ONTARIO POWER GENERATION

Lise Morton
Vice President
Nuclear Waste Management

177 Tie Road, B21, Tiverton Ontario, N0G 2T0

Tel. <contact information removed> Fax <contact information removed>
<email address removed>

May 26, 2017

CD# 00216-CORR-00521-00014

MS. ROBYN-LYNNE VIRTUE
Panel Manager
Canadian Environmental Assessment Agency
Place Bell Canada
160 Elgin Street, 22nd Floor
Ottawa, Ontario K1A 0H3

Dear Ms. Virtue:

Deep Geologic Repository for Low and Intermediate Level Radioactive Waste Project – Response to Information Request Package

Reference: 1. Letter from Robyn-Lynne Virtue to Lise Morton, "Deep Geologic Repository for Low and Intermediate Level Radioactive Waste Project – Results of the Technical Review of Ontario Power Generation's Response to the Ministerial Request for Additional Information," April 5, 2017, CD# 00216-CORR-00521-00010.

The purpose of this letter is to provide the Canadian Environmental Assessment Agency (the Agency) with OPG's response to the request for additional information required to inform the Minister's decisions [Reference 1].

The Attachment to this letter provides OPG's response to the Agency's Information Request Package.

OPG has fully addressed all of the questions from Reference 1, and maintains that the DGR Project at the Bruce Nuclear site remains the preferred location.

If you have any questions, or require additional information, please contact me at <contact information removed>, or by e-mail at <email address removed>

Sincerely,

<Original signed by>

Lise Morton
Vice President
Nuclear Waste Management

Attach.

cc: Derek Wilson – NWMO
Karine Glenn, Karina Lange – CNSC (Ottawa)

ATTACHMENT 1

Deep Geologic Repository for Low and Intermediate Level Radioactive Waste

Response to Information Request Package of April 5, 2017 from the Canadian Environmental Assessment Agency

Attachment 1: OPG Response to Information Request Package dated April 5, 2017 from the Canadian Environmental Assessment Agency

IR #	IR Title	Information Request and Response
IR-1.1	Regional Variability	***Information Request:*** • *Discuss how OPG has accounted for the variability in environmental conditions in each geologic region.* • *Discuss how OPG has managed uncertainty in its environmental effects assessment given the regional approach taken.* ***Rationale:*** *OPG presented alternative locations for the Project based on two geologic regions in Ontario: crystalline rock location within the Canadian Shield and sedimentary rock location in southern Ontario. A regional approach has resulted in evaluating potential alternatives located in areas that encompass a range of environmental conditions. A clear understanding of the methodology used to account for regional variability is required to validate OPG's conclusions on potential environmental effects for each valued component (VC).*
		OPG Response: As noted in the Information Request, there is a range of baseline environmental conditions that are expected to be encountered within each alternate location. This natural range of variability is carried through the effects assessments of alternate locations and influences confidence in the predictions. To account for and subsequently manage and address uncertainty associated with the variability in the environmental conditions, the Environmental Effects of Alternate Locations report [GOLDER 2016] considered the broader range of baseline conditions that would likely be encountered at the regional scale for the alternate locations. The assessment then focused on the range of baseline conditions at the local scales that were identified to be suitable for developing a project. For each Valued Component (VC) assessed in the Environmental Effects of Alternate Locations report [GOLDER 2016], potential VC-specific environmental criteria were considered for each alternate location. Table 1, enclosed (see Enclosure 1 starting on page 104), provides a summary of these environmental criteria, along with the expected range of conditions that would likely be encountered at the alternate locations for each of the VCs, and how uncertainty was managed to increase confidence in effects predictions. When predicting potential effects, conservative assumptions were made with regards to potential emissions and interactions within the alternate DGR locations and associated facilities, and VCs. Using this approach, it is acknowledged that the magnitude of effects would likely vary within each alternate location; however, the range of potential effects are identified, and all potential effects are included in the assessment of alternate locations. The assumptions and conditions applied to the assessment of alternate locations were consistent with those included in the Bruce Nuclear site Environmental Impact Statement [OPG 2011], which enabled confident comparisons of effects

<table>
<tr><th>IR #</th><th>IR Title</th><th>Information Request and Response</th></tr>
<tr><td></td><td></td><td>predictions between alternate locations. In addition, proposed project designs and mitigation measures are identified that would manage and mitigate effects related to natural variability.

References:

GOLDER. 2016. Environmental Effects of Alternate Locations. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883)

OPG. 2011. Environmental Impact Statement, Volume 1: Main Report. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298)</td></tr>
<tr><td>IR-1.2</td><td>Determining Significance of Effects</td><td>Information Request:

Using Agency guidance, update Table 6-1 to identify:

• the environmental effects for each VC for all three potential locations in order to make a comparison;
• the mitigation measures which may address potential environmental effects;
• whether there are residual effects and provide the benchmark used to determine whether the residual effects are significant;
• consider the ecological or social context as an additional criteria for the determination of significance; and
• indicate if the methodology used in evaluating the environmental effects of all three potential locations is the same and if not, explain why.

Rationale:

The Agency's operational policy statement on Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under CEAA 2012 recommends that the approach for determining significance includes considering whether the predicted environmental effects are adverse, significant and likely. The operational policy statement recommends characterizing adverse effects based on the following key criteria: magnitude, geographic extent, timing, frequency, duration, and reversibility, with consideration of the ecological and social context within which the potential residual adverse environmental effects may occur.

The Agency notes that OPG does not use consistent terminology when characterizing potential adverse environmental effects or a consistent approach when determining if a potential residual adverse environmental effect is likely to be significant. In order to evaluate the validity of OPG's conclusions, it is necessary to understand how the terms are used.

In OPG's technical document "Environmental Effects of Alternative Locations", Table 6-1, the analysis for each alternative location generally outlines which VCs could potentially be impacted but it does not describe the environmental effects and the mitigation measures that apply to reduce the potential effect of alternative locations as required by the Agency's guidance.</td></tr>
</table>

IR #	IR Title	Information Request and Response
		OPG Response: A revised Table 6-1 is enclosed (see Enclosure 2 starting on page 113), including the analyses for all identified Valued Components (VCs), the potential environmental effects, the proposed mitigation measures, and residual effects and their significance, including consideration of social and ecological context. The final column of the table presents a comparative summary of the three locations. The preferred location is denoted with a '⭘', whereas those locations with greater number or magnitude of environmental effects are denoted with a '▲'. If locations have similar effects, they are both denoted as preferred. A similar comparison is also provided with regard to the ability to implement mitigation at a location, with the location requiring the least mitigation being ranked as preferred. The overall approach used to assess effects on the environment of the alternate locations is consistent with that applied in the Environmental Impact Statement (EIS) [OPG 2011]. This approach is aligned with the Agency's technical guidance and Operational Policy Statement on *Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under CEAA 2012* [CEAA 2014]. The same VCs or groups of biophysical VCs were used to focus the assessment of both alternate locations. For each of the VCs, the same assessment steps were undertaken: • summarize relevant information related to the environmental setting; • assess potential project-environment interactions; • assess potential effects of the DGR at an alternate location on the VCs; and • identify mitigation measures that could be implemented to reduce or avoid these effects. Thresholds used in the EIS [OPG 2011] for whether an effect is likely to be measurable or residual were applied in the same way to the assessment of both alternate locations (i.e., sedimentary alternate location and crystalline alternate location). Where the effect was residual, the potential for it to be significant, or not, was assessed using the same criteria defined in the EIS and in OPG's response to Information Request EIS-12-510 [OPG 2014]. These thresholds are presented in the revised Table 6-1 (Enclosure 2 starting on page 113). The understanding of the range of existing conditions at each of the alternate locations was important to understanding the likelihood of an effect. This is discussed in the response to Information Request 1.1 and is not repeated here. Assumptions used to define potential effects at both alternate locations were kept consistent with the DGR Project at the Bruce Nuclear site, unless the geography and/or geology dictated a change, as identified in the Description of Alternate Locations report [OPG 2016]. For example, a similar distance to the closest receptor was assumed in all cases, as was a similar-sized construction fleet. This allowed the assessment to be representative of the range of conditions that may be encountered in an alternate location, and focus on highlighting those changes in effect driven by the different geology and setting, and therefore reasonably compare the predicted effects between the Bruce Nuclear site, and the sedimentary and crystalline alternate locations.

<table>
<tr><th>IR #</th><th>IR Title</th><th>Information Request and Response</th></tr>
<tr><td></td><td></td><td>References:
CEAA. 2014. Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under CEAA 2012.
OPG. 2011. Environmental Impact Statement, Volume 1: Main Report. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298)
OPG. 2014. Letter, Ontario Power Generation to Joint Review Panel, dated March 28, 2014. (CEAA Registry Doc# 1836)
OPG. 2016. Description of Alternate Locations. Ontario Power Generation Report 00216-REP-07701-00014-R000. (CEAA Registry Doc# 2883)</td></tr>
<tr><td>IR-1.3</td><td>Assessment Methodology</td><td>Information Request:
Provide a summary table that identifies and compares the alternative locations and the preferred site, including the following:
• Use a systematic approach (e.g. weighting, scoring and/or qualitative lines of reasoning) that clearly demonstrates the relative importance of the relevant criteria (feasibility criteria, risk, cost, and environmental effects) to the conclusion about the preferred location.
• Discuss whether other criteria could inform the location-selection process and incorporate them in the comparative analysis summary table if applicable. These criteria can include but are not limited to:
o Indigenous Interests (e.g. current land and resource use, traditional territory, access)
o Implications related to the later operational start of the Project at alternate locations
Rationale:
In its assessment of alternative means, including alternate locations, the Agency considered the proponent's ability to demonstrate that several key criteria were considered, whether the analysis of each of the key criteria was defensible and the extent to which an individual criterion influenced the preferred location. The assessment of alternatives and the identification of a preferred option requires that all technical and economic feasible alternatives be compared, before deciding upon a preferred option, to ensure that all aspects of the potential locations are equally and directly considered.
OPG presents three technical and economic feasibility criteria to identify two alternative locations. OPG states in its "Description of Alternatives Locations" Report (page 3) that the main technical objective of the DGR is safety and that safety is achieved by a combination of physical features of the site. Although there is no ideal number of criteria, additional criteria will help demonstrate why a specific location is preferred over others. For example, physical features that are necessary to construct, operate and monitor the Project may include minimum distance to a major waterbody or land availability.</td></tr>
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IR #	IR Title	Information Request and Response
		Other than identifying the technical and economic feasibility criteria in the report, OPG discusses the timeline associated with the alternative locations, environmental effects associated to selected VCs, cost and risk for packaging and transporting waste to alternate locations, incremental project costs unrelated to transportation, and social licence. OPG does not state explicitly whether these topics serve as criteria towards selecting the preferred location and, if they are criteria, to what degree do they factor into the decision-making process for preferred location. *Although the criteria appear adequate and are generally acceptable, it remains unclear how the comparative assessment of the alternate locations demonstrates why one location is preferred over the other.*
		OPG Response: OPG's assessment of alternate locations involves a multi-step process. In the first step, technical and economic feasibility criteria and thresholds were defined and alternate locations that were technically and economically feasible were identified and described (this was done in Section 2.0 of the Study of Alternate Locations Main Submission [OPG 2016]). In the second step, the potential environmental effects on valued components (VCs) of each technically and economically feasible alternate location were identified and described (this was done in Sections 4 and 5 of the Study of Alternate Locations Main Submission [OPG 2016]). In the third step, a preferred location was identified based on a relative consideration of environmental effects, transportation risks, transportation and other project-related costs and uncertainties (this was done in Section 10.0 of the Study of Alternate Locations Main Submission [OPG 2016]). The methodology used to identify the preferred location relied on a comparative evaluation of the overall advantages and disadvantages of the two technically and economically feasible alternate locations and the Bruce Nuclear site. The assessment was conducted by experts at OPG, Golder, NWMO and Energy Solutions Canada and summarized in a narrative form and at an appropriate level to distinguish the relative merits of three alternatives: the DGR project at the Bruce Nuclear site, the DGR Project at a crystalline alternate location, and the DGR Project at a sedimentary alternate location. The advantages and disadvantages of each were systematically assessed based on a number of evaluation criteria, meaningful attributes that provided a basis for distinguishing between the alternate locations and that helped define the preferred location. The criteria included are environmental effects, risks, uncertainty, cost effectiveness and an explicit criterion associated with Indigenous interests. These criteria are listed in Table 1. In this response the evaluation criteria, the factors associated with them (and used to inform the assessment), and the assessment are made more explicit. The rating scale used to indicate whether an alternate location was preferred, acceptable or unacceptable is also described in Table 1. The application of the criteria and the indicators/factors is documented in a tabular format (Table 2) to allow a direct comparison of the advantages and disadvantages of the three identified technically and economically feasible alternate locations. Summary narratives are also provided for each criterion to illustrate how each alternate location obtained its rating. All criteria and all factors for each criterion were weighted equally, so that each criterion was considered equally and directly in the determination of the preferred location. The alternate location with the greatest number of preferred

IR #	IR Title	Information Request and Response
		ratings is the most preferred. If more than one alternate location has an equivalent number of acceptable ratings, then other factors can influence the final determination (such as social licence). Most important is that the final evaluation of alternate locations is a reasoned process, in which the basis for the final section is clear and transparent. OPG used the methodology described in the Agency's Operational Policy Statement titled "*Addressing 'Purpose of' and 'Alternative Means' under the Canadian Environmental Assessment Act, 2012* [CEAA 2015]. OPG has identified its preferred location based on the relative consideration of environmental effects, risk, uncertainty, cost effectiveness and Indigenous interests.

Table 1: Comparative Evaluation Criteria and Ratings

Criterion	Description	Overall Ratings
Environmental Effects – Residual Adverse Effects after Mitigation	Refers to the overall expected number and magnitude of residual adverse environmental effects resulting from the project's works and activities, following mitigation.	• Preferred: Minimal number of residual adverse effects and/or greatest number of positive effects; • Acceptable: Avoids or minimizes adverse effects to the environment, with mitigation; • Unacceptable: Likely to cause significant adverse effects that cannot reasonably be mitigated.
Risks (to Worker and Public Health)	This criterion addresses the overall expected level of worker and public risk from both a conventional and radiological perspective.	• Preferred: Provides the least worker and public health risk, through all phases of the project; • Acceptable: Provides worker and public health risk that can be reasonably mitigated, through all phases of the project with mitigation. • Unacceptable: Provides an unacceptable level of worker and public health risk that cannot be reasonably mitigated.
Uncertainty: Project Requirements or Social Licence	Refers to the expected ability to bring the project on time with a high degree of certainty and willing hosts	• Preferred: Can meet project in-service date with willing hosts and high degree of certainty; • Acceptable: In-service dates are delayed, high degree of uncertainty to schedule; some uncertainty associated with social licence; • Unacceptable: In-service dates are unpredictable; social licence unachievable.

IR #	IR Title	Information Request and Response

Indigenous Interests	Refers to the expected effects of any change that may be caused to the environment on: • health; • socio-economic conditions, • current use of lands and resources for traditional purposes; or • physical and cultural heritage, including any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.	• Preferred: Provides the least change that is expected to be caused; • Acceptable: Provides change that is expected to be able to be accommodated; • Unacceptable: Provides change that is not expected to be able to be accommodated.
Cost Effectiveness	Refers to the expected ability to achieve safety and environmental objectives with the lowest overall Project cost (including definition phase, execution/construction, operations and maintenance, closure and post-closure costs).	• Preferred: Environmental and safety objectives are met with the lowest overall project cost; • Acceptable: Environmental and safety objectives are met with additional costs which are not significant or material; • Unacceptable: Environmental and safety objectives can only be met with material change in costs.

Table 2: Comparative Assessment of Technically and Economically Feasible Alternatives

Comparative Evaluation Criteria	Indicators/Factors	Bruce Nuclear Site	Sedimentary Alternate Location	Crystalline Alternate Location
Environmental Effects – Residual Adverse Effects after Mitigation (Further detail can be found in response to	Atmospheric Environment – Air Quality Criteria Air Contaminants	Fewest effects	Greater effects	Greater effects
	Atmospheric Environment – Air Quality Greenhouse Gases	Fewest effects	Greater effects	Greater effects
	Atmospheric Environment – Noise	Fewest effects	Greater effects	Greater effects

IR #	IR Title	Information Request and Response				
		Information Request 1.2, Table 6-1 [Enclosure 2])	Surface Water Environment – Water Quality	Similar effects	Similar effects	Similar effects
			Surface Water Environment – Water Quantity and Flow	Similar effects	Similar effects	Greater effects
			Aquatic Environment - Habitat	Similar effects	Similar effects	Greater effects
			Aquatic Environment - Biota	Similar effects	Similar effects	Similar effects
			Terrestrial Environment - Vegetation Communities	Fewest effects	Greater effects	Greater effects
			Terrestrial Environment - Wildlife Habitat and Biota	Fewest effects	Greater effects	Greater effects
			Geology and Hydrogeology – Soil Quality	Similar effects	Similar effects	Similar effects
			Geology and Hydrogeology – Groundwater Quality	Similar effects	Similar effects	Similar effects
			Geology and Hydrogeology – Groundwater Flow	Similar effects	Similar effects	Similar effects
			Radiation and Radioactivity – Humans	Fewest effects	Greater effects	Greater effects
			Radiation and Radioactivity – Non Human Biota	Similar effects	Similar effects	Similar effects
			Land and Resource Use (non-traditional)	Fewest effects	Greater effects	Greater effects
		Overall Rating	All can be achieved without significant adverse environmental effects. Preferred has fewer overall residual adverse effects after mitigation.	**Preferred**	Acceptable	Acceptable
		Risks to Worker and Public Health	Risk through all project phases	Same	Same	Same

IR #	IR Title	Information Request and Response				
			Transportation Risk/Conventional Accidents	0	3.15 – 9.72 over project life	6.86 – 68.64 over project life
			Transportation Risk/Radiological (annual collective dose to workers & public)	0	7 person-rems per year (@ 100 km)	144 person-rems per year (@ 2,000 km)
		Overall Rating	Preferred minimizes conventional and radiological risks to workers and members of the public.	**Preferred**	Acceptable*	Acceptable*
		Uncertainty: Project Requirements and/or Social Licence	Scheduling/In-Service Date	2026	2045	2055
			Social Licence: Willing and supportive host community	Existing /Demonstrated	Acceptable	Acceptable
			Social Licence: Process of seeking support of Indigenous peoples	In progress	Acceptable**	Acceptable**
		Overall Rating	Preferred has the highest degree of certainty to meet project in-service, with a willing host community, and process for First Nations support	**Preferred**	Acceptable	Acceptable
		Indigenous Interests (Further detail can be found in response to Information Request 1.13)	Health	Fewest effects	Greater effects	Greater effects
			Socio-economic conditions	Similar effects	Similar effects	Similar effects
			Current use of lands and resources for traditional purposes	Fewest to similar effects	Similar to greater effects	Similar to greater effects
			Physical and Cultural Heritage Resources, including structures, sites or things that are of historical, archaeological, paleontological or architectural significance	Greater effects	Fewest effects	Fewest effects

IR #	IR Title	Information Request and Response

Overall Rating	Preferred has lowest potential to adversely affect Indigenous interests	Acceptable**	Acceptable**	Acceptable**
Cost Effectiveness	Baseline Project Cost	$2.4B	$2.4B	$2.4B
	Incremental Transportation Costs	$0	+ $381M – $493M	+$452M - $1,424M
	Incremental Project Costs	$0	+ $832M	+ $2,056M
Overall Rating	Preferred achieves project outcome with minimal cost.	**Preferred**	Unacceptable	Unacceptable

Notes:

- Acceptable*: OPG assumes that site-specific analysis and identification of further worker controls and measures could be completed such that increased risk to workers and public health are reduced to such a level that they would be acceptable.
- Acceptable**: For clarity and to avoid any confusion, OPG acknowledges that the affected Indigenous peoples have not accepted a DGR, but rather OPG anticipates that through a respectful joint process and through accommodation an acceptable outcome may be achieved.

References:

CEAA. 2015. *Operational Policy Statement Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012.*

OPG. 2016. *Study of Alternate Locations Main Submission*. Ontario Power Generation Report 00216-REP-07701-00013-R000. (CEAA Registry Doc# 2883)

IR #	IR Title	Information Request and Response
IR-1.4	Technical Feasibility Criteria	***Information Request:*** *Provide a discussion to clarify whether the alternate locations could be refined based on seismicity and gas pressure. OPG should consider adapting the range of environmental conditions for VCs based on these additional criteria.* ***Rationale:*** *OPG identified the following technical feasibility criteria in its “Description of Alternative Locations” report (page 3):* • *The host rock is geologically stable and resistant to expected geological and climate change processes,* o *Threshold: The rock has been stable for times that are long compared to the main hazard in the low and intermediate level waste, and has been resilient to past glacial and seismic events (older than 1 million years); and,*

IR #	IR Title	Information Request and Response
		• *The depth and volume of competent rock is sufficient to host and enclose a DGR,* o *Threshold: Minimum depth of 200 m and a minimum bedrock thickness of 300 m.* *With respect to geological stability, OPG defined its threshold as “older than 1 million years”. However, focusing the threshold on seismicity rather than age may allow OPG to refine the area included within the alternate locations to those of low seismic hazard.* *With respect to minimum depth, subject matter experts suggested that gas pressure would be a feasibility constraint for the DGR. The anticipated maximum gas pressure generated in the DGR must be lower than the overburden pressure to prevent host rock damage, which could lead to enhanced gas migration. It is unclear whether the selection of a depth of 200m accounts for the anticipated maximum gas pressure generated in the DGR.*
		OPG Response: OPG’s technical feasibility criteria are that the host rock is geologically stable and resistant to expected geological and climate change processes; and the depth and thickness of competent rock must be sufficient to host and enclose the DGR (Section 2.1, Description of Alternate Locations [OPG 2016]). Threshold values were defined for these criteria, and used to determine alternate locations. As noted in the report [OPG 2016], these were threshold or minimum criteria. Additional criteria would be developed and applied during a siting process, such as outlined for example in IAEA SSG-14 (Appendix I) [IAEA 2011]. Seismicity OPG is asked to consider an additional criterion related to seismicity. OPG agrees that assessing seismicity is part of a siting process. Seismicity is, in part, presently addressed through the feasibility criteria that the host rock is geologically stable. Siting of a DGR would be based on a site-specific seismic hazard assessment, which would consider lower probability, higher magnitude events. This would be a detailed assessment. See for example, the OPG DGR Seismic Hazard Assessment [AMEC GEOMATRIX 2011], which defined seismic events that could occur at the Bruce Nuclear site up to an annual exceedance frequency of 1 in 1 million years. For the purposes of this alternate locations assessment, OPG considered seismicity using the 2015 Seismic Hazard Map [NRCAN 2015], inserted as Figure 1. This map indicates the relative seismic hazard across Ontario; it is based on the National Building Code of Canada seismic hazard map for spectral acceleration at a 0.2 second period, and shows the ground motion that might damage single family dwellings. A DGR would be able to withstand stronger shaking.

IR #	IR Title	Information Request and Response
		OPG refined the alternate locations based on seismicity by limiting the crystalline alternate location and the sedimentary alternate location to the low to medium-low seismicity areas shown in Figure 1. This results in the areas around Niagara Falls in the sedimentary alternate location, and along the Ottawa river in the crystalline alternate location being excluded. Figure 2 shows the revised crystalline alternate location. Figure 3 shows the revised sedimentary alternate location. Also, the revised GPS coordinates, indicating the new boundaries of these alternate locations, are shown on these figures and listed in Table 1 and Table 2. The GPS coordinates are not themselves meant to pinpoint likely or potential sites for a DGR but, rather, are points on the perimeter of the alternate location that was studied to determine environmental effects, and within which a multi-year siting process would occur. The application of this additional seismicity criterion has resulted in a reduction of the area of the crystalline and sedimentary alternate locations. However the revised area changes are modest and do not significantly change the range of environmental conditions for the VCs considered and described in the Environmental Effects of Alternate Locations report [GOLDER 2016], or the conclusions with respect to them.

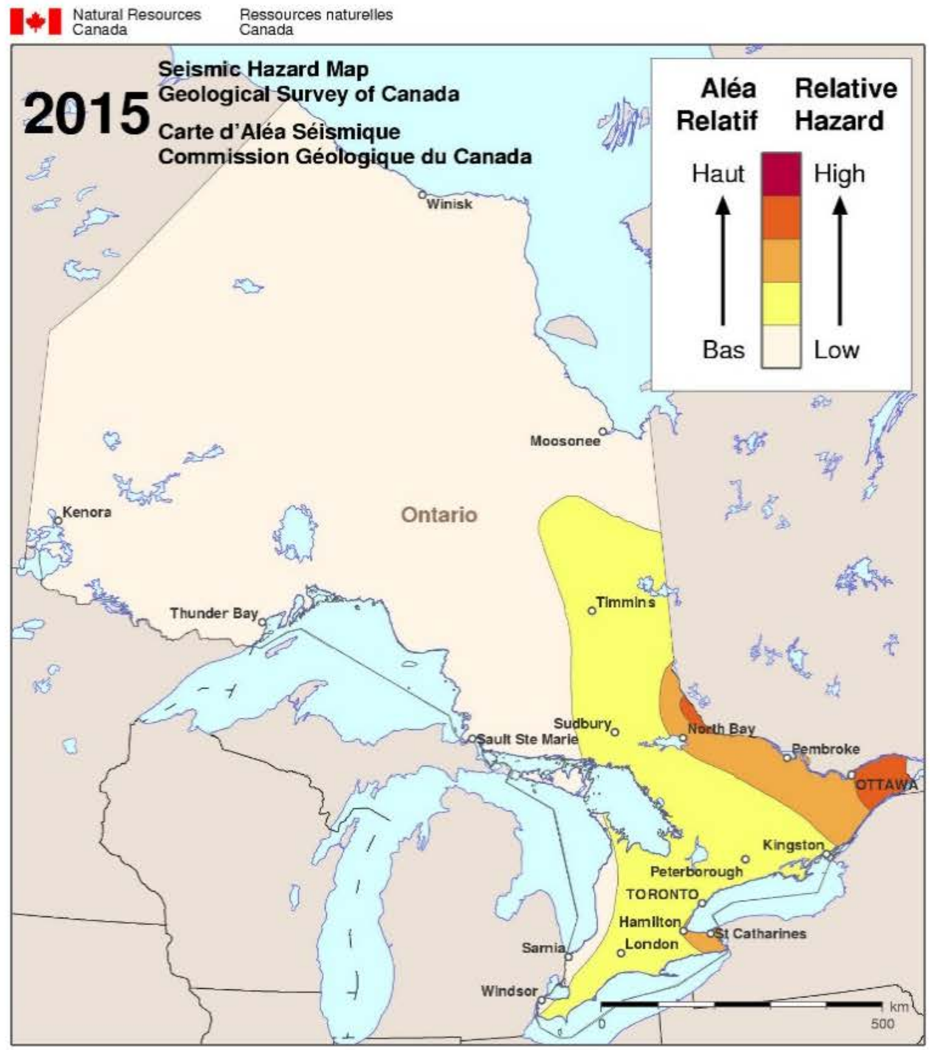
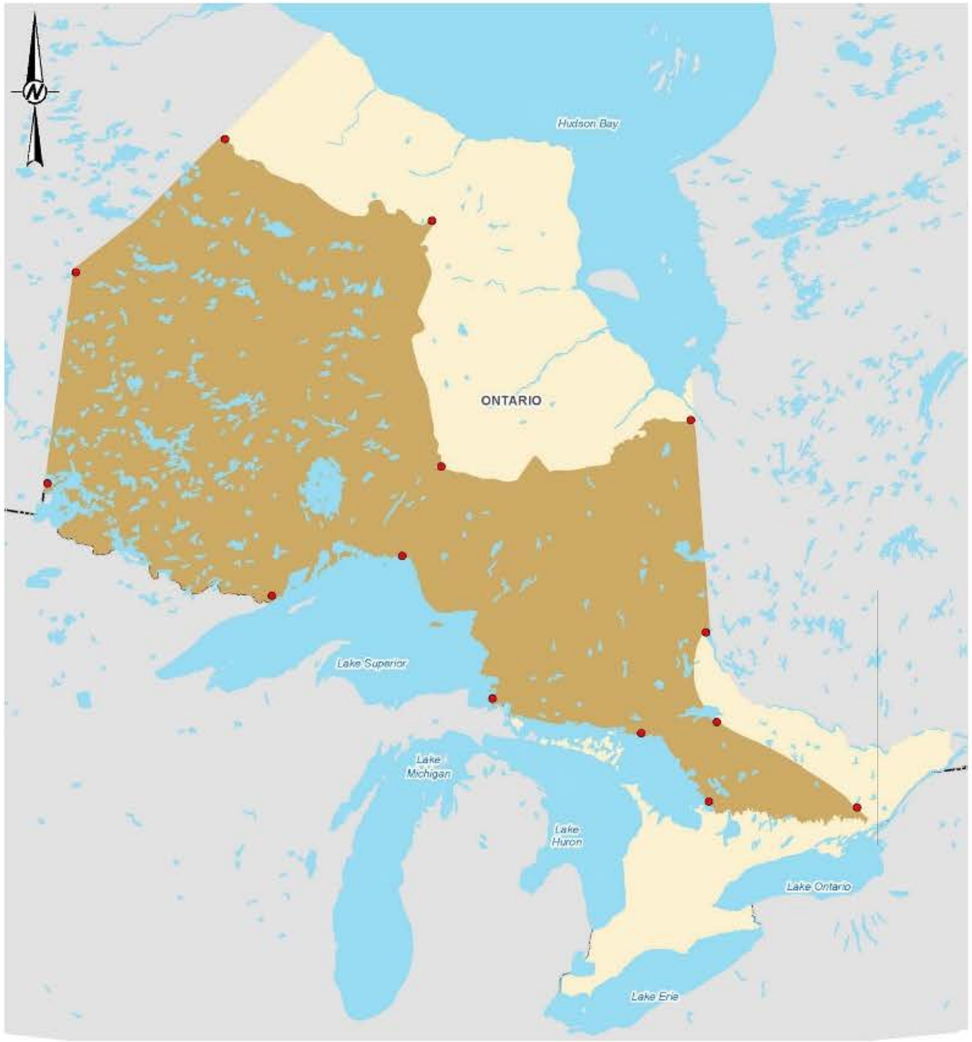
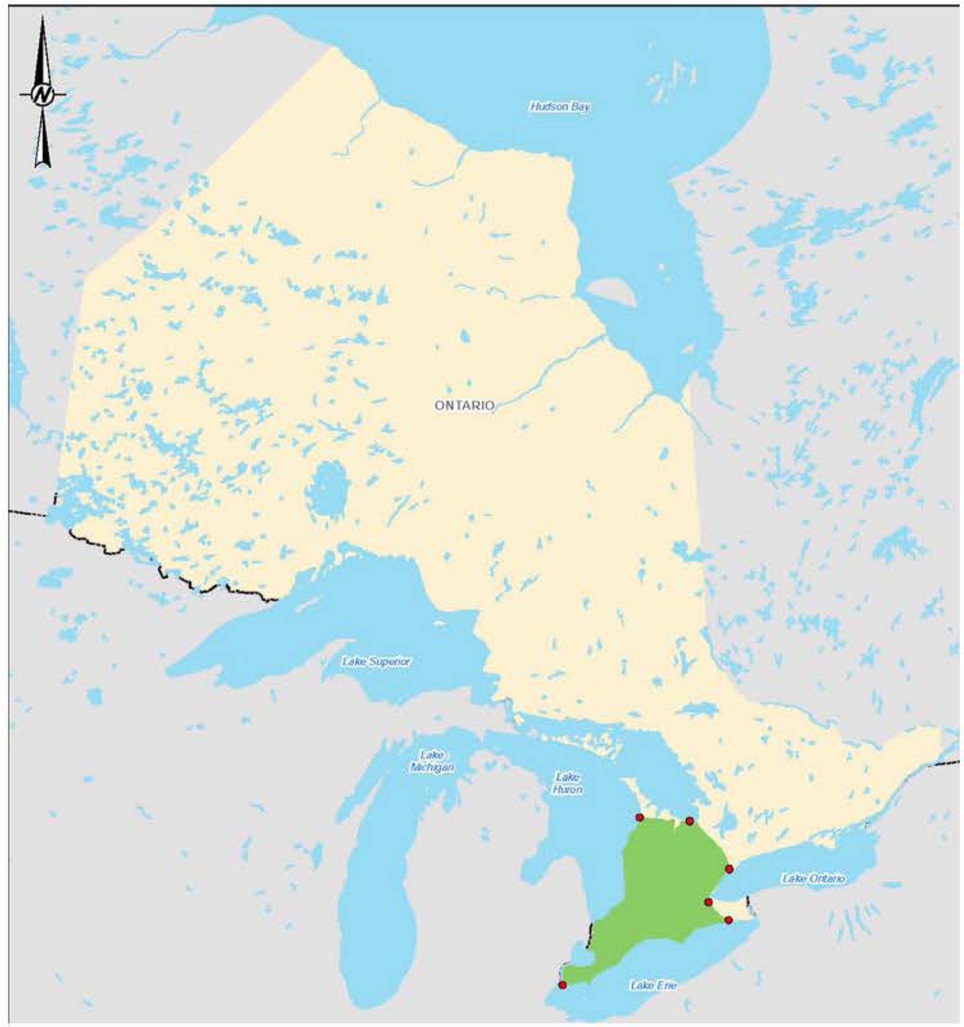
IR #	IR Title	Information Request and Response
		 Figure 1. 2015 Seismic Hazard Map of Ontario - Relative Hazard. [NRCAN 2015]

Figure 1. 2015 Seismic Hazard Map of Ontario - Relative Hazard. [NRCAN 2015]

IR #	IR Title	Information Request and Response
		 **Figure 2. Revised crystalline alternate location including GPS coordinates.**

IR #	IR Title	Information Request and Response
		**Figure 3. Revised sedimentary alternate location including GPS coordinates.**

IR #	IR Title	Information Request and Response
		Table 1. GPS Co-ordinates for revised crystalline alternate location shown in Figure 2

Latitude	Longitude
47.5	-79.6
46.1	-79.5
44.6	-76.6
44.9	-79.8
46.0	-81.2
46.6	-84.5
48.8	-86.6
48.1	-89.6
49.5	-95.1
52.8	-95.1
55.1	-91.6
53.5	-87.4
50.4	-85.4
50.8	-79.6

Note: The GPS coordinates are not themselves meant to pinpoint likely or potential sites for a DGR but, rather, are points on the perimeter of the alternate location that was studied to determine environmental effects, and within which a multi-year siting process would occur.

Table 2. GPS Co-ordinates for revised sedimentary alternate location shown in Figure 3

Latitude	Longitude
43.2	-79.9
42.9	-79.5
42.0	-83.1
44.6	-81.3
44.5	-80.2
43.7	-79.4

Note: The GPS coordinates are not themselves meant to pinpoint likely or potential sites for a DGR but, rather, are points on the perimeter of the alternate location that was studied to determine environmental effects, and within which a multi-year siting process would occur.

IR #	IR Title	Information Request and Response
		Gas Pressure OPG is also asked to consider a potential criterion related to gas pressure. The context is whether 200-m depth is sufficient to withstand the gas pressure generated in the DGR due to corrosion and decomposition of the waste packages. In response, OPG notes the following: • 200-m depth is a threshold or minimum value. It is not a preferred value. Shallower depths would not be considered; deeper depths would be considered. • Minimum depth is necessary but not sufficient for siting. Additional criteria would also be considered as part of a siting process. Evaluating these additional criteria would, in part, depend on having additional site-specific information that would be obtained through the siting process. • Gas pressure would be considered as part of a siting process. However, the maximum gas pressure in the repository is, in part, a function of the repository design, notably the amount of gas generating material in the waste packages and the repository volume available for the gas. For a repository at a significantly shallower depth than the proposed DGR at the Bruce Nuclear site, the repository design would have to be optimized differently with respect to gas to assure that engineered and natural barrier function is not materially altered. This could potentially include additional surface processing of certain waste forms such as resins in order to stabilize the C-14 present in these wastes, such that the gas pressure would be lower than considered in the Bruce Nuclear site design. Environmental Conditions In summary, seismicity and gas pressure have been considered in identifying the alternate locations. The alternate locations were revised based on a qualitative seismicity criterion, but not based on gas pressure. A quantitative seismic hazard analysis would be conducted as part of a siting process, as was undertaken in the assessment of the proposed DGR at the Bruce Nuclear site [AMEC GEOMATRIX 2011]. Also, the gas pressure, and other criteria, would be evaluated as part of the detailed site characterization, design and safety assessment that would be conducted as part of the siting process. The application of this additional seismicity criterion has resulted in a reduction of the area of the crystalline and sedimentary alternate locations. However the revised area changes are modest and do not significantly change the range of environmental conditions for the VCs considered and described in the Environmental Effects of Alternate Locations report [GOLDER 2016], or the conclusions with respect to them.

IR #	IR Title	Information Request and Response
		References: AMEC GEOMATRIX. 2011. *Seismic Hazard Assessment.* Prepared by AMEC Geomatrix Inc. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-20 R000. GOLDER. 2016. *Environmental Effects of Alternate Locations*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883) IAEA. 2011. SSG-14. *Geological Disposal Facilities for Radioactive Waste.* International Atomic Energy Agency, Specific Safety Guide. NRCAN. 2015. *Simplified seismic hazard map for Canada, the provinces and territories*. Natural Resources of Canada; Geologic Survey of Canada. (http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/simphaz-en.php) (website accessed 8 May 2017) OPG. 2016. *Description of Alternate Locations*. Ontario Power Generation Report 00216-REP-07701-00014-R000. (CEAA Registry Doc# 2883)
IR-1.5	Air Quality	***Information Request:*** *Provide a discussion to supplement the analysis for the potential environmental effects on air quality at the alternate locations and the applicable mitigation measures, addressing:* • *Emissions of acrolein;* • *Incremental GHGs emissions from the use of fossil fuels for power generation;* • *Incremental air emissions related to the requirement to excavate a higher volume of rock at the crystalline location; and* • *Identify assumptions, including applicable calculations, data or references.* *Consider IR 1.0 and IR 2.0 in framing your response.* ***Rationale:*** *Table 3-1 of OPG's "Environmental Effects of Alternative Locations" report (page 7) outlines the incremental works and activities for the Project at alternative locations which may cause temporary increases in emissions of combustion products, dust, and other compounds such as volatile organic compounds and acrolein. As a baseline, the report provides the predicted peak increases in ambient air quality indicators for activities at the Bruce site (NO_2, SO_2, CO, SPM, PM_{10}, $PM_{2.5}$). However, the report does not discuss whether incremental activities will result in increases in magnitude, frequency, and duration of potential effects on air quality using these indicators. The Agency notes that while acrolein is used in the EIS (section 7.11) as an indicator for air quality and human health, it is not presented as an air quality indicator in the environmental effects assessment of alternate locations.* *In addition, Table 3-1 of OPG's "Environmental Effects of Alternative Locations" report states that site preparation*

IR #	IR Title	Information Request and Response
		activities will include works related to the supply of power to the site. Accordingly, it is expected that all activities would need to make use of temporary power generation until the time that the site is connected to the power grid. However, the Report does not discuss the need for the use of fossil fuels for incremental works and activities at alternate locations, or the potential for environmental effects from additional emissions, including GHGs. *The "Environmental Effects of Alternative Locations" report also identifies the difference in rock density at the crystalline location versus the sedimentary location due to the granite formations of the Canadian Shield. The Report predicts that an increased volume of rock will need to be excavated in the crystalline location to account for additional engineered barriers that will be required due to vault design versus the sedimentary location. These factors are expected to require additional effort during site preparation, excavation and construction activities. However, the report does not indicate how these factors were taken into account in the assessment of the potential environmental effects on air quality.*
		OPG Response: Potential air quality effects were qualitatively assessed for the two alternate locations and compared to the assessment for a DGR at the Bruce Nuclear site in the Environmental Impact Statement (EIS) [OPG 2011]. For either alternate location, it has been assumed that waste packages would be brought to the site by truck, increasing the on-road transportation (up to two additional transport truck trips per day on affected roadways). This would result in increased emissions of acrolein, criteria air contaminants (CACs), and greenhouse gases (GHGs) for site preparation and construction, operations, and decommissioning, which are summarized below. <u>Background – Air Quality</u> It has been assumed that the local sources for air emission in the vicinity of either alternate location will be typical of rural areas in Ontario. The existing air quality conditions for the DGR Project at the Bruce Nuclear site, or background concentrations, described in the EIS also apply to the alternate locations, as either the crystalline alternate location or the sedimentary alternate location would be rural locations away from urbanized settings. The existing conditions were characterized as "good air quality" and typical of non-urbanized conditions in Ontario [GOLDER 2016]. Therefore, given the range of background conditions at the alternate locations, the background air quality would be expected to be similar to or better than that at the Bruce Nuclear site. <u>Emissions of Acrolein</u> Acrolein is a byproduct of both stationary and mobile combustion and therefore may be emitted from all phases of the Project. As transportation is a notable source of acrolein emissions, this substance is ubiquitous in urban areas and along highway corridors. During <u>site preparation and construction</u>, the operation of vehicles, equipment and material handling as part of all works and activities would cause temporary increases in emissions of combustion products, including acrolein, into the atmosphere, which could affect air quality. The magnitude of the acrolein emissions during construction of the DGR

IR #	IR Title	Information Request and Response
		facility would not vary significantly between the two alternate locations. However a crystalline alternate location could require the construction of up to 20 km of new access road, and up to 50 km of new power corridor [GOLDER 2016], and a sedimentary alternate location may require up to 5 km of similar supporting infrastructure [OPG 2016]. These construction activities would result in additional emissions of acrolein due to additional mobile and stationary combustion equipment; however, they would be less than the bounding emissions already assessed for site preparation in the EIS, which considered a worst case 24 hour emission rate scenario. Effects during construction would be temporary, and would cease upon the completion of the site preparation and construction activities. Similarly, increases in ambient concentrations of acrolein during decommissioning and closure activities are expected to be similar or lower than those identified for site preparation and construction, for either the Bruce Nuclear site or the two alternate locations, and these increases would also be temporary, lasting only through the decommissioning and closure activities (including dismantling surface facilities and sealing the shaft, expected to take five to six years [GOLDER 2011]). During operations, the additional handling and transportation of waste from the Western Waste Management Facility (WWMF) to the DGR at either alternate location, would increase the emissions of acrolein. Transportation between the WWMF and either alternate location would have the potential to increase emissions of combustion by-products, including acrolein, from the transport vehicles along existing roads. Transportation would be largely along existing roads, and the frequency of shipments is relatively small (two shipments per day [ENERGY SOLUTIONS 2016]); therefore localized effects of transport-related emissions on local acrolein concentrations are not likely to be measurably different from existing traffic emissions. Acrolein is emitted from heavy duty transport vehicles at levels roughly 5 ten-millionths (5×10^{-7}) of the emissions of CO_2 in grams per second [U.S. EPA 2003]. Using this approximation, and based on the GHG emissions provided in Table 4.1-4 of the Environmental Effects of Alternate Locations report [GOLDER 2016] (representing the sedimentary alternate location) and Table 5.1-1 (representing the crystalline alternate location), the total 30-year emissions of acrolein along the transportation route would range linearly with distance up to 0.9 kg over 30 years for the 300 km distance to the sedimentary alternate location, and up to 5.8 kg over 30 years for the 2,000 km distance to a crystalline alternate location. For comparison, the estimated annual acrolein emissions from transportation only in the Toronto and Hamilton Census Metropolitan Areas were 19.26 tonnes (i.e., 19,260 kg) [McMaster Institute for Transportation and Logistics 2014]. Therefore, the emissions of acrolein are anticipated to increase from the handling and transportation of waste from the WWMF to either the sedimentary alternate location, or the crystalline alternate location, compared to the emissions associated with the handling and transportation of waste from the WWMF to the Bruce Nuclear site. This increase is not material compared to existing transportation emissions in Ontario. Furthermore, acrolein breaks down rapidly into harmless constituents in the environment [Agency for Toxic Substances and Diseases Registry 2007], in the presence of sunlight, water, ozone, or certain other chemical species, and would not be anticipated to persist for more than a period of days, so the additional emissions are unlikely to have a measurable effect on air quality along the transportation route.

IR #	IR Title	Information Request and Response
		Incremental GHG Emissions from the Use of Fossil Fuels for Power Generation Consistent with the EIS for the DGR at the Bruce Nuclear site, for the purposes of this study it was assumed that electrical power would be supplied to the DGR’s electrical switchgear and repository-level substation by a 13.8 kV transmission line from the closest existing Hydro One substation. It was further assumed that up to 5 km or 50 km of transmission line would need to be constructed at the sedimentary or crystalline alternate locations, respectively. If grid power was not available at the start of the construction phase, then temporary on-site power generation may be required. In this case there may be an incremental increase in site emissions due to activities related to power line construction and use of the on-site power generation until the power line is complete. The temporary power requirements are not known. The capacity of the emergency power system during the operations phase was used as a conservative minimum power supply required during site preparation and construction phase. During the operations phase, the total connected load for surface and underground facilities at a DGR site is estimated to be approximately 16,360 kVA. An emergency power system using diesel generators is planned to be installed to power emergency lighting and safety equipment in the event of a grid power failure. The emergency load required is a small portion of the total projected load for the site. An emergency generation capacity of approximately 1,750 kW would be required to serve the site loads that are essential for personnel safety. Should temporary power need during the site preparation and construction phase be higher, GHG emissions would proportionally increase. For the purposes of this alternate locations assessment and assuming GHG emission rates for the diesel engine used in temporary power generation is similar to those for heavy-duty diesel vehicles [OPG 2016] the following emission factors were used:

GHG Species	Emission Factor (kg/L)	Global Warming Potential (GWP)
Carbon Dioxide (CO_2)	2.69	1
Methane (CH_4)	0.00015	25
Nitrous Oxide (N_2O)	0.000075	298

The total GHG emissions in carbon dioxide equivalents (CO_2e) for a stationary diesel generator would therefore be:

$$CO_2e\left(\frac{kg}{L}\right) = (2.69 + 0.00015 \times 25 + 0.000075 \times 298)\left(\frac{kg}{L}\right)$$

or 2.7161 kg/L.

IR #	IR Title	Information Request and Response
		Making the assumption of a 2,000 kW temporary power generator which would meet the power requirements during site operations , running for 12 hours per day for one month during the construction phase (estimated fuel use of 537.1 L/h at full load), it is estimated that 0.53 kt/month of carbon dioxide equivalents would be emitted. A comparison of this value to the direct GHG emissions during construction or operation of the DGR Project (estimated to be 91.06 kt/yr and 2.05 kt/yr respectively [Table 10.4.2-1, GOLDER 2011]) indicates that temporary on-site power generation would result in small increases of GHG emissions over those calculated for a DGR at the Bruce Nuclear site. To summarize, if grid power is not available at the start of the construction phase there would be additional incremental emissions of GHGs. The total emissions of GHGs from temporary diesel generation during site preparation and construction is small in comparison to the GHG emission from the other equipment and the timing of these activities would be prior to the main construction activities that were assessed to develop the annual GHG emissions. If the site preparation and construction phase is extended as a result of the construction of the power line, the duration of air quality effects would be extended and total GHG emissions during this phase would incrementally increase. <u>Incremental Air Emissions Related to the Requirement to Excavate the Alternate Locations</u> The site preparation and construction phase will result in emission of GHG and CAC emissions from the construction equipment. Relative to the DGR at the Bruce Nuclear site, in addition to GHG emissions from transportation of waste (assessed in GOLDER [2016]), there would be incremental increases in GHG and CAC emissions at the alternate locations due to the need for construction of additional site infrastructure and differences in waste rock volumes and densities. These are discussed below. Site preparation will include construction of access roads, removal of trees and shrubs, and grading. These activities are likely to increase total GHG and CAC emissions at an alternate site compared to construction at the Bruce Nuclear site. GHG emissions are likely to be higher at a crystalline alternate location than at the sedimentary alternate location given distance from existing infrastructure and degree of forestation. The crystalline alternate location may also require an increased volume of rock to be excavated if: i) waste processing and grouting leads to a larger volume of as-packaged wastes; ii) additional spacing is needed to avoid major fractures; or iii) additional concrete structure is needed as support for the rooms or waste packages due to the stress conditions in the host rock. Excavating this additional volume of rock is expected to result in a proportional increase in total blasting or mobile equipment GHG and CAC emissions during the construction phase at this location, and would incrementally increase the duration of effects on air quality during the site preparation and construction phase. Blasting will result in GHG and CAC emissions during the construction phase. As noted in the Information Request rationale, there is expected to be a difference (i.e., higher by 5 to 10%) in the density of the rock formations between the crystalline alternate location, and that occurring beneath the Bruce Nuclear site and the sedimentary alternate location. This may result in a similar increase in blasting and mobile equipment GHG and CAC emissions during the construction phase. Similarly, both alternate locations will require the construction of additional site infrastructure and access roads beyond that at the Bruce Nuclear site, extending the duration of construction activities. This is expected

IR #	IR Title	Information Request and Response
		to also result in larger total construction phase GHG and CAC emissions than estimated for the DGR at the Bruce Nuclear site. <u>Mitigation</u> Mitigation measures to reduce effects on CACs, including acrolein, and GHGs, would be inherent in the project design at either alternate location. Mitigation measures for air emissions would include the following: • Site preparation and construction - watering of unpaved roadways, unpaved construction laydown areas, and unpaved construction work areas; maintenance of on-site vehicles and equipment. • Construction - routine regular maintenance of on-site vehicles and equipment. <u>Overall Conclusions</u> Overall, the total emissions of acrolein anticipated from the handling and transportation of waste from the WWMF to either the sedimentary alternate location or the crystalline alternate location, would be greater than emissions of acrolein generated through the handling and transfer of waste from the WWMF to the DGR at the Bruce Nuclear site However, such incremental increases, assuming two trips per day, would be negligible compared to total emissions from transportation in Southern Ontario or along an assumed waste transportation route. It is anticipated that the construction of a DGR at either alternate location would result in greater GHG and CAC emissions at the site during the site preparation and construction phase, than if construction were to occur at the Bruce Nuclear site, due to the potential need for temporary site power (through the use of diesel combustion equipment), possibly larger volumes and/or masses of rock to be removed, and other activities. Further, due to increased transportation distances, GHG and CAC (including acrolein) emissions would likely be higher for a DGR at either alternate location than those predicted for a DGR at the Bruce Nuclear site. Total air emissions for a DGR at the Bruce Nuclear site and the alternate locations are predicted to marginally increase relative to baseline. However, the resultant effects are not likely to be significant as the maximum daily emission rate remains materially unchanged. Proposed mitigation measures are the same for the site preparation, construction and operations phases of the Project, regardless of the location (at the Bruce Nuclear site, or at an alternate location) and will be implemented to mitigate fugitive dust emissions (primarily due to site preparation and construction activities) and dust and CAC emissions (due to mobile equipment combustion during site preparation, construction, and operations phases). See also response to Information Request 1.2 for a summary of the likely effects and on determination of significance for air quality at the Bruce Nuclear site and the alternate locations.

IR #	IR Title	Information Request and Response
		References: Agency for Toxic Substances and Diseases Registry. 2007. *Public Health Statement Acrolein*. ENERGY SOLUTIONS. 2016. *Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations*. Prepared by Energy Solutions Canada Ltd. Ontario Power Generation Report 00216-REP-03450-00001-R000. (CEAA Registry Doc# 2883) GOLDER. 2011. *Atmospheric Environment Technical Support Document*. Prepared by Golder Associates Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-02 R44000. (CEAA Registry Doc# 299) GOLDER. 2016. *Environmental Effects of Alternate Locations*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883) McMaster Institute for Transportation and Logistics. 2014. *Estimating Vehicular Emissions for the Toronto and Hamilton Census Metropolitan Areas – A Report Prepared for Environment Canada*. OPG. 2011. *Environmental Impact Statement, Volume 1: Main Report*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298) OPG. 2016. *Description of Alternate Locations*. Ontario Power Generation Report 00216-REP-07701-00014-R000. (CEAA Registry Doc# 2883) U.S. EPA. 2003. *User's Guide to Mobile 6.1 and Mobile 6.2 Mobile Source Emission Factor Model. EPA420-R-03-010.*
IR-1.6	Surface Water	***Information Request:*** • *Provide a comparative analysis for the risk of acid generation and metal leaching in the sedimentary and crystalline geologic locations.* • *Given the variability of environmental conditions in both alternative locations, discuss whether there is a potential for environmental effects from acid generation or metal leaching of waste rock beyond those assessed in the EIS. If yes, identify any additional mitigation measures necessary beyond those identified in the EIS.* ***Rationale:*** *Section 5.2.1 of OPG's "Environmental Effects of Alternative Locations" report states that it is assumed that waste rock in the crystalline alternative location would not be acid generating. However, the Ontario Ministry of Natural Resources and Forestry ecozone and ecoclassification system (Crins et al. (2009)) indicates that, of the 9 ecoregions identified within the Ontario Shield ecozone, all but one are characterized by a geologic substrate that has low to moderate acid buffering capacity.*

IR #	IR Title	Information Request and Response
		OPG Response: <u>Mechanisms for Acid Rock Drainage (ARD) and Metal Leaching (ML)</u> When metal sulphide minerals are exposed to atmospheric conditions (including air and water), the oxidation of the metal sulphide minerals and dissolution of its constituents into surface water and groundwater can occur. The oxidation of pyrite (a common sulphide mineral) and some other sulphide minerals can result in low pH, or acidic water. Acidic water typically enhances dissolution of minerals that can result in elevated concentrations of a variety of chemical constituents, depending on the mineralogy of the rock. Although low-pH conditions can enhance metal release and mobility, some metals can leach from rock and result in elevated concentrations under near-neutral to basic-pH conditions. The acidic water produced through oxidation reactions (which are described above) may be attenuated by minerals that have neutralizing (i.e., buffering) capacity. Carbonate minerals are particularly important neutralizing minerals, and have a high capacity to buffer acidic conditions. Other minerals, such as aluminosilicates, may also contribute to the overall neutralization potential of a rock, but the dissolution of aluminosilicate minerals is typically slower and less effective as compared to carbonate minerals. If the quality or quantity of available neutralizing minerals is insufficient, significant acidity may be released and mobilized as a result of the oxidation of sulphide minerals. The generation of acidic and metal-rich waters as a result of coming into contact with sulphide oxidation products is commonly referred to as “acid-rock drainage”. Potential environmental effects associated with ARD/ML, if untreated, are related primarily to elevated concentrations of metals, sulphate, total dissolved solids, and acidic pH. The nature and extent of the potential environmental effects depends on the concentrations of metals, sulphate, total dissolved solids and pH compared to the receiving environment. <u>Sedimentary Alternate Location</u> Sedimentary rocks in Ontario consist mainly of Ordovician-aged limestones, dolostones, siltstones, conglomerates, sandstones and mudstones in which sulphide minerals are generally not present in significant quantities. Furthermore, many sedimentary rocks have significant quantities of readily available acid neutralizing minerals (e.g., carbonates found in limestone and dolostone). The sedimentary alternate location consists of, among others, dolostone, limestone and other carbonaceous rock. The sedimentary alternate location can be described as having: • typically low quantities of sulphide minerals; and • large quantities of acid neutralizing minerals (e.g., limestone deposits). Typically, ARD potential within limestone is low given the abundance of acid neutralizing minerals. However, it is possible to have some zones of sulphide mineralization; this would be assessed during detailed siting and confirmed

IR #	IR Title	Information Request and Response
		by monitoring of the excavated rock during construction, and either these zones would be avoided or appropriate mitigation measures would be installed. Some metals can be leached from rock under neutral conditions; this leaching would also be addressed. <u>Crystalline Alternate Location</u> Crystalline rocks in Ontario occur predominantly within the Precambrian-aged Canadian Shield, which includes a large variety of metamorphic and igneous rocks. The siting of a DGR in the crystalline alternate location would avoid mineralized deposits associated with sulphide deposits and a higher potential for acid drainage. Crystalline rocks generally do not contain significant amounts of acid neutralizing minerals (e.g., carbonates), although they are typically more elevated in aluminosilicates than sedimentary rocks. This is why the Ontario Shield ecozone is characterized as a region with low to moderate acid buffering capacity, as noted in the context to this Information Request. However, low to moderate acid buffering capacity does not necessarily mean that ARD will occur. The host rock at the crystalline alternate location consists of massive granite, granodiorite, tonalite pluton or large assemblages of gneissic rocks of a similar mineralogy and can be described as: • having the potential to contain elevated quantities of sulphide minerals in localized areas of high mineralization; and • not tending to have significant amounts of readily available acid neutralizing minerals (e.g., carbonates). ARD and metal leaching potential within these types of crystalline rocks is typically low, but there is some potential, and the limited availability of neutralizing minerals in the rock means that there could be limited neutralization capacity for passive ARD mitigation. <u>Characterization and Mitigation</u> Since a site selection process for a DGR in an alternate location would avoid areas with a high potential for mineral resources, it is unlikely that the site would have a high potential for ARD/ML. If through a site characterization process environmental ARD/ML issues are identified, available mitigation options are described below. The detailed design of the waste rock management system would account for the specific characteristics of the waste rock, and would include a geochemical characterization program, in order to understand and mitigate potential ARD/ML issues. Several guidelines (e.g., Price 1997; MEND 2009; INAP 2011) have been developed that are accepted by regulatory bodies for characterization of potential ARD/ML, as well as suggested management, mitigation and treatment options. ARD/ML management and mitigation measures include: • collection, monitoring and treatment of any water collected underground during construction and operation; • storage and management of waste rock on site, including closure and long-term chemical stability; • collection, monitoring and treatment of runoff water from the waste rock; and/or

IR #	IR Title	Information Request and Response
		• use of engineered and/or natural barriers under the waste rock pile and the water storage ponds to prevent seepage of untreated water. While a discussion of mitigation and treatment options for the Bruce Nuclear site has been provided in GOLDER [2012] and in OPG's responses to Information Requests EIS-02-34, EIS-04-159, EIS-04-130 [OPG 2012a, 2012b], they are specific to the Bruce Nuclear site. While similar options could be considered for both alternate locations, there could be site-specific conditions which would require additional, or different, mitigation options compared to the Bruce Nuclear site. Common and well-established treatment technologies that could be considered include: • neutralization; • metals removal; • desalination; and • specific treatment to target parameters of concern (arsenic, molybdenum, radioactive nuclides). <u>Summary of Potential for Environmental Effects from Acid Generation or Metal Leaching</u> In summary, in comparison to the crystalline alternate location, the sedimentary alternate location would typically be considered to have a lower risk for ARD due to the typically lower potential for elevated quantities of sulphide minerals and greater abundance of readily available acid neutralizing minerals (e.g., carbonates). This highlights the importance of proper geochemical characterization. The conclusion in the EIS for the proposed DGR at the Bruce Nuclear site indicates that no residual adverse effects (i.e., environmental effects) are anticipated on the water quality; this took into account geochemical considerations. Similarly, proper siting, characterization and mitigation would be an integral part of any siting assessment in the alternate locations. The process for geochemical characterizations and mitigation measures for typical ARD/ML issues are defined and generally common. Therefore, no adverse environmental effects would be expected on water quality or otherwise in either alternate location. Table 1 provides a summary of the key concepts of this response including the differences between the alternate locations and a comparison to the water quality effects for the Bruce Nuclear site in the EIS [OPG 2011].

IR #	IR Title	Information Request and Response

Table 1. Summary of Typical Characteristics and Potential for ARD/Metal Leaching

Location	Typical Characteristic	Potential for ARD / Metal Leaching
Sedimentary alternate location	• Lower quantities of sulphide minerals • Higher quantities of neutralizing minerals to limit the generation of low-pH water • Metal leaching can still be an issue even with near-neutral pH.	• Lower potential for ARD compared to the crystalline alternate location. • Equal potential for metal leaching compared to the crystalline alternate location. • Site specific mitigation measures would be developed as required such that there would be no anticipated residual adverse effects on water quality or otherwise.
Crystalline alternate location	• Higher quantities of sulphide minerals • Lower quantities of neutralizing minerals meaning higher potential for the generation of low-pH water.	• Higher potential for ARD compared to the sedimentary alternate location. • Equal potential for metal leaching compared to the sedimentary alternate location. • Site specific mitigation measures would be developed as required such that there would be no anticipated residual adverse effects on water quality or otherwise.
Bruce Nuclear site	• Lower quantities of sulphide minerals • Higher quantities of neutralizing minerals to limit the generation of low-pH water. • Limited potential for metal leaching.	• Potential for ARD and metal leaching has been assessed for the site. • Low potential for both ARD and metal leaching. • Site specific mitigation measures have been proposed such that there are no anticipated residual adverse effects on water quality or otherwise.

<table>
<tr><th>IR #</th><th>IR Title</th><th>Information Request and Response</th></tr>
<tr><td></td><td></td><td>References:

GOLDER. 2012. OPG'S Deep Geologic Repository for Low Level and Intermediate Nuclear Waste Work Package 2-12: Water Quality Modelling Results for the Stormwater Management Pond (SWMP). Golder Document No. 1011170042-TM-G2120-0014-01. (CEAA Registry Doc# 936)

INAP. 2011. Global Acid Rock Drainage (GARD) Guide. The International Network for Acid Prevention. (www.gardguide.com)

MEND. 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada.

OPG. 2011. Environmental Impact Statement, Volume 1: Main Report. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298)

OPG. 2012a. Letter, Ontario Power Generation to Joint Review Panel, dated June 1, 2012. (CEAA Registry Doc# 523)

OPG. 2012b. Letter, Ontario Power Generation to Joint Review Panel, dated September 28, 2012. (CEAA Registry Doc# 759)

Price, W.A., 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. Ministry of Energy and Mines.</td></tr>
<tr><td>IR-1.7</td><td>Aquatic Habitat and Biota</td><td>Information Request:
Provide a discussion clarifying whether environmental effects are anticipated from the water management systems on thermally sensitive aquatic species at the alternate locations, characterize the potential adverse environmental effects and describe any applicable mitigation measures.
Clarify whether project works and activities may impact floodplains.
Rationale:

OPG's "Environmental Effects of Alternative Locations" report indicates that there would be waterbodies at each alternative geologic location that would include cool to cold freshwater habitat. Based on the effluent characterization, it is anticipated that effluent discharge from the water management systems will be warmer than the receiving water temperatures. If warmer effluent discharge is released into a cold water habitat, it may be potentially result in adverse effects to the freshwater biota. The Agency notes that the report does not discuss the incremental effects to freshwater species caused by warm water effluent discharges into colder waterbodies.</td></tr>
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IR #	IR Title	Information Request and Response
		OPG Response: Potential Effects on Thermally Sensitive Aquatic Species The magnitude of the potential thermal effects will depend on the difference between the water temperature in the stormwater management pond (SWMP) and the receiving water at the time of discharge. During operation, it is expected that the water held in the SWMP would only have an increased temperature during dry periods when the discharge rate is relatively low (e.g., the only inflow water is treated effluent from underground). The magnitude of the temperature difference will depend on several factors such as inflow temperature, location (e.g., shading), meteorological conditions (e.g., solar radiation, wind, air temperature), and pond design (e.g., surface area to depth ratio). The water temperature of the receiving water is also dependent on location as well as the type of water body (e.g., a slow moving river or small lake is expected to be warmer than a fast moving stream). During dry periods, the discharge can be easily managed to limit the flow rate and minimize the thermal effects on the receiving water. The thermal effects of the low-flow discharge could potentially be mitigated by designing the outfall with enhanced mixing to minimize the extent and magnitude of the thermal plume. During rainfall events when the flow through the SWMP is higher, any warmer water that may have accumulated in the SWMP would be quickly diluted and quenched with runoff from the site which is expected to be cooler. However, during these precipitation events, the discharge from the SWMP would likely exceed the capacity of an outfall designed to mitigate the thermal effects during low-flow conditions. Under high-flow conditions, the discharge could be directed to the receiving water via an alternate route that is designed to convey higher flows (e.g., spillway). Mitigation of thermal effects would not be required during these events, as no, or negligible, thermal effects are anticipated at these times. Because it is likely that there is more potential for the Project to be sited near a coldwater watercourse at the crystalline alternate location, the possible thermal effects of a SWMP discharge may be greater at this alternate location. The siting of a SWMP and associated discharge location at the alternate locations would include consideration of background fisheries information (fish and/or fish habitat) in order to identify any potential for the immediate receiving watercourse/drainage feature to support thermally sensitive species and habitat (e.g., areas of groundwater upwelling that may support brook trout spawning habitat). Where possible, sensitive habitats or habitats directly used by sensitive species would be avoided; this would be the primary mitigation. If direct avoidance is not possible, site specific mitigation, examples of which are discussed below, would be identified and implemented to reduce effects. Thermal modelling may be applied to identify the extent of the thermal impact at periods of the year and identify the extent and magnitude, if applicable, of the thermal plume resulting from discharge. Modelling would also increase confidence in the identification and implementation of appropriate site-specific mitigation. This may include engineered measures to draw discharge waters from cooler waters under the surface of the pond rather than warmer surface layers. Additionally, the design could include measures to control the discharge so that relatively small amounts of

IR #	IR Title	Information Request and Response
		water get released at any one time and/or at certain times of year depending on the sensitivity of the receiving drainage feature and the associated aquatic community. Small amounts of stormwater would mix readily with the receiving water thereby minimizing the risk of an increase in the temperatures of receiving waters. Inclusion of bio-engineered solutions such as swales and attenuation wetlands or planting vegetation for shade are also options that could be used to moderate discharge water temperatures. If such mitigation is required, it would be further assessed in connection with the required Fisheries Act authorization. In summary, potential residual adverse effects on thermally sensitive aquatic species from the discharge of warmer than ambient water at both the crystalline and sedimentary alternate locations would be mitigated by selecting a well-informed SWMP location, avoiding direct discharge to thermally sensitive drainage features where possible, and implementing thermal discharge mitigation measures (as described above) if required. Mitigation requirements may be greater at the crystalline alternate location than the sedimentary alternate location. <u>Potential Effects on Floodplains</u> Potential effects on floodplains are considered through the surface water quantity and flow Valued Component (VC), as described in Section 4.2.1 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. Watercourses and associated floodplains of all sizes would be considered as constraints on project siting. The siting of surface facilities would consider mapping available through public or private sources, such as local conservation authorities. In the sedimentary alternate location, which is predominantly agricultural, it is assumed that the waste rock pile would be located in an area that was formerly an agricultural field, and that drains into the SWMP and then into the receiving surface water system. The surface facilities would be sited so that there would be no potential for water inflow into the shafts as a result of flooding. An assessment of floodplain limits would allow surface facilities to be sited outside of floodplain boundaries for both large and small watercourses at a sedimentary alternate location. In the crystalline alternate location, the often rugged, bedrock-controlled terrain and the expected size of the waste rock pile and surrounding infrastructure (up to 40 ha), would make it more difficult to site a facility and associated infrastructure (e.g., access road, transmission line) without affecting and/or encroaching to some degree on a creek or stream and its associated floodplain. Therefore, it is expected that a DGR in a crystalline alternate location would likely have some effects on drainage patterns in the area. Siting of the surface facility and associated infrastructure may change flows and affect floodplains to some degree, resulting in potential adverse effects on surface water quantity and flow. In order to mitigate these potential effects, there may be a need to assess multiple discharge points to alleviate peak flow pressure on one single receiver in the crystalline alternate location. For comparison, in the DGR at the Bruce Nuclear site, the site discharge goes directly to MacPherson Bay (an embayment of Lake Huron) via an existing engineered ditch. The maximum flood implications were also assessed for the DGR at the Bruce Nuclear site [AMEC NSS 2011]. As discussed in the referenced reports there are no effects associated with flooding or floodplains associated with the DGR at the Bruce Nuclear site.

<table>
<tr><th>IR #</th><th>IR Title</th><th>Information Request and Response</th></tr>
<tr><td></td><td></td><td>References:

AMEC NSS. 2011. Maximum Flood Hazard Assessment. Prepared by AMEC NSS Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-35 R000. (CEAA Registry Doc# 300)

GOLDER. 2016. Environmental Effects of Alternate Locations. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883)</td></tr>
<tr><td>IR-1.8</td><td>Radiation and Radioactivity</td><td>Information Request:

Clarify whether the following factors have been considered in the comparative assessment of potential effects of radiation and radioactivity at the alternate locations and provide a discussion of how they were considered, if appropriate:

• The baseline radiation doses at the Bruce site, including sources of radiation from the Bruce power stations and other nuclear activities in the vicinity of the site.
• The presence of naturally-occurring radon, its effects on non-human biota, and potential for additional mitigation measures.
• The presence of unchartered and abandoned oil and gas wells, and whether there is a need for additional mitigation measures with respect to any such abandoned wells.

Rationale:

The Agency notes three areas that require clarification in the assessment of the radiation and radioactivity component for alternate locations.

First, the "Environmental Effects of Alternate Locations" report states that radiological effects of the sedimentary and crystalline geologic locations are predicted to be similar to those at the Bruce site, other than incremental exposure due to waste handling, packaging, and transportation. In the EIS, however, the Bruce DGR regional study area included the radiological impacts from the existing Bruce Power stations and other nuclear operations in the vicinity of the Bruce site. It is unclear whether the baseline radiation from the existing Bruce Power stations has been taken into account in the comparative analysis of alternate locations.

Second, in the crystalline location, it is noted that higher uranium levels in granitic rock could lead to elevated levels of naturally occurring radon. The report also states that appropriate mitigation measures would be implemented to mitigate effects on workers. No consideration of the potential effects of naturally occurring radioactive materials on non-human biota is presented.

Finally, in the alternate sedimentary location, the presence of unchartered and abandoned oil and gas wells is not discussed in the report as a potential risk to radionuclide containment.</td></tr>
</table>

IR #	IR Title	Information Request and Response
		OPG Response: The following factors have been considered in the comparative assessment of potential effects of radiation and radioactivity at the alternate locations: • The baseline radiation doses at the Bruce Nuclear site, including sources of radiation from the Bruce Power stations and other nuclear activities in the vicinity of the site. • The presence of naturally-occurring radon, its effects on non-human biota, and potential for additional mitigation measures. • The presence of unchartered and abandoned oil and gas wells, and whether there is a need for additional mitigation measures with respect to any such abandoned wells. Below is a discussion of how they were considered. For a DGR at any of the locations (i.e., Bruce Nuclear site, crystalline alternate location or sedimentary alternate location), the facility would be sited and designed, including site-specific mitigation measures, to avoid significant impact on humans and biota (Tables 4.6-2 and 5.6-1, Environmental Effects of Alternate Locations [GOLDER 2016]). <u>Baseline Radiation Implications</u> As noted in the rationale for this Information Request, the Environmental Impact Statement (EIS) for the proposed DGR at the Bruce Nuclear site, as presented in the Radiation and Radioactivity Technical Support Document [AMEC NSS 2011], identified both the dose rate attributable to the existing Bruce Nuclear site operations (which includes the Bruce Power stations and other nuclear activities in the vicinity), as well as an additional dose rate due to the DGR if placed at the Bruce Nuclear site. That report concluded that if the proposed DGR was included, the effects were not significant as total dose rates would be well below the regulatory limits and benchmarks for humans and non-human biota (Section 14, Preliminary Safety Report [OPG 2011]). At either alternate location (sedimentary or crystalline), there would be no dose rate from the existing Bruce Nuclear site facilities. At the alternate locations, there would only be the effect of the DGR added to the natural background. Therefore, in principle the total dose rate at the alternate locations (DGR + background at the alternate location) could be less than the total dose rate at the Bruce Nuclear site (DGR + existing Bruce facilities + background at the Bruce Nuclear site), assuming similar background dose rate. Of course, depending on the natural background dose rate at the alternate locations, the total dose rate at the Bruce Nuclear site could be less than at the alternate location. To illustrate the impact of the existing Bruce Nuclear site operations further, its public dose rate is typically below 0.004 mSv/a (Section 5.10, Radiation and Radioactivity Technical Support Document [AMEC NSS 2011]). The DGR at the Bruce Nuclear site is estimated to have a public dose impact of less than 0.001 mSv/a (Section 7.4.2.3, Preliminary Safety Report [OPG 2011]). The cumulative impact on the public from all facilities at the Bruce Nuclear site together with the DGR would therefore typically be less than 0.005 mSv/a. At the alternate locations, with similar fencelines, the incremental public dose rate would be less than 0.001 mSv/a, which is less than the 0.005 mSv/a value

IR #	IR Title	Information Request and Response
		for the Bruce Nuclear site. However, in either case, this dose rate is much less than the regulatory criterion of 1 mSv/a for the public. Furthermore, this total facility dose rate is also much lower than the average natural background dose rate of about 1.8 mSv/a for Canadians [Grasty and LaMarre 2004]. This natural background is also variable, including for example (and not limited to) 1.6 mSv/a in Toronto and 4.0 mSv/a in Winnipeg [Grasty and LaMarre 2004]. This variability in natural background dose rate is much larger than the incremental difference in dose rate between the Bruce Nuclear site and the alternate locations due to the presence or absence of the Bruce Nuclear facilities. In summary, there is a small reduction in total facility dose rate at the alternate locations due to the absence of the Bruce Nuclear facilities' dose rate contribution. However, this dose rate is small in an absolute sense and there could be much larger differences in the natural background rate at the alternate locations. Furthermore, the alternate locations would have small increases in public and biota dose due to the extra handling of waste packages at the Western Waste Management Facility at the Bruce Nuclear site, transportation of waste over long distances and, at the crystalline location, from higher levels of C-14 (Section 3.6, Description of Alternate Locations [OPG 2016]). Since in all cases the specific sites would have to meet regulatory limits, the environmental effects on public and biota are not expected to be significantly different between the Bruce Nuclear site and either of the alternate locations, but there could be greater mitigation needed at the alternate locations to achieve this result. This observation is summarized in Tables 4.6-2 and 5.6-1 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. <u>Naturally Occurring Radon</u> Uranium is distributed in rock worldwide at low concentrations. Radon gas is a natural radioactive gas produced by uranium, and therefore also widely present. Any DGR will create additional pathways for radon release from the underground rocks via the operating repository, and from the waste rock pile at surface. As per Table 3.1 of the Radon Assessment report for the OPG DGR [NWMO 2011a], uranium concentrations in the Cobourg Formation in the vicinity of the Bruce Nuclear site vary between 0.66 and 2.5 ppm, with a mean uranium concentration of 1.2 ppm. Similar levels would be expected at the sedimentary alternate location given the lateral traceability of these bedrock formations across the location. The host rock at a DGR in the crystalline alternate location is expected to consist of massive granite, granodiorite, tonalite pluton, or gneissic rocks of a similar mineralogy. Uranium concentrations in crystalline rocks will vary, but would be generally higher than in the sedimentary rock at the Bruce Nuclear site or the sedimentary alternate location. The uranium concentration at the crystalline alternate location has not been measured, but granitic rocks of an undifferentiated igneous source typically have uranium concentrations comparable to the average concentration of 2.7 ppm found in the upper continental crust [Rudnick and Gao 2003]. It is therefore likely that the crystalline alternate location would have an average uranium concentration no greater than 5 ppm.

IR #	IR Title	Information Request and Response
		A DGR at the crystalline alternate location would be comparable to or slightly larger in size than a DGR at the Bruce Nuclear site or the sedimentary alternate location, with a comparable or slightly larger waste rock pile. The incremental radon gas released into the underground repository from the surrounding host rock, and into the atmosphere from the waste rock pile, would be proportionate to the increased amount of rock and the increased uranium content of the rock (i.e., by a factor of approximately 5 ppm/1.2 ppm×110% = 4.6). With respect to non-human biota, the primary exposure pathway to radon would be from inhalation. The radon gas from the mine ventilation system and waste rock management area would be released to the atmosphere and disperse downwind. The contribution of this radon to air concentrations at the site boundary would be very low for the DGR Project at the Bruce Nuclear site (~0.001 Bq/m^3) [NWMO 2011a]. This radon concentration is low compared to a continental-average outdoor radon background level of about 9 Bq/m^3 [Government of Canada 1995]. Even a 4.6 fold increase in radon releases for a crystalline alternate location would result in no exceedances of standards and no off-site effect on biota. Groundwater can also be a significant source of exposure to radon and uranium, depending on inflow rates to the underground workings and the concentration of uranium in the host rock. While the actual inflow would be dependent on site-specific details, it is likely that an underground repository located in the crystalline alternate location would have increased inflow of groundwater relative to the Bruce Nuclear site or a sedimentary alternate location (Section 5.6.1, Environmental Effects of Alternate Locations [GOLDER 2016]). Therefore, it is likely that there would be a need for increased mitigation measures at the crystalline alternate location to limit the potential environmental effects from radon and other naturally occurring radioactive materials (Section 5.6, Environmental Effects of Alternate Locations [GOLDER 2016]). Such mitigation measures might include: • bedrock grouting to reduce groundwater inflow to underground workings; • ventilation control to ensure that monitored worker radon exposure remains below regulatory levels; • treatment of DGR underground and surface waters to ensure regulatory criteria are satisfied for release, including uranium concentrations; and • an engineered cap on the rock waste management area to reduce water infiltration and release of radon and airborne dust. Table 5.6-1 of Environmental Effects of Alternate Locations report [GOLDER 2016] indicates no significant changes in effects on non-human biota, but increased mitigations at the crystalline alternate location. As described above, the change in environmental levels of radon is not expected to be significant, and is addressed within the range of additional mitigations considered in Table 5.6-1. <u>Abandoned Oil and Gas Wells</u> An abandoned oil and gas well intersecting the DGR horizon could create a pathway for contaminant

IR #	IR Title	Information Request and Response
		release from a site otherwise able to provide safe and passive waste isolation and containment. This risk would be avoided or mitigated as follows: • Siting would require the avoidance of areas hosting economically viable natural resources, including base minerals, conventional and unconventional petroleum hydrocarbons. This would minimize the risk that there were historic uncharted or abandoned boreholes in the area. • Review of provincial Ministry of Natural Resources and Forestry oil and gas well records for the area to assess abandoned well locations, depth and status in proximity to any alternate location. A similar approach was taken in the case of the proposed Bruce Nuclear site DGR (NWMO 2011b; Section 2.2.5.2). If an unlicensed and/or abandoned borehole was found during site characterization or repository site preparation/construction activities, the borehole would be surveyed, sealed and distanced from the repository such that it would not influence safety. **References:** AMEC NSS. 2011. *Radiation and Radioactivity Technical Support Document*. Prepared by AMEC NSS Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-06 R000. (CEAA Registry Doc# 299) GOLDER. 2016. *Environmental Effects of Alternate Locations*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883) Government of Canada. 1995. *Radon*. Government of Canada Publication H48-10/1-88-1995-IN. publications.gc.ca/collections/Collection/H48-10-1-88-1995E.pdf Grasty, R. and LaMarre, J. 2004. *The Annual Effective Dose from Natural Sources of Ionizing Radiation in Canada*. Radiation Protection Dosimetry, 108(3), p.215-226. NWMO. 2011a. *Radon Assessment*. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-34 R000. (CEAA Registry Doc# 300) NWMO. 2011b. *Geosynthesis*. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-11 R000. (CEAA Registry Doc# 300) OPG. 2011. *Preliminary Safety Report*. Ontario Power Generation Report 00216-SR-01320-00001-R000. (CEAA Registry Doc# 300) OPG. 2016. *Description of Alternate Locations*. Ontario Power Generation Report 00216-REP-07701-00014-R000. (CEAA Registry Doc# 2883) Rudnick, R.L. and Gau, S. 2003. *Composition of the Continental Crust*. In Treatise on Geochemistry, volume 3, Elsevier Ltd., ISBN 0-08-04438-9, pp. 1-64.

IR #	IR Title	Information Request and Response
IR-1.9	Malfunctions & Accidents	***Information Request:*** *Provide a discussion with respect to malfunctions and accidents to inform the comparative analysis among alternate locations. The discussion should include the following:* • *Describe the differences among disruptive scenarios;* • *Discuss the potential environmental effects from accidents and malfunctions during all phases of the project on-site and during off-site waste transportation; and* *Provide a description of the disruptive scenarios (including inadvertent human intrusion, undetected major fracture, and shaft failure) in relation to post-closure safety for both sedimentary and crystalline locations.* ***Rationale:*** *The Agency notes that the "Environmental Effects of Alternate Locations" report does not discuss malfunctions and accidents beyond the consideration of risks related to offsite transportation on human health.*
		OPG Response: For clarity, note that "accidents, malfunctions and malevolent acts" after repository closure (i.e., postclosure) are referred to as "disruptive scenarios" in previous DGR submissions, and that terminology is used in this Information Request response. <u>Accidents, Malfunctions and Malevolent Acts (prior to Repository Closure)</u> The plausible accident, malfunctions and malevolent acts at the alternate locations would be broadly similar to those for the DGR at the Bruce Nuclear site during site preparation, construction, operations, and decommissioning. A summary of these is provided in the Malfunctions, Accidents and Malevolent Acts Technical Support Document [AMEC NSS 2011]. Prior to repository closure, potential accidents would range from conventional accidents such as a fuel spill, vehicle impact, fire and underground rock failure, to radiological accidents such as a package drop or package fire. Potential external initiating events would also be similar, although different in likelihood. For example, a tornado or hurricane would be more likely at the sedimentary alternate location (in southern Ontario), but a forest fire would be more likely at the crystalline alternate location (in central to northern Ontario). Malevolent acts range from threat to theft to sabotage to attack. Credible scenarios would be similar at the two alternate locations, since the wastes would be transported to the facility on public roads, and the facility itself would be situated within secured (fenced, monitored) properties, with all the wastes eventually located deep underground.

IR #	IR Title	Information Request and Response
		Disruptive Scenarios (after Repository Closure) After closure, the most important disruptive scenarios for a repository at the alternate locations would be similar to those considered for the DGR Project at the Bruce Nuclear site: inadvertent human intrusion, vertical fault, shaft seal failure, and poorly sealed borehole (Malfunctions, Accidents and Malevolent Acts Technical Support Document [AMEC NSS 2011, Table 4.2.4-1], Postclosure Safety Assessment Disruptive Scenarios report [QUINTESSA and SENES 2011]). A description of these unlikely disruptive scenarios, and their consequences on postclosure safety, follows: • Inadvertent human intrusion – A scenario where knowledge of the repository has been lost at some time after its closure, and humans drill a deep borehole that intercepts the repository. This bypasses all the natural barriers and directly brings waste material to surface. It could also create a pathway that allows further release of contaminated gas and water from the repository to surface if the borehole is not plugged (however, provincial regulations, O. Reg. 245/97, would require the borehole be plugged when no longer needed). • Vertical fault – A scenario where there is a permeable geological fault close to the repository that is not detected during siting and construction. Such a fault could provide a path for release of contaminated gas and water to surface, depending on how close it was to the repository and its nature (e.g., whether it extends through the shale caprock). • Shaft seal failure – A scenario whereby there is substantive failure of the seals along the bulk of a sealed shaft. Such a failure could provide a path for the release of contaminated gas and water in particular from the repository to the surface. • Poorly sealed borehole – A scenario whereby the deep boreholes used to characterize the site are poorly sealed, contrary to current regulations. These could provide a path for release of contaminated gas and water to surface. Potential Environmental Effects The potential environmental effects from accidents, malfunctions and malevolent acts during all phases of the DGR project on-site and during off-site transportation are primarily from releases of contaminants to air or water. The environmental effects could include loss of habitat for biota, and chronic or acute effects on the health of local biota depending on the magnitude of the release. Prior to repository closure, the public and environmental effects at the alternate locations and at the Bruce Nuclear site from accidents, malfunctions and malevolent acts on-site or during transportation off-site would be expected to be low, due to factors including: • nature and radioactivity of the wastes (solid low and intermediate level waste); • small number of packages that would be handled at any time; • waste packages (more robust packages are used for transport and storage of higher radioactivity intermediate level wastes);

IR #	IR Title	Information Request and Response
		• underground isolation of stored packages; • mitigations measures such as planned response to potential accidents; and • radioactive decay. After closure, the public and environmental effects at the alternate locations and at the Bruce Nuclear site due to future events such as tornadoes, hurricanes, earthquakes and glaciation, would be low. This is primarily because of the isolation provided by the deep repository. In the case of the disruptive scenarios described above, the geological and engineered barriers that provide isolation and containment of the waste are assumed to be bypassed or breached. This would allow release of radioactivity; this is the primary risk, although the waste contains small amounts of other contaminants. The activity released is dependent on the details of the scenario, site conditions and design, and timeframe. The public and environmental effects from disruptive scenarios would be expected to be low to medium due to factors including: • repository depth; • selection of a stable and resilient geologic repository setting; • site-specific repository design to withstand such events; and • amount of radioactivity in the DGR, taking into account radioactive decay. These postclosure scenarios are all very unlikely. At any location, the repository would be sited and designed to meet regulatory criteria for public and environment at the facility fenceline. Releases of contaminants would also be subject to natural attenuation, further assuring any effects would be localized to the area in which the release occurred before mitigation. Quantitative differences between the alternate locations with respect to the potential environmental effects from accidents, malfunctions, malevolent acts and postclosure disruptive scenarios would depend on several factors, most of which are currently not known in sufficient detail, including the specific site and design for an alternate location. These factors would be determined in a siting process. However, for the purposes of the alternate location assessment, some general considerations can be provided regarding the implications of different locations. • <u>Remoteness</u>: The crystalline alternate location would likely be more remote than the sedimentary alternate location or the Bruce Nuclear site. For example, the crystalline alternate location may require up to 20 km of new road access. However, the potential environmental effects do not necessarily decrease with remoteness since: 1) the facility would be sited and designed to meet all criteria at its fenceline regardless of location; and 2) there may be sensitive environmental aspects outside the fenceline at any location. From a human health perspective, remoteness also is not necessarily significant since the facility must meet the same regulatory criteria at any location. Any site in Ontario regardless of perceived “remoteness” would be within the traditional territory of at least one Indigenous community, they would be impacted, and they would need to be consulted with respect to potential impacts.

IR #	IR Title	Information Request and Response
		• Transportation: As already noted in the Study of Alternate Locations Main Submission [OPG 2016], the additional waste transportation involved to an alternate location would result in a small additional transportation risk. This would increase with distance, and so would be higher for the crystalline alternate location than the sedimentary alternate location. • Permeability and fracturing: The host rock at the crystalline alternate location would likely be more permeable than that at the sedimentary alternate location. There are also likely to be fractures in the crystalline alternate location. Consequently, the repository would likely be optimized differently from the sedimentary alternate location; in particular, a repository at the crystalline alternate location would likely require more waste stabilization before disposal and engineered barriers within the repository, to ensure that the overall facility is safe (Section 3.6, Description of Alternate Locations [OPG 2016]). These measures could have positive and negative impacts on the risks from disruptive scenarios in the crystalline alternate location; this would have to be evaluated as part of a siting program (since these impacts would depend on site-specific characteristics). • Site characterization: In general, the sedimentary alternate location would be easier to characterize with respect to faults or fractures than the crystalline alternate location, and therefore have less likelihood of undetected faults or fractures. This increases the confidence in the conclusions about the safety margins in the sedimentary alternate location. • Salinity: The sedimentary alternate location is likely to have much higher salinity groundwater at repository depth than the crystalline alternate location. This has advantages and disadvantages. Saline water is not drinkable, so a deep borehole well is unlikely to be drilled in the vicinity of the repository to obtain drinking water, which reduces the likelihood of future inadvertent intrusion. Very high salinity is also an indication of very slow groundwater movement. These factors are favorable for the sedimentary location. However, higher salinity may require more repository engineering measures (e.g., corrosion of rock support bolts). Furthermore, the deep groundwater in the crystalline alternate location may also be sufficiently saline to prevent its use for drinking, and may have other indications of slow groundwater movement. • Natural resources: A significant factor in the risk of future inadvertent human intrusion is the presence of natural resources near the repository. In the sedimentary alternate location, the natural resources of most interest would most likely be hydrocarbons and/or salt, while in the crystalline alternate location, the resource would most likely be metal ores. At present, no general difference between the two alternate locations can be identified with respect to the likelihood of natural resources and therefore of human intrusion. In general, it may be concluded that the same low-probability accidents, malfunctions, malevolent acts and disruptive scenarios would be of relevance at the alternate locations as at the Bruce Nuclear site. The detailed assessment available for the proposed DGR at the Bruce Nuclear site [AMEC NSS 2011] indicates the risks associated with these scenarios to be very low at this site. A properly sited and designed repository in the alternate locations would have to meet the same regulatory criteria. The likelihood and consequences of these events at the alternate locations would vary somewhat depending on site-specific details. Ultimately, if OPG were required to site the facility at an alternate location, a detailed safety assessment would be performed, which would provide this information.

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<tr><th>IR #</th><th>IR Title</th><th>Information Request and Response</th></tr>
<tr><td></td><td></td><td>References:

AMEC NSS. 2011. Malfunctions, Accidents and Malevolent Acts Technical Support Document. Prepared by AMEC NSS Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-07 R000. (CEAA Registry Doc# 299)

OPG. 2016. Description of Alternate Locations. Ontario Power Generation Report 00216-REP-07701-00014-R000. (CEAA Registry Doc# 2883)

QUINTESSA and SENES. 2011. Postclosure Safety Assessment: Analysis of Human Intrusion and Other Disruptive Scenarios. Prepared by Quintessa Ltd. and SENES Consultants Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-27 R000.</td></tr>
<tr><td>IR-1.10</td><td>Rail Transportation</td><td>Information Request:

Provide a discussion to clarify the key criteria that support the selection of road over rail transportation and clarify whether there would be important differences in cost, risk, and potential environmental effects.

Rationale:

OPG's technical document "Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations" provides the following statement as a footnote on page 6 states:

"Experience has shown that for large long duration transport campaigns such as this, transport of nuclear waste by rail would require dedicated trains, rail siding construction on both sites to facilitate direct rail access and staging of multiple railcars, and potential upgrades to secondary railroads (if mainline rail routes are not available). Alternatively, intermodal trucking between the nearest viable railhead to both sites would be required."

This statement suggests that additional project components would be required, but does not explain whether rail transportation is excluded based on criteria such as cost, risk, and environmental effects.</td></tr>
<tr><td></td><td></td><td>OPG Response:

Road and rail transportation have been used internationally for the safe transportation of low and intermediate level waste (L&ILW). Below is a brief overview and comparison of these two transportation modes and a discussion of the key criteria that support OPG's decision to use road transportation.

<u>Road Transportation</u>
There is an extensive existing public road network throughout Ontario.
Road transportation is suitable for the movement of various load sizes over short or long distances.
Road transportation mode fuel efficiency is 145 ton-mile/gallon (which converts to approximately 56 tonne-</td></tr>
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IR #	IR Title	Information Request and Response
		kilometre/litre) [Texas A&M Transportation Institute 2014] and entails emissions of 154 metric tons of GHG/million ton-miles (which converts to approximately 105 metric tons GHG/million tonne-kilometres). A tractor trailer standard cargo capacity is 25 tons (which converts to approximately 22.7 tonnes). • OPG has extensive, successful operating experience in road transportation of nuclear waste. • Transport personnel radiation dose is higher for road than for rail [Sentuc and Brücher 2010], but still far below regulatory limits. <u>Rail Transportation</u> • There is a sizable existing freight rail network throughout Ontario. The nearest terminal to the Western Waste Management Facility (WWMF) is at Goderich (a distance of approximately 60 to 70 km). • Rail transportation is suitable for the movement of large load sizes over longer distances where rail lines exist and is capable of high levels of cargo utilization (i.e., efficient loading of vehicles). • Rail transportation mode fuel efficiency is 477 ton-mile/gallon (which converts to approximately 184 tonne-kilometre/litre) [Texas A&M Transportation Institute 2014] and emits 21 metric tons of GHG/million ton-miles (which converts to approximately 14.4 metric tons GHG/million tonne-kilometres). A railcar standard cargo capacity is 110 tons (which converts to approximately 99.8 tonnes). • Transportation of the waste packages by rail could be conducted using intermodal transport operations (using two or more modes of transportation to complete a shipment). For rail transport such intermodal transports may involve: 1. transportation of the waste packages from the WWMF by truck to the Goderich commercial rail terminal; 2. placement on a railcar and transport by rail to the commercial railhead nearest the alternate location; and 3. placement on a truck for transport by road to the alternate location. These additional starts/stops/idling of the trucks in the railway terminals and the loading/unloading equipment will emit GHG to the environment. • Alternatively a new short branch line to service the WWMF and/or (if necessary) the alternate location could be constructed. Construction of a rail system to connect the WWMF to Goderich terminal and the supporting infrastructure is conservatively estimated to cost approximately $2 to 3 million/km [Hewitt Estimate Consultants 2016] not including land acquisition costs (which would be substantial) or the intermodal transfer facilities[1]. Also, a new rail line would require the necessary approvals and permits, including possibly an environmental assessment. • Waste packages may have a longer residence time at commercial rail terminals to synchronize the transfer of

[1] The Ontario Government announced on May 19, 2017 that they will oversee the building of a high speed rail line between Toronto and Windsor. The estimated cost is $21 billion or $60 million per kilometre for the 350 km distance.

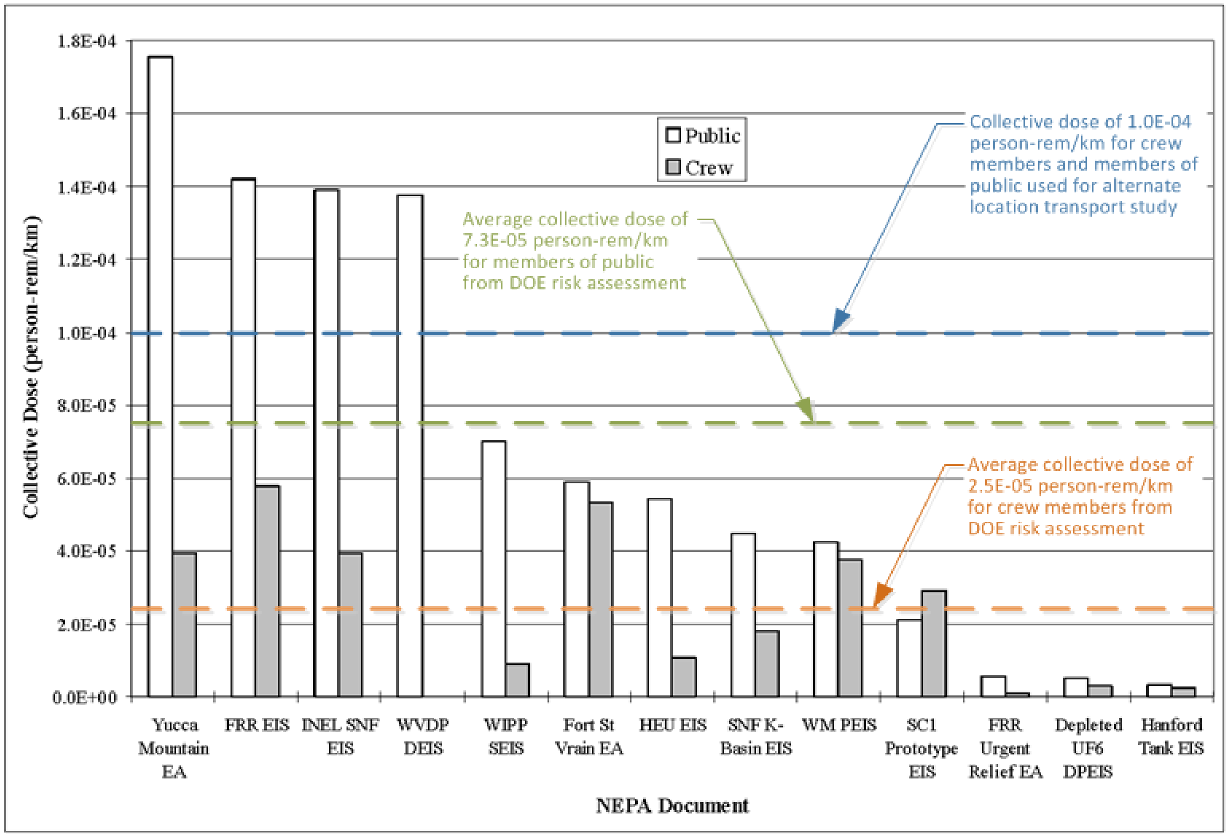
IR #	IR Title	Information Request and Response
		waste packages from multiple trucks to a railcar and multiple railcars per train, both to make rail transport operations efficient and to account for equipment failure/maintenance. This would need to be factored into the operating schedule of the DGR. OPG focused on safety/risk, infrastructure, and cost as key criteria in determining which transportation mode to use for the purposes of this study. OPG selected road transportation for the following reasons: • Safety/Risk: o Intermodal transport operations (as required for rail) can introduce additional risks due to additional handling using commercial facilities. Intermodal transport is typically avoided for the following reasons: ▪ the conventional safety hazards associated with multiple waste package handlings and conveyance tiedowns, ▪ the additional challenges of performing such transfers using commercial facilities that are accessible to the public and that are used for other purposes which may be interrupted, ▪ the additional labour resources and equipment that are required and the associated incremental radiation dose uptake, and ▪ the incremental cost and schedule impacts of conducting such intermodal transports. o Extended residence time of transport packages at commercial intermodal terminals may increase radiological exposure of personnel in the terminal. o OPG has extensive, successful operating experience in road transportation of nuclear waste. OPG has safely transported waste to the WWMF by road for nearly 40 years as a part of its ongoing operations. There have been no accidents which resulted in the release of radioactivity. • Infrastructure: o The existing road infrastructure in Ontario is extensive. Transportation of waste packages by road is flexible as trucks can move wherever there is a highway, road or street and can also accommodate different size shipments. o Transportation by rail may require additional infrastructure, possibly including a new rail line connecting the WWMF to the nearest commercial rail terminal, which would require additional time and environmental approvals. There may be adverse environmental impacts associated with rail line construction (those impacts would not occur with road transportation). • Cost: o While rail transportation can be less costly from an operating perspective, the capital costs associated with developing the infrastructure can be significant. Also, there may be ongoing maintenance cost of the infrastructure and equipment. o Rail transportation logistics are more complex compared with road transportation and will require additional scheduling support staff.

IR #	IR Title	Information Request and Response
		In summary, road transport was selected for the alternate location transportation study due to existing infrastructure, no capital costs to implement and the fact that OPG has extensive, successful operating experience in the road transportation of nuclear waste. OPG is confident that it can safely transport the waste packages by road to any proposed alternate location. By contrast, using rail transport would require, among other things, a large capital investment in the construction of new facilities, and construction would likely cause some negative environmental impact. Intermodal transport using the existing commercial rail system could also introduce additional safety, environmental and radiological risks. **References:** Hewitt Estimating Consultants. 2016. The Chief Estimator Software [Computer software]. Guelph, ON: Infrastructure Cost. http://www.infrastructurecost.com/ Sentuc, F-N. and Brücher, W. 2010. *Safety Analysis of the Transportation of Radioactive Waste to the Konrad Final Repository*. Paper presented at EUROSAFE Forum 2010: Innovation in Nuclear Safety and Security - Seminar 2: Radiation Protection and Environment. November, 2010. Cologne, Germany. https://www.eurosafe-forum.org/sites/default/files/Eurosafe2010/2_07_Paper_Eurosafe_2010_final_rev1.pdf Texas A&M Transportation Institute. 2014. *A Modal Comparison of Domestic Freight Transpiration Effects on the General Public* 2017. http://nationalwaterwaysfoundation.org/documents/Final%20TTI%20Report%202001-2014%20Approved.pdf ***Conversion Factors:*** *3.785 litres = 1 U.S. gallon* *1 Ton miles = 1.460 tonne km* *1 US ton = .907 tonne*
IR-1.11	Radiological Risk to Human Health from Transportation	***Information Request:*** *Provide a discussion regarding the study by the U.S. Department of Energy that:* • *Clarifies how the study's receptors and exposure pathways apply to the DGR and the study of alternate locations; and,* • *Explains how the doses have been scaled to correspond to shipments of low and intermediate-level waste for the DGR.*

IR #	IR Title	Information Request and Response
		Rationale: *OPG's technical document "Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations" considers annual individual and collective doses resulting from normal routine transportation. These doses are adapted from a study by the U.S. Department of Energy. However, OPG does not explain how the data from this study applies to the DGR Project.*
		OPG Response: In regard to radiological risk for routine normal conditions of transport, the exposure pathway to the receptors is limited to ionizing radiation emanating directly from the external surface of the transport package, as is assumed in the U.S. Department of Energy (DOE) transportation risk assessment [U.S. DOE 2002]. The radiological risk of receptor exposure to other environmental pathways is precluded since compliance with the transport packaging regulations assures that there is no release or dispersal of radioactive materials to the environment. The DOE transportation risk assessment assumes a dose rate of 1 millirem per hour (mrem/hr) at a distance of 1 metre (m) from the transport package surface for truck transports of low level waste (LLW). Similarly, dose rates of 3 to 7 mrem/hr at a distance of 1 m from the transport package surfaces are assumed for truck transports of higher activity wastes that are comparable to intermediate level waste (ILW). The effective sizes (and surface areas) of the LLW and ILW transport packages utilized in the DOE transportation risk assessment are comparable to those described in the "Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations" [ENERGY SOLUTIONS 2016 referred to in this response as the "alternate location transport study"]. On average, these transport package dose rates are expected to be conservative for low and intermediate level waste (L&ILW) transports from the Western Waste Management Facility (WWMF) to an alternate location. For the major groups of potentially exposed persons (i.e., receptor groups) described in Section 2.6.1.1 of the alternate location transport study [ENERGY SOLUTIONS 2016], the following distance and duration assumptions are made in the DOE transportation risk assessment to determine collective doses to these receptor groups for routine normal transport conditions: • *Persons along the Route:* People living or working on each side of the transportation corridor including those that reside near entrance/exit to the nuclear facilities are assumed to reside 30 m (98 feet [ft]) from the road. Shipments are assumed to pass at an average speed of 24 kilometres per hour (km/h) (15 miles per hour [mph]), exposing such persons to low levels of direct radiation. Cumulative doses are determined assuming that the maximally exposed individual resident is present for the full duration of all the shipments. • *Persons Sharing the Route:* People in vehicles sharing the transportation corridor. This group includes persons traveling in the same or the opposite direction as the shipment, as well as persons in vehicles passing the shipment. Such persons are assumed to be exposed to low levels of direct radiation at an average distance of 1 m (3.3 ft) from the transport package for a duration of 30 minutes.

IR #	IR Title	Information Request and Response
		• *Persons at Stops:* People nearby while a shipment is stopped on route, including stops for refueling, food, and rest. Such persons are assumed to be exposed at an average distance of 20 m (66 ft) for a duration of 2 hours. • *Crew Members:* Truck transportation crew members including drivers are assumed to be occupational radiation workers that are monitored by a dosimetry program. The associated regulatory dose limit is 5 rem per year (rem/yr), however, in practice doses are limited to 2 rem/yr by DOE's administrative procedure. Drivers are assumed to be exposed at an average distance of 3.1 m (10.2 ft) for the entire duration of the transport. Other transportation crew members, such as federal or local vehicle inspectors are not assumed to be monitored by a dosimetry program. Such crew members are assumed to be exposed at an average distance of 3 m (10 ft) for duration of 30 minutes. • *Person in Traffic Obstruction:* A person or persons is assumed to be stopped next to a radioactive material shipment (e.g., because of a traffic slowdown). Such persons are assumed to be exposed to low levels of direct radiation at a distance of 1 m (3.3 ft) from the transport package for a duration of 30 minutes. • *Person at Truck Service Station:* A person or persons that work at a service station utilized for truck maintenance or repairs while on route. Maintenance workers are not typically monitored by a dosimetry program. Such persons are assumed to be exposed at an average distance of 10 m (33 ft) for a duration of 2 hours. These receptor groups are conservatively assumed to be unshielded by building structures or other materials that would serve to attenuate dose rates. While not exhaustive, the above receptor assumptions utilized in the DOE transportation risk assessment are considered representative of conditions expected for transport to an alternate location. The DOE risk assessment assumes up to 95,000 LLW shipments, 38,000 shipments of higher activity waste comparable to ILW, and over 10,000 High Level Waste (HLW) and Spent Nuclear Fuel (SNF) shipments. Multiple locations are considered with transport distances ranging from a few hundred kilometres (km) to over 5,000 km. A range of rural, suburban and urban population densities are considered. This number of shipments, transport distances and population densities are expected to bound those applicable for the alternate location transports. Based on the assumptions and inputs described above, Figure 4.2 of the DOE risk assessment (which is provided on the next page for convenience) presents the results for truck shipments from several facility locations and transport distances, and a range of radioactive material types. The results are expressed in terms of unit cumulative exposures to the collective receptor group per kilometre (person-rem/km). They include truck transports of all radioactive material types, including LLW, higher activity waste comparable to ILW, and HLW including SNF. The results for the crew member receptor group and the combined members of the public receptor groups are shown separately. As Figure 4.2 of the DOE transportation risk assessment indicates, the unit exposures risks for the crew member receptor group ranges from 8.5×10^{-7} to 5.8×10^{-5} person-rem/km, with an average unit exposure risk of 2.5×10^{-5} person-rem/km. Similarly, the unit exposures risks for the members of the public receptor group range from 3.4×10^{-6}

IR #	IR Title	Information Request and Response
		to 1.7 × 10^{-4} person-rem/km, with an average of 7.3 × 10^{-5} person-rem/km. Further, the results indicate that the majority of the exposure risk for members of the public occurs during stops for rest and fuel (i.e., approximately 90% of the total exposure risk occurs during such routine stops). Those persons residing or working along transport routes receive less than 10% of the total exposure risk. These results are considered conservative compared with the exposure risk expected for transport to an alternate location, in part because the aggregate activity levels for the radioactive material assumed in the DOE transportation risk assessment include a significant amount of HLW and SNF, neither of which will be transported to the alternate location. As Figure 4.2 indicates [U.S. DOE 2002], the highest collective doses to members of the public correspond to DOE facilities shipping HLW and/or SNF.

IR #	IR Title	Information Request and Response
		 **Figure 4.2. Incident-Free Cargo-Related Unit Risks for Members of the Public and Transportation Crews by Truck Transport** Based on the results of the DOE risk assessment described above and annotated in Figure 4.2, a unit exposure risk of 1.0 x 10^{-4} person-rem/km was assumed for the collective exposure risk to crew members and members of the public for purposes of assessing the collective exposure risk for alternate location transports. This assumed exposure risk conservatively bounds the combination/sum of the average collective exposure risks to the crew member and members of the public receptor groups reported in the DOE risk assessment. The assumed exposure risk was then

IR #	IR Title	Information Request and Response
		multiplied by the total road distance travelled corresponding to each scenario (e.g., 2,267,515 km for the 100 km distance) and then divided by the assumed number of affected persons on route (e.g., 200 affected persons for the 100 km scenario). The result is further divided by the assumed project duration of 30 years resulting in an anticipated dose per year to an individual. As described in Section 2.6.1.1, the incremental dose to an individual in the affected population resulting from transport to an alternate location is anticipated to be well below the 100 mrem (1 mSv) annual exposure limit to a member of the public set by the CNSC regulations. As indicated in Section 2.6.1.1 of the alternate location transport study, this conclusion is substantiated by the results of the L&ILW transportation study performed for the Konrad repository in Germany [KONRAD TRANSPORT STUDY 2009]. In summary, the alternate location transport study utilizes information from the referenced DOE transportation risk assessment as an indicator to show that the cumulative annual dose to the collective population for the transport of L&ILW from the WWMF to an alternate location can be expected to be low. The DOE assessment also serves to indicate that doses from such transport activities are expected to be below the defined regulatory dose limits for workers and members of the public. **References:** ENERGY SOLUTIONS. 2016. *Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations*. Prepared by Energy Solutions Canada Ltd. Ontario Power Generation Report 00216-REP-03450-00001-R000. (CEAA Registry Doc# 2883) U.S. DOE. 2002. *A Resource Handbook on DOE Transportation Risk Assessment*. Prepared for U.S. Department of Energy, Office of Environmental Management, National Transportation Program. Prepared by DOE Transportation Risk Assessment Working Group Technical Subcommittee. https://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-DOE-DOE_Transportation_Risk_Assmt.pdf KONRAD TRANSPORT STUDY. 2009. GRS - Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH. https://www.grs.de/en/content/2009-konrad-transport-study
IR-1.12	Cost Estimate Variance	***Information Request:*** *Provide a discussion to clarify the range in variation for the cost estimates presented in the technical document, taking into account the adjustment factors and the management reserve.* ***Rationale:*** *OPG's technical document "Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations" uses a methodology based on the Association for the Advancement of Cost Engineering International guidelines for a conceptual cost estimate (Class 5). This reference stipulates that the variation for a conceptual cost estimate can range from -20% to -50% at the low end and +30% to +100% at the high end.*

IR #	IR Title	Information Request and Response
		OPG’s technical document uses adjustment factors and a management reserve to account for levels of uncertainty pertaining to certain components of the transport and packaging cost estimates. The variation in accuracy for the final numbers presented is not explicitly stated in the technical document or in the main study of alternate locations.
		OPG Response: The Association for the Advancement of Cost Engineering International [AACE INTERNATIONAL 2016] cost estimating recommended practices define a classification system with Class 5 being the most approximate and Class 1 being the most accurate [AACE INTERNATIONAL 2016]. The classification levels are based on the level of the project definition as the primary characteristic, and the cost estimating methodology employed and how the resulting estimate will be utilized as secondary characteristics. As indicated in the report “Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations” [ENERGY SOLUTIONS 2016; referred to in this response as the “alternate location transport study”], Class 5 cost estimating practices are appropriate to provide a high-level indication of the approximate cost and feasibility of a project such as this that is in the early conceptual stage and has a limited definition. A Class 5 cost estimate is intended to be indicative, not definitive, and thus the range of uncertainty in the resulting as-estimated cost is high compared with more rigorous cost estimates developed for projects in a more advanced stage. As noted in the AACE International recommended practices, the methodology typically used for Class 5 estimates employs capacity factors, parametric models, judgment, analogies and other approximations. The alternate location transport study is sufficient to provide a basic definition of the project to package and transport low and intermediate level waste (L&ILW) to an alternate location, including a high level framework, technical approach and project timeline. However, at this conceptual stage, a detailed work breakdown structure for the project with itemized line-item costing of materials, labour and other direct costs for each activity in the project has not been developed, as is typical for Class 5 estimates. Rather, to estimate the indicative total cost of materials, the bulk quantities of materials (i.e., general transport packaging types and quantities) have been approximated and aggregate unit costs based on past project experience have been used rather than specific cost quotations obtained from suppliers for specific transport packaging designs. Similarly, to estimate the total cost of labour, a level-of-effort person-loading approach with aggregate commercial labour rates has been used rather than task-based estimating, resource loading, and resource-specific rate build-ups. Other direct costs, (e.g., for consumable materials), have been included as an allowance item and have not been specifically estimated. Consistent with Class 5 cost estimating practices, adjustment factors which increase with transport distance are used at the waste category level of the costs estimate to account for technical uncertainties and operational risks that have not yet been defined, evaluated and estimated based on specific and detailed planning for each waste category. As described in the alternate location transport study, technical uncertainties include variability in the actual waste characteristics, waste container types, and large component preparations to render them transportable. Operational risks include potential interruptions and delays in waste retrieval and packaging operations, and truck transports and

IR #	IR Title	Information Request and Response
		turn-around times given that specific logistical planning based on site and route selection has not been performed. All of these factors affect the assumed transport packaging approaches, transport packaging and tractor/trailer fleet sizes, and trucking costs that are not specifically evaluated and accounted for given the conceptual nature of the study. The adjustment factors used in the waste category estimates as described in Section 3.2 of the transport study provide a simplified way to account for these costs in lieu of specific estimates for these costs. Consistent with Class 5 estimating practices, a prudent management reserve (which can be considered contingency) is included in the total estimated cost for the alternate location transport study. The management reserve provides an allowance for the project-level unknowns at this juncture, given the future timeframe, long duration and the early conceptual stage of the study. The management reserve also provides an allowance for unanticipated and unplanned but necessary additional work needed to complete the project. This includes additional materials, equipment, and labour resources; extended delays, work stoppages and rework; onerous regulatory changes and oversight, extraordinary working conditions, performance payment delays, etc. At this conceptual stage, a formal risk assessment which typically includes development of a risk register, performing Monte Carlo simulations and identifying risk mitigations for the purpose of deriving an appropriate level of contingency has not been undertaken. Rather, a management reserve of 12% is assumed based on judgment considering the magnitude, complexity and long duration of the project. The AACE International cost estimate classification system provides accuracy ranges based on statistical analysis of past engineering, procurement and construction projects to achieve an estimate of lower and upper bound actual project costs. It is judged that the cost estimate described in the alternate location transport study, including the conceptual definition, the cost estimating methodology utilized and the resulting estimate of total costs including the contingency, are sufficient to achieve a 50% level of confidence of actual costs consistent with AACE International cost estimating practices. The AACE International accuracy ranges for Class 5 estimates are -20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, the extent of reference information available, and the inclusion of an appropriate contingency. Applying these accuracy ranges to the as-estimated total costs provided in Section 4 of the alternate location transport study, the lower and upper bound range of actual cost in accordance with AACE International Class 5 estimating practices are shown in the table below.

IR #	IR Title	Information Request and Response
		AACE Class 5 Estimate Range of Actual Project Costs Geology/Year Transports Initiated | One-Way Distance by Road (km) | Total Project Cost as Estimated | Lower Bound Actual Project Cost (-50% accuracy) | Upper Bound Actual Project Cost (+100% accuracy) Sedimentary 2045 | 100 | $381,800,901 | $190,900,450 | $763,601,802 Sedimentary 2045 | 300 | $493,081,328 | $246,540,664 | $986,162,655 Crystalline 2055 | 200 | $451,719,110 | $225,859,555 | $903,438,220 Crystalline 2055 | 2,000 | $1,424,369,884 | $712,184,942 | $2,848,739,768 **References:** AACE INTERNATIONAL. 2016. *AACE International Recommended Practice No. 18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries*. TCM Framework: 7.3 – Cost Estimating and Budgeting. Rev. March 1, 2016. http://www.aacei.org/toc/toc_18R-97.pdf ENERGY SOLUTIONS. 2016. *Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations*. Prepared by Energy Solutions Canada Ltd. Ontario Power Generation Report 00216-REP-03450-00001-R000. (CEAA Registry Doc# 2883)
IR-1.13	Valued Components	***Information Request:*** *As per the Agency's draft technical guidance "Assessing the Current Use of Lands and Resources for Traditional Purposes under CEAA 2012", and taking into account the input provide by Indigenous groups, identify the potential effects of any change caused to the environment for each alternative location and provide a comparative qualitative analysis on:* • *health and socio-economic conditions,* • *physical and cultural heritage,* • *the current use of lands and resources for traditional purposes, or* • *any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.* *Provide a discussion of whether constructing the Project at an alternate location would reduce the risk or harm on potentially affected Indigenous groups in the preferred Project area.*

IR #	IR Title	Information Request and Response
		Rationale: *OPG's "Environmental Effects of Alternative Locations" report (page 4-5) states that the list of VCs considered in the alternative means analysis includes the environmental components as defined in section 5(1)(a) of CEAA 2012 and that constructing the Project at an alternate location may affect VCs within the socio-economic environment.* *However, the report does not make any explicit reference to the environmental components as defined in section 5(1)(c) of CEAA 2012. Although OPG states that the change in environmental conditions has the potential to affect health, socio-economic conditions, cultural heritage and land use, it has not provided a discussion on the potential environmental effects of the Project on VCs other than traditional and non-traditional land and resource use.* *The report indicates that many socio-economic effects would be beneficial, and may serve to enhance community well-being.*

		OPG Response:
		
		This Information Request response provides a comparative qualitative analysis of environmental effects of a DGR on the following and related valued components (VCs) with respect to Indigenous peoples:
		
		• health;
		• socio-economic conditions;
		• the current use of lands and resources for traditional purposes, or
		• physical and cultural heritage, including any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.
		
		Within each of the above components, the potential effects at the Bruce Nuclear site, the sedimentary alternate location, and the crystalline alternate location are described and compared. Following the analysis of effects on the above VCs, the response also considers whether constructing the DGR Project at an alternate location would reduce the risk of harm to potentially affected Indigenous groups in the preferred Project area.
		
		First, however, OPG acknowledges the ongoing meaningful and respectful engagement with Saugeen Ojibway Nation, Historic Saugeen Métis and Métis Nation of Ontario on the DGR project at the Bruce Nuclear site. OPG acknowledges the concerns of the communities as they have been expressed to OPG.
		
		<u>Health</u>
		
		Pathways that have the potential to contribute effects to the health of Indigenous peoples from implementation of a DGR at any location include:
		
		• changes in physical factors such as:
		    o changes to air quality
		    o changes to noise levels

IR #	IR Title	Information Request and Response
		o changes to surface water quality, groundwater quality and soil quality o changes in human exposure to radiation • changes in socio-economic factors • changes in cultural factors Socio-economic and cultural factors are discussed in the sections below; therefore this next section is focused on potential effects associated with changes in the environment on physical factors. *Potential Effects at the Bruce Nuclear Site* Potential effects on the health of Indigenous peoples with respect to the DGR Project at the Bruce Nuclear site are described in Section 7.11 and Appendix C of the EIS [OPG 2011a, OPG 2011b]. The EIS [OPG 2011b] identified that acrolein had a hazard quotient value in excess of the desired target (i.e., 1.0) for the Indigenous peoples' receptor. Therefore a potential adverse effect to the health of the members of the Indigenous peoples because of potential exposure to acrolein in air was identified as a result of the DGR Project during site preparation and construction phase. Acrolein exposures are related to existing concentrations from the Bruce Power and other operations in the vicinity. Conservatively, it was assumed that the adverse effect for this one determinant warranted the identification of an adverse effect on overall health for a member of the Indigenous peoples. This residual adverse effect was determined to be not significant given the magnitude (including consideration of the conservatism applied to the assessment), extent, frequency, duration and reversibility of Project related exposure, the contribution of the project is not deemed to contribute to significant adverse health risks [OPG 2011a]. Potential effects of radiation and radioactivity to both members of the public (including individuals from Indigenous peoples) and workers were considered in Section 7.6 of the EIS [OPG 2011a]. No residual adverse effects were identified. The controls and mitigation measures are expected to provide adequate control to protect the health of members of the public, including Indigenous peoples, and workers. *Potential Effects at the Sedimentary Alternate Location* Changes to physical factors such as air quality, noise levels, surface water quality, groundwater quality and soil quality at the sedimentary alternate location are discussed in Section 4 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. Consideration of the health-based criteria was implicit in the assessment of the physical environmental components and VCs and how they may be affected by a DGR at the sedimentary alternate location, through the discussion of relevant standards, guidelines and receptor locations, where applicable (e.g., changes in air quality). There would be emissions and associated potential effects on air quality and noise levels, as a result of the construction and operation of a DGR at the sedimentary alternate location [GOLDER 2016], as well as transportation of waste. Implementation of mitigation measures will reduce or eliminate these effects; however residual adverse effects are likely for these pathways. Potential acrolein emissions are further discussed in response to Information Request 1.5, and would be anticipated from the handling and transportation of waste from the WWMF to the

IR #	IR Title	Information Request and Response
		sedimentary alternate location. With regard to surface water quality, groundwater quality and soil quality, the Environmental Effects of Alternate Locations report [GOLDER 2016] indicated that: • A surface water management plan would be implemented to manage water affected by the project. This would include collection of all water, either from underground or the surface, which has been in contact with waste rock that may leach contaminants. The water would be treated on-site, as needed, to meet criteria established to be protective of human health. These would be required to be met at discharge. • No residual adverse effects to groundwater or soil quality are anticipated outside of the project footprint. Therefore, no adverse effect on surface water, groundwater or soil quality was considered likely, and consequently no adverse effects on health via these pathways is likely for the sedimentary alternate location. Potential effects of radiation and radioactivity to both members of the public (including Indigenous peoples) and workers, including risks associated with risk of conventional highway accidents associated with waste transportation to an alternate location, were considered in Section 4 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. To minimize the radiological effects, mitigation measures would be developed during the design of the DGR, such that radiation dose to members of the public, including Indigenous persons, from the DGR would be well below the 1 mSv/a regulatory limit. Overall, taking into consideration mitigation measures, none of the above pathways are expected to contribute to unacceptable risks to Indigenous peoples' health. *Potential Effects at the Crystalline Alternate Location* Changes to physical factors such as air quality, noise levels, surface water quality, groundwater quality and soil quality at the crystalline alternate location are discussed in Section 5 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. As at the sedimentary location, human health was considered through the discussion of relevant standards, guidelines and receptor locations, where applicable. In addition to the construction and operation of the DGR site, at the crystalline alternate location there will be emissions to air quality, including acrolein, and noise from the activities associated with additional site clearing requirements, development of new infrastructure (such as roads and power), and management of higher volumes of excavated waste rock. With regard to surface water quality, groundwater quality and soil quality, potential effects would all be mitigated such that there would be no residual adverse effects on these VCs and consequently no potential effect on Indigenous peoples' health [GOLDER 2016]. Potential effects of radiation and radioactivity to both members of the public (including Indigenous peoples) and workers, including risks of conventional highway accidents associated with waste transportation to an alternate location, were considered in Section 5 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. To minimize the radiological effects, mitigation measures would be developed during the design of the DGR, such that

IR #	IR Title	Information Request and Response
		radiation dose to members of the public, including Indigenous persons, from the DGR would be well below the 1 mSv/a regulatory limit. Overall, taking into consideration mitigation measures, none of the above pathways are expected to contribute to unacceptable risks to Indigenous peoples' health. *Comparison of Locations* Potential effects on Indigenous peoples' health are identified for all three locations considered as a result of changes in physical factors of health (e.g., air quality/acrolein, noise). There would be increased air emissions at the two alternate locations relative to the Bruce Nuclear site; however, background air quality is likely lower at the alternate locations. Similarly for noise, lower background levels may result in higher magnitude effects at the crystalline location than at either the sedimentary alternate location or the Bruce Nuclear site. When considering the effect of these changes on human health, the distance to the closest receptor would influence the magnitude of the potential effect, and some adverse effects could be avoided through siting. At the alternate locations there would also be potential for additional effects from changes in air quality emissions (including acrolein) and noise levels associated with the transportation of waste from the WWMF to the alternate location, as well as incremental operation of vehicles, equipment and material handling during the site preparation and construction phase of the Project due to additional site infrastructure requirements. Specifically, the response to Information Request 1.5 notes that the emissions of acrolein anticipated from the handling and transportation of waste from the WWMF to either the sedimentary alternate location, or the crystalline alternate location, would be greater than emissions of acrolein generated through the handling and transfer of waste from the WWMF to the proposed DGR site at the Bruce Nuclear site. <u>Socio-economic Conditions</u> Implementation of a DGR may affect VCs and socio-economic factors within the socio-economic environment. Many effects would be beneficial, and may serve to enhance community well-being including: • increased employment and income associated with workers, payroll and purchasing in nearby Indigenous peoples; • increased educational opportunities for local students and others with an interest in nuclear technology; • the creation of new direct, indirect and induced employment opportunities through project spending; and • increased business activity through policies to utilize local business services wherever practical and appropriate. Adverse effects on socio-economic VCs and socio-economic factors of health may occur due to changes in the environment, such as nuisance effects to nearby land users associated with visibility of project infrastructure, noise, dust and vibrations, and depletion of resources (e.g., forestry resources) through land clearing. These effects were considered through discussion of potential effects on the land and resource use VC (Section 5.4.7 of the Study of Alternate Locations Main Submission [OPG 2016]), and are summarized below under *Current Use of Lands and*

IR #	IR Title	Information Request and Response
		Resources for Traditional Purposes. Examples of indirect adverse effects that may result include changed demands for housing and accommodation if an increase in population levels is realized, or changes to community character. *Potential Effects at the Bruce Nuclear Site* Potential effects on Indigenous peoples with respect to the DGR Project at the Bruce Nuclear site are described in Section 7.9 of the EIS [OPG 2011a]. The assessment identified potential positive effects related to direct, indirect and induced employment opportunities, as well as generation of business activity through household spending due to project expenditures and payroll. No adverse effects were identified through indirect pathways (e.g., air quality and noise). *Potential Effects at the Sedimentary Alternate Location* Potential effects on Indigenous peoples near the sedimentary alternate location include those outlined above (i.e., beneficial effects, indirect nuisance effects). However, the specific scope and nature of socioeconomic interactions that may result from the DGR at the sedimentary alternate location would ultimately be determined by a knowledgeable community making an informed decision on whether to accept the responsibility of hosting the facility following a process for the identification, management and mitigation to avoid or minimize adverse effects. *Potential Effects at the Crystalline Alternate Location* Potential effects on Indigenous peoples near the crystalline alternate location include those outlined above (i.e., beneficial effects, indirect nuisance effects). Similar to the sedimentary alternate location, the specific scope and nature of socioeconomic interactions that may result with a DGR would follow a process for the identification, management and mitigation to avoid or minimize adverse effects. However, given the more remote nature of the crystalline alternate location, and the generally smaller size of the Indigenous peoples, the magnitude of socio-economic effects may be more pronounced in the more remote Indigenous peoples. *Comparison of Locations* Potential effects on socio-economic factors are identified for all three locations considered. Overall, the magnitude of effects is likely to be similar between locations; however, they may be more pronounced in Indigenous peoples in the crystalline alternate location. Current Use of Lands and Resources for Traditional Purposes Construction and operation of a DGR has the potential to affect current use of lands and resources. Considering the *Technical Guidance for assessing the Current Use of Lands and Resources for Traditional Purposes under the Canadian Environmental Assessment Act, 2012* [CEAA 2015], the following sections describe how potential changes to the environment caused by a DGR may affect the current use of lands and resources for traditional purposes. The discussion is focused on the potential for the DGR to affect the quality of or access to lands currently used for

IR #	IR Title	Information Request and Response
		traditional activities such as hunting, trapping, fishing and gathering. Potential effects on spiritual or cultural sites are described under *Physical and Cultural Heritage Resources*, below. *Potential Effects at the Bruce Nuclear Site* Current use of lands and resources for traditional purposes by Indigenous peoples at and surrounding the Bruce Nuclear site is described in Section 6.9 of the EIS [OPG 2011a]. Given that the DGR Project is proposed within the existing licenced Bruce Nuclear site, an existing nuclear facility with supporting infrastructure, there were no likely effects on access to lands currently used for traditional purposes. No measurable changes in the biophysical environment were identified off-site that could affect hunting, trapping, fishing and gathering (e.g., no changes to water quality were identified in Lake Huron, and therefore there are no potential effects on the local First Nations fishery). *Potential Effects at the Sedimentary Alternate Location* The potential for the sedimentary alternate location to affect the current use of lands and resources for traditional purposes was considered through the use of the Lands and Resources VC in Section 4.7 of the Environmental Effects at Alternate Locations report [GOLDER 2016], and is discussed further below. A DGR at the sedimentary alternate location is likely to be located in the traditional territory of one or multiple Indigenous peoples. The sedimentary alternate location is densely populated and highly developed commercially and agriculturally, with pervasive infrastructure and cultivated agricultural land usage. As such, the Aboriginal and treaty rights at this location (e.g., access to lands for hunting, fishing, harvesting, etc.) are, to a degree, already circumscribed by development (for further information see response to Information Request 1.15). Establishment of a new secured site through the acquisition of land for industrial purposes (i.e., a DGR) could result in the removal of lands that were used for fishing, camping, hunting, or other traditional purposes and therefore have a direct effect on access to those lands for traditional purposes. Increased nuisance-related effects (e.g., dust, noise, light) as a result of the construction and operation of the DGR would also have potential indirect effects on the quality of surrounding land for fishing, hunting, trapping and/or gathering. Changes to air quality, noise levels, surface water quality, groundwater quality and soil quality at the sedimentary alternate location are discussed in Section 4 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. These indirect pathways were also considered in Sections 4.3 and 4.4 of [GOLDER 2016] for their potential to affect aquatic and terrestrial biota; they are discussed further below for their potential to affect current use of lands and resources. • No direct effects on aquatic habitat at the sedimentary alternate location are likely, although indirect or contributing habitat may be affected through construction of surface facilities. In addition, no adverse effects on surface water quality are likely. Therefore, no adverse effects on aquatic biota VCs (i.e., fish) are likely and there would be no potential effect on access to or quality of fisheries. • Direct effects on vegetation at the sedimentary alternate location through construction of surface facilities are likely, resulting in a potential indirect effect on wildlife habitat. The fragmentation of habitats through

IR #	IR Title	Information Request and Response
		vegetation removal may disrupt current uses of land and resources for traditional purposes (see also response to Information Request 1.14). Further encroachment on remnant plant communities or smaller wetland communities may further reduce the potentially already restricted ability of traditional users to access lands and resources (e.g., for hunting or gathering). The magnitude and importance of such changes would need to be assessed in consultation with local communities as part of a site selection process. • Increases in noise levels are predicted in the vicinity of the sedimentary alternate location, which may also have an indirect effect on the quality of wildlife habitat. These changes may also contribute to an adverse effect on the quality and availability of lands for the purposes of hunting, gathering or camping. *Potential Effects at the Crystalline Alternate Location* The potential for the crystalline alternate location to affect the current use of lands and resources for traditional purposes was considered through the use of the Lands and Resources VC in Section 5.7 of the Environmental Effects at Alternate Locations report [GOLDER 2016], and is discussed further below. A DGR at the crystalline alternate location is likely to be located in the traditional territory of one or multiple Indigenous peoples. The crystalline alternate location is less encumbered by overall development, with Indigenous people potentially being able to exercise a greater range of Aboriginal and treaty rights over a correspondingly larger traditional territory due to a lack of the pervasive infrastructure typical of the sedimentary alternate location (such as, highways, rail lines, and farms) as well as a lower population density meaning less competition for traditional resources, i.e., trapping, hunting, fishing, harvesting. Therefore, a DGR in this location is more likely to be sited on land that is actively used by Indigenous peoples (see response to Information Request 1.15 for further information). Construction of a DGR at the crystalline alternate location would require the establishment of a new secured site through the acquisition of land for industrial purposes (i.e., a DGR). The site and required supporting infrastructure may result in the removal of lands that are currently used for fishing, camping, hunting, or other traditional purposes, therefore resulting in a direct effect on access to those lands for traditional purposes. Construction and operation of the DGR would also have potential indirect effects on the quality of surrounding land for fishing, hunting, trapping and/or gathering due to increased nuisance-related effects (e.g., dust, noise, light). Changes to air quality, noise levels, surface water quality, groundwater quality and soil quality at the crystalline alternate location are discussed in Section 5 of the Environmental Effects of Alternate Locations report [GOLDER 2016]. These indirect pathways were also considered in Sections 5.3 and 5.4 of [GOLDER 2016] for their potential to affect aquatic and terrestrial biota. These are discussed further below for their potential to affect current use of lands and resources. • Direct habitat loss is probable at the crystalline alternate location as a result of siting of surface facilities and infrastructure (e.g., an access road). Changes in water quality would be mitigated such that there would be no adverse effects on aquatic biota. Potential changes to aquatic habitat are likely to be mitigated such that there are no effects on aquatic biota VCs. Therefore, no adverse effects on the access to or quality of fishing or fisheries are likely. • Direct effects on vegetation at the crystalline alternate location through construction of surface facilities and

IR #	IR Title	Information Request and Response
		additional linear infrastructure are likely, which would have a potential indirect effect on wildlife habitat through habitat loss and fragmentation. This in turn results in a potential effect on the quality of lands for hunting, gathering and camping. • In addition, increases in noise levels are predicted, which may also have an indirect effect on the quality of wildlife habitat. As background noise levels are assumed to be lower, with few anthropogenic sources at the crystalline alternate location, wildlife may not be habituated to the increased noise and activity levels from construction. These changes may result in an indirect effect on the quality of lands for the purposes of traditional uses such as hunting, gathering or camping. *Comparison of Locations* Overall project-related effects of the DGR at either alternate location on current use of lands and resources are likely to be greater in magnitude than those related to the Bruce Nuclear site. Up to 40 ha of clearing is assumed to be required, and would likely include some areas that have not been previously disturbed in the crystalline alternate location or may include some areas that have not been previously disturbed in the sedimentary alternate location, and would therefore, have land use potential. Up to 900 ha will need to be repurposed from its existing land use potentially affecting current uses/users of the land and surrounding lands. Clearing and repurposing of the land will also have direct and indirect effects on vegetation communities and wildlife[2], which in turn may affect Indigenous interests such as hunting, fishing, trapping or gathering. In addition, background levels of nuisance-related environmental pathways (e.g., noise) are likely to be lower; therefore, changes as a result of the project may be more pronounced, potentially necessitating additional mitigation. <u>Physical and Cultural Heritage Resources, Including Structures, Sites or Things that are of Historical, Archaeological, Paleontological or Architectural Significance</u> As defined in the *Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site or Thing that is of Historical, Archeological, Paleontological or Architectural Significance under the Canadian Environmental Assessment Act, 2012* a physical and cultural heritage resource may include any structure, site or thing with value associated with one or more important aspects of human history or culture; historical, archaeological, paleontological or architectural significance; or association with a particular group's practices, traditions or customs. Construction and operation of a DGR has the potential to affect physical and cultural heritage resources directly and indirectly as discussed below. *Potential Effects at the Bruce Nuclear Site* Physical and cultural heritage resources, including structures, sites or things that are of historical, archaeological, paleontological or architectural significance were addressed in Section 6.9 of the EIS [OPG 2011a]. A residual adverse effect occurs to the Indigenous Heritage Resources VC from the DGR Project as it is likely to diminish the quality or value of activities undertaken by Indigenous peoples at the burial site located at the Bruce Nuclear site. As a

[2] Effects of emissions from the project are not predicted to affect health of vegetation and wildlife in the vicinity of the Project.

IR #	IR Title	Information Request and Response
		result, a residual adverse effect on Indigenous heritage resources is expected to occur during all phases of the DGR Project. This results from changed aesthetics (associated with visibility of the DGR Project), and temporarily increased noise and dust. The DGR Project will not change the access to the burial site nor the ability of Indigenous peoples to undertake their cultural/ceremonial activities at this site. *Potential Effects at the Sedimentary Alternate Location* In considering the implementation of the DGR at the sedimentary alternate location, it is assumed that the site could be located to avoid physical and cultural heritage resources. The identification of physical and cultural heritage resources would be done as part of a site selection process (i.e., during the technical screening of potential sites and the detailed investigations of identified preferred sites). In the unlikely event that unanticipated physical or cultural heritage artifacts were to be discovered as a result of site preparation and construction at the sedimentary alternate location, mitigation measures could be implemented to assess and conserve the cultural heritage value of the artifacts. *Potential Effects at the Crystalline Alternate Location* Similar to the sedimentary alternate location, it is assumed that the crystalline site could be located to avoid physical and cultural heritage resources as part of a site selection process. In the unlikely event that unanticipated physical or cultural heritage artifacts were to be discovered as a result of site preparation and construction at the crystalline alternate location, mitigation measures could be implemented to assess and conserve the cultural heritage value of the artifacts. *Comparison of Locations* Given that an adverse residual effect to heritage resources was identified for the DGR Project at the Bruce Nuclear site, the opportunity to screen and select an alternative location that would avoid Indigenous heritage resources altogether represents an opportunity to decrease effects to physical and heritage resources. However, the residual adverse effect associated with the DGR at the Bruce Nuclear site was not considered to be significant because the burial site is located on an existing industrial site, and would likely be affected by dust and noise infrequently. It is considered unlikely that ceremonies would occur during these times. Apart from the visibility of the waste rock pile, adverse effects over the long term were not anticipated. Harm and/or Risk Reduction of Constructing the DGR at an Alternate Location on Indigenous Peoples in the Preferred Project Area The types of interactions between the DGR Project, whether implemented at the Bruce Nuclear site or one of the alternate locations, would be similar for potentially affected Indigenous peoples. As noted above, the overall effect to land use may be much greater at an alternate location compared to that at the existing Bruce Nuclear site; however, there is the potential that an alternate site could be located so that it avoids effects to heritage resources altogether. Therefore, the construction of a DGR at an alternate location would result in the potential transfer of risk from one affected community to one or more others rather than the complete removal or reduction of overall risk.

IR #	IR Title	Information Request and Response
		Moreover, there is the potential that the total risk may be increased on Indigenous peoples if the DGR is constructed at an alternate location, this due to the introduction of a new facility in an area previously without a nuclear facility as well as the transportation of wastes to that facility. OPG acknowledges the SON's assertion that implementation of the DGR at an alternate location may distribute risk away from SON. OPG is prepared to continue its consultation with SON regarding this and other ongoing assertions regarding the potential effects of existing and future nuclear projects on the spiritual and cultural relationship between the SON people and their Territory, their use of lands, waters, resources and economy. OPG has committed to the SON that OPG will not move forward with the construction of a DGR at the Bruce Nuclear site for low and intermediate level waste until SON is supportive of the Project. Further OPG and SON have committed to the good faith, informed resolution of potential Project impacts through the ongoing engagement between SON and OPG. The SON have further commented, that these commitments are not mere acknowledgements of social commitments to the SON; they are the mitigation mechanisms in respect of potential impacts to SON that can only be identified, understood and resolved through a process with SON and its communities. The SON have gone on to state [Saugeen Ojibway Nation 2017] that "Since August 7, 2013, SON and OPG have been working together pursuant to the SON-OPG commitment to understand and address legacy issues relating to OPG's operations within the SON Territory and to understand issues relating to the proposed DGR Project". SON has indicated that for the last 40 years, the SON communities have had to bear the risks and impacts associated with the facilities at the Bruce Nuclear site which hosts the world's largest operating nuclear facility, 40 percent of Canada's used nuclear fuel, and almost all of Ontario's low and intermediate level waste. SON has suggested that the existing development at the Bruce Nuclear site could work against situating the DGR Project there because of the additional harm and risk to which the SON communities could be exposed. SON has further indicated that additional processes - pursuant to the commitments given by OPG to SON - are required to determine the potential impacts to SON, the significance of those impacts, and the manner in which they can be mitigated. SON has also indicated that the commitments are the mitigation mechanisms in respect of potential impacts to SON that can only be identified, understood, and resolved through a process with SON and its communities. OPG is committed to working with SON in this regard. HSM and MNO through their engagement with OPG and the Canadian Environmental Assessment Agency (the Agency), has continued to provide input on the DGR project and the range of associated studies. For example, the MNO has expressed concerns that the removal of land from its previous use is central to identifying potential impacts to Métis harvesters and that Métis-specific VCs should be included in future assessments (see also response to Information Request 1.14). HSM has indicated that they expect to be included in future monitoring. United Chiefs and Councils of Mnidoo Mnising (UCCM) represents six Abishnawbe First Nations in Ontario: Aundeck Omni Kaning, Sheguiandah, M'Chigeeng, Sheshegwanining, Whitefish River and Zhiibaahaasing, all located in the Manitoulin Island region. UCCM's role is to represent their interests and rights. UCCM stated in its written submission

IR #	IR Title	Information Request and Response
		to the Agency that UCCM does not believe that the DGR process to date adequately addresses their concerns or accommodate their interests regarding the perceived risks associated with the DGR project at the Bruce Nuclear site, and that in their view there may be no safe place to store radioactive waste. UCCM has, in its written submissions, noted that many of the studies do not incorporate Indigenous traditional knowledge; e.g., the interconnectedness of the environment from an Indigenous perspective. UCCM is seeking participation in mitigation and monitoring plans and asserts that a DGR location in the Bruce area is part of its traditional territory. Wikwemikong Unceded Territory is centred on the eastern end of Manitoulin Island located within 160 kilometres of the proposed DGR site. The community is made up of Anishnaabe peoples who have indicated that they have continually occupied the island since time immemorial. Wikwemikong is not supportive of a DGR project at the Bruce Nuclear site for a variety of reasons which were detailed in its submission to the Agency including concerns about proximity to Lake Huron; the potential for radioactive leakage to affect clean water supplies and the economic livelihood of community members; and that monitoring will have to be continuous (i.e., a human presence is required). The studies of the DGR Project at the Bruce Nuclear site to date have indicated no effect on Indigenous peoples compared to non-Indigenous peoples that would be significantly adverse. OPG will continue to reach out to both UCCM and Wikwemikong to establish a dialogue and address their concerns. Such concerns are potentially indicative of the nature of concerns that may be perceived in either alternate location. **References:** CEAA. 2015. *Technical Guidance for assessing the Current Use of Lands and Resources for Traditional Purposes under the Canadian Environmental Assessment Act, 2012.* GOLDER. 2016. *Environmental Effects of Alternate Locations*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883) OPG. 2011a. *Environmental Impact Statement, Volume 1*: Main Report. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298) OPG. 2011b. *Environmental Impact Statement, Volume 2*: Appendices. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298) OPG. 2016. *Study of Alternate Locations Main Submission*. Ontario Power Generation Report 00216-REP-07701-00013-R000. (CEAA Registry Doc# 2883) Saugeen Ojibway Nation. 2017. Letter from Chief and Council to the Honourable Catherine McKenna, Minister of Environment and Climate Change. *SON Preliminary Comments on OPG Response to Information Requested by the Minister of Environment and Climate Change.* March 7, 2017.

IR #	IR Title	Information Request and Response
IR-1.14	Terrestrial Environment	***Information Request:*** • *Provide a brief discussion on the potential effects of the terrestrial environment as a result of clearing and excavation at the sedimentary location.* • *Discuss how increased fragmentation of the sedimentary location will affect traditional land use in the area.* ***Rationale:*** *OPG's "Environmental Effects of Alternate Locations" report (page 29) states that no measureable changes to soil quality, groundwater quality or groundwater flow are likely outside the immediate footprint of the DGR at the sedimentary location. Given that the preferred location at the Bruce site it is an existing Nuclear facility, it can be reasonable concluded that there may be no measurable changes to these VCs. However, given that the alternate sedimentary location would have to be cleared and excavated, it is difficult to understand that there would be no changes.*
		OPG Response: For the site preparation and construction of the DGR at the sedimentary alternate location, additional lands would have to be cleared and developed for necessary infrastructure. Overall, it is assumed that a minimum of 9 ha (equivalent to area of woodland to be cleared at the Bruce Nuclear site), and up to 40 ha (equivalent to the total project surface facilities footprint) of natural vegetation would be removed as part of site preparation and construction. In addition, the full site would be fenced (up to 900 ha). This may cause fragmentation of habitats and a potential effect on wildlife Valued Components (VCs). However, for the sedimentary alternate location, considering the regional setting, there is a high probability that the land has already been anthropogenically altered (i.e., historical agricultural, commercial or industrial disturbances). As noted in Crins et al. [2009], the land cover in this eco-region is fairly disturbed and it is likely that few natural plant communities or small, remnant pockets of natural plant communities exist on the landscape. Therefore, it is likely that the development of a DGR in this location would site infrastructure to avoid the remaining intact natural features where possible and as such it is anticipated that minor removal of natural vegetation would be required. In general, the spatial extent of natural plant communities and wetlands at the sedimentary alternate location would likely be limited because of extensive anthropogenic influences (i.e., alteration due to land development pressure such as drainage for agriculture, and filling in for urban development) [Ontario's Biodiversity Council 2015; NRCAN 2008]. The smaller amount of natural plant community and wetland cover on the landscape does increase the importance of each remaining natural plant and wetland community as it must perform the same biological, hydrological, social and cultural functions to ensure ecosystem integrity than regions with more extensive and intact natural plant community and wetland cover. These natural plant communities and wetlands have the potential to be more sensitive to the incremental effects of further development such as a DGR.

IR #	IR Title	Information Request and Response
		As described in Section 4.5 of the Environmental Effects of Alternate Locations report [GOLDER 2016], no measurable changes to soil quality, groundwater quality or groundwater flow, are likely outside the footprint of the DGR. Similarly, as described in Section 4.2 [GOLDER 2016], changes in surface water quality, quantity and flow, are also not likely to be measurable as a result of the project outside the footprint. Therefore, no indirect effects on vegetation or wildlife VCs are likely through these pathways. Overall the potential changes in the quantity and quality of plant communities and wildlife and wildlife habitat may have an adverse effect on biodiversity (i.e., a reduction in the variety of vegetation and wildlife habitats and species) in the 40 ha project site at the sedimentary alternate location. However, the land cover in this ecoregion is fairly disturbed [Crins et al. 2009] and few natural plant communities would likely be removed as part of the Project. In addition, the site would be re-vegetated during decommissioning. Generally, the historic loss of natural plant communities at a sedimentary location would mean an increase in the importance of those remaining communities. However, those communities would be well-defined on the landscape and thus can be avoided for the most part by appropriate siting of DGR infrastructure. Therefore, it is assumed that because this eco-region is disturbed in the current state, that fewer natural communities will require removal for the development of a sedimentary location DGR. Overall, it is likely that any adverse effects to biodiversity would be of low magnitude. The fragmentation of habitats through vegetation removal may disrupt current uses of land and resources for traditional (i.e., Indigenous) purposes. Additionally, further encroachment on remnant plant communities or smaller wetland communities may further reduce the potentially already restricted ability of Indigenous and other users to access lands and resources. The magnitude and importance of such changes would need to be assessed in consultation with local communities as part of a site selection process, especially with regard to Aboriginal and treaty rights. Appropriate mitigation would also be identified in consultation with all local communities to minimize these potential effects (i.e., removal of naturally occurring plant communities and wetlands that are used for traditional purposes, or fragmentation of habitats that disrupt those current uses). Additionally in this response, OPG acknowledges the matters raised by the Métis Nation of Ontario. The Métis are one of three distinct Aboriginal peoples in Canada, whose rights, interests and way of life are constitutionally protected under Section 35 of the Constitution Act, 1982. In its ongoing work with OPG, the MNO has prepared a "DGR Project Specific Traditional Use Study" to help inform the monitoring program. In that work, the MNO have identified key traditional land use activities including hunting, trapping, fishing, gathering, occupation and access, cultural sites and places and traditional ecological knowledge. The report also discusses Métis use to include harvested plants and animals for subsistence, medicinal, cultural purposes and for crafts, former village sites, ceremonial sites/places, burial sites, trading posts, sacred/spiritual sites, important landscape features and contemporary gathering places.

IR #	IR Title	Information Request and Response
		OPG has assumed that similar concerns about potential effects on traditional land uses may be expressed in the alternate locations, including for example: • reluctance to continue to use the land in proximity to the Project; • whether the DGR would change perception of the land in the vicinity of the Project, thereby potentially impacting use of the area; • potential biophysical effects of the DGR Project, need for assurances that the plants and animals are safe in the area; and • how future effects from the DGR Project may impact generations to come. **References:** Crins, W.J., P.A. Gray, P.W.C. Uhlig and M.C. Wester. 2009. *The Ecosystems of Ontario, Part 1: Ecozones and Ecoregions.* Ministry of Natural Resources Science and Information Branch: Inventory, Monitoring and Assessment Section. Technical Report SIB TER IMA TR-01. GOLDER. 2016. *Environmental Effects of Alternate Locations*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883) NRCAN. 2008. *Deforestation in Canada-What are the Facts?* Natural Resources Canada, Canadian Forest Service Science-Policy Notes. Ontario's Biodiversity Council. 2015. *Extent of Wetland Cover and Wetland Loss*. Website accessed April 24, 2017. http://sobr.ca/indicator/loss-of-wetlands/
IR-1.15	Indigenous Interests	***Information Request:*** *Provide a description of the land and resource uses for the alternative locations that highlight the unique characteristics of these locations from the perspective of Indigenous peoples (e.g. land availability for traditional uses, access, etc.).* ***Rationale:*** *The concepts of land removal, current land use activities and access are important to understanding potential impacts to Indigenous rights and interests. Despite the range of environmental conditions presented for the two alternate locations, the description of land and resource use in the “Environmental Effects of Alternate Locations” report is nearly identical.*

IR #	IR Title	Information Request and Response
		OPG Response: Consistent with its Indigenous Relations Policy, OPG respects the Aboriginal and treaty rights, and associated constitutional rights, of Indigenous people. OPG has committed in its Indigenous Relations Policy to building long term, mutually beneficial relationships with Indigenous peoples near its present and future operations. OPG's business plans include the following areas specific to this policy; community relations; community capacity building; employment opportunities; business and procurement opportunities; and staff Indigenous relations training. OPG's commitments are made on its own behalf and not on behalf of the Crown or any other government agency (Section 53.1(2) of the *Electricity Act, 1998*). It should be noted that Indigenous peoples and communities are found throughout both alternate locations. Indigenous peoples also have access to traditional territories in both alternate locations, and additionally, a series of treaties between First Nations and the Crown cover both alternate locations. Should an alternate location be selected for the DGR project, OPG would identify the affected Indigenous peoples and engage in a robust consultation process with them in order to assess potential impacts to their Aboriginal and treaty rights. First Nations have both a distinct boundary based on the Indian Reserve system established by the federal government and Métis communities are also located throughout the province. Indigenous peoples in both alternate locations have Aboriginal and treaty rights, which are recognized under Section 35 of the *Constitution Act, 1982*. These rights are based on traditional uses and treaties and are often related to, but not limited to, lands for hunting, fishing, harvesting (including traditional medicines) as well as engaging in cultural practices, often in association with sacred sites. Several First Nation representative organizations, such as the Nishnawbe-Aski Nation (NAN), Chiefs of Ontario (COO) and the Association of Iroquois and Allied Indians (AIAI), have passed a series of resolutions between 2006 and 2015 against nuclear waste storage in certain parts of the province (e.g., near the Great Lakes, northern Ontario). They have also called for a moratorium on the production of any more nuclear waste, which would necessitate a shut-down of all nuclear reactors. Should either alternate location be selected, in addition to engaging local Indigenous communities in order to find a willing host site, OPG would have to address with these representative bodies their opposition to the DGR concept. This process would likely be a complex and lengthy one.

IR #	IR Title	Information Request and Response
		<u>Sedimentary Alternate Location</u> The sedimentary alternate location contains predominantly arable land and built areas [Statistics Canada 2017][3]. Agriculture accounts for much of the land use in this area. The grey-brown luvisolic soils of southern Ontario developed under forest vegetation from till and glacial deposits are reasonably fertile. Deltas, left behind from the ice age, form sand plains, especially to the north of Lake Erie. Forage crops are the most predominant, but corn, mixed grains, winter wheat and barley are also grown. Because of these forage crops, Ontario is able to sustain commercial hog, dairy and beef livestock farms. It ranks second only to Québec in dairy farms, which are primarily located in the London-Woodstock region, the Bruce Peninsula and in eastern Ontario [The Canadian Encyclopedia 2017]. New developments in areas that are extensively developed and previously disturbed, such as in the sedimentary alternate location, can still introduce environmental concerns and affect Indigenous interests. While transportation corridors and transmission lines are pervasive, the acquisition of land for industrial purposes in an area that is largely arable could result in the removal of lands that are used for fishing, camping, hunting, harvesting; effects on resources (e.g., loss of fisheries, displacement of wildlife) and/or increased nuisance-related effects (e.g., dust, noise, light). These types of effects may be of particular importance to local Indigenous peoples, and may have an effect on Indigenous peoples’ current use of lands, waters and resources for traditional purposes, especially if such uses have already been greatly restricted due to treaties, non-traditional uses and other causes. According to the most recent data available from 2011, Statistics Canada reports that 214,200 Indigenous people live in the sedimentary alternate location. However, Indigenous community representatives report that the population is higher, perhaps significantly. Statistics Canada notes that an undercount occurs because some communities choose not to complete the census [Statistics Canada 2011]. Lack of a home address is another factor, while Indigenous community members also report to OPG that they received census forms that did not ask them to self-identify as an Indigenous person. There are no Inuit interests in the sedimentary alternate location. The sedimentary alternate location is densely populated and highly developed commercially and agriculturally, with pervasive infrastructure and cultivated agricultural land usage. As such, the Aboriginal and treaty rights as described above (e.g. access to lands for hunting, fishing harvesting, etc.) are, to a degree, already circumscribed by development. This may mean that any further effect on Aboriginal and/or treaty rights is critical. In any event, if OPG undertakes a site selection process, OPG would consult with the affected Indigenous peoples based on community location, relevant treaties and traditional territories. It is assumed that appropriate mitigation and accommodation measures could be applied to address potential effects on current use of lands and resources for traditional purposes, or other issues that could be raised during consultation on Indigenous interests, including Aboriginal or treaty rights. Published reports from Indigenous peoples in the sedimentary alternate location, such as the Aamjiwnaang First Nation’s Land Use Study, indicate concerns about air quality, noise and vibration from increased industrialization as

[3] Statistics Canada 2017. Human Activity and the Environment 2016: Freshwater in Canada is an annual publication of Statistics Canada which includes maps, tables and charts on among other things, land cover for each of Canada’s 25 drainage regions. The crystalline alternate location includes portions of the Northern Ontario, Winnipeg and Great Lakes Drainage Regions.

IR #	IR Title	Information Request and Response
		well as perceptions of contamination, (e.g., from the petroleum refinement process, industrial fires, pipeline failures) which may restrict harvesting for traditional and commercial purposes. These concerns may be of particular importance when considering the potential effects of new development and will need to be mitigated and/or offset in conjunction with the affected communities. <u>Crystalline Alternate Location</u> The crystalline alternate location consists almost entirely of natural and semi-natural areas — arable land, natural land for pasture and built-up areas combined accounts for less than 2% of the total land area (less than 1% in the northern portion) [Statistics Canada 2017]. It is mostly, but not entirely, unsuitable for agriculture. Soils are extremely thin and low in fertility, but sufficient to support boreal forests. The forest cover includes bogs containing stunted willows and black spruce, spruce, aspen and jack pine. There is a long history of mineral development beginning in the late 1880s, including exploitation of deposits of nickel, copper, lead, zinc, silver, platinum, gold and uranium. Iron ore is also mined north of Lake Superior [The Canadian Encyclopedia 2017]. New developments in areas that are remote, largely undeveloped or undisturbed as may be found in the crystalline alternate location, can introduce additional environmental concerns and otherwise harm Indigenous interests. For example, transportation corridors (all-season roads or railways) and transmission lines can result in fragmentation of both terrestrial and aquatic habitat, which can result in impacts on migration and daily wildlife movements. In addition, transportation corridors can result in: • ongoing disturbance to wildlife due to noise, traffic and dust; • impacts on stream morphology and flow; • increased sedimentation of water bodies from road runoff; • increased access and traffic to remote or wilderness areas, increasing fishing and hunting pressure as well as other resource development (logging, mining, other human use and presence); and • fragmentation and disturbance of major rivers, wetland areas and protected areas. According to the 2011 data from Statistics Canada, 95,645 Indigenous people reside in the crystalline alternate location. Again, Indigenous community members reported to OPG that the population is higher (see explanation above.) There are no Inuit interests in the crystalline alternate location. The following statements are intended to answer the question of comparative analysis between the Bruce Nuclear site and alternate locations but are not intended to diminish the concerns expressed by Saugeen Ojibway Nation as described in Section 1.13. The crystalline alternate location is much less encumbered by overall development, due to a lack of the pervasive infrastructure typical of the sedimentary alternate location (highways, rail lines, farms) as well as a lower population density, meaning less competition for traditional resources, i.e., trapping, hunting, fishing, harvesting. It follows that a DGR in this location is more likely to be sited on land that is currently used by Indigenous people. The types of effects

IR #	IR Title	Information Request and Response
		associated with transportation corridors and transmission line development may be of particular importance to Indigenous peoples. • Linear development may have an effect on an Indigenous peoples' current use of lands, waters and resources for traditional purposes (e.g., the introduction of herbicides or pesticides along a transmission line may result in reluctance to harvest or gather food plants from those areas); • The influx of project workers and improved access to a designated project area may create greater pressure on and competition for species used by Indigenous peoples, or expose sacred sites (burial grounds, cultural landscapes), ceremonial sites, or places where transmission of cultural knowledge occurs; • Increased access can create external pressures for new or additional developments, which may not be consistent with the views, expectations and plans of Indigenous peoples. While some of these effects may be temporary, some may result in permanent loss or change. That said, if OPG undertakes a site selection process, OPG would consult with the Indigenous peoples impacted based on community location, relevant treaties and traditional territories. For example, several northern First Nations have published land use plans [Pikangikum First Nation 2006; Deer Lake First Nation and Ontario Ministry of Natural Resources and Forestry 2015; Cat Lake First Nation, Slate Falls First Nation and Ontario Ministry of Natural Resources 2011] that OPG would be obligated to work with should the DGR be located in the traditional territory of these First Nations. OPG expects that appropriate mitigation and accommodation measures could be applied to address potential effects on current use of lands and resources for traditional purposes, or other issues that could be raised during consultation on Indigenous interests, including Aboriginal or treaty rights. <u>Traditional Knowledge and Land Use (TKLU) [LeBlanc et al. 2011]</u> In terms of land usage, it is common for First Nation communities to undertake traditional knowledge and land use (TKLU) studies as a part of their community planning process and to engage possible proponents on projects, though the Métis Nation of Ontario has informed OPG that it does not use these studies in this way for its purposes. It is important to understand that Indigenous peoples view the land, its flora and fauna, as non-human members of their communities, imbued with spiritual significance. As a result, Indigenous peoples are typically reluctant to share detailed TKLU data in order to protect the precise locations of sacred sites, important harvesting areas, medicines, and other culturally important locations from unauthorized access and use. However, some general considerations can be determined. Indigenous peoples underpin the stewardship of their traditional lands with both their long oral history and their Aboriginal and treaty rights. It is also common for First Nations, such as in the case of those land use studies cited above, to map out specific uses for lands and bodies of water. This is sometimes described as values mapping, which identifies and defines the expectations of various zones. Such zones might include: • zones for sustainable development (e.g., areas of resource development where the community will benefit through partnerships with proponents while minimizing impacts to the environment);

IR #	IR Title	Information Request and Response
		• zones for traditional uses by community members (e.g., hunting, fishing, trapping, harvesting); • zones for eco-tourism; and • zones where there is to be little or no human presence at all. OPG has participated in TLKU studies with Indigenous peoples in the past and seeks to work supportively and collaboratively to incorporate traditional knowledge into mitigations and/or accommodations for Project related impacts to Indigenous interests. There is also an opportunity to impart economic benefits to Indigenous peoples through employment and procurement based on the larger population in the alternate locations and greater access to education, training and business opportunities; OPG would undertake efforts to do so as part of a site selection process. **References:** Cat Lake First Nation, Slate Falls First Nation, Ontario Ministry of Natural Resources. 2011. Cat Lake - Slate Falls Community Based Land Use Plan. July, 2011. Retrieved from URL https://dr6j45jk9xcmk.cloudfront.net/documents/2293/cat-lake-slate-falls-community-based-land-use-plan.pdf Deer Lake First Nation, Ontario Ministry of Natural Resources and Forestry. 2015. *Deer Lake First Nation Draft Community Based Land Use Plan*. June, 2015. Retrieved from URL http://apps.mnr.gov.on.ca/public/files/er/DeerLakeDraftPlan.pdf Pikangikum First Nation. 2006. *Keeping the Land: A Land Use Strategy*. 2006. Retrieved from URL http://www.whitefeatherforest.ca/wp-content/uploads/2008/06/land-use-strategy.pdf LeBlanc, J.W.; McLaren, B.E.; Pereira, C.; Bell, M. and Atlookan, S. 2011. *First Nations Moose Hunt in Ontario: A community's Perspectives and Reflections*. Alces 47: 163-174. Available at http://alcesjournal.org/index.php/alces/article/viewFile/97/119 Statistics Canada. 2011. *Aboriginal Peoples in Canada: First Nations People, Métis and Inuit*. Available at http://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-011-x/99-011-x2011001-eng.cfm Statistics Canada. 2017. *Human Activity and the Environment 2016: Freshwater in Canada*. Available at http://www.statcan.gc.ca/pub/16-201-x/16-201-x2017000-eng.htm The Canadian Encyclopedia. 2017. *Ontario*. Available at http://www.thecanadianencyclopedia.ca/en/article/ontario/

IR #	IR Title	Information Request and Response
IR-2.1	Methodology for Temporal Boundaries	***Information Request:*** *Provide a description of the variability in the timelines (upper and lower estimates) during all phases of the Project.* • *Based on that variability, identify the activities that have the potential to overlap with the APM DGR project, and the potential cumulative effect on VCs, and;* • *Where the site preparation and construction activities of the Project overlap in time with the APM DGR project, the Western Waste Management Facility or the Project’s expansion at the Bruce site, provide a description of the potential cumulative effects to all VCs, including air quality.* ***Rationale:*** *Figure 2-2 on page 7 of the “Updated Analysis Cumulative Environmental Effects” report provides timelines for the Project at the Bruce Site and the Adaptive Phased Management (APM) DGR project for the disposal of used nuclear fuel. Given that the Project is in the engineering designing phase and the APM DGR project is in the pre-feasibility stage, there could be a large degree of overlap and variability in the timelines for each project. For example, OPG’s analysis found that there is a potential for geographic overlap of effects between the Project and the APM DGR project. However, OPG states that it is likely that activities that generate air emissions associated with each project will occur at the exact same time due to the anticipated infrequent nature of air emissions across the phases of the projects. OPG further states that it is also unlikely that the air emissions will persist in the atmosphere for the same duration and therefore concludes no residual adverse cumulative effect on air quality.* *In order to better predict the range of potential cumulative environmental effects of both projects, there must be an understanding of the variability for the project timelines and where there could be additional overlapping activities.*
		OPG Response: The assessment of cumulative effects conducted in the Updated Analysis Cumulative Environmental Effects report [GOLDER 2016] considered the potential for cumulative effects between the construction, operation, monitoring and decommissioning phases of the OPG DGR and a potential future APM DGR in the communities shown on Figure 4-1 of GOLDER [2016] (i.e., the Township of Huron-Kinloss, Municipality of South Bruce, or Municipality of Central Huron). As shown on Figure 1, the site preparation and construction phases of the two projects are likely to occur at different times, involving little to no overlap, while operations would overlap for about 30 years. Since there is a substantial degree of potential variability in the timelines for both of these projects, when the specific upper and lower estimates will begin or end cannot be identified with confidence. However, the assessment of cumulative effects took this variability into account. Figure 1 shows the earliest reasonably achievable start dates for each project, and the longest predicted duration for each phase. The start dates for either or both projects may be delayed, depending on the timing required for each of the phases, and some of the phases may overlap more or less

IR #	IR Title	Information Request and Response
		through time. To conservatively address all of the described variability in the analysis of potential cumulative effects, it was assumed that all of the effects would overlap temporally for all of the Valued Components (VCs) (as summarized in Table 7-1 of [GOLDER 2016]). Of course, this approach provides the worst case scenario and would likely overestimate the potential cumulative effects.

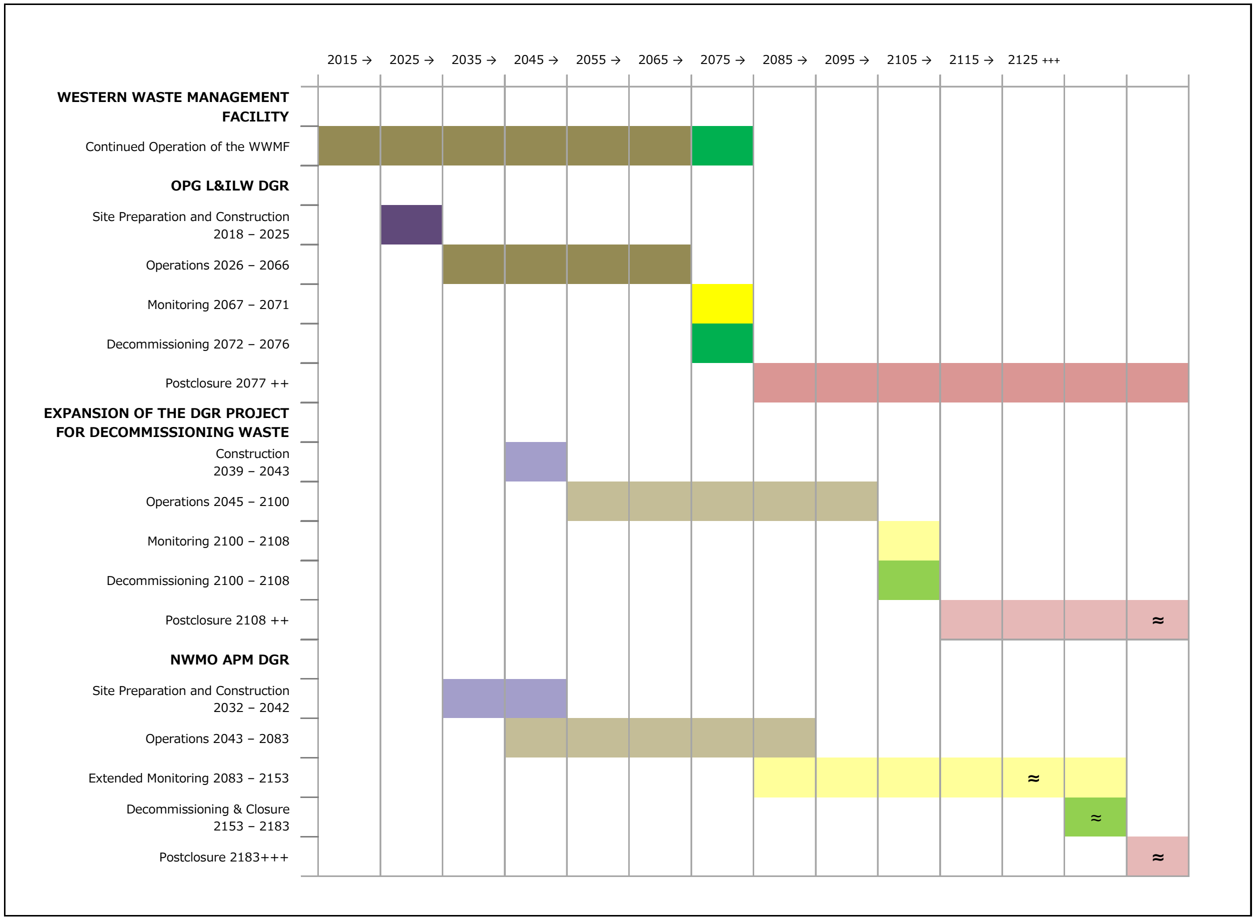


Figure 1. Timelines of the DGR Project at the Bruce Nuclear site and the APM DGR Project

IR #	IR Title	Information Request and Response
		Description of Potential Cumulative Effects With respect to the potential OPG DGR expansion to accommodate decommissioning wastes, similar effects to those identified for the DGR Project would be experienced. Therefore, during a potential expansion, effects similar to the DGR Project construction phase would be predicted, but the effects would occur farther into the future. Subsequent OPG DGR expansion for decommissioning waste would only occur after the proposed DGR construction ends. There is no specific time frame associated with the OPG DGR expansion; however, if construction of the expansion (approximately 5-10 years) were assumed to occur sometime between 2040 and 2080, then there would be a period of overlap with the APM DGR operations. Following construction to expand the OPG DGR, operations would then extend an additional 30 to 40 years, and overlap in time with the APM DGR monitoring. In general, the greatest potential cumulative effects from the two projects (i.e., the DGR Project or the OPG DGR expansion on the one hand and the APM DGR on the other hand) would occur during temporal and spatial overlap of construction activities, and then decrease with any combination of the remaining phases in the life of the projects. Thus, the assessment assumed temporal overlap in construction activities (and future phases) of the two projects so that potential cumulative residual adverse effects would not be underestimated. For greater clarity and to avoid confusion, it should be noted that the operation of the Western Waste Management Facility (WWMF) was included in baseline conditions, and as part of the cumulative effects assessment in the Environmental Impact Statement (EIS) [OPG 2011]. Thus, the operation of WWMF would not further increase the cumulative effects beyond those described in the EIS. As a result of having already applied the most conservative scenario (i.e., construction phases of the APM DGR and the OPG DGR overlap in time – either initial construction or construction for the expansion), the cumulative effects determined in the assessment completed for the atmospheric environment (Sections 5.4 and 5.5 in GOLDER [2016]) would not increase – but would likely be reduced – as a result of using different combinations of temporal overlap between phases of the two projects. Moreover, effects on atmospheric VCs (i.e., air quality and noise levels) are quickly reversible, and are predicted to be infrequent in nature even in the most conservative case. Specifically, concentrations of air quality indicators were predicted to exceed relevant criteria less than 0.5% of the time in a small area immediately adjacent to the Bruce Nuclear site within the Atmospheric Environment Local Study Area (LSA) [GOLDER 2011, OPG 2014]. The Atmospheric Environment LSA extends approximately 10 km around the Bruce Nuclear site. Similar localized and infrequent effects are predicted for the APM DGR, which is anticipated to be located 20 km to 86 km from the OPG DGR project. Consequently, there is predicted to be little to no geographic overlap in residual adverse effects from the two projects on atmospheric VCs. Similarly, the projects are also unlikely to act cumulatively on air quality at the same receptors. For all non-atmospheric VCs, temporal overlap was assumed in the updated assessment of cumulative effects [GOLDER 2016]. Therefore the conclusions would not change in consideration of the other activities noted in the Information Request. Overall, given the anticipated distance between projects and the calculated spatial extent and infrequent nature of effects, cumulative residual adverse effects from the APM DGR and OPG DGR projects on air quality are predicted to

IR #	IR Title	Information Request and Response
		be unlikely. Similarly, potential effects on non-atmospheric VCs were conservatively assumed to persist and overlap in time whether the activities causing the effect occurred at the same time or not; cumulative effects assessment conclusions also would not change (see also response to Information Request 2.2). **References:** GOLDER. 2011. *Atmospheric Environment Technical Support Document*. Prepared by Golder Associates Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-02 R000. (CEAA Registry Doc# 299) GOLDER. 2016. *Updated Analysis of Cumulative Environmental Effects*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP07701-00018-R000. (CEAA Registry Doc# 2883) OPG. 2011. *Environmental Impact Statement, Volume 1: Main Report*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298) OPG. 2014. Letter, Ontario Power Generation to Joint Review Panel, dated March 28, 2014. (CEAA Registry Doc# 1836)
IR-2.2	Methodology for Types of Cumulative Environmental Effects	***Information Request:*** • *Provide a discussion of other types of cumulative environmental effects as a result of the interaction between two or more effects or activities from the APM DGR project and the Project; and,* • *Discuss the potential for smaller, incremental effects from both projects, when combined, to have the potential to have adverse effects over time* ***Rationale:*** *It is important to consider the various ways cumulative environmental effects may interact and manifest themselves in order to meaningfully predict, monitor and mitigate them. On page 15 and 33 of the "Updated Analysis of Cumulative Environmental Effects" report, radiation and radioactivity, including radiological emissions during all phases of the Project, were deemed to have the potential for additive cumulative environmental effects with the APM DGR project; however, OPG did not consider compensatory, masking or synergistic types of cumulative environmental effects in its discussion of all VCs.* *On page 8 of the "Updated Analysis of Cumulative Environmental Effects" report, OPG describes the residual adverse effects from the Project. However, on page 10, OPG lists all the VCs for which there are no residual effects adverse effects from the Project. Using the same methodology as in the EIS, OPG considers the cumulative effects assessment of the residual effects identified for the Project at the Bruce site on each VC and the potential for effects of past, present, and reasonably foreseeable projects and activities to affect the same VCs within the same spatial and temporal boundaries. Though this is a reasonable approach, smaller and potentially incremental effects of other VCs,*

IR #	IR Title	Information Request and Response
		such as those listed on page 10 of the "Updated Analysis of Cumulative Environmental Effects" report, when combined with other projects, could also have the potential for a greater environmental effect over time.
		OPG Response: <u>Background – Other Types of Cumulative Effects</u> In addition to additive effects, other types of cumulative environmental effects that might occur as a result of the interaction between two or more effects or activities from the APM DGR and OPG DGR projects were considered and include: • Synergistic effects – these occur as a result of the interaction between two or more effects, when the resultant combination is greater or different than the simple addition of effects. • Compensatory effects – these occur when two or more physical activities 'offset' each other. • Masking effects – these occur when the effects of one project mask the effects of another in the field. The effect from one project becomes visible only when the other project is removed or terminated. Effects from point source disturbances such as the two projects on the biophysical environment are typically stronger at the local scale (i.e., strength of effect is largest adjacent to the development). Broader scale changes on the environment that occur farther from the DGR Project are more likely to result from other natural ecological factors and human activities (e.g., the APM DGR). For the purposes of the updated analysis, the APM DGR was assumed to be at least 20 km from the DGR Project at the Bruce Nuclear site, and potentially as far as approximately 86 km, and in a different watershed [GOLDER 2016]. Thus, although the two projects will likely overlap in time during certain phases, environmental effects associated with the two projects would not spatially overlap for most VCs, and cumulative synergistic, compensatory and/or masking effects would be unlikely. This response focuses on those VCs not previously described for cumulative effects from the APM DGR and OPG DGR projects (Table 3-2; [GOLDER 2016]); cumulative effects to VCs previously described in Section 5 of the Updated Analysis of Cumulative Environmental Effects report [GOLDER 2016] are not provided here. The description below sets out the potential for other types of cumulative effects, including small effects that may accumulate over time, on VCs specified in Table 3-2 of GOLDER [2016]. <u>Potential for Other Types of Cumulative Environmental Effects with the OPG DGR Project</u> Table 1 presents a summary of the potential for other types of cumulative effects from the DGR Project and the APM DGR. This includes small effects that may accumulate over time on those VCs with no adverse effect identified as a result of the DGR Project. Further rationales for the conclusions presented in the table are provided below, considering the regional ecological context of the Project locations. The DGR Project was predicted to result in non-measurable changes to wildlife VCs from direct habitat disturbance and some measurable changes from alterations in surface water quantity and sensory disturbance (i.e., air quality, noise, light and vibrations). Similar non-measurable and measurable changes may occur at the APM DGR, and if

IR #	IR Title	Information Request and Response
		these small incremental changes from both projects are accumulated over time, then there could be larger changes and potential residual adverse effects. However, the direct loss of habitat is expected to be localized to each project area (because there is no geographic overlap), and a previously completed meta-analysis showed that sensory disturbance effects from infrastructure on bird and mammal populations typically extended over distances of up to 1 and 5 km, respectively [Benítez-López et al. 2010]. For wildlife VCs with small to moderate breeding home ranges (e.g., midland painted turtle, northern leopard frog, muskrat, northern short-tailed shrew, mallard, songbirds and wild turkey), environmental changes (measurable or not measurable) from the two projects would likely influence different populations. Here, the population (or population area) is defined by a group of individuals of the same species occupying an area of sufficient size so that emigration and immigration are infrequent, and most of the changes in abundance and distribution are determined by reproduction and survival [Berryman 2002]. For these VCs, any effects from the DGR Project on the abundance and distribution of a local breeding population would likely not be transferred to other populations in the region that could be affected by the APM DGR. In other words, local-scale environmental changes from one project on a population are not expected to influence more distant populations that are not well connected while they inhabit a particular project area for part or all of the year. Similar reasoning is applicable for common cattail and heal-all plant VCs (Table 1). By extension, localized changes from both projects in the physical, chemical and biological properties of soil from direct disturbance and alterations in air or ground water quality would not spatially overlap. Thus, the potential for synergistic, compensatory, masking and/or temporal accumulating effects is unlikely. Alternatively, for white-tailed deer, and perhaps bald eagle, which have larger home ranges, non-measurable and measurable changes from the two projects have a much higher likelihood of combining over time and across space to generate potential cumulative residual effects. White-tailed deer that may be influenced by one project may encounter the other project in their seasonal ranges, depending on the distance between the developments. Consequently, effects from the DGR Project could combine with influences from APM DGR in an individual’s home range. In addition, the home ranges of several individuals may be affected, which may result in cumulative effects to the population. However, the direct and indirect changes to the environment from each project are expected to be small and localized (even if it is assumed that all 60 ha of habitat is removed by the APM DGR). These changes are predicted to have little to no influence on the abundance and distribution of white-tailed deer in the region, particularly considering the high resilience and adaptive capacity of this species (i.e., high reproduction rate, and flexibility to use a variety of habitats near and affected by human disturbance). Cumulative measurable changes in water quality and quantity are not predicted (see below), and should have no demographic influence on survival and reproduction rates of the bald eagle populations that may overlap the projects. As discussed in the response to Information Request 2.4, there are no radiological additive effects likely that have the potential to have a population-level effect on non-human biota VCs. Therefore, adverse cumulative effects of any type on white-tailed deer and bald eagle are unlikely (Table 1). For the aquatic environment, there would only be a potential for cumulative effects to occur within the Regional Study Area (RSA, which is Lake Huron), as the Local Study Areas (LSAs) for the two projects would not overlap spatially,

IR #	IR Title	Information Request and Response
		because they are in different local watersheds. The RSA for hydrology and surface water quality and the aquatic environment (Figure 2.4.2-1 of the EIS [OPG 2011]) extends 4 km offshore into Lake Huron, with northern and southern limits selected to include municipal Water Supply Plant intakes at Southampton and Kincardine. As the APM DGR would be sited at a different watershed than the DGR Project, there would be no potential for cumulative effects of any type in the local watershed in the DGR Project LSA. For example, there is no potential for cumulative effects to surface water quality or quantity to occur in Stream C or Underwood Creek in the Little Sauble watershed, and as a result, no synergistic, compensatory or masking cumulative effects to populations of aquatic VCs, such as burrowing crayfish, benthic invertebrates, Redbelly Dace, or Creek Chub. Section 5.1-1 of the Updated Analysis of Cumulative Effects report [GOLDER 2016] describes the potential cumulative effects on surface water quantity and flow. The EIS predicted a residual adverse effect on surface water quantity and flow from measurable decreases in stream flow in the North Railway Ditch and increases in the drainage ditch to Lake Huron. However, no changes in flow will be measurable in Lake Huron beyond the point of discharge. No residual adverse effects to surface water quality are expected as a result of the DGR Project; furthermore, water released from the stormwater management system will meet discharge criteria. Therefore, any changes to surface water quantity or water quality in Lake Huron would not be measurable and would not interact cumulatively, synergistically or through lag effects, with the APM DGR. Even if an ultraconservative approach was taken and a small non-measurable change in Lake Huron were identified to interact cumulatively with effects from the APM DGR, it is expected that changes to VCs would also be very small and likely not measurable due to the overall size and depth of the lake. The updated analysis of cumulative effects determined that cumulative residual adverse effects from the APM DGR and DGR Project on human health, and radiation and radioactivity would be unlikely (Sections 5.6 and 5.8 [GOLDER 2016]). This report [GOLDER 2016] indicates that due to the localized and infrequent nature of effects, and the anticipated distance between the two projects, there is predicted to be little to no geographic overlap in residual adverse effects from the two projects on air quality (see also response to Information Request 2.1). The two projects would be located in different watersheds and based on the analysis described above, adverse cumulative effects to the quality of drinking water and human health are unlikely. As set out in Section 5.4.1 of the EIS [OPG 2011], Lake Huron is the second largest of the Great Lakes, with a surface area of approximately 60,000 km^2 and a shoreline length of approximately 6,200 km. The average depth is 59 m and the maximum depth is 229 m at a location near Sault Sainte Marie. The maximum depth near the study area is approximately 180 m. Any cumulative changes to water levels or water quality from both projects would be expected to be non-measurable and well within the range of natural variability in such a large, deep lake. As a result, no measurable cumulative effects to the nearshore or offshore fish habitat quality (i.e., no changes to depth, substrate, water quality) or quantity for fish species selected as VCs for Lake Huron and the embayments’ Lake Whitefish, Smallmouth Bass, Spottail Shiner would be expected. Therefore, synergistic, compensatory, masking and/or temporal accumulating cumulative effects on Lake Whitefish, Smallmouth Bass and Spottail Shiner are unlikely.

IR #	IR Title	Information Request and Response
		Table 1: Summary of Assessment of Potential Other Cumulative Effects for Valued Ecosystem Components Previously Identified as Having No Residual Adverse Effects from the DGR Project

Environmental Component	Valued Ecosystem Component	Potential for Cumulative Adverse Effects from APM DGR
Geology	Soil quality	No spatial overlap between projects is predicted to result in any non-measurable or measurable changes in soil quality. Potential for any type of cumulative effects (synergistic, compensatory, masking, temporal accumulation) is unlikely.
	Overburden Groundwater Quality Overburden Groundwater Transport Shallow Bedrock Groundwater Quality Shallow Bedrock Solute Transport Intermediate Bedrock Water Quality Intermediate Bedrock Transport Deep Bedrock Water Quality Deep Bedrock Solute Transport	Due to the location of the two projects, spatial overlap for the overburden groundwater and shallow bedrock groundwater and solute transport VCs is unlikely due to the local geological and hydrogeological conditions. The Palaeozoic sedimentary rocks beneath the Bruce Nuclear site are predictable and include multiple natural barriers to contaminant transport. Furthermore, near-surface groundwater aquifers are isolated from the deep saline groundwater system. In the EIS [OPG 2011], no residual adverse effects were identified for groundwater quality or solute transport. Depending on the location selected for the APM DGR and the timing of construction, there is a potential for small local changes to overburden and shallow bedrock groundwater transport. For example, for overburden groundwater and shallow bedrock groundwater and solute transport (Section 8.3), the zone of influence (ZOI) is estimated to be 54 m for dewatering during shaft sinking through the overburden and shallow bedrock. This is a small portion of the Project Area and no water use would be affected by this ZOI (i.e., no nearby overburden groundwater users) and the ZOI would not approach any surface water courses (i.e., no potential effects on base flow to surface water bodies). In addition, the dewatering is temporary (up to 36 months). The ZOI created will not result in an adverse effect on local groundwater resources, water levels, or discharge to Lake Huron. No likely direct or indirect environmental effects were identified from solute transport-project interactions. Therefore, it was concluded that the DGR Project will not create residual adverse effects on the overburden groundwater and shallow bedrock groundwater and solute transport VCs. Even if this ZOI were to overlap with the APM DGR (which would be highly unlikely given the distance between the projects), the cumulative effects would be temporary and localized and not be expected to adversely affect local water bodies, including Lake Huron.

IR #	IR Title	Information Request and Response			
			Hydrology and Surface Water Quality	Surface Water Quantity	The EIS predicted a residual adverse effect on surface water quantity and flow from measurable decreases in stream flow in the North Railway Ditch and increases in the drainage ditch to Lake Huron. However, all changes in flow will not be measurable in Lake Huron beyond the point of discharge. Therefore, any changes to surface water quantity in Lake Huron would not be measurable and would not interact with the APM DGR. Even if an ultraconservative approach was taken and any small non-measurable change in Lake Huron were to result and to interact cumulatively with effects from the APM DGR, it is expected that changes to surface water quantity would also be very small and likely not measurable. Because of the size and depth of the Lake Huron and that the effects from the DGR Project are predicted to be non-measurable, any cumulative changes to water levels from both projects would also be expected to be non-measurable and well within the range of natural variability of such a large, deep lake, as Lake Huron.
				Surface Water Quality	In the EIS [OPG 2011], no residual adverse effects to surface water quality were predicted as a result of the DGR Project; furthermore, water releases from the stormwater management system would meet discharge criteria. Therefore, any changes to surface water quality in Lake Huron would not be measurable and would not interact with the APM DGR.
			Terrestrial Environment	Other Plant VCs (Heal-all, Common Cattail)	Small, local changes from each project affect non-overlapping (or disconnected) populations. Potential for any type of cumulative effects is unlikely.
				Mammal VCs (muskrat, white-tailed deer, northern short tailed shrew)	For muskrat and short-tailed shrew, possible local changes from each project would affect different populations (i.e., no spatial overlap through time). Potential for any type of cumulative effects is unlikely. For white-tailed deer, the direct and indirect changes to the environment from each project are expected to be small and localized (even if it is assumed that all 60 ha of habitat is removed by the APM DGR). These changes are predicted to have little to no influence on the abundance and distribution of white-tailed deer in the region, particularly considering the high resilience and adaptive capacity of this species (i.e., high reproduction rate, and flexibility to use a variety of habitats near and affected by human disturbance). Therefore, adverse cumulative effects (of any type) on white-tailed deer are unlikely.

IR #	IR Title	Information Request and Response		
			Amphibian and Reptile VCs (midland painted turtle, northern leopard frog)	For amphibian and reptile VCs, possible local changes from each project would affect different populations (i.e., no spatial overlap through time). Potential for any type of cumulative effects is unlikely.
			Bird VCs (mallard, red-eyed vireo, wild turkey, yellow warbler, bald eagle)	For bird VCs, except bald eagle, possible local changes from each project would affect different populations (i.e., no spatial overlap through time). Potential for any type of cumulative effects is unlikely. For bald eagle, cumulative measurable changes in water quality and quantity are not predicted, and are expected to have no demographic influence on bald eagle populations that may overlap the two projects. Potential for any type of cumulative effects is unlikely.
		Aquatic Environment	Lake Whitefish	Cumulative effects to water levels or water quality from both projects would be expected to be non-measurable and well within the range of natural variability in such a large, deep lake. As a result, no measurable cumulative effects to the nearshore or offshore habitat quality or quantity for fish species selected as VCs for Lake Huron and the embayments would be expected.
			Smallmouth Bass	
			Brook Trout	
			Spottail Shiner	
		Vibrations	Vibrations	Vibrations restricted to immediate area around each project (no spatial overlap). Potential for any type of cumulative effects is unlikely.
		Human Health	Overall Health of Seasonal Users	The Updated Analysis of Cumulative Environmental Effects determined that cumulative residual adverse effects from the APM DGR and DGR Project on human health, and radiation and radioactivity would be unlikely (Sections 5.6 and 5.8 [GOLDER 2016]). The assessment considered the health of local residents and Indigenous peoples, and would also be considered applicable to seasonal users. Health of workers is considered through protection of individual workers under the *Occupational Health and Safety Act* and compliance with CNSC’s regulatory dose limits.
			Health of Workers	
		Ecological Features	Lake Huron	Potential cumulative effects to Lake Huron are discussed under surface water quantity and quality above; any potential effects are expected to be non-measurable and well within the range of natural variability of a large, deep lake.
			Stream C	There is no potential for cumulative effects of any type to occur in Stream C as the APM DGR will be located in a separate watershed (i.e., outside of the Little Sauble watershed).

IR #	IR Title	Information Request and Response
		<table><tr><td></td><td>South Railway Ditch</td><td>There is no potential for cumulative effects of any type to occur in the South Railway Ditch as the APM DGR will be located in a separate watershed (i.e., outside of the Little Sauble watershed).</td></tr><tr><td></td><td>Wetland within the Project Area</td><td>There is no potential for cumulative effects of any type to occur in the Wetland within the Project Area as APM DGR will be located in a separate watershed (i.e., outside of the Little Sauble watershed).</td></tr></table> **References:** Benítez-López A, Alkemade R, Verweij PA. 2010. *The Impacts of Roads and other Infrastructure on Mammal and Bird Populations: A Meta-analysis.* Biol Conserv 143:1307-1316. Berryman AA. 2002. *Population: A Central Concept for Ecology?* Oikos 97:439-442. GOLDER. 2016. *Updated Analysis of Cumulative Environmental Effects*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00018-R000. (CEAA Registry Doc# 2883) OPG. 2011. *Environmental Impact Statement, Volume 1*: *Main Report*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298)
IR-2.3	Accidents, Malfunctions and Malevolent Acts	***Information Request:*** • *Provide a risk assessment that discusses the severity (catastrophic, severe, moderate, low, minor, none) and the probability of occurrence (very unlikely, unlikely, possible, very possible, certain) of accidents, malfunctions and malevolent acts.* • *Discuss the potential effects on the environment and human health of a possible long-term release of other radionuclides via water sources if the failure of both the APM DGR project and the Project at the Bruce site occurs, due to a common or unrelated cause(s).* ***Rationale:*** *OPG states on page 36 of the “Updated Analysis Cumulative Environmental Effects” report that several disruptive or “what if” scenarios (i.e., inadvertent human intrusion, shaft seal failure, poorly sealed borehole, and vertical fault) are unlikely to occur, so the risk of occurrence remains low for those locations. Although the probability of occurrence of a hazardous event may be low, the magnitude of the impact on the environment or human health can still be high. A risk assessment should include the magnitude of the event and the probability of occurrence in order to understand the overall risk.*

IR #	IR Title	Information Request and Response
		The Agency also notes there is a limited discussion on the potential long-term release of contaminants should remediation or emergency response not occur in a timely manner (e.g staff no longer on site, resource not available, etc.).
		OPG Response: The Updated Analysis of Cumulative Effects report [GOLDER 2016] considers the potential cumulative effects of an APM DGR assuming it would be constructed in one of three municipalities around the OPG DGR at the Bruce Nuclear site. Based on that assumption, this Information Request response provides further information on the implications of accidents, malfunctions and malevolent acts. <u>OPG DGR at Bruce Nuclear Site</u> For the OPG DGR Project at the Bruce Nuclear site, the risks (likelihood and consequences) from accidents, malfunctions and malevolent acts, including postclosure disruptive scenarios, are described in the Preliminary Safety Report [Section 7 and 8, OPG 2011] and also summarized in the Malfunctions, Accidents and Malevolent Acts Technical Support Document [AMEC NSS 2011]. The overall conclusions with respect to potential accidents during operations (i.e., prior to closure) were that the impacts on the public were generally minor and always within regulatory dose criteria. The most consequential accidents were fires in waste packages, and there are waste package design and operational measures to make these accidents unlikely at the OPG DGR. The overall conclusions with respect to potential disruptive scenarios after closure was that the most consequential scenarios (including inadvertent human intrusion into the repository) could result in peak doses to persons directly living over the repository in the future in the range of one to tens of millisieverts (mSv). Natural attenuation would reduce the dose impacts further to below the public dose criterion. However, the location and design of the DGR would ensure that disruptive events that could bypass the natural barriers would be very unlikely. <u>APM DGR</u> As noted in the APM DGR Preliminary Description report [NWMO 2016a], no site has been selected, no detailed design has been developed, and there has been no detailed assessment of these accident scenarios for a specific APM DGR in these communities. The project is conceptual at this time, and the available risk assessment is limited in scope. During site preparation, construction, operation, monitoring and decommissioning, potential accidents and malfunctions range from possible to very unlikely and include conventional accidents such as a diesel fuel spill, vehicle impact, fire and underground rock failure; and radiological accidents such as a fuel bundle drop during handling in the hot cell or fuel container drop during transfer [OH 1994; Kremer and Garisto 2011; NWMO 2016b]. External events

IR #	IR Title	Information Request and Response
		that could potentially lead to accidents would include, for example, tornados, hurricanes, and earthquakes. Malevolent act scenarios would range from threats to theft to sabotage to attack. However, the facility would be designed to handle the credible events that could occur at that site. With respect to consequences during the preclosure phase from accidents and malfunctions, the radiological and non-radiological consequences would be below the dose limits at the site boundaries. Essentially, the consequences to public and environment are expected to be low during APM DGR operations because the main operational action is the transfer of solid used fuel from one robust sealed package (the transportation package) into another robust sealed package (the used fuel container), which is then placed underground encased in a bentonite-clay buffer box. The used fuel does not require active cooling, and it is always contained inside a robust shell - either the transport package, the packaging plant hot cell walls, or the used fuel container and buffer box. Ultimately, the used fuel is isolated inside sealed placement rooms deep underground. Malevolent act scenarios are mitigated through design and operating practices (e.g., secure site, robust containers, solid radioactive material, employee screening), and therefore are unlikely. The consequences have not been evaluated in detail at this stage of the project, but are constrained by the same factors that minimize consequences of accidents and malfunctions, as outlined above. No severe public consequences are expected for credible malevolent act scenarios. Environmental consequences and risks have not been assessed in detail at this stage of the APM DGR project, but would be expected to be below criteria and/or very localized, similar to the assessed effects on the public. These events and consequences will be evaluated further as part of the site selection process, based on site-specific conditions and detailed design. After closure, the main accidents and malfunction scenarios (i.e., the postclosure disruptive scenarios) of potential concern for an APM DGR would include early container failure, inadvertent human intrusion, undetected vertical fault, shaft seal failure, and poorly sealed borehole. These disruptive scenarios are expected to be very unlikely based on the repository site, depth and design. With respect to consequences of postclosure disruptive scenarios, the main concern would be the potential for radiological releases. The consequences for two important disruptive scenarios are considered in the next two paragraphs, based on published analysis for a generic case study. In the APM DGR illustrative safety assessment for a repository in a sedimentary rock site [NWMO 2013], the consequences were assessed for the all-container-failure at 60,000 year scenario. This illustrative assessment indicates that the consequences would be well below the public dose criteria. This is because the radioactivity in an APM DGR is embedded within the solid used fuel pellet and would be released very slowly in a failed container, and because the transport time from the repository to the surface is extremely long given the very low permeability of the sedimentary host rock. The highest consequence assessed for the APM DGR in the generic sedimentary site was for inadvertent human intrusion [NWMO 2013]. In this scenario, a deep borehole is drilled at the site in the distant future without realizing there is nuclear waste buried there, and used fuel material is brought to surface. This scenario bypasses all the engineered and geological barriers, and can result in significant dose (causing radiation sickness) to the drillers, and

IR #	IR Title	Information Request and Response
		to future people living on the site if there was no remediation. However, these impacts are localized, the site can be remediated, and the selection of a deep repository specifically makes this future intrusion scenario very unlikely as both the repository site and depth would be selected to avoid natural resources and therefore minimize the risk of future boreholes in the area. <u>Potential Effects</u> This Information Request asks about the consequences of release of radionuclides via water assuming the failure of both repositories. The consequences would depend on the nature of the failure scenario – the mechanism, the extent of the effect on the repository and the geosphere, and the timing of the release. Both the proposed OPG DGR at the Bruce Nuclear site and the APM DGR, if sited in the regional area, would be placed in a stable, deep, very low permeability, mechanically strong rock formation. Any transport of radionuclides via water would take a very long time, so most radioactivity would decay. The two facilities would be located at least 20 km, and possibly 90 km apart, depending on if and where the APM DGR is ultimately sited in the area [Section 4.1, GOLDER 2016]. With respect to releases via water, the release path would involve radionuclide migration vertically upward into the permeable Guelph Formation, which is above the low-permeability limestone and shale cap rock formations that would host and enclose both repositories. The Guelph Formation extends beneath both potential repository locations as a confined (5 m thick) aquifer that contains non-potable saline groundwater. At the Bruce Nuclear site, this formation is about 375 m below surface; within the three municipalities under consideration for the APM DGR (as part of this Information Request response), this formation ranges from about 200 to 600 m below the surface. This formation is not used as a groundwater resource in those three municipalities. Numerical analysis for a generic sedimentary rock site [NWMO 2013] indicated that the radionuclide concentrations in the Guelph Formation would nonetheless remain below criteria for public and environmental protection even if used as a source of drinking water. Furthermore, at nearest point, an APM DGR would be 20 km from the Bruce Nuclear site DGR. This physical separation and hydrogeological isolation within a stable ancient diffusion dominated groundwater domain suggest that a significant cumulative effect or interaction within this sub-surface formation is very unlikely. Any further migration of radionuclides upward from the Guelph Formation would be through additional low-permeability rock before they could reach near-surface waters. This would ensure further natural attenuation and radioactive decay. Furthermore, since the two repositories would be in different surface watersheds, this would minimize cumulative effects [GOLDER 2016]. And there would also be further natural attenuation, which would reduce the amount of radioactivity at locations more distant from either repository. It is therefore expected that the failure of both repositories would be very unlikely to happen, and further that the cumulative impact would be minor to humans and the environment. This potential impact would be further evaluated as part of any future proposed APM DGR, in the licensing process.

IR #	IR Title	Information Request and Response
		References: AMEC NSS. 2011. *Malfunctions, Accidents and Malevolent Acts Technical Support Document*. Prepared by AMEC NSS Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-07 R000. (CEAA Registry Doc# 299) GOLDER. 2016. *Updated Analysis of Cumulative Environmental Effects*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00018. (CEAA Registry Doc# 2883) Kremer, E. and N. Garisto. 2011. *Dose Considerations for a Site Boundary for Surface Operations at a Deep Geological Repository*. Presented at Waste Management, Decommissioning and Environmental Restoration Conference, Canadian Nuclear Society. Toronto, Canada. NWMO. 2013. *Postclosure Safety Assessment of a Used Fuel Repository in Sedimentary Rock, Pre-project Report*. Nuclear Waste Management Organization Report NWMO TR-2013-07 NWMO. 2016a. *APM DGR Preliminary Description. Prepared to Support Ontario Power Generation Cumulative Effects Response to Minister of Environment and Climate Change Canada (2016)*. Prepared by Nuclear Waste Management Organization. Ontario Power Generation Report 00216-REP-07701-00017-R000. (CEAA Registry Doc# 2883) NWMO. 2016b. *Preliminary Hazard Identification for the Mark II Conceptual Design*. Prepared by Saanio & Riekkola Oy and Empresarios Agrupados Internacional S.A. Nuclear Waste Management Organization Report NWMO-TR-2016-02. OH. 1994. *The Disposal of Canada’s Nuclear Fuel Waste: Preclosure Assessment of a Conceptual System*. Ontario Hydro Report N-03784-940010 (UFMED). OPG. 2011. *Preliminary Safety Report*. Ontario Power Generation Report 00216-SR-01320-00001-R000. (CEAA Registry Doc# 300)
IR-2.4	Radiation, Radioactivity and Groundwater Monitoring	***Information Request:*** • *Discuss measures that are available for identifying and monitoring potential effects on groundwater quality from post-closure migration of radionuclides.* • *Provide a narrative discussion of the potential cumulative effects from the APM DGR project and the Project on appropriate non-human biota VCs.*

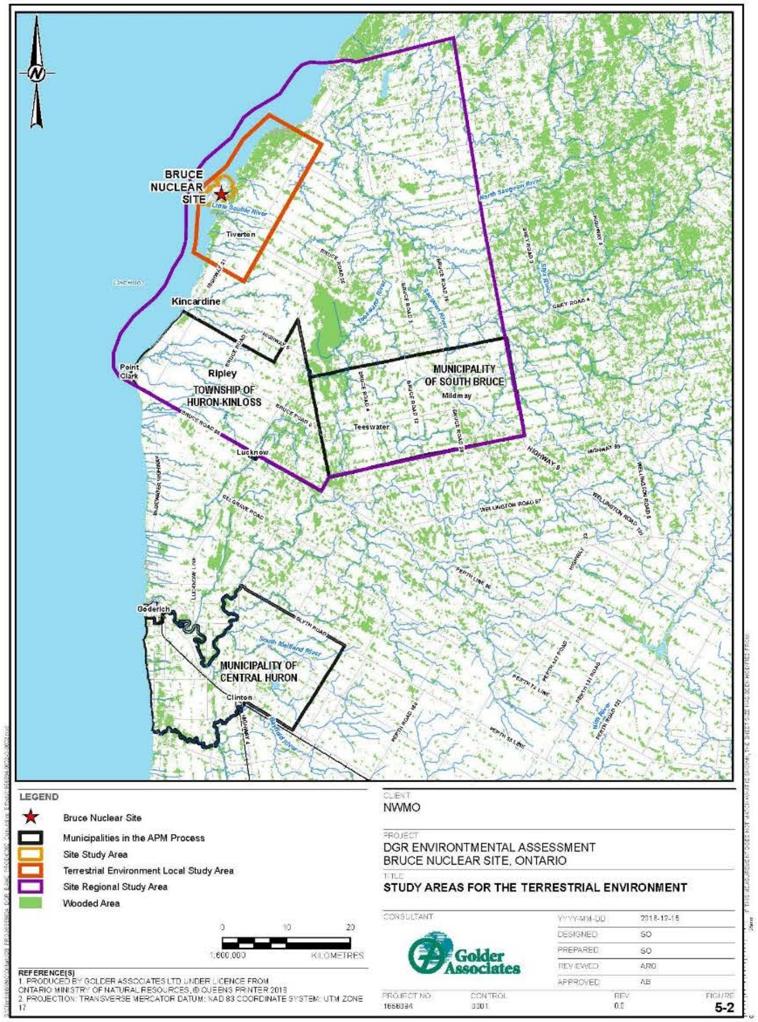
IR #	IR Title	Information Request and Response
		Rationale: *The updated assessment of cumulative environmental effects is limited to those VCs for which residual adverse environmental effects from the Project are predicted. The "Updated Analysis Cumulative Environmental Effects" report describes the potential adverse effects resulting from the APM DGR project in one of the nearby host communities. Within section 5.8.1 of the report, OPG states that during all phases of the Project, the APM DGR project has the potential for radiological emissions. These radiological emissions from the APM DGR project may have additive radiation effects on the emissions resulting from the Project at the Bruce site.* *When effects of the two projects overlap in time and in space there is potential for cumulative environmental effects. These effects are assessed and mitigation measures are identified in the "Updated Analysis Cumulative Environmental Effects" report; however, the report concludes that any cumulative adverse environmental effects related to post-closure migration of radionuclides in deep groundwater systems would be unlikely. The report also identifies a potential for adverse cumulative environmental effects for the environment components of radiation and radioactivity related to deep ground water systems. Specifically, radionuclide diffusion from the two repositories could eventually reach more active ground water systems in the Cambrian sandstone and Guelph Formation, which are connected across the region. The consequences of such movement could have potentially adverse effects. Taking this into consideration, it is unclear why VCs directly related to geology and hydrogeology were not assessed further in the cumulative environmental effects assessment.* *Further, an assessment of the ecological risk due to C-14 and H-3 on a number of terrestrial species with large habitat ranges, including mammals, such as white tailed deer and resident bird species such as wild turkey, was not conducted.*
		OPG Response: <u>Postclosure Migration</u> The rationale for this question refers to the potential for postclosure radionuclide diffusion from the two repositories (i.e., the OPG DGR at the Bruce Nuclear site and an APM DGR assuming that it is sited in the region) to reach the Cambrian sandstones or the Guelph Formation. These are the closest permeable rock formations below and above the repositories. They extend across the region, and therefore could provide a path for interaction between the repositories. The Cambrian sandstone and the Guelph formations represent deep-seated confined saline aquifers. Beneath the Bruce Nuclear site, these thin confined aquifers are vertically separated by 430 m of low permeability shales and carbonates of upper Ordovician to lower Silurian age. The groundwater in the aquifers is non-potable and there is no evidence of mixing with surface glacial origin meltwaters. The Cambrian formation is not laterally continuous and likely does not lie beneath the APM DGR siting areas that are tens of kilometres inland of Lake Huron. This situation, coupled with the repositories being positioned in the Cobourg Formation with vertical separation to the saline aquifers by diffusion dominated aquitard/aquiclude systems exceeding 150 m in thickness, strongly indicates radionuclide

IR #	IR Title	Information Request and Response
		release would occur over extremely long time periods. Peak release to the Cambrian formation from the OPG DGR described in OPG’s response to Information Request EIS-04-129 [OPG 2012] was on the order of 1.5 Ma and 100 times less than the regulatory criteria. At nearest, an APM repository would be 20 km from the Bruce Nuclear site repository. This physical separation and hydrogeological isolation within a stable ancient diffusion dominated groundwater domain suggests that material cumulative effects or interaction within these sub-surface pathways is highly unlikely. Cumulative radiological effects could only potentially occur in the non-credible (i.e., “what if”) event of failure of multiple barriers at both the OPG DGR and APM DGR sites that would be 20 to 90 km apart. Both repositories are to be sited and engineered to withstand the effects of future glaciations and earthquakes [NWMO 2013]. <u>Monitoring Potential Effects on Groundwater</u> There are a number of measures available for monitoring and identifying potential effects on groundwater quality from postclosure migration of radionuclides. These are discussed below. Postclosure monitoring activities would be informed by more than 50 years of environmental monitoring conducted within the DGR and in the surrounding vicinity. This monitoring performed during the site preparation and construction, operation and decommissioning phases of the OPG DGR would allow verification of predictions regarding potential environmental effects and, if required, the effectiveness of mitigation measures. Proposed monitoring measures will include formation pressure profiles within different aquifer systems, along with groundwater sampling and analysis for major ions, general chemistry (e.g., pH, Eh, temperature, electrical conductivity), radionuclides, trace elements, and petroleum hydrocarbons. The proposed monitoring measures will verify isolation of the waste from the surrounding environment. The OPG DGR is designed to be passively safe after closure. Confidence in postclosure DGR performance is gained, in part, from the regulatory reported environmental monitoring program described above. Postclosure monitoring would be performed in a manner that does not influence the repositories’ passive safety. The nature and duration of postclosure monitoring will be decided in the future with the regulator and will likely include parameters similar to those proposed for the earlier stages of the project such that unexpected conditions associated with repository re-saturation and/or contaminant release could be detected. The APM DGR would also be subject to similar postclosure monitoring [NWMO 2016]. These programs would be established as part of the applicable regulatory process in advance of decommissioning. <u>Cumulative Effects on Non-human Biota</u> Aquatic and terrestrial biota receive radiation doses from exposure to radioactivity in the atmosphere, surface water and from other media into which it transfers. The effects of the OPG DGR and APM DGR projects arising from radiological emissions would be a small increment to the baseline concentrations around each of the respective sites.

IR #	IR Title	Information Request and Response
		The Terrestrial Environment Local Study Area is the scale most applicable for considering potential effects on maintenance of plant and wildlife species diversity and for local populations of wildlife that require linked home ranges for genetic viability [OPG 2014; Figure 5-2 in GOLDER 2016]. Residual adverse effects at this scale, cumulative effects are considered to influence woodland ecosystem sustainability throughout the region. For aquatic biota, the Aquatic Environment Local Study Area (Figure 5-3 in [GOLDER 2016]) is used to determine the potential for the OPG DGR Project at the Bruce Nuclear site to act cumulatively with the APM DGR [GOLDER 2016]. Radiation dose to terrestrial non-human biota under existing conditions was estimated for the terrestrial VCs in the EIS [OPG 2011] and conservative predictions of estimated dose rates to non-human biota as a result of the OPG DGR Project were orders of magnitude below benchmarks as shown on Figure 7.6.2-1 of the EIS [OPG 2011]. These benchmarks represent chronic dose rates that were observed not to produce any adverse effects upon populations of biota [AMEC NSS 2011]. As noted in the Updated Analysis of Cumulative Effects report [GOLDER 2016], the radiological releases from the APM DGR are expected to be similarly low. It is worth noting that, based on generic case studies, the primary radionuclides relevant during normal operations from the APM DGR are isotopes of strontium (Sr-90) and caesium (Cs-137) [OH 1994], not tritium (H-3) and carbon (C-14), which are important for the OPG DGR [NWMO 2013]. The very low radiological releases expected from the APM DGR and the OPG DGR at the Bruce Nuclear site combined with the spatial separation of at least 20 km avoids the potential for cumulative effects to sedentary or non-migratory non-human biota, as those species would be present within the immediate vicinity of each of the DGR locations on a permanent basis or for extended periods of time. Among migratory or highly mobile species such as white-tailed deer and wild turkey, there is some limited potential for exposure to both sites at different times. However, since the radiological releases at both facilities are much less than the conservative effects thresholds, any exposure of non-human biota to the individual or combined DGR sites (i.e., the OPG DGR Project at the Bruce Nuclear site and the APM DGR) is not expected to result in adverse cumulative radiological effects at either site. Therefore, a cumulative adverse effect at the population level for these VCs is very unlikely. Current radioactivity levels in Lake Huron and the other Great Lakes are well below levels that would affect humans or other biota, and continue to decline following the international moratorium on atmospheric nuclear weapons testing in the 1960's. Isolation and containment of radiological sources deep underground as a cumulative outcome of the OPG DGR Project at the Bruce Nuclear site and the APM DGR would in fact help ensure the continued protection of Lake Huron from potential radiological effects in the very long term. Based on the above, a cumulative adverse effect of radiation and radioactivity on non-human (i.e., aquatic and terrestrial) biota as a result of the OPG DGR Project at the Bruce Nuclear site and the APM DGR is very unlikely.

IR #	IR Title	Information Request and Response
		References: AMEC NSS. 2011. *Radiation and Radioactivity Technical Support Document*. Prepared by AMEC NSS Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-06 R000. (CEAA Registry Doc# 299) GOLDER. 2016. *Updated Analysis of Cumulative Environmental Effects*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00018-R000. (CEAA Registry Doc# 2883) NWMO. 2013. *Postclosure Safety Assessment of a Used Fuel Repository in Sedimentary Rock, Pre-project Report*. Nuclear Waste Management Organization Report NWMO TR-2013-07. NWMO. 2016. *APM DGR Preliminary Description. Prepared to Support Ontario Power Generation Cumulative Effects Response to Minister of Environment and Climate Change Canada (2016)*. Prepared by Nuclear Waste Management Organization. Ontario Power Generation Report 00216-REP-07701-00017-R000. (CEAA Registry Doc# 2883) OH. 1994. *The Disposal of Canada’s Nuclear Fuel Waste: Preclosure Assessment of a Conceptual System*. Ontario Hydro Report N-03784-940010 OPG. 2011. *Environmental Impact Statement, Volume 1*: *Main Report*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298) OPG. 2012. Letter, Ontario Power Generation to Joint Review Panel, dated September 6, 2012. (CEAA Registry Doc# 725) OPG. 2014. Letter, Ontario Power Generation to Joint Review Panel, dated March 28, 2014. (CEAA Registry Doc# 1836)
IR-2.5	Species at Risk	***Information Request:*** *Provide an assessment of the potential cumulative environmental effects on the terrestrial environment that includes impacts on wetlands and species at risk, specifically the Snapping Turtle, Eastern Ribbonsnake and Eastern Milksnake.* ***Rationale:*** *As part of the site preparation and construction activities of the Project, wetland 3 would be infilled. Snapping Turtles have been observed in this wetland, and Environment and Climate Change Canada (ECCC) advised that it could be possible for Eastern Ribbonsnake and Eastern Milksnake individuals to move into the Bruce DGR site. These potential residual effects from the Project were not assessed in combination with the potential effects from the three proposed APM DGR sites.*

IR #	IR Title	Information Request and Response
		OPG Response: Assessment of Cumulative Effects in Consideration of the APM DGR Environment and Climate Change Canada (ECCC) has identified a potential residual adverse effect of the DGR Project at the Bruce Nuclear site on wetlands and snapping turtle [ECCC 2013]. ECCC also identified potential residual effects on eastern ribbonsnake and milksnake as they may move (migrate) through the Site Study Area [ECCC 2013]. The residual effect on these Valued Components (VCs) is predicted to occur during construction of the DGR, in particular at the time of infilling of Wetland 3 (shown on Figure 1 of OPG's response to Information Request EIS-05-168 [OPG 2012]) and removal of other terrestrial vegetation, and will remain in full effect until rehabilitation following decommissioning. Wetland 3 is a very small feature (described as a feature with a 50 m radius in response to IR EIS-05-168) and provides marginal foraging habitat for snapping turtle. There is also potential for eastern ribbonsnake and milksnake to migrate through the DGR Project Site Study Area. There were no critical habitats (e.g., over-wintering or nesting/gestation areas) identified for any Species At Risk wildlife on the DGR Project at the Bruce Nuclear site. The predicted loss of Wetland 3 as a result of the DGR Project at the Bruce Nuclear site is less than one hectare within the Site Study Area. This loss is predicted to have no measurable residual adverse effect on the sustainability of populations of snapping turtle, eastern ribbonsnake and milksnake in the Terrestrial Environment Local Study Area (LSA) (shown on Figure 5-2 from [GOLDER 2016] inserted below).

IR #	IR Title	Information Request and Response
		 [Note: A larger size figure is enclosed at the end of this table (see Enclosure 3 starting on page 143).]

IR #	IR Title	Information Request and Response
		The cumulative effects assessment for the DGR Project at the Bruce Nuclear site terrestrial environment [OPG 2011] used the Site Study Area to determine the potential for the Project to interact cumulatively with other projects and activities on VCs, since the residual adverse effect of the DGR Project at the Bruce Nuclear site on the terrestrial environment (specifically the eastern white cedar VC) is restricted to the Site Study Area (Figure 5-2). Because snapping turtle, eastern ribbonsnake and milksnake are mobile and will move in and out of the Site Study Area and potential direct effects (i.e., removal of potential suitable habitat) are limited to the Site Study Area, it is appropriate to consider the Terrestrial Environment LSA as the range of movement for local populations of these species and for the assessment of potential residual effects of the DGR on these species. In addition, the effects assessment inherently gives consideration to combined effects of other regional land uses or sources of stress on VCs. No future land uses were identified at a scale that cumulatively would involve removal of plant and wetland communities and compromise the sustainability of snapping turtle, eastern ribbonsnake or milksnake. There is more abundant and well distributed quality habitat for snapping turtle, eastern ribbonsnake and milksnake outside of the Site Study Area in the Terrestrial Environment LSA (Figure 5-2). As a result, it is predicted that the small measurable loss of Wetland 3 and other terrestrial vegetation communities as a result of the DGR Project at the Bruce Nuclear site relative to similar habitat available in the Terrestrial Environment LSA would likely have no significant residual adverse effect on these VCs. <u>Assessment of Cumulative Effects at the APM DGR</u> The APM DGR site selection will consider environmental constraints such as the need for clearing vegetation and effects to wetland communities for the construction of surface facilities. It is expected that key habitats (hibernation and gestation/nesting habitats) identified during baseline data collection for Species at Risk such as snapping turtle, eastern ribbonsnake and milksnake could be avoided by the siting of infrastructure away from these features. Direct physical changes from the APM DGR footprint to these key features would be avoided or minimized. Additional direct impacts to these species from the construction and operation phases may include an increased risk of injury or mortality from interactions with vehicle traffic and heavy equipment. These risks can be mitigated and likely eliminated by the implementation of measures, such as reptile exclusion fencing around the active construction site. Additionally, if heavy traffic volumes are anticipated on the access roadways, exclusion fencing could be erected along identified potential movement corridors along the roadway to convey snakes and turtles through culvert crossings. Potential residual adverse effects from the APM DGR have been identified on terrestrial habitat and biota during all project phases of the APM DGR [NWMO 2014, NWMO 2015]. The APM DGR would involve vegetation clearing for site access, and for the construction of surface facilities and a waste rock management area. It is anticipated that surface facilities, waste rock management and the ventilation exhaust shaft would require a maximum land clearing of up to 60 ha. These activities will contribute to a long-term loss of terrestrial vegetation, which may include wetland communities and potential habitats for snapping turtle, eastern ribbonsnake and milksnake. The APM DGR is likely to overlap in time with potential effects of the DGR Project at the Bruce Nuclear site on snapping turtle, eastern

IR #	IR Title	Information Request and Response
		ribbonsnake and milksnake. The potential location of the APM DGR relative to the DGR Project at the Bruce Nuclear site is expected to be a minimum of 20 km away, and up to 86 km. The two projects are in different watersheds and likely influence the survival and reproduction rates of populations that have no to little connectivity (please also see response to Information Request 2.2). Thus, although the two projects will likely overlap in time, direct and indirect (sensory disturbance, water quantity, water quality) habitat changes associated with the two projects would not spatially overlap for these VCs. Adverse cumulative effects on snapping turtle, eastern ribbonsnake and milksnake from the DGR and APM DGR projects are unlikely. <u>Mitigation at the APM DGR</u> In-design mitigation may include selection of infrastructure and corridor locations to avoid protected areas and suitable habitat for sensitive or important plant communities (e.g., wetlands that specifically provide suitable habitat for species of conservation concern). These mitigation measures for the protection of terrestrial habitat would inherently protect plant communities of importance. However, for the purposes of the updated cumulative effects analysis, it is conservatively assumed the full 60 ha APM DGR surface footprint would be cleared. Where permitting may be required, for example from the local Conservation Authority or the municipality, the permit would be obtained prior to site clearing and conditions outlined in the permit would be implemented, as required. <u>Conclusion</u> Although there is the potential for a cumulative effect of loss of wetland communities and habitats suitable for snapping turtle, eastern ribbonsnake and milksnake as a result of the APM DGR and the DGR Project at the Bruce Nuclear site, the APM DGR would be no closer than 20 km to the DGR Project at the Bruce Nuclear site (Figure 5-2). The APM DGR will not result in a spatial overlap of wetland community or other terrestrial vegetation community loss in the Site Study Area or a spatial overlap of the Terrestrial Environment LSA. In addition, there is more abundant, better quality, suitable habitat for these species outside of the Site Study Area in the Terrestrial Environment LSA. Therefore, based on the above, there are no likely adverse cumulative effects on snapping turtle, eastern ribbonsnake and milksnake in consideration of the APM DGR. **References:** ECCC. 2013. *Canadian Nuclear Safety Commission – Canadian Environmental Assessment Act Joint Review Panel, In Respect of Ontario Power Generation's Deep Geologic Repository for Low and Intermediate Level Radioactive Wastes.* Environment and Climate Change Canada. (CEAA Registry Doc# 1253) GOLDER. 2016. *Updated Analysis of Cumulative Environmental Effects*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP07701-00018-R000. (CEAA Registry Doc# 2883) NWMO. 2014. *Phase 1 Desktop Assessment, Environmental Report. Communities of Huron-Kinloss, Brockton and South Bruce, Ontario*. Nuclear Waste Management Organization Report APM-REP-06144-0107.

IR #	IR Title	Information Request and Response
		NWMO. 2015. *Phase 1 Desktop Assessment, Environmental Report. Municipality of Central Huron, Ontario*. Nuclear Waste Management Organization Report APM-REP-06144-0125. OPG. 2011. *Environmental Impact Statement, Volume 1*: Main Report. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298) OPG. 2012. Letter, Ontario Power Generation to Joint Review Panel, dated October 24, 2012. (CEAA Registry Doc# 776)
IR-2.6	Residual Cumulative Environmental Effects	***Information Request:*** *Provide a rationale as to why the potential interaction between the APM DGR and those environmental components under 5(1)(c) of CEAA 2012 was not considered in the updated cumulative effects assessment and discuss the potential for cumulative effects related to Indigenous interests.* ***Rationale:*** *According to OPG's "Updated Analysis of Cumulative Effects" (page 10), the residual adverse effects on radiation and radioactivity were not identified in OPG's EIS [OPG 2011] for the Project at the Bruce site, however, radiation and radioactivity have been included to allow for the consideration of potential cumulative effects in the updated analysis of cumulative effects. This same consideration was not provided for Indigenous interests.*
		OPG Response: With respect to environmental components under section 5(1)(c), Valued Components (VCs) related to Indigenous interests include: • human health; • socio-economic conditions (economic benefits and/or effects); • Aboriginal Heritage Resources (any structure, site or thing that is of historical, archaeological, paleontological or architectural significance); and • Traditional Use of Land and Resources (physical and cultural heritage, the current use of lands and resources for traditional purposes). The following provides the predicted likelihood of cumulative effects from the DGR Project and APM DGR project on VCs associated with Indigenous interests. <u>Human Health</u> The previous assessment determined that cumulative residual adverse effects from the APM DGR project and DGR Project on human health, and radiation and radioactivity would be unlikely (Sections 5.6 and 5.8; GOLDER [2016]). Additional analyses indicates that due to the localized and infrequent nature of effects, and the anticipated distance

IR #	IR Title	Information Request and Response
		between the two projects (20 to 86 km), there is predicted to be little to no geographic overlap in residual adverse effects from the two projects on air quality (see response to Information Request 2.1). Similarly, because the two projects are in different watersheds and with the implementation of mitigation, cumulative residual adverse effects to water quality are predicted to be unlikely (see response to Information Request 2.2). <u>Socio-economic Conditions</u> In addition, there are no likely cumulative adverse effects to VCs of the aquatic and terrestrial species that might be harvested or used by Indigenous peoples for traditional purposes (e.g., brook trout, lake whitefish, smallmouth bass, muskrat, wild turkey, mallard, white-tailed deer) (see response to Information Request 2.2). Subsequently, there are no predicted incremental or cumulative changes from the projects associated with traditional harvest of plants, wildlife or fish. The DGR Project is predicted to create direct, indirect and induced employment opportunities, which should have a positive influence on the economies for municipalities and Indigenous peoples in the local and regional study areas. Similar measurable economic benefits are anticipated for the APM DGR, and would likely overlap temporally and geographically with the DGR Project to generate positive cumulative effects on Indigenous interests. OPG acknowledges a concern stated by Métis Nation of Ontario (MNO) that barriers may exist to access by Indigenous peoples to direct or indirect employment associated with a project such as the DGR, and is engaging with Indigenous peoples to develop policies to promote better access to such benefits, including with OPG suppliers. OPG also acknowledges a concern stated by MNO that benefits such as employment growth may also be accompanied by increased competition by non-Indigenous peoples for use of resources such as for hunting and fishing. <u>Aboriginal Heritage Resources</u> An Indigenous burial site associated with cultural/ceremonial activities is located at the Bruce Nuclear site. Cumulative effects from dust, noise and aesthetics on the quality or value of activities undertaken by Indigenous peoples at the burial site would be unlikely (see response to Information Request 2.7). Residual effects from dust, noise and aesthetics would be localized to the areas around each project, and given the anticipated distance between the projects, there is predicted to be little to no spatial overlap in noise and dust effects, and no overlap in aesthetics. <u>Traditional Use of Land and Resources</u> Traditional hunting, trapping and gathering activities are not permitted within the Bruce Nuclear site boundary, and the same policy would be expected to be implemented for the APM DGR project. Residual effects from direct habitat loss, and dust and noise (indirect habitat loss) are predicted to cause small and localized changes on vegetation and wildlife VCs outside of the project site boundaries. These changes are predicted to result in no measurable decrease in harvesting success of terrestrial VCs that may be used by Indigenous peoples [OPG 2011]. In addition, there are no likely cumulative adverse effects to VCs of the aquatic and terrestrial species that might be harvested or used by Indigenous peoples for traditional purposes (e.g., brook trout, lake whitefish, smallmouth bass, muskrat, wild turkey,

IR #	IR Title	Information Request and Response
		mallard, white-tailed deer) (see response to Information Request 2.2). For most VCs, except white-tailed deer, the two projects likely influence the survival and reproduction rates of populations that have little to no connectivity. Thus, although the two projects would likely overlap in time, direct and indirect (noise, dust, water quantity, water quality) habitat changes associated with the two projects would not spatially overlap for most aquatic and terrestrial VCs (Information Request 2.2). For white-tailed deer, cumulative changes from the two projects are predicted to have little to no influence on the abundance and distribution of the population in the region, particularly considering the high resilience and adaptive capacity of this species (i.e., high reproduction rate, and flexibility to use a variety of habitats near and affected by human disturbance). **References:** GOLDER. 2016. *Updated Analysis of Cumulative Environmental Effects*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP07701-00018-R000. (CEAA Registry Doc# 2883) OPG. 2011. *Environmental Impact Statement, Volume 1*: *Main Report*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298)
IR-2.7	Cumulative Effects – Indigenous Interests	***Information Request:*** • *Provide a definition of the term 'Local Enjoyment of the Area' that reflects the environmental component Cultural Heritage (Indigenous Heritage Resources).* • *Provide a discussion on the potential environmental interactions identified for the APM DGR project that could act cumulatively with the residual effects identified for Indigenous interests.* ***Rationale:*** *OPG states that its updated cumulative environmental effects assessment builds on the results of effects of the Project at the Bruce site as described in section 7 of the EIS [OPG 2011a]. These results are summarized in Table 3-1 of OPG's "Updated Analysis of Cumulative Environmental Effects" report.* *It appears that Indigenous interests were not included in the updated analysis of cumulative effects. Section 7.9.2.2 of the EIS [OPG 2011a] states that the Project is likely to diminish the quality or value of activities undertaken by Aboriginal peoples at the Jiibegmegoong burial site located at the Bruce nuclear site. This occurs as a result of changed aesthetics, noise and dust. However, the assessment of the overall local enjoyment of the area does not discuss factors other than increased ambient noise, which was previously discussed in section 5.5 Noise Levels of OPG's "Updated Analysis of Cumulative Effects" report, and focuses on the Baie du Dore residences in particular.*

IR #	IR Title	Information Request and Response
		OPG Response: <u>'Local Enjoyment of the Area'</u> For the DGR Project, "enjoyment" of areas/amenities was an indicator used in the assessment of social assets (Socio-economic environment component) and was not identified directly as an indicator for use in the assessment for Aboriginal[4] Interests. Indicators used in the assessment for Aboriginal Interests were outlined in Table 4.3-1 of the Aboriginal Interests Technical Support Document (TSD) [AECOM 2011]. The term "local enjoyment of the area" was identified as a "main consideration" with regard to the potential for the APM DGR to affect Cultural Resources (both Indigenous Heritage Resources and Euro-Canadian Heritage Resources) and was intended to capture the potential for the APM DGR to affect these resources in a general way. For the purposes of this Response the interaction between the APM DGR and Indigenous Heritage Resources and Euro-Canadian Heritage Resources was interpreted as having the potential to overlap (in terms of effect type, and temporal and spatial extent of effects) with the residual effects of the DGR Project to the Aboriginal Interests Heritage Resource Valued Component (VC) identified for assessment of the DGR Project. <u>Potential APM DGR Environmental Interactions that Could Act Cumulatively with the OPG DGR</u> The approach used for updating the cumulative effects analysis has been applied to the following discussion of the potential environmental interactions identified for the APM DGR that could act cumulatively with the residual effects from the DGR Project on Aboriginal Interests. The EIS [OPG 2011 Sections 7, 8 and 11] and the Aboriginal Interests TSD [AECOM 2011] identified the following residual adverse effect to Aboriginal Interests (Heritage and Resources VC) from the DGR Project: • The DGR Project is likely to diminish the quality or value of activities undertaken by Aboriginal peoples at the Aboriginal burial site located at the Bruce Nuclear site. As a result, a residual adverse effect on the Aboriginal Heritage Resources VC is expected to occur during all phases of the DGR Project. This results from changed aesthetics (associated with visibility of the DGR Project), and temporarily increased noise and dust. The DGR Project will not change the access to the Aboriginal burial site nor the ability of Aboriginal peoples to undertake their cultural/ceremonial activities at this site. The identified residual adverse effect was not considered to be significant because the burial site is located on an existing industrial site (the Bruce Nuclear site), and may be affected by dust and noise infrequently. It is considered unlikely that ceremonies would occur during these times. Moreover, apart from the visibility of the waste rock pile, adverse effects over the long term are not anticipated.

[4] The term "Aboriginal" was used in OPG's EIS [OPG 2011] and its supporting documentation [AECOM 2011].

IR #	IR Title	Information Request and Response
		As noted above, the factors contributing to the DGR Project residual adverse effect on Aboriginal Interests are related to changes in aesthetics (visibility of the DGR Project), noise and dust. The potential for the effects of the APM DGR to overlap with these effects is discussed below. *Visibility* The Updated Analysis of Cumulative Environmental Effects report [GOLDER 2016] did not explicitly describe the potential for cumulative effects to aesthetics between the DGR Project and the APM DGR. Given the APM DGR will be at least 20 km distant and possibly as far away as 86 km from the DGR Project, it is not expected to be visible from the burial site located on the Bruce Nuclear site. As such, no cumulative effects associated with aesthetics are predicted between the projects. Accordingly, the APM DGR is not predicted to add cumulatively to aesthetic effects in a manner that would further diminish the quality or value of activities undertaken by Indigenous peoples at the Indigenous burial site located at the Bruce Nuclear site. *Noise* The Updated Analysis of Cumulative Environmental Effects report (Section 5.5 [GOLDER 2016]) assessed the potential for cumulative effects to noise between the DGR Project and the APM DGR. The assessment identified that noise levels associated with the DGR Project are predicted to attenuate within 400 m of the Bruce Nuclear site (note that movement of used fuel from the Bruce Nuclear site to the APM DGR was already considered in the noise cumulative effects assessment for the DGR Project in the original EIS [OPG 2011]). Noise effects at the APM DGR are likely to be similar to those of the DGR Project and will similarly attenuate with distance. Given that the APM DGR site would be at least 20 km from the Bruce Nuclear site, no cumulative effects from noise are predicted in association with the APM DGR. As such, no cumulative effects associated with noise are predicted between the projects. Accordingly, the APM DGR is not predicted to add cumulatively to noise effects in a manner that would further diminish the quality or value of activities undertaken by Indigenous peoples at the Indigenous burial site located at the Bruce Nuclear site. *Dust* The Updated Analysis of Cumulative Environmental Effects report (Section 5.4 [GOLDER 2016]) assessed the potential for cumulative effects to air quality between the DGR Project and the APM DGR. The assessment concluded that the residual effects of the DGR Project, which extend just beyond the Site Study Area, are unlikely to overlap spatially with air quality effects that may be associated with the APM DGR because the APM DGR project will be at least 20 km distant and possibly as far as 86 km from the DGR Project, depending on the site selected. Given that the burial site is located within the Site Study Area for the DGR Project, no cumulative effects from dust are predicted in associated with the APM DGR. Accordingly, the APM DGR is not predicted to add cumulatively to dust effects in a manner that would further diminish the quality or value of activities undertaken by Indigenous peoples at the Indigenous burial site located at the Bruce Nuclear site.

IR #	IR Title	Information Request and Response
		While effects to aesthetics, noise and dust associated with the APM DGR are likely to overlap in time with effects from the DGR Project, the effects are not expected to overlap spatially. Accordingly, APM DGR effects to aesthetics, noise and dust are not predicted to contribute cumulatively to the residual adverse effects identified for Aboriginal Interests in association with the DGR Project. As noted in the Updated Analysis of Cumulative Environment Effects report [GOLDER 2016], OPG has committed to the SON that OPG will not move forward with the construction of a DGR for low and intermediate level waste at the Bruce Nuclear site until the SON community is supportive of the Project. Further OPG and SON have committed to the good faith, informed resolution of potential Project impacts through the ongoing engagement between SON and OPG. The engagement process between SON and OPG is meaningful, respectful and ongoing. In addition, NWMO has also specifically committed that an APM DGR would not be sited in the traditional territory of the SON – the Chippewas of Nawash Unceded First Nation and Saugeen First Nation – without community support. Any siting within this territory would be informed by discussions with the SON regarding potential effects and their mitigation [NWMO 2016]. OPG also has agreements with Métis representative organizations in the area and meets with them on a quarterly basis. The same level of information about the DGR project is shared with these Métis organizations as with SON. Specifically, the Métis organizations are the Historic Saugeen Métis (HSM), based in Southampton, and the Georgian Bay Traditional Territory Community Committee (GBTTCC), made up of the Moon River, Georgian Bay, and Great Lakes Métis Councils within the Métis Nation of Ontario Region 7. NWMO has also engaged with these Métis organizations on the APM DGR project. Both the Saugeen Ojibway Nation (SON) and the Métis Nation of Ontario (MNO) have signaled concerns regarding intangible VECs, namely the stigma of potentially hosting two DGRs. For example, tourists may choose not to visit the location out of fear of contamination and fishers would be concerned about the health of their catch. Members of these Indigenous peoples may avoid the area, impacting their traditional harvesting practices, as an example. OPG has committed to the ongoing engagement and dialogue to address these concerns. These mechanisms, along with any federal requirements for future assessments and regulatory approvals, provide a reasonable basis to address any ongoing and future concerns that may arise, if an APM DGR is located in one of the three identified municipalities and any unforeseen cumulative effect affecting any Indigenous interest that is subsequently identified. **References:** AECOM. 2011. *Aboriginal Interests Technical Support Document*. Prepared by AECOM Ltd. Nuclear Waste Management Organization Report NWMO DGR-TR-2011-09 R000. (CEAA Registry Doc# 299) GOLDER. 2016. *Updated Analysis of Cumulative Environmental Effects*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP07701-00018-R000. (CEAA Registry Doc# 2883)

IR #	IR Title	Information Request and Response
		NWMO. 2016. *APM DGR Preliminary Description. Prepared to Support Ontario Power Generation Cumulative Effects Response to Minister of Environment and Climate Change Canada (2016)*. Prepared by Nuclear Waste Management Organization. Ontario Power Generation Report 00216-REP-07701-00017-R000. (CEAA Registry Doc# 2883) OPG. 2011. *Environmental Impact Statement, Volume 1*: *Main Report*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298)
IR-3.1	Clarification of MIT-P-02	***Information Request:*** *Provide a revised version of MIT-P-02 to clarify how in-design mitigation measures for underground facilities will integrate seismic requirements.* ***Rationale:*** *MIT-P-02 indicates that "All underground facilities (office, tunnel, emplacement room) will be constructed in accordance with the seismic requirements of the latest edition of the National Building Code at the time of the construction."* *Given that there are no specific seismic requirements in the National Building Code for underground facilities, this statement is ambiguous.*
		OPG Response: The detailed commitment supporting MIT-P-02, referred to by the rationale of the Information Request, was intended to show OPG's adherence to applicable codes and standards, including in this case to the latest edition of the National Building Code of Canada (NBCC) at the time of the construction. For clarity, the commitment refers to designing the underground portion of the DGR to resist ground motions due to the seismic event that is specified in the NBCC for the location of the DGR (for details, see OPG's supplementary response to Information Requests LPSC-01-05 and LPSC-01-17 [OPG 2012]). The detailed commitment is revised from: "All underground facilities (office, tunnel, emplacement room) will be constructed in accordance with the seismic requirements of the latest edition of the National Building Code at the time of the construction. [EA-142, IRC-LPSC-01.01, IRC-LPSC-01.02, IRC-LPSC-04.09]" To

IR #	IR Title	Information Request and Response
		"All underground facilities will be designed and constructed to resist ground motions caused by a seismic event specified for this area in the latest edition of the National Building Code of Canada (NBCC) at the time of construction. Under the current NBCC, this seismic event will have a return period of 1 in 2,500 years (or a probability of 2% per 50 years). The occurrence of such an event shall not lead to failure of underground structures during the operational life of the facility." [based on EA-142, IRC-LPSC-01.01, IRC-LPSC-01.02, IRC-LPSC-04.09]." This commitment, demonstrating compliance with the NBCC, will be addressed through the detailed design and the construction of the underground facilities. The dimensioning of the underground openings, and the detailed design of the shaft liner and the ground support system will be carried out incorporating this seismic design requirement. **Reference:** OPG. 2012. Letter, Ontario Power Generation to Joint Review Panel, dated July 10, 2012. (CEAA Registry Doc# 606)

ENCLOSURE 1

Table 1 (associated with IR-1.1 response): Regional Variability and Management of Uncertainty

Enclosure 1

Table 1 (associated with IR-1.1 response): Regional Variability and Management of Uncertainty

Valued Component	**Range of Baseline Environmental Conditions at the Alternate Locations**	**Environmental Criteria Used to Focus the Range of Background Conditions**	**How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects**
Air Quality (Criteria Air Contaminants; Greenhouse Gases)	Background air quality varies across Ontario and is influenced by the number and intensity of anthropogenic sources within and nearby both alternate locations. For example urbanized areas, industrial sources and local infrastructure (i.e., highways) and distance from long range transportation sources (e.g., coal fired power plant in the Ohio Valley). Potential effects on air quality are experienced at and beyond the DGR site's fenceline. The DGR site chosen could be between 40 and 900 ha. The sedimentary alternate location includes densely populated areas, which have been converted to human uses for agriculture and infrastructure. Existing air quality conditions typical of non-urbanized areas at the sedimentary alternate location are characterized as “good air quality” [GOLDER 2011]. Areas proximate to urbanized areas and other industrial activity have moderate to poor air quality. The crystalline alternate location is almost entirely a natural and semi-natural area, where built-up areas combined account for less than 2% of the total land area (less than 1% in the northern portion) [Statistics Canada 2017]. Therefore, air quality throughout most of the crystalline alternate location is characterized as “good air quality”. Areas collocated with existing industrial activity may be characterized as moderate air quality.	The DGR in an alternate location is not likely to be located within an urban or built up area. Therefore, the DGR would not likely be in a location with poor background air quality. The distance to the fenceline at either alternate location could be up to a kilometre distant from the DGR surface facilities (i.e., for a 900 ha site).	Uncertainty in identifying environmental effects was first reduced by focusing the range of background conditions likely to be encountered. The expectation of good background (baseline) air quality was therefore assumed when assigning the magnitude of the potential adverse effects. Although existing environmental conditions are included in the assessment, effects predictions are more influenced by project design inputs and mitigations, which have the greatest impact on the ability to permit an alternate location. Therefore, uncertainty in the project emissions and mitigation were considered and managed. The nature of the potential emissions associated with the construction and operation of a DGR are well understood and the in-design mitigation measures for air quality are known to be effective and are the greatest factor in the assessment. Environment and Climate Change Canada has further commented that the mitigation measures should be equivalent for the DGR regardless of its location. Among other things, uncertainty in predictions was therefore managed through making conservative assumptions surrounding emissions. Uncertainty with regard to predictions of effects on air quality was further managed through consideration of applicable regulatory requirements that would need to be met. Compliance of an alternate location would need to be demonstrated at the facility fenceline through an Environmental Compliance Approval (ECA) in accordance with O. Reg. 419/05 of the Ontario *Environmental Protection Act*.

Valued Component	**Range of Baseline Environmental Conditions at the Alternate Locations**	**Environmental Criteria Used to Focus the Range of Background Conditions**	**How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects**
Noise Levels	Similar to air quality, background noise levels vary across both alternate locations and are influenced by the location, number and intensity of anthropogenic sources. Potential effects on noise are generally most acutely experienced at the closest off-site receptor. Within the sedimentary alternate location, urbanized areas have greater background noise levels, whereas rural portions of this alternate location would be generally free of or have limited influence from existing industrial activities. At the sedimentary alternate location, the closest off-site receptor is likely to be within a couple kilometres of the DGR site. Due to the generally remote nature of the crystalline alternate location, the majority of this alternate location is generally even further removed from anthropogenic noise sources than the sedimentary alternate location. Therefore, background noise levels in the crystalline alternate location range from very low in the majority of areas; however, areas further south would be more likely to experience background noise levels similar to those observed at the sedimentary alternate location. At the crystalline alternate location, the closest off-site receptor could be as close as adjacent to the DGR site, but potentially several kilometres away.	The DGR in an alternate location is not likely to be located within an urban or built up area. Therefore, background levels in the sedimentary alternate location during the quietest nighttime hour is likely to be less than or equal to 35 dBA 1-hour L_{eq}. At the crystalline alternate location, background levels are likely to be less than or equal to 30 dBA 1-hour L_{eq}. The distance to the closest off-site receptor at within either alternate location was assumed to be approximately 1 km from the DGR site.	Uncertainty in identifying environmental effects was first reduced by focusing the range of background conditions likely to be encountered at the quietest nighttime hour. Uncertainty was managed in considering noise emissions by applying conservative assumptions. Specifically, maximum project noise emissions would be limited to 40 dBA regardless of which alternate location to ensure compliance with NPC 300 under the *Environmental Protection Act*. Noise emissions and effectiveness of mitigation from the construction and operation of the DGR are well understood. The proximity of the closest off-site receptor to the DGR activities is important for considering the magnitude of noise level effects. Uncertainty in the distance to the closest receptor was managed through assuming a similar distance to the closest off-site receptor for all three locations, so direct comparisons between the locations could be made.
Hydrology and Water Quality	Within the sedimentary alternate location, there are extensive networks of small rivers, streams and creeks feeding into one of the Great Lakes. These different waterbodies would have different assimilative capacities to accommodate surface water discharges. Outside of urbanized portions of the sedimentary alternate location, most of the land is developed for livestock and cash crop farming, with areas not developed for agriculture generally either forested or	While the nearby presence of a Great Lake is generally not a technical feasibility factor, per the Agency's clarification, this assessment considers alternate locations that are not the same as the Bruce Nuclear site. Therefore, the receiving water body for emissions from surface facilities at the sedimentary alternate location are likely to be an agricultural drainage ditch or small stream. At the crystalline alternate location it is likely to be a small ditch, stream or lake.	Water quality and hydrology is specific to a site and ranges widely depending on several factors. Uncertainty in identifying environmental effects was first reduced by focusing the range of background conditions likely to be encountered in each alternate location. Conservative assumptions were made when identifying potential effects to manage uncertainty. For the crystalline location, where siting criteria may not be met an effect was assumed to occur; and permitting with the local Conservation Authority,

Valued Component	Range of Baseline Environmental Conditions at the Alternate Locations	Environmental Criteria Used to Focus the Range of Background Conditions	How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects
	consisting of small rural communities. Water quality in the sedimentary alternate location is generally good with some anthropogenic influences (e.g., agriculture), and therefore some exceedances of Provincial Water Quality Objectives (PWQO) and Ontario Drinking Water Standards (ODWS), with more frequent exceedances in urban areas. The crystalline alternate location is generally well drained with an abundance of lakes, wetlands and rivers. The crystalline alternate location is within the Great Lakes and Hudson Bay watersheds. Within the crystalline alternate location, water quality is generally good with limited anthropogenic influences, and therefore limited exceedances of PWQO and ODWS. Local geology also influences the nature of potential effects on water quality (e.g., through acid rock drainage/metal leaching from the waste rock pile). The sedimentary alternate location would typically be considered to have a lower risk for acidic (low pH) waters, but metal leaching is still possible. Acid rock drainage and metal leaching potential is generally more likely for the crystalline alternate location.	Where possible, construction of surface facilities would be avoided: • within floodplains or in other areas that can be flooded (e.g., below the high water line on a lake). • within a water feature; and/or • within the buffer zone surrounding waterbodies (e.g., typically 3 to 5 metres (m) in width for small streams in gently sloping terrain; wider for larger watercourses or different terrain). Within the sedimentary alternate location, it is expected that these siting criteria can be met. Meeting such criteria may not be feasible in the crystalline alternate location given the number and distribution of floodplains, water features and water bodies. Where possible, localized areas with high potential for acid rock drainage/metal leaching from the waste rock would be avoided.	Fisheries and Oceans Canada (DFO), Ministry of Natural Resources and Forestry (MNRF) or Ministry of Environment and Climate Change (MOECC) may be required. Uncertainty was further managed through considering the nature of project emissions, mitigation measures and approvals processes in place to ensure no significant effect. Existing conditions would be monitored as part of a baseline program and the variability would be included in predictive water quality results that would then form the basis for determining any required mitigation measures. As permitting through an ECA under the *Environmental Protection Act*, or as agreed by the CNSC, would establish release limits to the environment considering aquatic toxicity thresholds, by definition there can be no adverse residual impacts to surface water quality. If site-specific predictive modelling indicated a potential effect, changes to the design or additional mitigation measures would be made. Mitigation measures (e.g., treatment for the parameters of concern or ARD) are well understood and could be implemented at either location and scaled to the requirements of the receiving body.
Aquatic Habitat and Biota	Both alternate locations have watercourses or waterbodies that support sensitive coldwater, coolwater, and warmwater species including potential aquatic Species at Risk. The ecozone of the sedimentary alternate location (mixed wood plains) is generally well drained. Most watercourses in the area are cool to coldwater and are considered to be more sensitive to disturbance than warmwater systems. There are also warmwater systems in this ecozone. The ecozone of the crystalline alternate location (Boreal shield) is generally well	In accordance with the *Fisheries Act*, no surface facilities would affect a Commercial, Recreational or Aboriginal (CRA) fishery, unless duly authorized through Fisheries and Oceans Canada (DFO) or the Minister of Fisheries. The presence or potential presence of a CRA fishery would be determined through field collected information and engagement with Indigenous peoples considering guidance and definitions provided through the *Fisheries Act*. Site selection principles noted above for hydrology and water quality are also protective for fish species. In addition, where possible, any site within an alternate location would avoid	Conservative assumptions were applied to both alternate locations concerning predicted effects from blasting, changes to surface water quality and quantity and groundwater quality and quantity. In addition, the general nature of the potential indirect effects of the project on aquatic habitat and biota (e.g., effects to groundwater and surface water quality and quantity, blasting and vibrations, and the SWMP) are well understood for the construction and operation of a DGR. This knowledge of effects and the understanding of local baseline conditions were used to manage uncertainty and increase confidence in effects predictions.

Valued Component	Range of Baseline Environmental Conditions at the Alternate Locations	Environmental Criteria Used to Focus the Range of Background Conditions	How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects
	drained with an abundance of wetlands, lakes and rivers. As noted above, water quality in this region is generally good with limited anthropogenic influences. There are both warmwater and cool to coldwater systems in this ecozone. Critical habitat for Species at Risk can be found in both alternate locations.	sensitive aquatic features (e.g., coldwater habitat), as well as Species at Risk and their critical habitats as a primary mitigation. At the sedimentary alternate location avoidance is likely achievable given the topography and mitigation identified. At the crystalline alternate location, direct effects on habitat are likely unavoidable given the abundance of habitats, although siting would avoid potential effects on the most sensitive habitats (i.e., for Species at Risk).	Mitigation measures to avoid potential effects on sensitive cold water species were considered at both alternate locations. Effectiveness of mitigation is also known, which further reduced uncertainty.
Vegetation Communities, including upland and wetland	The sedimentary alternate location corresponds with the mixed wood plains ecozone. Land cover in the ecozone is dominated by cropland, pasture and abandoned fields, with woodland cover at only 16%. Vegetation is low quality fragmented stands of mixed woods. The Boreal shield ecozone of the crystalline alternate location is relatively cold and moist, with long, cold winters and short, warm summers. Land cover in this ecozone tends to be dominated by woodlands, including mixed, coniferous and deciduous forests. Other areas in the crystalline alternate location are classified as meadows or wetlands. In addition, some areas have been subject to cutover and burns, whereas other areas have not been.	Where possible, surface facilities would not be located within a provincially significant wetland (PSW) or a significant coastal wetland, as defined by the MNRF. Proximity to wetlands, and consideration of a buffer from wetlands including 120 m of a PSW would also be considered. Where possible, significant woodlands would be avoided, taking into consideration the relative area of the woodlands potentially affected. Site selection principles noted above for hydrology are also protective for wetlands. After considering these environmental criteria at the sedimentary alternate location, a DGR is most likely to affect remnant, already affected natural plant communities. At the crystalline alternate location, with avoidance of bogs and wetland areas, resultant vegetation communities that may be affected are woodlands and meadows with less existing fragmentation.	Conservative assumptions were applied to both alternate locations concerning predicted effects from direct (up to 40 ha of land cover removed) and indirect (dust, water quantity and quality) changes in vegetation communities and plants. In addition, the general nature of the potential pathways of effect from a DGR on vegetation is well understood (e.g., vegetation loss from site clearing). This knowledge of potential effects and the understanding of local baseline conditions were used to manage uncertainty and increase confidence in effects predictions. Mitigation measures to reduce potential impacts are well understood and expected to minimize any potential effects of the DGR, regardless of location. This further reduced uncertainty. It was assumed that the project would avoid the most sensitive communities such as provincially significant wetlands and coastal wetlands. Significant woodlands would be avoided where possible, but in the case that one could not be avoided, the project would be sited such that the overall form and function of the woodland would not be affected.

Valued Component	Range of Baseline Environmental Conditions at the Alternate Locations	Environmental Criteria Used to Focus the Range of Background Conditions	How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects
Wildlife Habitat and Biota	The vegetation in the ecozone of the sedimentary alternate location is relatively diverse and includes hardwood forest species, lowlands including floodplain forests and peatlands. Characteristic wildlife in this ecozone includes white-tailed deer, northern raccoon, striped skunk, great blue heron, field sparrow, American bullfrog, and snapping turtle. Vegetation in the Boreal shield ecozone of the crystalline alternate location is diverse. Land cover in this area tends to be dominated by woodlands, including mixed, coniferous and deciduous forests, and wetlands. Characteristic wildlife species vary within the ecozone, but can include species such as American black bear, moose, snowshoe hare, bald eagle, yellow-rumped warbler, and western painted turtle. In certain areas of the ecozone woodland caribou and gray wolf are also characteristic species.	Where possible, the following features would be avoided: • habitat of threatened or endangered species listed under the Ontario *Endangered Species Act,* and the federal *Species at Risk Act;* • Significant Wildlife Habitat (SWH) as defined in the MNRF Significant Wildlife Habitat Technical Guide [MNR 2000] and the MNRF Significant Wildlife Habitat Criteria Schedules for Ecoregions [2015]; and • significant Areas of Natural and Scientific Interest (ANSI). Environmental criteria noted above for vegetation and wetlands are also protective for wildlife habitat and biota, including Species at Risk. Environmental criteria noted above for physical VCs (e.g., air quality, noise, hydrology and water quality) are also protective of potential indirect effects on for wildlife habitat and biota, including Species at Risk.	Conservative assumptions were applied to both alternate locations concerning predicted effects from direct and indirect (includes sensory disturbance from lights and noise) changes in habitat. In addition, the general nature of the potential effects from a DGR on wildlife are well understood. The assumptions and understanding of local baseline conditions were used to manage uncertainty and increase confidence in effects predictions. Mitigation measures to reduce potential effects are well understood and expected to minimize any potential effects of the DGR, regardless of location. This further reduced uncertainty. Although the specific magnitude of the predicted effects may vary within an alternate location, through management of uncertainty as described above, the assessment considered the different types of effects that may occur, and considered the avoidance of effects on significant or sensitive habitats to the extent possible, through implementation of mitigation.
Geology and Groundwater	The sedimentary alternate location is defined by a suitable thickness of low permeability Ordovician sediments below ground surface in which the DGR could be positioned. The thickness of these sedimentary rocks is well defined because of this geological uniformity. Within these sedimentary rocks, the Ordovician sediments (shales and carbonates) are particularly attractive. They extend across much of southern Ontario and are generally thick, deep, and geologically stable. The geology of the crystalline alternate location is defined by a layer of glacial drift, and lake and river sediments (i.e., clay, silt and sand), overlying the crystalline rock of the Canadian Shield. The Canadian Shield	The range of conditions encountered for geology and groundwater were focused through consideration of technical criteria outlined in the Main Submission [OPG 2016]. Specifically, the host geology must have been stable for times that are long compared to the lifetime of the main hazard in the low and intermediate level waste, and that have been resilient to past glacial and seismic events. In addition, the depth and thickness of competent rock must be sufficient to host and enclose a DGR, that is, a minimum 200 m depth and 300 m bedrock thickness.	Understanding baseline conditions and effectiveness of mitigation were used to manage uncertainty and increase confidence in effects predictions. The behaviour of the geology at both alternate locations is well understood and the effectiveness of mitigation is known. Uncertainty was also managed through the need for a site-specific DGR design that, through a combination of engineered and natural barriers, would achieve regulatory criteria with an appropriate margin of safety.

Valued Component	Range of Baseline Environmental Conditions at the Alternate Locations	Environmental Criteria Used to Focus the Range of Background Conditions	How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects
	consists of a variety of igneous and metamorphic rock types, including granite. As crystalline rock is typically fractured, the DGR position within the rock would be dependent on the nature of the fractures. These rocks are geologically stable. Active groundwater flow in crystalline bedrock is generally confined to shallow localized fractured systems, which at depth diminish as discrete fracture pathways become less frequent and interconnected.		
Radiation and Radioactivity (Humans, Non-human biota)	Background levels of radiation and radioactivity present in the environment vary across both alternate locations due to variations in natural and anthropogenic sources. Naturally occurring radioactive materials (NORM) and radon exist at both alternate locations, as driven by uranium concentrations in the host geological formation. Uranium concentrations in the sedimentary rock are generally low. Whereas, higher uranium levels in granitic rock at the crystalline alternate location could lead to higher levels of natural radon.	The technical siting criteria as outlined for geology and groundwater are also applicable for radiation and radioactivity.	Uncertainty was managed through the understanding of project-specific emissions and the core assumed need for a site-specific DGR design that through a combination of engineered and natural barriers, would achieve regulatory criteria with an appropriate margin of safety. In addition, dose to workers would be minimized in the context of As Low As Reasonably Achievable (ALARA) regardless of location. Furthermore, understanding the range of baseline conditions and effectiveness of mitigation in the identified geology was also used to manage uncertainty and increase confidence in effects predictions. The nature of the potential sources of radiation and radioactivity is well understood through the detailed studies completed as part of the DGR EIS [OPG 2011]. The alternate locations are not likely to have existing anthropogenic sources of radioactivity. However, for comparison the total existing dose rate at site boundary from the Bruce Nuclear site operations is approximately 0.004 mSv/a [OPG 2011], which is small compared to the natural background dose rate of about 1.8 mSv/a across Canada.
Land and Resource Use (Non-traditional)[5]	The sedimentary alternate location contains a variety of settings and land use areas, including densely populated areas, which	The DGR is not likely to be located within an urban or built up area. Therefore, the land use likely to be affected is one that is not currently	Uncertainty in identifying environmental effects was first reduced by focusing the range of background conditions likely to be encountered within each

[5] The original Land and Resource Use VC included both traditional and non-traditional uses. For the purposes of this submission we are distinguishing them. The Land and Resource Use VC is now called Land and Resource Use (Non-traditional). Land and Resource Use (Traditional Purposes) has been integrated into an explicit Indigenous Interests VC.

Valued Component	Range of Baseline Environmental Conditions at the Alternate Locations	Environmental Criteria Used to Focus the Range of Background Conditions	How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects
	have been converted to human uses for agriculture and infrastructure. Within the sedimentary alternate location, these lands are, to a degree, already circumscribed by development. The crystalline alternate location is almost entirely a natural and semi-natural area, where built-up areas combined account for less than 2% of the total land area (less than 1% in the northern portion) [Statistics Canada 2017]. The crystalline alternate location is therefore substantially less encumbered by overall development.	used for industrial or commercial purposes. Environmental criteria noted above for biophysical VCs are also applicable for use of land and resource.	alternate location, with the environmental features discussed above. Where possible, conservative assumptions were made in the assessment regarding potential effects to reduce uncertainty. In addition, in some cases a range of potential effects was described. For example, removal of land from use considered a range of site sizes (i.e., between 40 and 900 ha). A DGR located at an alternate location would have all of the same potential effects of a DGR at the Bruce Nuclear site, with the addition of a number of potential effects on land and resource use (e.g., establishment of a new site and infrastructure, new and larger land clearing). Uncertainty was further managed through considering the nature of project emissions, mitigation measures and approvals processes in place to ensure no significant effect.
Indigenous Interests	The sedimentary alternate location includes the traditional territories of multiple Indigenous peoples (see response to Information Request 1.15) and lands currently being used for Aboriginal and treaty rights such as hunting, fishing and harvesting. The crystalline alternate location is almost entirely a natural and semi-natural area, where built-up areas combined account for less than 2% of the total land area (less than 1% in the northern portion) [Statistics Canada 2017]. The crystalline alternate location is less encumbered by overall development, with Indigenous people exercising a range of Aboriginal and treaty rights over their traditional territories.	The DGR is not likely to be located within an urban or built up area. Therefore, the land use likely to be affected is one that is not currently used for industrial or commercial purposes. Considering this, it follows that a DGR in an alternate location is more likely to be sited on land that is currently used for traditional purposes by Indigenous people. For the avoidance of any confusion, this reasoning is not intended to undermine or otherwise diminish the concerns expressed by SON over the historic development of the Bruce Nuclear site, which is the subject of further discussions between SON and OPG. Environmental criteria noted above for biophysical VCs are also applicable for use of land and resource.	Uncertainty in identifying environmental effects was first reduced by focusing the range of background conditions likely to be encountered within each alternate location, with the environmental features discussed above. Where possible, conservative assumptions were made in the assessment regarding potential effects to reduce uncertainty. In addition, in some cases a range of potential effects was described. For example, removal of land from use considered a range of site sizes (i.e., between 40 and 900 ha). A DGR located within an alternate location would have all of the same potential effects of a DGR at the Bruce Nuclear site, with the addition of a number of potential effects on land and resource use (e.g., establishment of a new site and infrastructure, new and larger land clearing). Uncertainty was further managed through considering the nature of project emissions, mitigation measures and approvals processes in place to ensure no significant effect. In the case of

Valued Component	Range of Baseline Environmental Conditions at the Alternate Locations	Environmental Criteria Used to Focus the Range of Background Conditions	How Uncertainty was Managed to Increase Confidence in Predicted Environmental Effects
			land use, the siting of the DGR at an alternate location would require the support of Indigenous peoples in whose traditional territory the DGR would be located. Although the specific community and/or interests and rights potentially affected are not known, it is expected that appropriate mitigation and accommodation measures could be provided as determined through consultation.

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ENCLOSURE 2

Table 6-1 (associated with IR-1.2 response): Summary of Likely Environmental Effects of Alternate Locations as Compared to the DGR Project at the Bruce Nuclear Site

Enclosure 2

Table 6-1 (associated with IR-1.2 response): Summary of Likely Environmental Effects of Alternate Locations as Compared to the DGR Project at the Bruce Nuclear Site

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
Atmospheric Environment					
Air Quality – Criteria Air Contaminants	***Methodology used in identifying potential environmental effects at all three locations:*** *Any increase in project-related emissions to air.* ***Bruce Nuclear site:*** • Potential environmental effects on air quality are identified during site preparation and construction, operations and decommissioning as a result of emissions associated with the DGR. These effects are increased calculated maximum ambient concentrations of 1-hour NO_2, 24-hour NO_2, annual NO_2, 1-hour CO, 24-hour CO, 24-hour SPM, annual SPM, 24-hour PM_{10} and 24-hour $PM_{2.5}$ over baseline conditions.	***Bruce Nuclear site:*** • Mitigation would include Best Management Practices and Procedures (BMPPs) for dust, and proper maintenance of equipment and vehicles associated with all activities. • The DGR would have to meet Ministry of the Environment and Climate Change (MOECC) air quality criteria at the facility fenceline during Environmental Compliance Approval (ECA) permitting. These criteria are established to be protective of the environment and human health.	***Criteria used in identifying a residual adverse effect:*** *Project-related emissions resulting in a measurable increase in ambient air quality concentrations.* ***Bruce Nuclear site:*** • Residual adverse effect on air quality include concentrations of criteria air contaminants (CACs) greater than background concentrations during site preparation and construction phase, operations, and decommissioning.	***Benchmark used to determine whether residual effects are significant:*** *Ambient air concentrations beyond the Site Study Area (i.e., the DGR site) that exceed relevant established ambient air quality criteria more than 10% of the time*. ***Bruce Nuclear site:*** • Magnitude: Low to High; some exceedances of ambient air quality criteria are predicted. • Extent: Local; high magnitude effects are limited to an area adjacent to, but beyond, the Site Study Area. • Frequency: High magnitude effects occur very infrequently (<0.5% of the time). • Duration: High magnitude effects occur throughout the site preparation and construction, and decommissioning phases. • Reversibility: Immediately reversible when activities cease. • Ecological/social context: The existing air quality measured in the region is generally good, with concentrations of gaseous indicator compounds meeting all relevant ambient criteria and particulate matter concentrations infrequently exceeding ambient criteria. High magnitude effects (i.e., above relevant ambient air quality criteria) are predicted to occur less than 0.5% of the time during the site preparation and construction, and decommissioning phases. During the operations phase, no high magnitude effects are predicted. Therefore, residual adverse effects on air quality at the Bruce Nuclear site are not significant.	○ **Bruce Nuclear site –** fewest adverse effects on air quality ▲ **Sedimentary alternate location** – Increased effects compared to the Bruce Nuclear site due to additional waste transportation and construction of supporting infrastructure required; however, effects are not likely to be significant. ▲ **Crystalline alternate location –** Increased effects compared to the Bruce Nuclear site due to additional waste transportation required, construction of supporting infrastructure, and increased emissions during excavation; however, effects are not likely to be significant.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	Sedimentary alternate location: • Potential effects on air quality are identified from emissions associated with the DGR, construction of additional surface facilities (e.g., new road up to 5 km) and transportation of waste including: increased calculated maximum ambient, concentrations of 1-hour NO_2, 24-hour NO_2, annual NO_2, 1-hour CO, 24-hour CO, 24-hour SPM, annual SPM, 24-hour PM_{10} and 24-hour $PM_{2.5}$ over baseline conditions. • DGR-related increases in concentrations of air quality indicator compounds (criteria air contaminants [CACs]) at the DGR's fenceline are likely to be similar to those predicted in the EIS [OPG 2011] for site preparation and construction, operations and decommissioning. • Increased concentrations of above-noted parameters are also anticipated as a result of emissions from trucking shipments of waste packages up to 300 km from the Western Waste Management Facility (WWMF) to the sedimentary alternate location [ENERGY SOLUTIONS 2016]. These may also result in potential nuisance-related effects (e.g., dust) to adjacent residences along the transport route. • Additional effects on air quality due to increase in CAC emissions during construction of new road and power transmission lines (up to 5 km).	***Sedimentary alternate location:*** • Mitigation identified for the Bruce Nuclear site is also applicable for the sedimentary alternate location[6].	***Sedimentary alternate location:*** • Residual adverse effect on air quality include concentrations of CACs greater than background concentrations during site preparation and construction phase, operations, and decommissioning. Effects on air quality during waste transportation would be low in magnitude and infrequent (i.e., approximately 2 trips per day each way [ENERGY SOLUTIONS 2016]) along the transportation routes.	***Sedimentary alternate location:*** • Magnitude: Low to High; some exceedances of ambient air quality criteria may occur. • Extent: Local; high magnitude effects would be limited to an area immediately adjacent to the DGR site. Potential effects from waste transportation would extend beyond the site. • Frequency: High magnitude effects, if any, would occur very infrequently (<0.5% of the time). • Duration: High magnitude effects occur throughout the site preparation and construction, and decommissioning phases. • Reversibility: Immediately reversible when activities cease. • Ecological/social context: The existing air quality measured in the sedimentary location is generally good, with concentrations of gaseous indicator compounds meeting all relevant ambient criteria and particulate matter concentrations infrequently exceeding ambient criteria. Potential exceedances of ambient air quality criteria, if any, are not likely to be frequent (less than 0.5% of the time) considering mitigation and compliance with applicable permits. Therefore residual adverse effects would not be significant.	
	Crystalline alternate location: • Potential effects on air quality are identified from emissions associated with the DGR, construction of additional surface facilities and transportation of waste including: increased calculated maximum ambient, concentrations of 1-hour NO_2, 24-hour NO_2, annual NO_2, 1-hour CO, 24-hour CO, 24-hour SPM, annual SPM, 24-hour PM_{10} and 24-hour $PM_{2.5}$ over baseline conditions. • DGR-related increases in concentrations of air quality indicator compounds (i.e., CACs) at the DGR's fenceline are likely to be similar to those predicted in the EIS [OPG 2011] for site preparation and construction, operations and decommissioning at the DGR at the Bruce	***Crystalline alternate location:*** • Mitigation identified for the Bruce Nuclear site are also applicable for the crystalline alternate location[1].	***Crystalline alternate location:*** • Residual adverse effect on air quality include concentrations of CACs greater than background concentrations during site preparation and construction, operations, and decommissioning phases. • Effects on air quality during waste transportation would be low in magnitude and infrequent (i.e., approximately 2 trips per day each way [ENERGY SOLUTIONS 2016]) along the transportation routes.	***Crystalline alternate location:*** • Magnitude: Low to High; some exceedances of ambient air quality criteria may occur. • Extent: Local; high magnitude effects would be limited to an area immediately adjacent to the DGR site. Potential effects from waste transportation and construction of additional supporting infrastructure would extend beyond the site. • Frequency: High magnitude effects, if any, would occur very infrequently (<0.5% of the time). • Duration: High magnitude effects occur throughout the site preparation and construction, and decommissioning phases.	

[6] Within the Environmental Effects of Alternate Locations report [GOLDER 2016], it was stated that lower background air quality may necessitate less mitigation to meet relevant air quality criteria. However, taking into consideration feedback received from Environment and Climate Change Canada, this has been revised to state that mitigation would likely be similar to that proposed at the Bruce Nuclear site, in an effort to minimize potential effects overall. However, it is noted that given the likely lower background air quality, there may be a lower frequency of high magnitude effects observed at the alternate locations.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	Nuclear site. Emissions during excavation may be slightly greater due to increased density and volume of material to be removed (difference of approximately 5 to 10%). • Additional effects on air quality (CACs) and increased emissions of GHGs are anticipated as a result of trucking shipments of waste packages between 200 and 2,000 km from the WWMF to the crystalline alternate location. These may also result in potential nuisance-related effects (e.g., dust) to adjacent residences along the transport route. • Additional effects on air quality due to increase in CAC emissions during construction of new road (up to 20 km) and power transmission lines (up to 50 km) to the crystalline alternate location [ENERGY SOLUTIONS 2016], including the potential need for temporary on-site power from diesel combustion generator(s).			• Reversibility: Immediately reversible when activities cease. • Ecological/social context: The existing air quality measured in the crystalline location is good, with concentrations of gaseous indicator compounds meeting all relevant ambient criteria and particulate matter concentrations infrequently exceeding ambient criteria. Potential exceedances of ambient air quality criteria, if any, are not likely to be frequent (less than 0.5% of the time) considering mitigation and compliance with applicable permits. Therefore residual adverse effects would not be significant.	
Air Quality – Greenhouse Gases	***Methodology used in identifying potential environmental effects at all three locations:*** *Any increase in project-related greenhouse gas (GHG) emissions.* ***Bruce Nuclear site:*** • Emissions of GHGs were identified for the site preparation and construction, operation and decommissioning of the DGR Project at the Bruce Nuclear site [OPG 2011]; site preparation and construction totalling 91.06 kt/yr, and operations totalling 2.05 kt/yr. ***Sedimentary alternate location:*** • GHG emissions are likely to be similar to those predicted for the Bruce Nuclear site for site preparation and construction, operations and decommissioning of the DGR. • Additional incremental emissions associated with the transportation and handling of waste from trucking of waste packages up to 300 km from the WWMF to the sedimentary alternate location adding up to 1.8 kt/30-yr [GOLDER 2016]. • Increased total GHG emissions during construction of additional site infrastructure, specifically the new road and power transmission lines (up to 5 km)	***Bruce Nuclear site:*** • Mitigation would include proper maintenance of equipment and vehicles associated with all activities. ***Sedimentary alternate location:*** • Mitigation identified for the Bruce Nuclear site are also applicable for the sedimentary alternate location.	***Criteria for identification of a residual adverse effect:*** *Project-related emissions resulting in a measurable change relative to local and provincial GHG emissions.* ***Bruce Nuclear site:*** • Taking into consideration mitigation, no residual adverse effect on GHG emissions are likely. Total GHG emissions for each phase are insignificant in the context of local and provincial totals. ***Sedimentary alternate location:*** • Taking into consideration mitigation, no residual adverse effect on GHG emissions are likely. Total GHG emissions for each phase are insignificant in the context of local and provincial totals.	***Benchmark used to determine whether residual effects are significant:*** *Generation of Project-related GHG emissions results in a potential measurable effect on global climate.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Sedimentary alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	○ **Bruce Nuclear site –** fewest adverse effects on air quality ▲ **Sedimentary alternate location** – Increased effects compared to the Bruce Nuclear site due to additional waste transportation required; however, effects are not likely to be significant. ▲ **Crystalline alternate location –** Increased effects compared to the Bruce Nuclear site and sedimentary alternate location due to additional waste transportation required and construction of supporting infrastructure, construction of supporting infrastructure, and increased emissions during excavation;

Valued Component	Potential Environmental Effects	Mitigation Measures[a]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	Crystalline alternate location: • Potential effects on air quality are identified from GHG emissions associated with DGR site, transportation of waste and construction of supporting infrastructure. • Increased emissions of GHGs are anticipated as a result of trucking of waste packages between 200 and 2,000 km from the WWMF to the crystalline alternate location adding between 1.2 kt/30-yr and 12 kt/30-yr [GOLDER 2016]. • Increased total GHG emissions during construction of additional site infrastructure, specifically the new road (up to 20 km) and power transmission lines (up to 50 km), as well as the potential need for temporary on-site power from diesel combustion generator(s). Additional GHGs possible due to increased density of rock and volume of rock to be excavated at this location (requiring additional mobile equipment trips and/or operation at higher load to accommodate the additional material), estimated to be 5% to 10% higher than activities as described above for the Bruce Nuclear site.	***Crystalline alternate location:*** • Mitigation identified for the Bruce Nuclear site are also applicable for the crystalline alternate location.	***Crystalline alternate location:*** • Taking into consideration mitigation, no residual adverse effect on GHG emissions are likely. Total GHG emissions for each phase are insignificant in the context of local and provincial totals.	***Crystalline alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	however, effects are not likely to be significant.
Noise Levels	***Methodology used in identifying potential environmental effects at all three locations:*** *Any increase in project-related noise emissions.* ***Bruce Nuclear site:*** • Potential effects are identified as a result of DGR noise emissions associated with the construction operation and decommissioning of the DGR. Increases in noise levels up to 5 dB are predicted during the site preparation and construction phase, and decommissioning, and less than 3 dB during operations. • Blasting activities have the potential to cause an indirect effect on aquatic habitat through changes in vibration levels (see aquatic habitat and biota, below).	***Bruce Nuclear site:*** • Maintain noise emission sources within a compact Project site. • Proper maintenance of on-site equipment and vehicles equipped with appropriate silencers. • Compliance with the noise guideline limit for Class 3 areas during night-time hours.	***Criteria for identification of a residual adverse effect:*** *Predicted noise levels that result in a change from existing conditions that would be perceptible to humans (i.e., an increase in the quietest existing hourly by more than 3 decibels [dB]).* ***Bruce Nuclear site:*** • Taking into consideration the described mitigation measures, residual adverse effects on noise levels are likely during site preparation and construction, and decommissioning phases. No residual adverse effects are likely during the operations phase.	***Benchmark used to determine whether residual effects are significant:*** *A predicted increase of more than 10 dB over background noise levels (i.e., a level perceived as disruptive to humans).* ***Bruce Nuclear site:*** • Magnitude: Low; Project-related increase from the quietest hour of 5 dB. • Extent: Local; effect extends approximately beyond the Site Study Area (i.e., the Bruce Nuclear site) to the closest resident. • Frequency: The effect would occur on a daily basis during late night/early morning hours. • Duration: Effect occurs throughout the site preparation and construction phase, and decommissioning phase. • Reversibility: Immediately reversible when activities cease. • Ecological/social context: The existing area is	○ **Bruce Nuclear site –** fewest adverse effects on noise levels ▲ **Sedimentary alternate location** – Increased magnitude of effect compared to the Bruce Nuclear site; however, effects are not likely to be significant. ▲ **Crystalline alternate location –** Increased magnitude of effect compared to the Bruce Nuclear site and the sedimentary alternate location; however, effects are not likely to be significant.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
				adjacent to an established industrial site. Existing noise levels are consistent with typical rural environments, with noise from the operations at the Bruce Nuclear site audible at some receptors. With the described mitigation measures in place residual effects would not be significant as the change in the ambient noise level would be less than 10 dB.	
	Sedimentary alternate location: • Potential effects are identified as a result of DGR noise emissions associated with the DGR site, transportation of waste and construction of supporting infrastructure. • Noise emissions during site preparation and construction, operation and decommissioning are likely to be similar to those described above for the Bruce Nuclear site. Effects on noise levels are predicted to be ≥5 dB at the sedimentary alternate location due to lower background noise levels, although it would be dependent on distance to closest receptor. • There is also the potential for increased noise to adjacent residences along the transport route due to trucking shipments of waste packages from the WWMF to the sedimentary alternate location. • Blasting activities have the potential to cause an indirect effect on aquatic habitat through changes in vibration levels (see aquatic habitat and biota, below). ***Crystalline alternate location:*** • Potential effects are identified as a result of DGR noise emissions associated with the DGR site, transportation of waste and construction of supporting infrastructure. • Noise emissions during site preparation and construction, operation and decommissioning described above for the Bruce Nuclear site are also applicable to the crystalline alternate location. Effects on noise levels are likely to be ≥10 dBA during construction, ≥3 dBA during operations at the crystalline alternate location, due to lower background noise levels, although it would be dependent on distance to closest receptor.	***Sedimentary alternate location:*** • Mitigation identified for the Bruce Nuclear site are also applicable for the sedimentary alternate location. • In addition, mitigation measures may also be required, including siting of facilities to maximize distance to receptors, or take advantage of shielding through terrain. A noise management plan customized to the selected site would likely be required. ***Crystalline alternate location:*** • Mitigation identified for the Bruce Nuclear site are also applicable for the crystalline alternate location. • In addition, mitigation measures may also be required, including siting of facilities to maximize distance to receptors, or take advantage of shielding through terrain. A noise management plan customized to the selected site would likely be required.	***Sedimentary alternate location:*** • Taking into consideration the described mitigation measures, residual adverse effects on noise levels are likely during all phases. • Effects on noise levels during waste transportation would be low in magnitude and infrequent (i.e., approximately 2 trips per day each way [ENERGY SOLUTIONS 2016]) along the transportation route. ***Crystalline alternate location:*** • Taking into consideration the described mitigation measures, residual adverse effects on noise levels are likely during all phases. Site specific mitigation would be identified to reduce the magnitude of effects such that noise guidelines are met, and change in magnitude are ≤10 dBA. Additionally, in a crystalline environment, the closest receptor may be further removed, which would also reduce the magnitude of effects. • Effects on noise levels during waste transportation would be low in	***Sedimentary alternate location:*** • Magnitude: Low to Moderate; Project-related increase from the quietest hour of ≥5 dB. • Extent: Local; effect extends beyond the site to the closest receptor. Potential effects from waste transportation would also extend beyond the site. • Frequency: The effect would occur on a daily basis during late night / early morning hours. • Duration: Effect occurs throughout the site preparation and construction phase, and decommissioning phase. • Reversibility: Immediately reversible when activities cease. • Ecological/social context: The existing noise levels are consistent with a quiet rural environment with occasional anthropogenic noise sources. With the described mitigation measures in place residual effects would not be significant as the change in the ambient noise level would be less than 10 dB. ***Crystalline alternate location:*** • Magnitude: Moderate; Project-related increase from the quieted hour of <10 dB • Extent: Local; effect extends beyond the site to the closest receptor. Potential effects from waste transportation and construction of additional supporting infrastructure would also extend beyond the site. • Frequency: The effect would occur on a daily basis during late night / early morning hours. • Duration: Effect occurs throughout the site preparation and construction, operation, and decommissioning phases. • Reversibility: Immediately reversible when activities cease.	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	• There is also the potential for increased noise to adjacent residences along the transport route due to trucking shipments of waste packages from the WWMF to the crystalline alternate location. • Additional noise emissions are likely during construction of new road (up to 20 km) and power transmission lines (up to 50 km) to the crystalline alternate location. • Blasting activities have the potential to cause an indirect effect on aquatic habitat through changes in vibration levels (see aquatic habitat and biota, below).		magnitude and infrequent (i.e., approximately 2 trips per day each way [ENERGY SOLUTIONS 2016]) along the transportation routes.	• Ecological/social context: The existing noise levels are consistent with a remote environment with no anthropogenic noise sources. With the described mitigation measures in place, residual effects would not be significant as the change in the ambient noise level would be less than 10 dB.	
Surface Water Environment					
Surface Water Quality	***Methodology used in identifying potential environmental effects at all three locations:*** *Any changes in water quality parameters were considered as to whether they could result in a change beyond the background variability of the receiving water body.* ***Bruce Nuclear site:*** • Site preparation and construction of the DGR may affect surface water quality and quantity through diversion of surface runoff to a stormwater management pond (SWMP) and discharge to the environment. This effect would persist through the operations phase through continued operation of the SWMP. ***Sedimentary alternate location:*** • Site preparation and construction of the DGR at the sedimentary alternate location may affect surface water quality and quantity through diversion of surface runoff to a SWMP and discharge to the environment. This effect would persist through the operations phase through continued operation of the SWMP. • Stormwater quality is likely to be similar to that described and assessed in the EIS [OPG 2011], and as described for the Bruce Nuclear site above, given the similar geologic setting and waste rock management strategy.	***Bruce Nuclear site:*** • The SWMP would collect all water, either from underground or the surface, which has been in contact with waste rock for storage, monitoring and treatment on site as needed. Discharge from the SWMP would have to meet criteria established as part of an ECA, which would be protective of humans and the environment. ***Sedimentary alternate location:*** • Mitigation described for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • Site-specific discharge limits may be more restrictive than the Bruce Nuclear site for the sedimentary alternate location if the receiving water body has a low assimilative capacity. • Best management practices would be implemented to control	***Criteria for identification of a residual adverse effect:*** *Concentrations of surface water indicator compounds in excess of relevant surface water quality criteria.* ***Bruce Nuclear site:*** • Given the proposed mitigation, it is expected that all discharge would meet applicable criteria, and therefore no residual adverse effects on water quality are likely. ***Sedimentary alternate location:*** • Given the proposed mitigation, it is expected that all discharge would meet applicable criteria, and therefore no residual adverse effects on water quality are likely. • Waste transportation introduces the potential for additional off-site conventional spills (e.g., small quantities of oil); however given proposed mitigation, no residual adverse effects are likely.	***Benchmark used to determine whether residual effects are significant:*** *Concentrations of surface water quality criteria are likely such they result in an alteration of the surface water quality regime to an extent that it would adversely affect sensitive or critical habitats on a long-term or continuous basis.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Sedimentary alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	**Bruce Nuclear site –** No residual adverse effects taking into consideration described mitigation **Sedimentary alternate location** – No residual adverse effects taking into consideration described mitigation **Crystalline alternate location –** No residual adverse effects taking into consideration described mitigation

Valued Component	Potential Environmental Effects	Mitigation Measures[a]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	• Trucking shipments of waste packages from the WWMF to alternate location may increase the risk of increased sedimentation to local ditches, as well as the incremental risk of a conventional spill (e.g., a small amount of fuel or oil) as a result of an accident or malfunction and associated effects on water quality.	sediment transport, and development of a spills management plan.			
	Crystalline alternate location: • Site preparation and construction of the DGR at the crystalline alternate location may affect surface water quality and quantity through diversion of surface runoff to a SWMP and discharge to the environment. This effect would persist through the operations phase through continued operation of the SWMP. • Construction of additional surface infrastructure (i.e., access road, transmission line) may increase the risk of increased sedimentation to local ditches and resulting temporary changes in water quality during construction of watercourse crossings. • Given the different geologic setting, runoff from the Waste Rock Management Area (WRMA) may result in different water quality than assessed in the EIS. Acid Rock Drainage (ARD) and metal leaching potential within the types of crystalline rocks at the crystalline alternate location is typically low, but the crystalline alternate location has some increased potential of ARD and metal leaching compared to the Bruce Nuclear site or the sedimentary alternate location. • Trucking shipments of waste packages from the WWMF to the crystalline alternate location may increase the risk of increased sedimentation to local ditches, as well as the incremental risk of a conventional spill (e.g., a small amount of fuel or oil) as a result of an accident or malfunction and associated effects on water quality.	***Crystalline alternate location:*** • Mitigation described for the Bruce Nuclear site are also applicable to the crystalline alternate location. • Site-specific discharge limits may be more restrictive for the crystalline alternate location than the Bruce Nuclear site if the receiving water body has a low assimilative capacity. • Additional site-specific ARD/metal leaching mitigation measures to collect, isolate, monitor and treat may be required. • Best management practices would be implemented to control sediment transport, and development of a spills management plan and erosion control measures.	***Crystalline alternate location:*** • Given the proposed mitigation, it is expected that all discharge would meet applicable criteria, and therefore no residual adverse effects on water quality are likely. • Waste transportation and construction of additional linear infrastructure introduces the potential for additional off-site conventional spills (e.g., small quantities of oil) and changes in water quality; however given proposed mitigation, no residual adverse effects are likely.	***Crystalline alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
Surface Water Quantity and Flow	***Methodology used in identifying potential environmental effects at all three locations:*** *Any change to the drainage area of the waterbody or any direct addition or abstraction of flow from the receiving waterbody.*		***Criteria for identification of a residual adverse effect:*** *A change in surface water flow that could be detected by using standard stream flow measurement techniques (i.e., ±15% relative to existing conditions).*	***Benchmark used to determine whether residual effects are significant:*** *A change in high flow events sufficient to alter the geomorphological conditions of a stream, or to alter habitat for sensitive aquatic species on a long-term or continuous basis. Within an engineered ditch/channel, a change in flow sufficient to cause flooding, erosion, or excessive sediment deposition.*	
	Bruce Nuclear site: • Site preparation and construction of the DGR surface facilities and operation of the SWMP will result in changes in drainage patterns and resultant changes in surface water quantity and flow in local drainage ditches. No measurable changes in flow were identified in natural local streams and Lake Huron.	***Bruce Nuclear site:*** • Collection of surface water in a SWMP, with liner, to collect and direct all surface water. • Lining of shaft to minimize water inputs to the SWMP from underground. • Confirmation of channel capacity of receiving drainage ditches during detailed design and redesign where applicable.	***Bruce Nuclear site:*** • Given the proposed mitigation, residual effects on local engineered drainage ditches are likely.	***Bruce Nuclear site:*** • Magnitude: Low to High. Changes in flows in engineered ditches were identified varying between -31% to +114%. • Extent: Limited to the Site Study Area. • Frequency: High magnitude effects will be observed infrequently during high flow events caused by storms and snowmelt. • Duration: Changes are predicted to occur through all phases. • Reversibility: Changes in flow can be reversed. Following decommissioning, water will no longer be pumped from the repository; however, at this time the flow diversion is expected to remain in place. • Ecological/social context: Low; no adverse effects predicted in Stream C or Lake Huron (the closest natural habitats stream). Effects are only predicted in engineered ditches. Overall, predicted effects are not significant. Considering proposed mitigation, the DGR will not affect the design capacity enough to cause flooding.	○ **Bruce Nuclear site –** residual adverse effects isolated to local drainage ditches ○ **Sedimentary alternate location** –residual adverse effects likely to be localized and similar to the Bruce Nuclear site. ▲ **Crystalline alternate location –** Increased effects compared to the Bruce Nuclear site and the sedimentary alternate location from the DGR surface facilities footprint as well as larger volumes of water to manage.
	Sedimentary alternate location: • Construction of surface facilities for the DGR may result in changes in drainage patterns and resultant changes in surface water quantity and flow in local waterbodies. • The magnitude of potential effects on surface water quantity and flow are likely to be similar at the sedimentary alternate location to those identified in the EIS [OPG 2011] at the Bruce Nuclear site, given the similar geologic setting and volumes of water to be managed in the SWMP.	***Sedimentary alternate location:*** • In addition to the measures identified for the Bruce Nuclear site, where possible, infrastructure would be sited to avoid watercourses. • Site-specific discharge limits may be more restrictive for both alternate locations if the receiving water body has a low assimilative capacity for changes in flow. • Watershed boundaries, watercourses and associated	***Sedimentary alternate location:*** • When the proposed mitigations are considered, changes in surface water flow and associated residual adverse effects on hydrology are still likely.	***Sedimentary alternate location:*** • Magnitude: Low to high, depending on the assimilative capacity of the receiving waterbody. • Extent: Site to Local; effects may be measurable beyond the DGR site. • Frequency: High magnitude effects will likely be observed infrequently during high flow events caused by storms and snowmelt. • Duration: Changes are predicted to occur through all phases. • Reversibility: Effects can be reversed following decommissioning; however it is assumed that the flow diversion will remain in	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
		floodplains would be considered as constraints on project siting.		place. • Ecological/social context: Effects are mostly likely to be to engineered/agricultural ditches, with some potential to affect local streams and/or small waterbodies. Overall, the effect on surface water hydrology is unlikely to be significant, if mitigation is applied. At the sedimentary alternate location, it is likely that the DGR would be sited outside of floodplain boundaries for both large and small watercourses and mitigated to the point that it would not likely alter geomorphic conditions.	
	Crystalline alternate location: • Siting the DGR at the crystalline alternate location may affect surface water quantity and flow directly through the requirement to redirect drainage patterns during site preparation and construction (i.e., in addition to redirection of catchment areas, direct footprint effects on watercourses may be unavoidable at the crystalline alternate location). • Operation of the DGR may result in surface water quantity and flow in local waterbodies through continued operation of the SWMP. • Effects are likely to be higher in magnitude at the crystalline alternate location as there may be more water to manage and greater likelihood of drainage area changes. • Additional watercourse crossings built to access site (e.g., bridges and culverts) have potential to change flow regime at multiple locations.	***Crystalline alternate location:*** • In addition to the measures identified for the Bruce Nuclear site, where possible, infrastructure would be sited to avoid watercourses and associated floodplains. • Site-specific discharge limits may be more restrictive for both alternate locations if the receiving water body has a low assimilative capacity for changes in flow. • Alternative methods for water handling during excavation (e.g., grouting, full hydrostatic shaft liners) may be considered to minimize volumes of water to be managed.	***Crystalline alternate location:*** • Given the proposed mitigation, residual adverse effects are likely. Considering the terrain at the crystalline alternate location, it is would be more difficult to site a facility and associated infrastructure (e.g., access road, transmission line) without affecting and/or encroaching to some degree on a smaller watercourse (e.g., creek or stream) and its associated floodplain increasing the magnitude of the effect.	***Crystalline alternate location:*** • Magnitude: Moderate to high, depending on the assimilative capacity of the receiving waterbody. • Extent: Site to Local; effects may be measurable beyond the DGR site. Effects would also be observed along the access road to the DGR site. • Frequency: High magnitude effects will likely be observed infrequently during high flow events caused by storms and snowmelt. • Duration: Changes are predicted to occur through all phases. • Reversibility: Effects can be reversed following decommissioning; however it is assumed that the flow diversion will remain in place. • Ecological/social context: Effects are mostly likely to be to engineered/agricultural ditches, with some potential to affect local streams and/or small waterbodies. Overall, the effect on surface water hydrology is unlikely to be significant, if mitigation is applied. At the crystalline alternate location, siting within floodplain boundaries for watercourses may not be avoided. However, during siting, avoidance of habitats for sensitive aquatic species would be considered, and further mitigation would be incorporated into the project design to reduce the magnitude of the effect.	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
Aquatic Environment					
Aquatic Habitat	***Methodology used in identifying potential environmental effects at all three locations:*** *Any direct removal of aquatic habitat or changes that would result in indirect effects to aquatic habitat (e.g., changes in surface or groundwater quality or quantity).*		***Criteria for identification of a residual adverse effect:*** *The loss or degradation of aquatic habitat. These effects are further considered for their potential to affect aquatic biota, as noted below.*	***Benchmark used to determine whether residual effects are significant:*** *Critical habitat is removed or rendered non-useable; and there is no comparable habitat available elsewhere in the watercourse.*	
	Bruce Nuclear site: • Adverse effects identified on VCs in the Railway Ditch and other aquatic habitat due to the site preparation and construction of the DGR. • Changes in water quality (including temperature) also have the potential to indirectly affect aquatic habitat. As noted above for the surface water quality VC, no adverse effects on water quality are likely and therefore no adverse indirect effects on aquatic habitat are likely. • Blasting activities have the potential to cause an indirect effect; however, these are not likely to be measurable at nearby aquatic habitats.	***Bruce Nuclear site:*** • Aquatic habitat crossings (i.e. at the railway ditches) will incorporate appropriate design features to minimize effects. • Specific mitigation measures (e.g., management of surface runoff) and best management practices (e.g., erosion and sediment control) will be applied during and after construction. • Timing of construction will take place according to the Fisheries and Oceans Canada (DFO) Timing Windows, where applicable.	***Bruce Nuclear site:*** • When the proposed mitigations are considered, changes in contributing aquatic habitat and associated residual adverse effects are still likely.	***Bruce Nuclear site:*** • Magnitude: Low; no critical habitat will be removed. • Extent: Low; effects are limited to the site. • Frequency: Any habitat loss is continuous. • Duration: Changes are predicted to occur during the site preparation and construction phase. • Reversibility: The effects of habitat removal are not reversible. • Ecological/social context: Effects are associated with engineered ditches, which do not provide critical habitat. Residual adverse effects on aquatic habitat are not likely to be significant with the described mitigation in place as only a small amount of non-critical habitat will be affected.	○ **Bruce Nuclear site –** Small amount of non-critical habitat may be affected ○ **Sedimentary alternate location** – Small amount of non-critical habitat may be affected. ▲ **Crystalline alternate location –**Direct habitat loss is probable as a result of siting of surface facilities and infrastructure.
	Sedimentary alternate location: • The site preparation and construction of the DGR has the potential to affect aquatic habitat. No direct removal of stream or wetland aquatic habitat is likely; however, some supporting habitat may be removed. • Changes in water quality (including temperature) also have the potential to indirectly affect aquatic habitat. As noted above for the surface water quality VC, no adverse effects on water quality are likely and therefore no adverse indirect effects on aquatic habitat are likely. • Blasting activities have the potential to cause an indirect effect on aquatic habitat through changes in vibration levels.	***Sedimentary alternate location:*** • Mitigation described for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • The siting of the DGR surface facilities and discharge locations for the SWMP would consider the potential to affect aquatic habitat. Where possible, sensitive habitats or habitats directly used by sensitive species, including Species at Risk, would be avoided as the primary mitigation. • Blasting management strategies would be developed to demonstrate compliance with	***Sedimentary alternate location:*** • When the proposed mitigations are considered, changes in contributing aquatic habitat and associated residual adverse effects are still likely.	***Sedimentary alternate location:*** • Magnitude: Low to moderate as critical habitat will be avoided. • Extent: Effects are likely to be limited to the site. • Frequency: Any habitat loss is continuous. • Duration: Changes are predicted to occur during the site preparation and construction phase. • Reversibility: The effects of habitat removal are not reversible. • Ecological/social context: Effects are mostly likely to be to small local watercourses, with some potential to affect small waterbodies and associated habitat. Residual adverse effects on aquatic habitat are not likely to be significant with the described mitigation in place. Although contributing aquatic	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
		DFO thresholds. • Mitigation measures as described above for surface water are also applicable to aquatic habitat.		habitat may be affected, no direct loss of critical habitat is likely at the sedimentary alternate location (i.e., only non-critical habitat is removed or rendered non-usable).	
	Crystalline alternate location: • The site preparation and construction of the DGR has the potential to affect aquatic habitat. Direct habitat loss is likely at the crystalline alternate location for construction of the DGR and supporting infrastructure (e.g., watercourse crossings for the access road). • Changes in water quality (including temperature) also have the potential to indirectly affect aquatic habitat. As noted above for the surface water quality VC, no adverse effects on water quality are likely and therefore no adverse indirect effects on aquatic habitat are likely. • Blasting activities have the potential to cause an indirect effect on aquatic habitat through changes in vibration levels.	***Crystalline alternate location:*** • Mitigation measures for aquatic habitat as identified for the sedimentary alternate location are also applicable to the crystalline alternate location. • Where direct avoidance of aquatic habitat is not possible, site specific mitigation would be identified and implemented to reduce effects. • Appropriate design features would be implemented for any watercourses that would be crossed by the additional site infrastructure.	***Crystalline alternate location:*** • When the proposed mitigations are considered, as there is likely little disturbance at the crystalline alternate location, direct loss of aquatic habitat as well as contributing habitat, and associated residual adverse effects are still likely. In addition, there may be more sensitive aquatic habitats affected at this location.	***Crystalline alternate location:*** • Magnitude: Moderate to high as critical habitat will be avoided. • Extent: Effects may be measurable beyond the DGR site into the local area, including along the access road. • Frequency: Any habitat loss is continuous. • Duration: Changes are predicted to occur during the site preparation and construction and decommissioning phases. • Reversibility: The effects of habitat removal are not reversible. • Ecological/social context: Effects are mostly likely to be to small local watercourses, with some potential to affect small waterbodies. Comparable habitat is likely to be available elsewhere in the location. Residual adverse effects are not likely to be significant with the described mitigation in place. As part of a site selection process, critical habitat (i.e., for Species at Risk) would be avoided when considering the location of the surface facilities and the SWMP discharge.	
Aquatic Biota	***Methodology used in identifying potential environmental effects at all three locations:*** *Any changes in aquatic habitat or changes that would result in indirect effects to aquatic biota.* ***Bruce Nuclear site:*** • Aquatic biota in the Railway Ditch and other aquatic habitat may be affected indirectly through the loss of non-critical habitat during the site preparation and construction, and continued operation of the DGR (i.e., the SWMP), as described above.	***Bruce Nuclear site:*** • Mitigation measures for aquatic habitat as identified above are also protective of aquatic biota.	***Criteria for identification of a residual adverse effect:*** *The loss or degradation of supporting aquatic habitat.* ***Bruce Nuclear site:*** • When the proposed mitigations are considered, changes in contributing aquatic habitat and associated residual adverse effects remain likely.	***Benchmark used to determine whether residual effects are significant:*** *Critical habitat is removed or rendered non-useable; and there is no comparable habitat available elsewhere in the watercourse.* ***Bruce Nuclear site:*** • Magnitude: Low; no critical habitat will be removed. • Extent: Low; effects are limited to the site. • Frequency: Any habitat loss is continuous. • Duration: Changes are predicted to occur during the site preparation and construction phase. • Reversibility: The effects of habitat removal are not reversible.	○ **Bruce Nuclear site –** Residual effects on aquatic biota due to loss of non-critical habitat. ○ **Sedimentary alternate location** – Residual effects on aquatic biota due to loss of non-critical habitat. ○ **Crystalline alternate location –** Residual effects on aquatic biota due to loss of non-critical habitat.

<table>
<tr><th>Valued Component</th><th>Potential Environmental Effects</th><th>Mitigation Measures[a]</th><th>Residual Adverse Effects</th><th>Significance of Residual Adverse Effects</th><th>Comparison of Environmental Effects Between Locations</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Ecological/social context: Effects are associated with engineered ditches, which do not provide critical habitat.
Residual adverse effects are not significant as potential effects on critical habitat have been avoided.</td><td rowspan="3"></td></tr>
<tr><td rowspan="2"></td><td>Sedimentary alternate location:
Aquatic biota may be affected indirectly through changes in aquatic habitat from site preparation and construction, and continued operation of the DGR (i.e., the SWMP).
Effects on aquatic biota are likely to be similar at the sedimentary alternate location as those identified in the EIS for the Bruce Nuclear site (i.e., small loss of non-critical habitat).</td><td>Sedimentary alternate location:
Mitigation measures for aquatic habitat as identified for the sedimentary alternate location are also applicable to aquatic biota.
Avoidance of critical habitat for Species at Risk would be taken into consideration as part of a site selection process.</td><td>Sedimentary alternate location:
When the proposed mitigations are considered, changes in contributing aquatic habitat and associated residual adverse effects are still likely.</td><td>Sedimentary alternate location:
Magnitude: Low to moderate as critical habitat will be avoided.
Extent: Effects are likely to be limited to the site.
Frequency: Any habitat loss is continuous.
Duration: Changes are predicted to occur during the site preparation and construction phase.
Reversibility: The effects of habitat removal are not reversible.
Ecological/social context: Effects are mostly likely to be to small local watercourses, with some potential to affect small waterbodies and associated habitat.
Residual adverse effects are not likely to be significant as potential effects on critical habitat would be avoided during site selection.</td></tr>
<tr><td>Crystalline alternate location:
Aquatic biota may be affected indirectly through changes in aquatic habitat from site preparation and construction, and continued operation of the DGR (i.e., the SWMP).
Direct habitat loss is probable as a result of siting of surface facilities and infrastructure. Potential indirect effects would be mitigated as described above.</td><td>Crystalline alternate location:
Mitigation measures for aquatic habitat as identified for the crystalline alternate location are also applicable to aquatic biota.
Avoidance of critical habitat for Species at Risk would be taken into consideration as part of a site selection process.</td><td>Crystalline alternate location:
When the proposed mitigations are considered, direct loss of aquatic habitat as well as contributing habitat, and associated residual adverse effects are still likely.</td><td>Crystalline alternate location:
Magnitude: Moderate to high as critical habitat will be avoided.
Extent: Effects may be measurable beyond the DGR site into the local area, including along the access road.
Frequency: Any habitat loss is continuous.
Duration: Changes are predicted to occur during the site preparation and construction and decommissioning phases.
Reversibility: The effects of habitat removal are not reversible.
Ecological/social context: Effects are mostly likely to be to small local watercourses, with some potential to affect small waterbodies. Comparable habitat is likely to be available elsewhere in the location.
Residual adverse effects are not likely to be significant as potential effects on critical habitat would be avoided during site selection.</td></tr>
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Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
Terrestrial Environment					
Vegetation Communities including upland and wetland	***Methodology used in identifying potential environmental effects at all three locations:*** *Any direct removal of vegetation communities including wetlands or changes that may result in indirect effects to vegetation communities (e.g., changes in air quality, soil quality surface or groundwater quality or quantity).*		***Criteria for identification of a residual adverse effect:*** *Changes between baseline values and predicted values that result in local changes in population.*	***Benchmark used to determine whether residual effects are significant:*** *Loss of vegetation such that the sustainability and productivity of the local population would be compromised, and/or species or ecological functions that are unique in the local study area would be affected.*	○ **Bruce Nuclear site –** Approximately 9 ha of mixed wood forest vegetation community will be removed [OPG 2011]. ▲ **Sedimentary alternate location** – Between 9 and 40 ha of vegetation communities would likely be removed for surface facilities associated with the DGR [GOLDER 2016] with additional vegetation removal for associated additional site infrastructure (e.g., up to 5 km new access road and transmission lines). ▲ **Crystalline alternate location –** Up to 40 ha of vegetation communities would likely be removed for surface facilities associated with the DGR [GOLDER 2016]; with additional vegetation removal for associated additional site infrastructure (e.g., up to 20 km new access road and up to 50 km new transmission lines).
	Bruce Nuclear site: • Adverse effect on eastern white cedar (mixed wood forest vegetation community) as a result of vegetation removal for DGR surface facilities (approximately 9 hectares [ha]) [OPG 2011]. No other direct adverse effects identified. • Potential indirect effects of changes in air quality, soil quality, groundwater quality or groundwater flow, or surface water flow not likely to be adverse.	***Bruce Nuclear site:*** • Temporary construction fencing would be installed. • BMPPs for construction would be used to minimize the transfer of soils from the DGR site to surrounding natural features.	***Bruce Nuclear site:*** • Taking into consideration mitigation identified, residual adverse effects remain likely.	***Bruce Nuclear site:*** • Magnitude: Moderate. Loss of greater than 25% of Mixed Forest within the Project Area and loss of less than 25% of Mixed Forest within the site study area. • Extent: Effect is limited to the Site Study Area (i.e., the Bruce Nuclear site). • Frequency: The effect will persist continuously. • Duration: Changes will occur during the site preparation and construction phase. • Reversibility: Effects are reversible with time. • Ecological/social context: Low; effects are limited to a single vegetation community only within the Site Study Area. Residual adverse effects due to the removal of mixed wood forest communities are not significant. The vegetation communities to be removed are not unique or critical to the sustainability of local wildlife VCs.	
	Sedimentary alternate location: • Direct effects on vegetation communities as a result of increased area of vegetation removal for additional surface facilities (9 to 40 hectares [ha]) [GOLDER 2016]. • Potential indirect effects on wetland features from site development activities. At the sedimentary alternate location, wetland communities may experience a greater degree of effect from developmental activities as this alternate location has already been subject to extensive anthropogenic influences. • Potential indirect effects on vegetation outside of the project footprint from changes in air quality, soil quality, groundwater quality or groundwater flow, or surface water flow. Changes in indirect pathways (i.e., soil quality,	***Sedimentary alternate location:*** • Mitigation measures for the Bruce Nuclear site are also applicable to sedimentary alternate location. • Surface facilities would not be located within a provincially significant wetland, as defined by the Ministry of Natural Resources and Forest (MNRF). In addition, surface facilities are assumed to maintain a 120 m setback surrounding Provincially Significant Wetlands. • Further site-specific mitigation may be required, depending on the amount and nature of habitat	***Sedimentary alternate location:*** • Taking into consideration mitigation identified, residual adverse effects remain likely.	***Sedimentary alternate location:*** • Magnitude: Moderate to high; conditions are expected to be similar to those at the Bruce Nuclear site. Loss of vegetation communities will be dependent on the siting of the DGR. • Extent: Effects are not anticipated to extend beyond the site. • Frequency: Effects of vegetation removal will persist continuously. • Duration: Changes will occur during the site preparation and construction phase. • Reversibility: Effects are reversible with time. • Ecological/social context: Low; effects are predicted to be limited to small likely to be fragmented vegetation communities within the site study area. Residual adverse effects are not likely to be	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	groundwater quality or groundwater flow, or surface water flow) are not likely to be measurable as a result of the project outside the immediate vicinity of the footprint. Therefore, no indirect effects on vegetation VCs are likely through these pathways.	the vegetation removed supports and the specific wildlife VCs affected.		significant. It is likely that the DGR and supporting infrastructure can be sited such that vegetation communities that are unique or critical to sustainability of local wildlife VCs could be avoided.	
	Crystalline alternate location: • At the crystalline alternate location, the land is assumed to be undeveloped natural lands. Therefore development of the DGR at this alternate location is likely to result in loss of vegetation up to 40 ha for surface facilities and up to 20 km and 50 km for required site access road and electrical transmission line, respectively [GOLDER 2016]. • Potential indirect effects on wetland features from site development activities. Because of the large extent of wetland cover on the landscape, the removal of small pieces would not be considered as significant or detrimental to the function of wetlands at the regional scale.	***Crystalline alternate location:*** • Mitigation measures for the Bruce Nuclear site are also applicable to crystalline alternate location. • Surface facilities would not be located within a provincially significant wetland, as defined by the MNRF. In addition, surface facilities are assumed to maintain a 120 m setback surrounding Provincially Significant Wetlands. • Further site-specific mitigation may be required, depending on the amount and nature of habitat the vegetation removed supports and the specific wildlife VCs affected.	***Crystalline alternate location:*** • Taking into consideration mitigation identified, residual adverse effects are likely.	***Crystalline alternate location:*** • Magnitude: Moderate to high; effects will dependant on siting of the DGR. • Extent: Effects are anticipated at the DGR site and extending beyond the site for additional supporting infrastructure. • Frequency: Effects of vegetation removal will persist continuously. • Duration: Changes will occur during the site preparation and construction phase. • Reversibility: Effects are reversible with time. • Ecological/social context: Low to moderate. Effects are predicted to include removal of contiguous vegetation communities within the site study area. Residual adverse effects are not likely to be significant. It is likely that the DGR and supporting infrastructure can be sited such that vegetation communities that are unique or critical to sustainability of local wildlife VCs could be avoided.	
Wildlife Habitat and Biota	***Methodology used in identifying potential environmental effects at all three locations:*** *Any direct removal of habitat or direct impacts to wildlife. Any indirect changes that would result in effects to wildlife populations.* ***Bruce Nuclear site:*** • Potential for effects on wildlife from habitat loss due to vegetation clearing during site preparation. EIS [OPG 2011] identified no adverse effects on wildlife species. • Potential adverse effect on wetlands and snapping turtle identified by ECCC [ECCC 2013] from indirect effects of the project (i.e., changes in surface water hydrology).	***Bruce Nuclear site:*** • Temporary construction fencing to protect vegetation and exclude wildlife • Generally accepted BMPPs for construction to minimize the transfer of soils from the DGR Project to surrounding natural features. • Installation of exclusion barriers to prevent turtles, snakes from entering the DGR project site. • Rehabilitation after	***Criteria for identification of a residual adverse effect:*** *Changes in species distributions, numbers and activities, habitat area and quality, and/or foraging opportunities that lead to measurable reductions in population status.* ***Bruce Nuclear site:*** • No residual adverse effects were identified on wildlife habitat and biota after consideration of mitigation measures.	***Benchmark used to determine whether residual effects are significant:*** *Changes in habitat quality and quantity such that sustainability of local populations would be compromised.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	○ **Bruce Nuclear site –** Limited habitat loss and potential for indirect effect on wildlife habitat and biota. ▲ **Sedimentary alternate location** – Increased magnitude of habitat loss due to vegetation clearing and associated fragmentation effects; additional indirect effects; and potential for wildlife-vehicle interactions. ▲ **Crystalline alternate**

Valued Component	Potential Environmental Effects	Mitigation Measures[a]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
		decommissioning including both active and passive naturalization to provide additional suitable habitat.			**location –** Increased magnitude of habitat loss due to vegetation clearing and associated fragmentation effects; additional indirect effects; and potential for wildlife-vehicle interactions.
	Sedimentary alternate location: • Potential effects on wildlife from habitat loss due to vegetation clearing during site preparation. • Potential effects on habitat connectivity due to establishment of additional fenced areas and onsite roads. • Potential for indirect adverse effects from changes in air quality, noise, light, vibrations, as the sedimentary alternate location may be less influenced by existing anthropogenic disturbances. • Potential for wildlife-vehicle interactions due to additional waste transport. ***Crystalline alternate location:*** • Potential effects on wildlife from habitat loss due to vegetation clearing during site preparation for both DGR site surface facilities and supporting infrastructure. • Potential effects on habitat connectivity due to additional fenced areas, onsite roads, new transmission line construction (up to 50 km), and access road (up to 20 km). • Potential for adverse indirect effects from changes in air quality, noise, light, vibrations, as the crystalline alternate location is likely to be less influenced by anthropogenic disturbances.	***Sedimentary alternate location:*** • Mitigation measures for the Bruce Nuclear site are also applicable to sedimentary alternate location. • Should avoidance of sensitive environmental features such as Significant Wildlife Habitat, Areas of Natural and Scientific Interest (ANSIs), habitat of threatened or endangered species under the *Endangered Species Act* and the *Species at Risk Act* not be possible, further mitigation measures would be required to reduce or eliminate adverse effects. • Additional mitigation measures may include avoiding construction/site clearing activities during sensitive timing windows (e.g., migratory bird nesting season) and habitat compensation measures (e.g., installation of bat boxes). ***Crystalline alternate location:*** • Mitigation measures for vegetation communities at the crystalline alternate location, and wildlife at the sedimentary alternate location are also applicable to wildlife at a crystalline alternate location.	***Sedimentary alternate location:*** • Residual adverse effects remain likely, following application of mitigation measures. ***Crystalline alternate location:*** • Residual adverse effects remain likely following application of mitigation measures.	***Sedimentary alternate location:*** • Magnitude: Low to moderate; the loss of habitat is likely to be small, fragmented communities, but will be dependent on siting of the DGR. • Extent: Effect is likely limited to the wildlife populations in the site and immediately surrounding areas. • Frequency: The effects will persist continuously. • Duration: Effects are predicted during the site preparation, operations (transportation of waste) and decommissioning phases. • Reversibility: Effects to habitat are reversible over time. Effects to wildlife such as increased noise and light will be reversible immediately upon completion of decommissioning. • Ecological/social context: Low to moderate; the populations of wildlife that may be affected are likely those only within the site study area. Residual adverse effects are not likely to be significant with appropriate mitigation in place. It is likely that the DGR can be sited such that high magnitude effects on critical habitat to local wildlife VCs could be avoided. ***Crystalline alternate location:*** • Magnitude: Moderate to high; the loss of habitat is likely to be part of larger contiguous habitats, but will be dependent on siting of the DGR. • Extent: Effects would extend from the site into to the local study area. • Frequency: The effects will persist continuously. • Duration: Changes are predicted during the site preparation, operations (transportation of waste) and decommissioning phases. • Reversibility: Effects to habitat are reversible over time. Effects to wildlife such as	

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	• Potential for wildlife-vehicle interactions due to additional waste transport.			increased noise and light will be reversible immediately upon completion of decommissioning. • Ecological/social context: Low to high; the populations of wildlife that may be affected could extend from the site to the local study area and include species with larger home ranges. Residual adverse effects are not likely to be significant with appropriate mitigation in place. It is likely that the DGR and supporting infrastructure can be sited such that high magnitude effects on critical habitat to local wildlife VCs could be avoided.	
Geology and Hydrogeology					
Soil Quality	***Methodology used in identifying potential environmental effects at all three locations:*** *Any changes in soil quality parameters were considered as to whether they could result in a change measurable from background.* ***Bruce Nuclear site:*** • No measurable changes to soil quality are likely as a result of the site preparation and construction, operation or decommissioning of the DGR at the Bruce Nuclear site. ***Sedimentary alternate location:*** • Potential effects on soil quality are expected to be similar to those identified for a DGR at the Bruce Nuclear site in the EIS [OPG 2011]. Specifically: o Potential to change soil quality during removal, grading and stockpiling during the site preparation work and activity. o Potential indirect effects on off-site soil quality through changes in groundwater quality and air quality (i.e., through deposition). Changes through these pathways are not likely to be measurable outside of the project footprint and therefore no adverse effects on soil quality are likely.	***Bruce Nuclear site:*** • In-design mitigation includes ground treatment in the upper 170 m of the two shafts to minimize groundwater migration. • A liner will be placed under the waste rock management areas and the SWMP to minimize infiltration. ***Sedimentary alternate location:*** • Mitigation measures described for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • No non-native materials would be used for site preparation and grading. • Mitigation measures for groundwater quality and air quality are also applicable to soil quality.	***Criteria for identification of a residual adverse effect:*** *Changes in soil quality relative to baseline and greater than the MOECC Site Conditions Standard (SCS) for soil.* ***Bruce Nuclear site:*** • Taking into consideration the described mitigation measures, no residual adverse effects are identified. ***Sedimentary alternate location:*** • Taking into consideration the described mitigation measures, no residual adverse effects are identified.	***Benchmark used to determine whether residual effects are significant:*** *Change to soil or groundwater quality that likely poses a significant threat to human health or ecological health on a frequent or continuous basis.* ***Bruce Nuclear site:*** No residual adverse effects identified, therefore, no evaluation of significance required. ***Sedimentary alternate location:*** No residual adverse effects identified, therefore, no evaluation of significance required.	○ **Bruce Nuclear site –** No residual adverse effects on soil quality likely. ○ **Sedimentary alternate location** – No residual adverse effects on soil quality likely. ○ **Crystalline alternate location –** No residual adverse effects on soil quality likely.

Valued Component	Potential Environmental Effects	Mitigation Measures(a)	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	Crystalline alternate location: • Potential effects on soil quality are expected to be similar to those identified for a DGR at the Bruce Nuclear site in the EIS [OPG 2011], and as described above for the sedimentary alternate location.	***Crystalline alternate location:*** • Mitigation measures described for the Bruce Nuclear site are also applicable to the crystalline alternate location. • No non-native materials would be used for site preparation and grading. • Mitigation measures for groundwater quality and air quality are also applicable to soil quality.	***Crystalline alternate location:*** • Taking into consideration the described mitigation measures, no residual adverse effects are identified.	***Crystalline alternate location:*** No residual adverse effects identified, therefore, no evaluation of significance required.	
Groundwater Quality	***Methodology used in identifying potential environmental effects at all three locations:*** *Any changes in groundwater quality parameters were considered as to whether they could result in a change measurable from background.* ***Bruce Nuclear site:*** • No measurable changes to groundwater quality are likely during site preparation and construction, operation or decommissioning of the DGR at the Bruce Nuclear site. • The potential for long-term changes to groundwater quality in the abandonment and long-term performance phase from the DGR itself were evaluated. No adverse effects were identified. ***Sedimentary alternate location:*** • Dewatering during excavation of underground facilities during the site preparation and construction phase, and the long-term performance of the DGR have the potential to affect groundwater quality. • It is expected that the geology over this area would demonstrate similar behavior as at the Bruce Nuclear site. Therefore, potential effects on groundwater quality are expected to be similar to those described in the EIS for the Bruce Nuclear site [OPG 2011]. ***Crystalline alternate location:*** • Dewatering during excavation of underground facilities during the site preparation and	***Bruce Nuclear site:*** • Development of a site-specific DGR design with a combination of engineered and natural barriers. • Ground treatment in the upper 170 m of the two shafts to minimize groundwater transport. • A liner will be placed under the waste rock management areas and the SWMP to minimize infiltration. ***Sedimentary alternate location:*** • Mitigation measures described for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • A site-specific DGR design would be developed that, through a combination of engineered and natural barriers, including shaft seals, would ensure regulatory criteria were met with an appropriate margin of safety. ***Crystalline alternate location:*** • Mitigation measures described for the Bruce Nuclear site are	***Criteria for identification of a residual adverse effect:*** *Changes in groundwater quality relative to baseline and greater than the MOECC SCS for groundwater.* ***Bruce Nuclear site:*** • Given the described mitigation measures and the understanding of the sedimentary geology, no residual adverse effects are likely. ***Sedimentary alternate location:*** • Given the described mitigation measures and the understanding of the sedimentary geology, no residual adverse effects are likely. ***Crystalline alternate location:*** • Given the described mitigation measures and the understanding of	***Benchmark used to determine whether residual effects are significant:*** *Migration of contaminants of potential concern in the groundwater in excess of established criteria and/or guidelines relevant to human or ecological health, on a frequent and/or continuous basis.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Sedimentary alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Crystalline alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance	○ **Bruce Nuclear site –** No residual adverse effects on groundwater quality likely. ○ **Sedimentary alternate location** – No residual adverse effects on groundwater quality likely. ○ **Crystalline alternate location –** No residual adverse effects on groundwater quality likely.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	construction phase, and the long-term performance of the DGR have the potential to affect groundwater quality.	also applicable to the crystalline alternate location. • A site-specific DGR design would be developed that, through a combination of engineered and natural barriers, would ensure regulatory criteria were met with an appropriate margin of safety.	crystalline geology in central to northern Ontario, the potential effects on groundwater quality would therefore be unlikely to result in residual adverse effects.	required.	
Groundwater Flow	***Methodology used in identifying potential environmental effects at all three locations:*** *Any changes in groundwater flow were considered as to whether they could result in a change measurable to background conditions.* ***Bruce Nuclear site:*** • Potential adverse effects on overburden and shallow bedrock groundwater flow during excavation of underground facilities. • The potential for long-term changes to groundwater quality in the abandonment and long-term performance phase were evaluated. No adverse effects are expected. ***Sedimentary alternate location:*** • Given the similar geologic setting, potential effects on groundwater flow are expected to be similar at the sedimentary alternate location as described in the EIS for the Bruce Nuclear site [OPG 2011]. ***Crystalline alternate location:*** • Higher porosity and fracturing in crystalline rock may result in changes in groundwater flow at the crystalline alternate location. • Construction of additional site infrastructure to access the site may also have an interaction with shallow groundwater flows.	***Bruce Nuclear site:*** • Water inflow into the repository would be minimized by the repository layout, and also by grouting of the upper 170 m of the two shafts. ***Sedimentary alternate location:*** • Mitigation measures described for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • Water inflow into the repository would be minimized by the repository layout, and also by grouting or sealing of intersected fracture zones. ***Crystalline alternate location:*** • Mitigation measures identified for the sedimentary alternate location are also applicable to the crystalline alternate location. • Additional mitigation may be required at the crystalline alternate location relative to the Bruce Nuclear site and sedimentary alternate location due to increased volumes of water from dewatering of underground excavations.	***Criteria for identification of an adverse effect:*** *Changes to groundwater flow is measurable relative to the existing dominant transport process.* ***Bruce Nuclear site:*** • Taking into consideration the described mitigation measures, no residual adverse effects are likely. ***Sedimentary alternate location:*** • Taking into consideration the described mitigation measures, no residual adverse effects are likely. ***Crystalline alternate location:*** • Given the expected groundwater flow regimes in a suitable crystalline alternate location in central to northern Ontario, the potential effects on geology VCs would therefore be unlikely to result in residual adverse effects.	***Benchmark used to determine whether residual effects are significant:*** *Alteration of the shallow groundwater flow regime to an extent that it would alter sensitive or critical habitats on a frequent and/or continuous basis.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Sedimentary alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Crystalline alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	○ **Bruce Nuclear site –** No residual adverse effects on groundwater flow likely. ○ **Sedimentary alternate location** – No residual adverse effects on groundwater flow likely. ○ **Crystalline alternate location –** No residual adverse effects on groundwater flow likely.

Valued Component	Potential Environmental Effects	Mitigation Measures[a]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
Radiation and Radioactivity					
Humans	***Methodology used in identifying potential environmental effects at all three locations:*** *Any increase in project-related radiological emissions.*		***Criteria for identification of a residual adverse effect:*** *Comparison of predicted project-related emissions to regulatory limits for Nuclear Energy Workers (NEWs), non-NEWs and members of the public.*	***Benchmark used to determine whether residual effects are significant:*** *Radiological releases that result in doses to humans in excess of the relevant Canadian Nuclear Safety Commission (CNSC) regulatory requirements.*	
	Bruce Nuclear site: • A DGR at the Bruce Nuclear site has the potential to have radiological releases during the operations, decommissioning and long-term performance phases. All predicted doses are well below regulatory limits [OPG 2011].	***Bruce Nuclear site:*** • The DGR would be designed to protect workers and members of the public. • Dose to workers would be minimized in the context of As Low As Reasonably Achievable (ALARA). • Reasonable measures to prevent accidents and malfunctions, and appropriate response measures would be implemented. • Operating procedures and training would be in place.	***Bruce Nuclear site:*** • Taking into consideration the described mitigation measures, no residual adverse effects are expected. A site-specific DGR design would be developed that, through a combination of site selection, and engineered and natural barriers, would ensure regulatory criteria were met with an appropriate margin of safety.	***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	○ **Bruce Nuclear site –** No residual adverse effects of radiation and radioactivity likely. ▲ **Sedimentary alternate location** – No residual adverse effects of radiation and radioactivity likely. Incremental worker dose related to the handling, packaging and transportation of waste. ▲ **Crystalline alternate location –** No residual adverse effects of radiation and radioactivity likely. Incremental worker dose related to the handling, packaging and transportation of waste.
	Sedimentary alternate location: • A DGR at the sedimentary alternate location has the potential for radiological releases during the operations, decommissioning and long-term performance phases. • The performance of the DGR at the sedimentary alternate location would be broadly similar to that described above for the Bruce Nuclear site and therefore the radiological effects are predicted to be similar as those predicted in the EIS [OPG 2011]. • There is potential for incremental worker doses related to the handling, packaging and transportation of waste. Increased waste package transportation to the sedimentary alternate location could affect dose to members of the public.	***Sedimentary alternate location:*** • Mitigation measures identified for the Bruce Nuclear site also apply to the sedimentary alternate location. • Risk during transportation would be mitigated with strict compliance to applicable standards for packaging [ENERGY SOLUTIONS 2016] and transportation in accordance with the *Nuclear Safety and Control Act* and its regulations, and other applicable requirements (e.g., *Transportation of Dangerous Goods Act*, *1992*).	***Sedimentary alternate location:*** • Taking into consideration the described mitigation measures, no residual adverse effects are expected. A site-specific DGR design would be developed that, through a combination of site selection, and engineered and natural barriers, would ensure regulatory criteria were met with an appropriate margin of safety.	***Sedimentary alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	
	Crystalline alternate location: • A DGR at the crystalline alternate location has the potential for radiological releases during the operations, decommissioning and long-term performance phases. • Potential effects would be broadly similar to	***Crystalline alternate location:*** • Mitigation measures identified for the Bruce Nuclear site also apply to the crystalline alternate location. • Additional mitigation at the	***Crystalline alternate location:*** • Taking into consideration the described mitigation, no residual adverse effects are identified. A site-specific DGR design would be developed that, through a	***Crystalline alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	those described for the Bruce Nuclear site above. However, there are some additional requirements as a result of the differences in the nature of crystalline rock. • There is potential for incremental worker doses related to the handling, packaging and transportation of waste. Increased waste package transportation to the crystalline alternate location could affect dose to members of the public.	crystalline alternate location could include additional engineered barrier(s) to ensure safe containment and isolation even in the fractured, more permeable, crystalline rock; engineered barriers would include processing (e.g., solidification) of ion exchange resins, and backfilling the space within or around the waste packages with cement to minimize contact with groundwater and mitigate radionuclide release rates. • Risk during transportation would be mitigated with strict compliance to applicable standards for packaging [ENERGY SOLUTIONS 2016] and transportation as described for the sedimentary alternate location. •	combination of site selection, and engineered and natural barriers, would ensure regulatory criteria were met with an appropriate margin of safety.		
Non-human Biota	***Methodology used in identifying potential environmental effects at all three locations:*** *Any increase in project-related radiological emissions.* ***Bruce Nuclear site:*** • A DGR at the Bruce Nuclear site has the potential to interact with dose to non-human biota during operations, decommissioning and long-term performance phases. All predicted doses to non-human biota are well below regulatory limits [OPG 2011]. ***Sedimentary alternate location:*** • A DGR at the sedimentary alternate location has the potential to interact with dose to non-human biota during operations, decommissioning and long-term performance phases. Given the geologic similarity, the effects on non-human biota described for the Bruce Nuclear site above are considered to also be applicable to the sedimentary alternate	***Bruce Nuclear site:*** • Mitigation measures described for humans (above) are also applicable for non-human biota. ***Sedimentary alternate location:*** • Mitigation measures described for humans (above) are also applicable for non-human biota.	***Criteria for identification of a residual adverse effect:*** *Comparison of predicted project-related emissions to estimated no effect dose-rate values for non-human biota.* ***Bruce Nuclear site:*** • Taking into consideration the described mitigation measures, no residual adverse effects are expected. ***Sedimentary alternate location:*** • Taking into consideration the described mitigation measures, no residual adverse effects are expected.	***Benchmark used to determine whether residual effects are significant:*** *Radiological releases that result in doses to non-human biota in excess of the relevant CNSC regulatory requirements.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Sedimentary alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	○ **Bruce Nuclear site –** No residual adverse effects of radiation and radioactivity likely. ○ **Sedimentary alternate location** – No residual adverse effects of radiation and radioactivity likely. ○ **Crystalline alternate location –** No residual adverse effects of radiation and radioactivity likely.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	location. • Increased waste package transportation to the sedimentary alternate location could affect dose to non-human biota off-site.				
	Crystalline alternate location: • A DGR at the crystalline alternate location has the potential to interact with non-human biota during the operations, decommissioning and long-term performance phases. Effects are predicted to be broadly similar to those at the DGR Project at the Bruce Nuclear site described in the EIS [OPG 2011]. • Increased waste package transportation to the crystalline alternative location could affect dose to non-human biota off-site.	***Crystalline alternate location:*** • Mitigation measures described for humans (above) are also applicable for non-human biota.	***Crystalline alternate location:*** • Taking into consideration the described mitigation measures, no residual adverse effects are expected.	***Crystalline alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	
Land and Resource Use					
Land and Resource Use (Non-traditional)	***Methodology used in evaluating environmental effects at all three locations:*** *Identification of direct and indirect change that may affect the quality or quantity of lands available for use for traditional purposes.* ***Bruce Nuclear site:*** • No direct effects on use of lands and resources. • Potential indirect effects of changes in air quality and noise levels.	***Bruce Nuclear site:*** • Mitigation measures as described above for environmental pathways (e.g., air quality, noise) are also applicable to land use.	***Benchmark for identification of a residual adverse effect:*** *Change in access to or quality of use of lands non-traditional land use purposes.* ***Bruce Nuclear site:*** • Increased nuisance-related effects from changes in noise levels (as described above) were assessed to have a residual adverse effect on use and enjoyment of property [OPG 2011].	***Benchmark used to determine whether residual effects are significant:*** *Unacceptable risk to use of lands and resources, taking into consideration site-specific knowledge.* ***Bruce Nuclear site:*** • Magnitude: Low; changes in noise levels are predicted to be up to 5 dBA relative to the quietest hour; and indoor noise levels from the project would be likely indistinguishable from existing levels indoors. Therefore, the magnitude of effect on use and enjoyment of property was assessed to be low. • Extent: Effect is limited to the Local Study Area, specifically in the vicinity of Baie du Doré. • Frequency: Effects will occur at regular, although infrequent intervals. • Duration: Effects will be evident during the site preparation and construction phase and decommissioning phase. • Reversibility: Effects are reversible with time after increased noise levels cease. • Ecological/social context: Residents are currently adjacent to and experience noise from the existing Bruce Nuclear site. Therefore, based on the above, the residual	○ **Bruce Nuclear site –** Indirect effects of the Project on use of lands and resources (specifically use and enjoyment of property). ▲ **Sedimentary alternate location** – Increased effects on land and resource use due to increased noise and traffic as well as the establishment of a new licensed facility. ▲ **Crystalline alternate location –** Increased effects on land and resource use due to increased noise and traffic as well as the establishment of a new licensed facility. Effects are likely to be greater in magnitude than the sedimentary alternate location.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
				adverse effect is assessed to be not significant as there will not be unacceptable risk to the use of local lands and resources.	
	Sedimentary alternate location: • Direct effect on use of lands and resources through establishment of a new site of up to 900 ha. • Potential effects on transportation systems from additional waste transport and worker traffic. • Potential increases nuisance-related effects from changes in air quality and noise levels (as described above). • Disruption to current use of land and resources for traditional and non-traditional purposes due to removal of the site from general access (i.e., establishing a fenced, restricted access site). Potential indirect disruption to surrounding land through changes in air quality and noise levels and further indirect effects on hunting, trapping and gathering due to potential habitat fragmentation from vegetation removal and fencing.	***Sedimentary alternate location:*** • Mitigation measures as described above for environmental pathways (e.g., air quality, noise) are also applicable to land use. • Appropriate mitigation and accommodation measures would be applied to address potential effects on current use of lands and resources, or other issues raised during the consultation process.	***Sedimentary alternate location:*** • Residual adverse effects are likely on land and resource use due to establishment of the site and additional transportation.	***Sedimentary alternate location:*** • Magnitude: Moderate; there will be low to moderate changes in noise and traffic levels surrounding the site, as well as removal of access to land through the establishment of a new site. These changes would have a likely measurable change in contributors to community well-being. • Extent: Effects are likely to be limited to the Local Study Area. • Frequency: Effects from noise and traffic would occur on a daily basis; effects from removal of access to the site would persist continuously. • Duration: Effects occur throughout the site preparation and construction, operation, and decommissioning phases. • Reversibility: Effects from noise and traffic are reversible with time after activities cease. • Ecological/social context: Site specific social context would be determined through engagement with communities during a siting process. The local community would not be currently adjacent to an existing nuclear facility. Considering the magnitude of the effects at a sedimentary alternate location and the mitigation measures described, these are not likely to be significant as there will not be unacceptable risk to the use of local lands and resources.	
	Crystalline alternate location: • Direct effect on use of lands and resources through establishment of a new site of up to 900 ha as well as additional linear infrastructure. • Potential effects on local transportation systems from additional waste transport and worker traffic. • Potential increases nuisance-related effects from changes in air quality and noise levels (as described above). • Disruption to current use of land and resources for non-traditional purposes due to removal of the site from general access (i.e., establishing a	***Crystalline alternate location:*** • Mitigation measures as described for the sedimentary alternate location are also applicable to the crystalline alternate location.	***Crystalline alternate location:*** • Residual adverse effects are likely on land and resource use due to establishment of the site and additional transportation.	***Crystalline alternate location:*** • Magnitude: Moderate; there will be low to moderate changes in noise and traffic levels surrounding the site, as well as removal of access to land through the establishment of a new site and supporting infrastructure. These changes would have a likely measurable change in contributors to community well-being. • Extent: Effects are likely to be limited to the Local Study Area and extend to capture the additional site infrastructure (i.e., 20 km access road and 50 km transmission line). • Frequency: Effects from noise and traffic	

Valued Component	Potential Environmental Effects	Mitigation Measures[a]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	fenced, restricted access site). Potential indirect disruption to surrounding land through changes in air quality and noise levels and further indirect effects on hunting, trapping and gathering due to potential habitat fragmentation from vegetation removal and fencing.			would occur on a daily basis; effects from removal of access to the site would persist continuously. • Duration: Effects occur throughout the site preparation and construction, operation, and decommissioning phases. • Reversibility: Effects from noise and traffic are reversible with time after activities cease. • Ecological/social context: Site specific social context would be determined through engagement with communities during a siting process. The local community would not be currently adjacent to an existing nuclear facility. Considering the magnitude of the effects at a crystalline alternate location and the mitigation measures described, these are not likely to be significant as there will not be unacceptable risk to the use of local lands and resources. However, they may be of higher magnitude than at the sedimentary alternate location.	
Indigenous Interests					
Health	***Methodology used in identifying potential environmental effects at all three locations:*** *Combination of quantitative and qualitative methods, including professional expertise and judgment.* ***Bruce Nuclear site:*** • A DGR at the Bruce Nuclear site has the potential to interact with the health of Indigenous community members as a result of exposure to changes in: o Physical environment conditions (e.g., changes to air, surface water, groundwater and soil quality, changes in country food quality, radiation and radioactivity and noise levels). o Socio-economic conditions (discussed in next row as part of Socio-economic Conditions VC). o Cultural conditions (discussed below as part of Physical Cultural Heritage and	***Bruce Nuclear site:*** • Mitigation measures as described above for physical environment pathways (e.g., air quality, surface water quality, groundwater quality, soil quality, radiation and radioactivity and noise) are also applicable to Indigenous health.	***Criteria for identification of a residual adverse effect (post mitigation):*** *Exceedance of target concentrations (incremental lifetime cancer risks and hazard quotients) above which health effects may occur, or exceedance of regulatory limits for members of the public.* ***Bruce Nuclear site:*** • A residual adverse effect to the health of local Indigenous community residents is identified because of potential exposure to acrolein in air as a result of the DGR Project during the site preparation and construction phase. No changes to surface water, groundwater or aquatic and terrestrial resources that may be harvested that would result in measurable changes to health are predicted. • No residual adverse effects to Indigenous health were identified for	***Benchmark used to determine whether residual effects are significant:*** *Radiological releases that result in doses to humans in excess of the relevant CNSC regulatory requirements or exceedance of target concentrations for non-radiological releases above which would pose unacceptable risk to health of Indigenous peoples.* ***Bruce Nuclear site:*** • Magnitude: Low (HQ >1 and <10 at community receptor location). • Extent: Effect is limited to the Local Study Area. • Frequency: Conditions or phenomena causing the effect occur at infrequent intervals (i.e., once per year). • Duration: Effect occurs during site preparation and construction. • Reversibility: Effect is readily (i.e., immediately) reversible when the exposure ceases. • Ecological/social context: Acrolein concentrations in air are driven by existing	**Bruce Nuclear site –** Fewest adverse effects associated with exposure to acrolein (no significant adverse effects identified). No other residual adverse effects. **Sedimentary alternate location** – Potentially increased effects associated with exposure to acrolein and noise compared to the Bruce Nuclear site due to additional waste transportation; however, effects not likely to be significant. Distance to the closest receptor would influence the magnitude of the effect; effects not likely to be

Valued Component	Potential Environmental Effects	Mitigation Measures[a]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	Resources VC).		socio-economic or cultural conditions (see rows below).	conditions. Given magnitude (including consideration of the conservatism applied to the assessment), extent, frequency, duration and reversibility of Project related exposure, the contribution of the project is not deemed to contribute to significant adverse health risks.	significant, and some adverse effects could be avoided through siting.
	Sedimentary alternate location: • Potential effects on Indigenous health identified for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • Potential additional emissions to air and noise at a sedimentary alternate location summarized above in the air quality and noise levels VC rows are also relevant to Indigenous health.	***Sedimentary alternate location:*** • Mitigation measures identified for the Bruce Nuclear site are also applicable to the sedimentary alternate location.	***Sedimentary alternate location:*** • Residual effects on Indigenous health identified for the Bruce Nuclear site are also applicable to the sedimentary location.	***Sedimentary alternate location:*** • Magnitude: Low (HQ >1 and <10 at community receptor location). • Extent: Effect is limited to the local study area. • Frequency: Conditions or phenomena causing the effect occur at infrequent intervals (i.e., once per year). • Duration: Effect occurs during site preparation and construction. • Reversibility: Effect is readily (i.e., immediately) reversible when the exposure ceases. • Ecological/social context: Acrolein concentrations in air are driven by existing conditions. Given the low magnitude, conservatism in the assessment, and reversibility of the effect, effects on Indigenous health are not likely to be significant. Distance to the closest receptor would further influence the magnitude of the effect, and some adverse effects could be avoided through siting.	▲ **Crystalline alternate location –** Potentially increased effects associated with exposure to acrolein and noise compared to the Bruce Nuclear site due to additional waste transportation; however, effects not likely to be significant. Distance to the closest receptor would influence the magnitude of the effect; effects not likely to be significant, and some adverse effects could be avoided through siting.
	Crystalline alternate location: • Potential effects on Indigenous health identified for the Bruce Nuclear site are also applicable to the crystalline alternate location. • Potential additional emissions to air and noise at a crystalline alternate location summarized above in the air quality and noise levels VC rows are also relevant to Indigenous health.	***Crystalline alternate location:*** • Mitigation measures as described for the sedimentary alternate location are also applicable to the crystalline alternate location.	***Crystalline alternate location:*** • Residual effects on Indigenous health identified for the Bruce Nuclear site are also applicable to the crystalline alternate location.	***Crystalline alternate location:*** • Magnitude: Low (HQ >1 and <10 at community receptor location). • Extent: Effect is limited to the local study area. • Frequency: Conditions or phenomena causing the effect occur at infrequent intervals (i.e., once per year). • Duration: Effect occurs throughout all project phases. • Reversibility: Effect is readily (i.e., immediately) reversible when the exposure ceases. • Ecological/social context: Acrolein concentrations in air are driven by existing conditions.	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
				Given the low magnitude, conservatism in the assessment, and reversibility of the effect, effects on Indigenous health are not likely to be significant. Distance to the closest receptor would further influence the magnitude of the effect, and some adverse effects could be avoided through siting.	
Socio-economic Conditions	***Methodology used in identifying potential environmental effects at all three locations:*** *Measurable changes in socio-economic or cultural conditions compared to existing conditions.* ***Bruce Nuclear site:*** • The DGR Project is not likely to adversely affect the economic base, levels of service, social structure or the stability of Indigenous peoples [OPG 2011]. At the same time, concerns have been expressed by the Métis Nation of Ontario regarding: perception of change in land or water leading to avoidance behaviour, for example, not hunting, fishing, harvesting in the area due to a belief in possible contamination (MNO 2016). • The Saugeen Ojibway Nation (SON) has also indicated through its ongoing engagement with OPG concerns related to stigma; for example, will tourists avoid the area in which the DGR is built for fear of possible contamination; will SON's commercial fishery product be avoided for the same reason. • Conversely, a DGR Project at the Bruce Nuclear site will create new direct, indirect and induced employment opportunities and additional business opportunities for both Indigenous and non-Indigenous peoples, with potential for Indigenous peoples and communities to realize these opportunities. **Sedimentary alternate location:** • Potential effects on Indigenous socio-economic conditions identified for the Bruce Nuclear site are also applicable to the sedimentary alternate location, however, the specific scope and nature of socio-economic interactions that may result between the DGR at the sedimentary alternate location would ultimately be determined by a knowledgeable community	***Bruce Nuclear site:*** • Mitigation measures include a program of ongoing engagement with affected Indigenous groups. • Mitigation measures include involving local Indigenous peoples in planned employment and training with Indigenous-specific program components as well as procurement opportunities for Indigenous businesses. ***Sedimentary alternate location:*** • Mitigation measures as described above for the Bruce Nuclear site are also applicable to the sedimentary alternate location.	***Benchmark for identification of a residual adverse effect:*** *Adverse changes in socio-economic or cultural conditions compared to existing conditions.* ***Bruce Nuclear site:*** • Taking into consideration mitigation identified, no residual adverse effects predicted. ***Sedimentary alternate location:*** • Taking into consideration mitigation identified, no residual adverse effects predicted.	***Benchmark used to determine whether residual effects are significant:*** *Any adverse change in socio-economic or cultural conditions that results in an irreversible or high magnitude effect measurable to existing conditions at the community level.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required. ***Sedimentary alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	○ **Bruce Nuclear site –** No residual adverse effects predicted. Potential positive effects. ○ **Sedimentary alternate location** – Potential effects on Indigenous socio-economic and cultural conditions are anticipated to be similar to those identified for the Bruce Nuclear site. ○ **Crystalline alternate location –** Potential effects on Indigenous socio-economic and cultural conditions are anticipated to be similar to those identified for the Bruce Nuclear site. Given the more remote nature of the crystalline alternate location, and the generally smaller numerical size of the Indigenous peoples, the magnitude of socio-economic and cultural effects may be more pronounced in the more remote Indigenous peoples.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	making an informed decision on whether to accept the responsibility of hosting the facility following a process for the identification, management and mitigation to avoid or minimize adverse effects.				
	Crystalline alternate location: • Potential effects on Indigenous socio-economic conditions are anticipated to be the same as those identified for the Bruce Nuclear site. Similar to the sedimentary alternate location, the specific scope and nature of socio-economic interactions that may result with a DGR would follow a process for the identification, management and mitigation to avoid or minimize adverse effects. Given the more remote nature of the crystalline alternate location, and the generally smaller number of the Indigenous peoples, the magnitude of socio-economic effects may be more pronounced in the more remote Indigenous peoples.	***Crystalline alternate location:*** • Mitigation measures as described for the sedimentary alternate location are also applicable to the crystalline alternate location.	***Crystalline alternate location:*** • Taking into consideration mitigation identified, no residual adverse effects predicted.	***Crystalline alternate location:*** • No residual adverse effects identified, therefore, no evaluation of significance required.	
Current Use of Lands and Resources for Traditional Purposes	***Methodology used in identifying potential environmental effects at all three locations:*** *Identification of direct and indirect change that may affect the quality or quantity of lands available for use for traditional purposes.* ***Bruce Nuclear site:*** • No direct effects on use of lands and resources, taking into consideration concerns expressed by SON over the historic development of the Bruce Nuclear site. • Potential indirect effects of changes in air quality and noise levels are limited to the immediate vicinity of the Bruce Nuclear site. ***Sedimentary alternate location:*** • Direct effect on use of lands and resources through establishment of a new site of up to 900 ha. • Disruption to current use of land and resources for traditional purposes due to removal of the site from general access (i.e., establishing a fenced, restricted access site). • Potential indirect disruption to surrounding land through changes in air quality and noise levels (as described above) and further potential indirect effects, especially regarding Indigenous	***Bruce Nuclear site:*** • Mitigation measures as described above for environmental pathways (e.g., air quality, noise) are also applicable to current use of lands and resource for traditional purposes. ***Sedimentary alternate location:*** • Mitigation measures as described above for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • Appropriate mitigation and accommodation measures would be applied to address potential effects on current use of lands and resources for Indigenous purposes, or other issues raised	***Criteria used for identification of a residual adverse effect:*** *Change in access to or use of lands for traditional or non-traditional purposes.* ***Bruce Nuclear site:*** • Taking into consideration mitigation measures identified, no residual adverse effects were identified in the EIS as a result of the DGR Project [OPG 2011]. ***Sedimentary alternate location:*** • Residual adverse effects are likely on current use of lands and resources due to establishment of the site and supporting facilities.	***Benchmark used to determine whether residual effects are significant:*** *Unacceptable risk to use of lands, resources and interests, taking into consideration site-specific community knowledge.* ***Bruce Nuclear site:*** • No residual adverse effects identified, therefore, no evaluation of significance required. OPG continues to engage with the SON over concerns expressed by it. ***Sedimentary alternate location:*** • Magnitude: Low to moderate; specific magnitude of effects would be determined through engagement with communities during a siting process. • Extent: Effects would potentially extend beyond the site into the local study area. • Frequency: Direct effects would be continuous; indirect effects (e.g., through changes in air and noise) would be infrequent as described in rows above. • Duration: Effects would persist through all	○ **Bruce Nuclear site –** No residual adverse effects identified as a result of the DGR Project, acknowledging concerns raised by SON regarding the historic development of the Bruce Nuclear site. ▲ **Sedimentary alternate location** – Increased effects on current use of land and resource use due to the establishment of a new licensed facility. ▲ **Crystalline alternate location –** Increased effects on current use of land and resource use due to the establishment of a new licensed facility. Effects are likely to be greater in magnitude than the

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
	hunting, trapping and gathering due to potential habitat fragmentation from vegetation removal and fencing.	during the consultation process. • Ultimately, siting of the DGR at the sedimentary alternate location would require the support of Indigenous peoples in whose traditional territory the DGR would be located.		project phases. • Reversibility: Direct effects are assumed to be irreversible. • Ecological/social context: The alternate location includes the traditional territories of multiple Indigenous peoples. Site specific social context would be determined through engagement with Indigenous peoples during a siting process. Overall, effects are not likely to be significant as the magnitude of the effect would be managed through application of mitigation and accommodation measures such that the DGR would not cause unacceptable risk to use of lands, resources and interests. Ultimately, siting of the DGR at the sedimentary alternate location would require the support of Indigenous peoples in whose traditional territory the DGR would be located.	sedimentary alternate location.
	Crystalline alternate location: • Direct effect on use of lands and resources through establishment of a new site of up to 900 ha as well as additional linear infrastructure. • Disruption to current use of land and resources for traditional purposes due to removal of the site from general access (i.e., establishing a fenced, restricted access site). • Potential indirect disruption to surrounding land through changes in air quality and noise levels and further indirect effects on hunting, trapping and gathering due to potential habitat fragmentation from vegetation removal and fencing.	***Crystalline alternate location:*** • Mitigation measures as described for the sedimentary alternate location are also applicable to the crystalline alternate location.	***Crystalline alternate location:*** • Residual adverse effects are likely on current use of lands and resources due to establishment of the site and supporting facilities.	***Crystalline alternate location:*** • Magnitude: Low to moderate; specific magnitude of effects would be determined through engagement with Indigenous peoples during a siting process. • Extent: Effects would potentially extend beyond the site into the local study area. • Frequency: Direct effects would be continuous; indirect effects (e.g., through changes in air and noise) would be infrequent as described in rows above. • Duration: Effects would persist through all project phases. • Reversibility: Direct effects are assumed to be irreversible. • Ecological/social context: The alternate location includes the traditional territories of multiple Indigenous peoples. Site specific social context would be determined through engagement with Indigenous peoples during a siting process. Overall, effects are not likely to be significant as the magnitude of the effect would be managed through application of mitigation and accommodation measures such that the DGR would not cause unacceptable risk to use of lands, resources and interests. Ultimately, siting of the DGR at the crystalline alternate location	

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
				would require the support of Indigenous peoples in whose traditional territory the DGR would be located.	
Physical and Cultural Heritage Resources	***Methodology used in evaluating environmental effects at all three locations:*** *Combination of quantitative and qualitative methods, including professional expertise and judgment, including Stage 1 and Stage 2 archaeological assessments for the Bruce Nuclear site.* ***Bruce Nuclear site:*** • A DGR at the Bruce Nuclear site has the potential to interact with physical and cultural heritage resources through the following pathways: o Disturbance of archaeological sites/burials and artifacts from direct or indirect changes to the environment (e.g., site preparation and construction activities). o Changes to the quality or value of activities undertaken by Indigenous peoples at the burial site located on the Bruce Nuclear site due to changes in air quality, noise and presence of the DGR. ***Sedimentary alternate location:*** • Potential effects on physical and cultural heritage resources identified for the Bruce Nuclear site may also be applicable for the sedimentary alternate location.	***Bruce Nuclear site:*** • Mitigation, in the form of archaeological assessment to identify and avoid existing resources, has already been undertaken. Additional mitigation will include ensuring that, in the event of a discovery of previously unidentified heritage resources, all activity in the vicinity of the discovery will be suspended and applicable agencies and communities contacted until a plan is in place to mitigate effects. • The mitigation measures identified for air quality and noise are applicable to mitigation of effects to changes in quality or value of activities undertaken at the burial site. • In-design mitigation measures to reduce the visual effect of the DGR Project include a setback or buffer of 200 m from the Interconnecting Road to the long-term waste rock management area and other visual screening (e.g., berm and/or trees). ***Sedimentary alternate location:*** • Mitigation measures as described above for the Bruce Nuclear site are also applicable to the sedimentary alternate location. • Avoidance of physical and	***Benchmark for identification of a residual adverse effect:*** *Measurable change in physical and cultural heritage resources or the quality of those resources for cultural activities.* ***Bruce Nuclear site:*** • Taking into consideration the mitigation measures, no residual adverse effects to physical and cultural heritage resources are predicted as a result of disturbance of archaeological sites/burials and artifacts. The DGR Project site (i.e., footprint) does not overlap with known heritage resources. • Taking into the consideration the mitigation measures, a residual adverse effect on physical and cultural heritage resources is expected to occur during all phases of the DGR Project. Specifically, the DGR Project is likely to diminish the quality or value of activities undertaken by Indigenous peoples at the Aboriginal burial site located at the Bruce Nuclear site. This results from the presence of the DGR (site infrastructure will be visible) and temporarily increased noise and dust at the burial site. The DGR Project will not change the access to the Aboriginal burial site nor the ability of Aboriginal peoples to undertake their cultural/ceremonial activities at this site. ***Sedimentary alternate location:*** • In considering the implementation of the DGR at the sedimentary alternate location, it is assumed that the site could be located to avoid physical and cultural heritage resources. The identification of	***Benchmark used to determine whether residual effects are significant:*** *The material impairment or prevention of use of cultural heritage resources for cultural activities.* ***Bruce Nuclear site:*** • Magnitude: Low – no physical disturbance to physical or cultural heritage resources through direct or indirect change to environment conditions – the site will be indirectly affected by changes in aesthetics and/or changes in dust levels and noise. • Extent: Effect is limited to the site study area (i.e., Bruce Nuclear site). • Frequency: Conditions or phenomena causing the effect occur at regularly but infrequent intervals; the burial site is visited and used for ceremonial purposes infrequently. • Duration: Effects extend beyond any one phase of the DGR Project. • Reversibility: Effect is reversible with time. • Ecological/social context: The burial site is located on an existing industrial site. The overall assessment of the residual adverse effect on physical and cultural heritage resources during all three phases of the project lifecycle, found that this effect is not likely to be significant primarily because, and may be affected by dust and noise infrequently. It is considered unlikely that ceremonies would occur during these times. Moreover, apart from the visibility of the waste rock pile, adverse effects over the long term are not anticipated. ***Sedimentary alternate location:*** • No residual effects anticipated, therefore no evaluation of significance required.	▲ **Bruce Nuclear site –** residual adverse effects are predicted to be not significant. ○ **Sedimentary alternate location** – the opportunity to screen and select an alternative location that would avoid Indigenous heritage resources altogether represents an opportunity to decrease effects to physical and heritage resources. ○ **Crystalline alternate location –** the opportunity to screen and select an alternative location that would avoid Indigenous heritage resources altogether represents an opportunity to decrease effects to physical and heritage resources.

Valued Component	Potential Environmental Effects	Mitigation Measures[(a)]	Residual Adverse Effects	Significance of Residual Adverse Effects	Comparison of Environmental Effects Between Locations
		cultural resources during the siting process where possible.	physical and cultural heritage resources would be done as part of a site selection process (i.e., during the technical screening of potential locations and the detailed investigations of identified preferred locations). • In the unlikely event that unanticipated physical or cultural heritage artifacts were to be discovered as a result of site preparation and construction at the sedimentary alternate location, mitigation measures could be implemented to assess and conserve the cultural heritage value of the artifacts.		
	Crystalline alternate location: • Potential effects on physical and cultural heritage resources identified for the Bruce Nuclear site may also be applicable for the crystalline alternate location.	***Crystalline alternate location:*** • Mitigation measures as described for the sedimentary alternate location are also applicable to the crystalline alternate location. • Avoidance of physical and cultural resources during the siting process where possible.	***Crystalline alternate location:*** • Mitigation measures described for the sedimentary alternate location are also applicable to the crystalline alternate location.	***Crystalline alternate location:*** • No residual effects anticipated, therefore no evaluation of significance required.	

Notes:
○ = fewest effects; ▲ = increased number or magnitude of effects
[a] Not the complete lists of mitigation measures for the alternate locations, which would be developed specifically for the selected DGR location. For the Bruce Nuclear site, detailed lists of mitigation measures were provided previously in the Mitigation Measures Report [NWMO 2016].

References for Table 6-1 (associated with IR-1.2 Response):

ECCC. 2013. *Canadian Nuclear Safety Commission – Canadian Environmental Assessment Act Joint Review Panel, In Respect of Ontario Power Generation’s Deep Geologic Repository for Low and Intermediate Level Radioactive Wastes.* Environment and Climate Change Canada. (CEAA Registry Doc# 1253)

ENERGY SOLUTIONS. 2016. *Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations*. Prepared by Energy Solutions Canada Ltd. Ontario Power Generation Report 00216-REP-03450-00001-R000. (CEAA Registry Doc# 2883)

GOLDER. 2016. *Environmental Effects of Alternate Locations*. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-00015-R000. (CEAA Registry Doc# 2883)

MNO. 2016. Letter from Pauline Richardson, Chair, Georgian Bay Traditional Territory Consultation Committee, Region 7 Councillor – Provisional Council of the Métis Nation of Ontario to Ms. Cindy Parker, Panel Manager, Review Panels Division, Canadian Environmental Assessment Agency. *Re: Métis Nation of Ontario Comments on Ontario Power Generation Minister’s request for additional information on an Alternative Locations, Cumulative Environmental Effects and Mitigation Measures Report.* March 21, 2017.

NWMO. 2016. *Mitigation Measures Report*. Prepared by Nuclear Waste Management Organization. Ontario Power Generation Report 00216-REP-07701-00019-R000. (CEAA Registry Doc# 2883)

OPG. 2011. *Environmental Impact Statement, Volume 1*: Main Report. Prepared by Golder Associates Ltd. Ontario Power Generation Report 00216-REP-07701-0001 R000. (CEAA Registry Doc# 298)

ENCLOSURE 3

Figure 5-2 (associated with IR-2.5 response). Study Areas for the Terrestrial Environment.

Enclosure 3

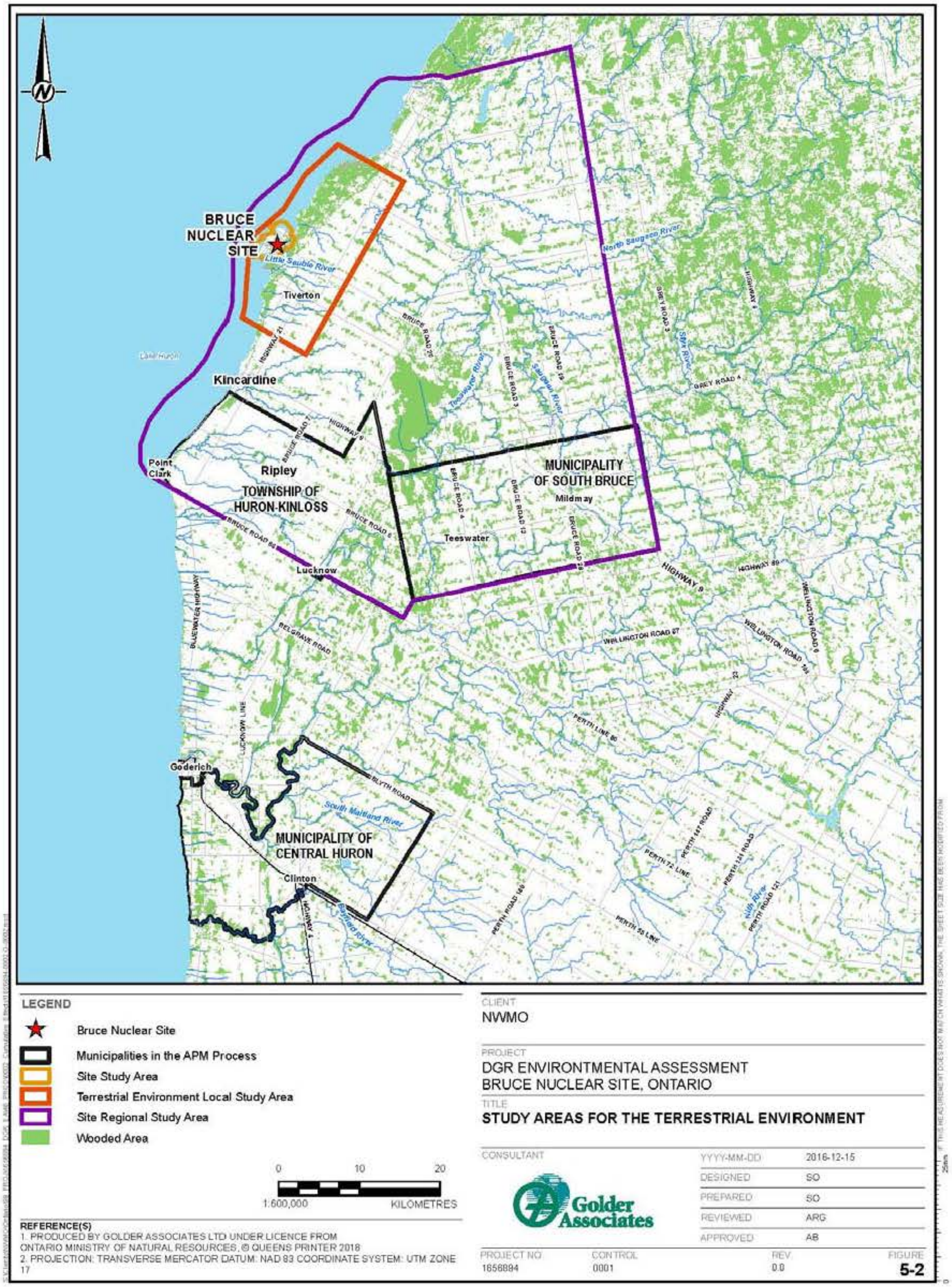

Figure 5-2 (associated with IR-2.5 response). Study Areas for the Terrestrial Environment.