill near Cochrane, Ontario;
- review for the Fournier Action Committee (1997 -1999).

Proposal to site a landfill in the abandoned Adams Mine Site near Kirkland Lake;
- review for the Coalition of Temiskaming Concerned Citizens (in 1995).

Proposal to site a landfill in the Taro East Quarry near the Niagara Escarpment
in Stoney Creek, Ontario;
- review for Stoney Creek Residents Against Pollution (in 1995).

Proposal to develop a perimeter-berm landfill around the Lake Ontario Steel Company Limited property in Whitby, Ontario; Peer Review for the Lasco Berm Liason Committee (1991-1995).

Proposal to build a landfill in a Class 2 Wetland near Cayuga, Ontario;
- review for Haldimand-Norfolk Organization for a Pure Environment (1989-1990).

Proposal to site a landfill in the Acton Quarry near Milton, Ontario;
- review for Protect Our Water and Environmental Resources (in 1989).

3) Review of Landfill Closure and End Use Plans

Closure Plan for the Tom Howe Landfill Site, for the Mississaugas of the New Credit First Nation (2005, and 2009/2010).

Closure Plan for the Richmond Landfill near Napanee, Ontario;
for the Concerned Citizens Committee of Tyendinaga Twp. (2007).

End Use Plan for the Glenridge Quarry Naturalization Site (formerly the Glenridge Laandfill), for the Glenridge Landfill Liaison Committee (2002).

Closure and post-Closure Care Plan for the Brockville Landfill Site, for the Brockville Public Liaison and Monitoring Group (2000-2001).

Closure and End Use Plan for Essex County Landfill No. 3, for Maidstone Against Dumping (1996).

4) Other Landfill-Related Projects

Peer Review of proposal to expand the Clean Harbors Hazardous Waste Landfill Facility near Sarnia, Ontario (since 2010); for the Township of St. Clair.

Investigation and review of groundwater and surface water contamination being caused by a cement kiln dust landfill near Bath, Ontario. Negotiated an agreement with Lafarge Cement to remediate the existing landfill and use an industry-standard design on a go-forward basis. For Lake Ontario Waterkeeper (2007-2010).

Member of the Expert Panel (appointed by the Minister of the Environment) to look into potential health and environmental impacts from the Taro East Landfill in Stoney Creek, Ontario (in 2000). The final report of the Expert Panel was released in October 2000, and the Addendum Report was released in December 2000.

Technical advisor to private citizens who successfully prosecuted the City of Hamilton (which pleaded guilty) for contamination by PCB-laden leachate of Redhill Creek (in 2000).
The resulting $450,000 fine was a record for fines paid under such prosecutions.

5) Reviews of Waste Management Master Plan (WMMP) Studies

Region of Haldimand-Norfolk Waste Management Master Plan (WMMP);
- review for the Mississaugas of the New Credit First Nation (1995-1996).

South Simcoe County Waste Management Master Plan;
- review for the South Simcoe Waste Action Network (since 1994).

Leeds and Grenville Waste Management Master Plan;
- review for Sabourins Crossing Residents Against Megadumps (in 1994).

Pembroke and Area Waste Management Master Plan;
- review for the Snake River/Micksburg Anti-Dump Association (1991-1992).

Northumberland County Waste Management Master Plan;
- review for Mr. and Mrs. J. Sherman (1989-1991).

Wellington County Waste Management Master Plan;
- review for the Concerned Alma Citizens (1988-1991).

6) Nuclear-Related Peer Review Work

Review of the Draft Environmental Impact Statement for the proposed Darlington 'B' New Nuclear Power Plant Project;
- review for Lake Ontario Waterkeeper (2010-2012).

Review of the proposed remediation of the Cameco Nuclear Waste Processing Facility in Port Hope, Ontario;
- review for Lake Ontario Waterkeeper (starting in 2010).

Review of the Draft Guidelines for the Environmental Impact Statement for the proposed Darlington 'B' New Nuclear Power Plant Project;
- review for Lake Ontario Waterkeeper (2008).

7) Other Investigations of Groundwater Contamination

Contamination by petroleum hydrocarbons of a greenhouse property from an adjacent Hydro One maintenance center in Kenora, Ontarioo; investigation for the Schmidt Family (2008)

Impacts of residual contamination on a former industrial property, which is now the site of St. Mary's High School; investigation for Environment Hamilton (2002 - 2004).

Contamination by petroleum hydrocarbons and volatile organic chemicals (VOCs) from a former service center near High Park, Toronto; investigation for Mr. Gerard Kennedy, MPP (in 2002).

Contamination of municipal water supply wells by E-coli bacteria in Walkerton, Ontario;
- investigation for Concerned Walkerton Citizens (2000 - 2002).

Contamination by petroleum hydrocarbons and volatile organic chemicals (VOCs) from an Imperial Oil fuel and liquid transfer facility in Kapuskasing, Ontario; investigation for the Schlechter family (in 2000).

Contamination by petroleum hydrocarbons from a Gulf Canada gas station in Port Loring, Ontario;
- investigation for People Against Contaminated Water (PACW); (1999 - 2001).

Contamination by petroleum hydrocarbons from a gas station in Bamberg, Ontario;
- investigation for the Bush and Fink families (1997 - 1998).

Groundwater contamination in Cambridge, Ontario caused by Ciba-Geigy Canada Ltd;
- investigation for Thomas Construction Company Ltd. (1993 - 1997).

Groundwater contamination from the Bristol Aerospace Plant near Lockport, Manitoba;
- investigation for Mrs. Elizabeth Andresen and Miss Ursula von Krogh (in 1993).

Extensive water contamination in Elmira, Ontario caused by Uniroyal Chemical Ltd; investigation for various clients, most recently the Region of Waterloo (since 1989).

8) Permits to Take Water and Drinking Water Systems

Preparation of applications to the Ministry of the Environment to upgrade the drinking water systems for Camp NeeKauNis near Waubaushene, Ontario (since 2012).

Review of an application for a Permit to Take Water for a Water Bottling Operation (to be operated by CJC Bottling Limited), with water to be taken from a well which feeds the headwaters of Colborne Creek; for the Concerned Citizens of Northumberland (2001 - 2004).

Review of an application for a Permit to Take Water for a municipal water supply project (for the Village of Woodville), with water to be taken from pumping wells near 5 families' homes;
- for the Mariposa Aquifer Protection Association (2000 - 2004).

Review of an application for a Permit to Take Water for a Water Bottling Operation (to be operated by Artemesia Springs Limited), with water to be taken from a springwell which feeds a headwater stream of the Rocky Saugeen River;
- for the Water Protection Coalition of South Grey (1999 - 2001).

Review of an application for a Permit to Take Water for a Water Bottling Operation (to be operated by Aquafarms 93 Limited), with water to be taken from a spring and 3 pumping wells situated near the headwaters of the Beaver River;
- for Ms. Samantha Wickens and other local residents (in 1999).

Preparation of an application for a Permit to Take Water for a fish farming operation (to be operated by Van Aqua Inc.), with water to be taken from a pumping well near the Town of Burford in Brant County; for Mr. Peter Van Kruistum (in 1988).

9) Reviews/Investigations Related to Impacts of Major Water-Takings

Impacts of ongoing pumping of municipal supply wells K50/K51 in Wilmot Township;
- review for Wilmot Center Monitoring Program Public Liaison Committee (since 2003).

Impacts of ongoing dewatering of the Canadian Gypsum Company mine near Hagersville Ontario;
- review for residents of 3rd Line, Six Nations Indian Reserve (1999-2003).

10) Reviews/Investigations related to Impacts from Pits, Quarries, and Mines

Investigation of potential impacts from the Miller Braeside Quarry near Braeside, Ontario;
- review for Friends Addressing Concerns Together in McNab/Braeside (since 2008).

Investigation of potential impacts from the unlicensed Nichol Quarry near Hagersville, Ontario;
- review for the Mississaugas of the New Credit First Nation (since 2007).

Impacts of the proposed expansion of the Nelson Aggregates Quarry near Mount Nemo, Ontario;
- review for Protecting Escaparment Rural Land (2005-2007).

Cumulative impacts of the proposed Halminen Quarry and Lafarge Quarry near Buckhorn, Ontario;
- review for Friends of Life in the Kawarthas (2004 - 2006).

Impacts of the proposed expansion of the Graham Brothers Aggregates Limited gravel pit near Caledon, Ontario; review for Dr. David Sylvester (2000 - 2001).

Impacts of the proposed Nichol Gravel Limited quarry near Hagersville, Ontario;
- review for the Mississaugas of the New Credit First Nation (1999 - 2001).

Impacts of well interference from the Canadian Gypsum Company mine near Hagersville;
- investigation for several families on the Six Nations Reserve (1999 - 2003).

Impacts of well interference from the Dunnville Rock Products Quarry near Dunnville;
- investigation for Mr. Ken Ricker and Mrs. Ethel Ricker (1997 - 2000).

Impacts of water takings asssociated with the Acton Quarry near Acton, Ontario;
- review for Protect Our Water and Environmental Resources (1997-2007).

Impacts of a quarry proposed adjacent to Mitchell Lake, near Victoria Road, Ontario;
- review for the Northern Victoria Ratepayers Association (1997 - 1999).

Impacts of a quarry, proposed to be located on the Bruce Peninsula;
- review for Mr. Ziggy Kleinau (1996).

Impacts of a proposed gravel pit, to be sited near Grippen Lake, Ontario;
- review for Township Residents Against Pit Pollution (1995 - 1998).

Impacts of a gravel pit to be built in an Earth Science Area of Natural Interest (ANSI);
- review for Ms. Jeanette Mazur (1995 - 1996).

Impacts of the proposed Seeley and Arnill Quarry near Orillia, Ontario;
- review for Mr. David Lowry (1993 - 1997)

Impacts of a proposed expansion of the Walker Brothers Quarry, near St. Catharines;
- review for Mrs. Ronnie DeMeel (1992).

Impacts of six (6) proposed gravel pit operations in Oro Twp., Ontario;
- review for Dr. E.J. Beaton and Dr. A.C. Beaton (1990 - 1992).

11) Participation in Public Hearings

An application to site a quarry in a Provincially Significant Wetland Complex near Duntroon, Ont;
• before the Ontario Municipal Board;
• Decision dated August 24, 2012.

A hearing into the proposed Darlington 'B' New Nuclear Power Plant Project;
• before the Canadian Nuclear Safety Commission;
• Decision dated August 17, 2012.

An application to develop a quarry in the Niagara Escarpment Plan area near Duntroon, Ontario;
• before the Joint Board;
• Decision dated June 18, 2012.

An application to develop a gravel pit in the Municipality of Grey Highlands, Ontario;
• before the Ontario Municipal Board;
• Decision dated April 30, 2008.

An application to massively expand the Dufferin Aggregates Milton Quarry;
• before the Joint Board;
• Decision dated June 8, 2005.

An application for conversion of 81 cottages into permanent homes adjacent to a World Biosphere Reserve, Class 1 Wetland and Wilderness Area in Turkey Point;
• before the Ontario Municipal Board;
• Decision dated August 13, 2002.

An application to develop a quarry near Mitchell Lake and Victoria Road, Ontario;
• before the Ontario Municipal Board;
• Decision dated January 22, 1999.

An application to develop a gravel pit adjacent to a Class 1 Wetland along the shore of Lake Katchewanooka near Lakefield, Ontario;
• before the Ontario Municipal Board;
• Decision dated June 4, 1998.

An application to develop a quarry near Kinmount, Ontario;
• before the Ontario Municipal Board;
• Decision dated August 18, 1995.

An act (Bill 62) to amend the Environmental Protection Act to phase out landfilling in the Niagara Escarpment Plan Area;
• before the Standing Committee on the Administration of Justice;
• Bill 62 received Royal Assent June 23, 1994.

An application to expand the Eastview Road Landfill Site near Guelph, Ontario;
• before the Environmental Assessment Board;
• Decision EP 92-02 dated September 22, 1993.

An application to develop six (6) gravel pits on the Oro Moraine in Oro Twp.;
• before the Ontario Municipal Board;
• Decision dated July 23, 1993.

An application to expand the Storrington Landfill Site;
• before the Environmental Assessment Board;
• Decision EP 91-01 dated March 31, 1993.

An amendment (No. 52/89) to the Niagara Escarpment Plan to delete waste disposal sites as a permitted land use in lands protected by the Plan;
• before a Niagara Escarpment Commission Hearing Officer;
• Decision dated Oct. 22, 1991.

An appeal against a zoning bylaw and a proposed plan of subdivision (which allowed construction of a golf course on a Class 1 Wetland);
• before the Ontario Municipal Board;
• Decision dated August 29, 1990.

An application to expand the Seeley and Arnill Aggregates Ltd. gravel pit in Oro Twp.;
• before the Ontario Municipal Board;
• Decision dated May 29, 1990.

An application to expand Essex County Landfill No. 3;
• before the Environmental Assessment Board;
• Decision EP 89-02 dated December 12, 1989.

An application to expand the Town of Cobourg landfill;
• before the Environmental Assessment Board;
• Decision EP 89-01 dated October 16, 1989.

Appendix 2

References

There is a voluminous amount of documentation available regarding the DGR proposal and the EIS. We did a good deal of "browsing" through the various documents. Major references which were reviewed in the course of preparing this report included the following:

Analysis of the impact of groundwater withdrawal associated with the construction of the DGR shafts, OPG DGR. File DGR-TM-3400(P). February 2012. Prepared by J. F. Sykes.

Consolidated Responses to JRP's Information Requests for DGR Project. 2013.

DGR EA Follow-Up Monitoring Technical Support Document, OPG's Deep Geologic Repository Project. March 2011. Prepared by Nuclear Waste Management Association.

DGR Project Consolidated Commitment List, OPG's Deep Geologic Repository Project. July 2013. Prepared by Nuclear Waste Management Association.

Environmental Impact Statement, OPG's Deep Geologic Repository Project. March 2011. Prepared by Golder Associates Ltd.

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