



# **Comments to the Minister of Environment and Climate Change on Ontario Power Generation's Response to the Minister's Request for Additional Information on the Proposed Deep Geologic Repository for Low and Intermediate Level Waste**

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Prepared by Members of SOS Great Lakes

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## INTRODUCTION

### SOS Great Lakes

SOS Great Lakes is a not-for-profit corporation comprised of volunteer Canadians and Americans dedicated to the prevention of the burial and abandonment of radioactive nuclear waste anywhere in the Great Lakes Basin. Our effort started in 2012 with the announcement by the Nuclear Waste Management Organization (NWMO) of a potential plan to locate a High Level Waste DGR (DGR2) in Saugeen Shores a few kilometres north of the Bruce Nuclear site. We started as S.O.S. (Save our Saugeen Shores) and were successful when NWMO backed down and withdrew. To save face they claimed it was because of a problem with the soil, soil they had rigorously tested years before. The reality was a Town unwilling.

Freed from work on DGR 2, we turned our attention the OPG plan to locate DGR1 for L&ILW at the Bruce Nuclear site. We learned quickly that concerned Canadians and Americans well outside the prescribed study area for DGR1 were being ignored by both the proponent and the joint regulators, CEAA and CNSC. We re-branded as SOS GREAT LAKES, with members from all walks of life, and a cross-section of occupations and expertise. Some have a family history near the Great Lakes for generations. Others have no close geographic connection but are intelligent observers, whether in Canada or the United States, of public policy issues and errors such as this one. All are appalled at the unnecessary and dangerous proposal of DGR1. We are not the “uninformed” or “anti-nuke fringe” players CNSC management regularly tries to marginalize. Locally, we have consistently supported Bruce Power for its economic and social contributions to the local communities in the region. Our concern is directed at the irresponsibly dangerous and unnecessary DGR1 plan and the deception that CEAA and CNSC have allowed OPG to perpetrate on the public throughout the approval process.

Many of our members and supporters in allied groups were registered participants in the Joint Review Panel Hearings of 2013 and 2014. Our written and oral presentations can be found on the CEAA website. Those submissions and our several detailed letters to you after your election show how siting a DGR for L&ILW on the shore of Lake Huron on the Bruce Nuclear site is a dangerous and deeply flawed project. The burial plan for the waste raises on-going safety, health, environmental and socio-economic concerns. In addition, it is our opinion that the political process surrounding the Hosting Agreement with Kincardine, and the ongoing support by neighbouring municipalities due to intervention by OPG has been fraught with conflicts of interest, the precise antithesis of democratic due process in the DGR planning.

The disposal of ILW in the DGR 1, some of which has the potential radioactive hazards of nuclear fuel waste and for comparable periods of time, requires the same standards of technical, safety, ethical awareness and social responsiveness as in planning for high-level radioactive waste. We continue to participate in the public process of review of this project because the DGR construction will cause a threat to the safety and security of the environment, the Great Lakes in perpetuity. We are all stewards of the Great Lakes, their shores and their role in the lives of not just the 40 million Canadians and Americans whose drinking water comes from the Lakes, but a world that cherishes fresh water anywhere. We expect no less of industry and our leaders.

## **Our Submission**

Our Submission to the Minister is comprised of commentary in chapter format relating each of the three primary questions sent to OPG by the Minister in February 2016. Each of our chapters has been written by one of our members. We have been assisted in our submission by Mr. John Jackson, hired through the CEAA Participant Funding Program, to prepare commentary on OPGs Cumulative Effects Analysis.

The topics discussed include: commentary on OPG's Study of Alternate Locations, the Cumulative Effects Analysis of the DGR for L&ILW in Kincardine, in combination with 3 potential APM used fuel DGRs in the one of the communities of Huron- Kinloss, South Bruce, and Central Huron, and the OPG Mitigation Measures Report.

OPG Has Submitted a Flawed Environmental Assessment.

In December 2016, OPG has presented a deeply flawed addition to its deeply flawed Environmental Impact Statement. We urge the Minister to reject the EA for OPGs Deep Geologic Repository and to reject the licensing of the DGR at Kincardine.

**Thank you.**

## TABLE OF CONTENTS

INTRODUCTION .....	3
<b>ALTERNATE LOCATIONS</b> .....	9
Summary .....	10
1 The Letters from the Minister and Agency to OPG, and Letters from OPG to the Agency .....	12
1.1 February 2016, the Minister to OPG .....	12
1.2 April 2016, OPG to the Agency .....	12
1.3 September 2016, the Agency to OPG .....	12
1.4 The OPG December 2016 Submission .....	13
2 Chronological Background to the Minister's Request for Information on Specific Comparative Alternate Locations.....	15
2.1 The OPG's EIS 2011 for the Joint Review Panel (JRP) .....	15
2.2 OPG Response to EIS-02-40 .....	15
2.3 CELA's Identification of the Error (2013) .....	15
2.4 OPG Responses on Alternative Locations from November 2013 to May 2015 .....	16
3 The JRP Report.....	19
3.1 The JRP Report (May 2015) had its Concerns with the IEG Report on Alternatives .....	19
4 Why a Failure to Study Actual Alternate Locations is Particularly Unacceptable .....	20
4.1 Avoiding Proximity to the Great Lakes .....	20
4.2 Recognition of Experimental Nature and Risk of DGRs .....	20
4.3 Why are Accidents and Failures of Great Importance to Analysis of Options and a Range of Actual Locations? .....	21
5 OPG's Submission to the Minister .....	23
5.1 Technical and Economic Feasibility at Alternate Locations .....	23
5.2 The Alternate Location, Project Description per OPG .....	25
5.3 Regional Characterization .....	25
5.4 Crystalline Location Characterization .....	26
5.5 Sedimentary Location Characterization .....	27
5.6 Environmental Assessment Analysis at Alternate Sites According to OPG .....	28
5.7 Specific Adverse Factors Crystalline Location According to OPG .....	30
5.8 Specific Adverse Factors Sedimentary Location according to OPG .....	31
6 Commentary on Chapter 7, Social License .....	33
7 Commentary of Chapter 8, Communications and Engagement .....	39
<b>COST AND RISK</b> .....	41
1 Introduction .....	42
2 Initial Flaws in OPG Presentation of Costs .....	43
2.1 The Cost of the Base .....	43
2.2 Administrative Requirements .....	43
2.3 OPG Has Not Located the Actual Alternative Sites.....	43
2.4 Lack of Authoritative Cost Modeling for Construction and Operation .....	43
2.5 Consideration for Reduction of Waste and Shipments and Size of the DGR .....	44
2.6 OPG Has Not Factored In Costs for Expansion for Decommissioning Waste in Transportation, Construction, Operation, and Monitoring .....	44
2.7 Precaution in Judgement of Economics of Highest and Best Use .....	45

2.8 The Relative Value of Transportation .....	44
3 Statement of Costs .....	46
4 The International Expert Panel (IEP) View on Cost .....	47
5 Energy Solutions Report: The Expert Report for Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations Dec 2016 .....	49
6 History of Costs for the Base Case .....	51
6.1 The Cost Assessments from the Golder Report in 2004 .....	51
6.2 What Were Others Saying about the Cost of the DGR 1 in 2004? .....	52
6.3 Revised Cost Estimate by Golder Associates in the Environmental Impact Statement, 2011 ...	53
6.4 Joint Review Panel Report May 2015 .....	55
6.5 OPG in November 2016 .....	55
6.6 Costs of the Base Reported in December 2016 by OPG .....	56
7 Are Final Lifecycle Costs for the Bruce or Alternate Sites Known? .....	57
7.1 The Answer is No .....	57
7.2 Lifecycle Costs .....	57
8 Similar Cost Comparisons .....	58
8.1 NWMO Cost for the APM DGR2 in Crystalline Rock .....	58
8.2 Why is the NWMO Cost Analysis of Interest in the DGR 1 Base and Alternative Locations Comparative Cost Estimates? .....	59
8.3 US DOE Cost Basis Summary, Jan 2016 .....	61
9 Conclusion .....	61
<b>PACKAGING AND TRANSPORTING WASTE TO ALTERNATE LOCATIONS .....</b>	<b>63</b>
Introduction .....	64
1 Excerpts from The Energy Solutions Canada Study and OPG Study on Alternate Locations .....	65
2 Diligence and Compliance Requirements .....	65
3 Costs and Risks for Transporting Wastes to Alternate Locations .....	66
4 The Value of New Information .....	66
5 Off-site Storage and Disposal and On-site Opportunities .....	67
6 Economic Feasibility .....	67
7 Uses of Baseline Packaging and Transportation Information .....	68
8 Packaging and Transport of L and ILW: The Obligation and Opportunity to Re-examine Assumptions .....	69
9 Packaging and Transport and the Effect on DGR Size and Uses .....	70
Figures .....	71-73
<b>CUMULATIVE ENVIRONMENTAL EFFECTS .....</b>	<b>75</b>
Overview .....	76
1 The Original Flawed Cumulative Effects Assessment .....	78
2 Analysis of OPG's Updated Assessment of Cumulative Effects: Getting to "Zero" .....	79
3 Conclusion .....	86
<b>CUMULATIVE EFFECTS AND HUMAN HEALTH .....</b>	<b>87</b>
1 Overview .....	88
2 Introduction .....	89
3 Health Effects .....	91
4 Comments .....	109
4 Conclusion: "First, Do No Harm" .....	114

Appendix A .....	116
Appendix B .....	119
<b>MITIGATION MONITORING .....</b>	<b>123</b>
1 Introduction .....	124
2 Mitigation and Monitoring of Valued Components.....	125
3 Conclusions .....	130
<b>MAJOR ENVIRONMENTAL PROTECTION POLICY ISSUES .....</b>	<b>131</b>
1 Evidence-based Science .....	133
2 Alternate Means .....	133
3 Sustainability and the Precautionary .....	133
4 Public Health and Safety .....	133
5 International Obligations .....	133
6 Public Acceptance .....	134
7 Incomplete Report .....	134
8 Partiality .....	134
9 Cost/Need .....	134

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**Response to OPG's Study of  
Alternate Locations Main  
Submission,**

**00216-RREP-07701-00013**

## SUMMARY

The JRP erred when they concluded that OPG had properly considered alternatives to the project and alternative means for carrying it out, and now OPG has continued to repeat those errors despite the Minister of Environment and Climate Change (the Minister) and the Canadian Environmental Assessment Agency (the Agency) requests of February 2016 and September 2016 to study actual alternative locations.

OPG's December 2016 submission has described two broad 'regions': one crystalline and one sedimentary, to which they apply high level and inaccurate regional characterizations. In addition, their reports recycle prior work from the Golder 2004 IAS and the 2011 OPG EIS, contrary to the Minister's requirement for new work. By adopting these approaches OPG continues to exert its strong and unreasonable control on the message and reporting, fails to meet the Minister's 2016 requirements, and fails to meet the minimum requirements of the Canadian Environmental Assessment Act (CEAA 2012) and the EIS Guidelines. This failure prevents the Minister from being able to review the suitability of the DGR site at the Bruce Nuclear Site, against other potentially more favourable actual sites.

We urge the Minister to reject the OPG DGR EA submission based on its failure to meet the CEAA 2012 and the EIS Terms of Reference; but that failure is accompanied by a chronology of failure to comply, sloppy workmanship, poor science, poor assessment methodology, incorrect assumptions and distortions of fact that we will highlight in this report.

The federal government and the government of Ontario are looking for an alternate site solution where the environmental effects and risks of storing or abandoning L&ILW from the Bruce Nuclear site, and decommissioning waste from other sites, is less than at the WWMP. They are seeking this information from experts who are trusted to have the best interests of the government and the public in mind, because the deep burial of that waste in perpetuity has the potential to cause radiological contamination of the atmosphere above Lake Huron, one of the five interconnected Great Lakes, and into the water of the Lake during periods of vulnerability of the planned DGR program. Those periods of particular vulnerability are: during construction when excavation of vast amounts of various types of rock occur, during waste handling and packaging on site, during placement of the waste in the rock emplacement rooms 680 metres below ground, during operation, during periods when gas and water are being extracted from the shaft to the environment above, during dewatering, that will be continuous, during extreme weather events and during unexpected accidents, and malfunctions. It is also the period of post closure, when excavated areas, including the caverns, shafts and head of the shaft are under pressure from water and gas, and from internal geologic pressures, that could speed collapse and release of contaminants up through the shaft, or laterally through the least stable of the geologic horizontal layers, to lateral and vertical fissures for active release.

An alternate site study is necessary to evaluate the potential advantages to the environment and to people, so that this high risk model 900 metres from Lake Huron, may be modified to suit a better plan that is more precautionary, and more sustainable over the life of the management of the waste, predicted to be 300 years (the period of institutional control).

Realizing that the transportation of radioactive waste is an issue which must be approached with caution, we expect that OPG will develop solutions that are viable and safe, and reflect the greatest cost benefit for Ontarians, and the greatest degree of sustainability for the future generations who will be left to pay for, worry about and manage the waste.

Transportation of the appropriate quantity and quality of waste off site is the logical solution to the high risk of radioactive contamination of the Lake. This does not have to be ALL of the radioactive waste, as is maintained by OPG. In fact it does not make sense to remove over 80% of the packaged volume of the waste, that is, the short lived LLW, from the site. The technical and financial viability of transportation of long-lived L&ILW from the Bruce site to a small repository in suitable sedimentary or crystalline formations using technology that could be better suited to the small volume and type of waste could be a strategy that is technically feasible and economically feasible, and potentially be the preferred solution.

OPG has refused to follow the instructions of the CEAA, the Terms of Reference of the EIS, the JRP, and now the Minister to propose alternate actual sites that could be reasonably judged to be viable. Twenty years ago, the owners of the waste committed among themselves to construct a DGR according to international models to join a nuclear community of countries that were doing the same thing. However these countries were undertaking serious alternatives analysis and experimenting with Underground Research Laboratories to perfect the methods of construction and storage, in a precautionary manner, and according to the guidelines set out by international agencies. In Ontario, our nuclear waste managers have skipped the step of precaution and planned since the year 2000 to construct a DGR on the Bruce site for convenience, rather than for logical or sustainable reasons. Since 2000 the shallow and deep repository experimental models have failed disastrously at Konrad, Morsleben, Asse and in New Mexico at WIPP. The Andra repository at Bure has experienced collapses causing death. The well lauded program of the Swedish nuclear industry the DGR at SFN, is stalled at the moment.

The financial and economic benefit of these repositories, and the economic burden of them has been proven, and continues to be a constant and exceptionally difficult issue to resolve for those already in the midst of construction. This is proven by the 2015-16 OECD NEA reports that are current, and easily available on the internet. They have said, there is actually no consistent cross-country reporting on cost or success, and that the issue of DGR construction as a means of storage and disposal, is stalled. Public perception and public support of these projects is also changing in the negative.

It is incumbent on OPG to be compliant with the Minister's request, to the letter, or even to extent past the limits of the request, to provide adequate explanations and solutions that would be the best possible, made in Canada, solution to this problem. OPG has failed dramatically, and has been defiant of the requirements of the CEAA to provide alternatives to the satisfaction of the government and the public. Their proposal for the DGR should be rejected, because it is not the best proposal, and it has not been prepared according to the process of law.

We urge the Minister to reject the OPG proposal on this basis, and others that will become clear in the reporting of our group, and the reporting of other citizens, those in public life, the scientific experts who have spoken out, and the facts of this argument.

## **1.0 THE LETTERS FROM THE MINISTER AND AGENCY TO OPG, AND LETTERS FROM THE OPG TO THE AGENCY**

### **1.1 February 2016, the Minister to OPG**

In February 2016, referencing CEAA 2012 47 (2), Minister required OPG to collect information and conduct studies on three subjects. One of the subjects was a study of environmental effects of technically and economically feasible alternate locations for the project with specific reference to actual locations.

The request for the alternative locations study reads:

*A study on the environmental effects of technically and economically feasible alternate locations for the Project, with specific reference to actual locations that would meet Ontario Power Generations criteria for technical and economic feasibility. In conducting this study, Ontario Power Generation is to detail the thresholds for what is considered to be technically and economically feasible. In addition, Ontario Power Generation is to indicate what the incremental cost and risk would be for additional off-site transportation of nuclear waste.<sup>1</sup>*

### **1.2 April 2016, OPG to the Agency**

In April 2016, OPG wrote to the Agency that they were going to interpret the Minister's request as follows:

[OPG:] *1. Alternate Locations*

*OPG has interpreted this request as follows: OPG will assess the environmental effects of two technically and economically feasible geologic regions (our emphasis) in Ontario for a new low and intermediate level waste (L&ILW) disposal facility. One assessment will consider a deep geologic repository located in a sedimentary rock formation located in southern Ontario. The second will consider a deep geologic repository located in a granite rock formation located in central to northern Ontario.<sup>2</sup>*

OPG sought confirmation from the Agency that OPG had interpreted the requirement correctly.

### **1.3 September 2016, the Agency to OPG**

In its response on September 7, 2016 the Agency wrote:

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<sup>1</sup> Letter from the Minister of the Environment to Laurie Swami, Vice President Nuclear Services, Feb 18, 2016

<sup>2</sup> Letter from Laurie Swami, Vice President Nuclear Services to the Minister, April 15, 2016

[CEAA]: *(OPG) has indicated that it intends to provide an assessment of the environmental effects for two technically and economically feasible geologic regions in Ontario, specifically in a sedimentary rock formation in southern Ontario and in granite rock formation located in central to northern Ontario, without providing specific reference to actual locations.*

*The Agency is aware that during the initial review, Ontario Power Generation provided to the Review Panel an assessment of the potential environmental effects of a deep geologic repository located in both sedimentary rock (the geologic formation located at the preferred Bruce Power site) and in a granite rock formation in central or northern Ontario. The Agency is also aware that in assessing the environmental effects of alternate locations for the Review Panel, Ontario Power Generation assumed that the alternate sites would have similar geographical and hydrological characteristics as the preferred site, including being proximal to a small wetland and a great lake. While the comparative value of assuming that any alternate sites would have the same characteristics as the preferred site can be appreciated, it is possible that suitable sites could be located within the geologic formations that are not near a wetland or a great lake. Therefore, in responding to this request, the Agency requests that the analysis of the environmental effects of the alternate locations to be provided by Ontario Power Generation provide a narrative assessment that does not assume that alternate sites in the geologic formation would have the same geographical and hydrological characteristics of the preferred site.<sup>3</sup>*

There is no basis to assume that the Agency has deviated from the Minister's original clear request for focused studies on specific feasible, actual locations outside of a close proximity to wetlands, Lake Huron, or another Great Lake. The critique of the OPG approach is well-stated by CELA in their recent report to the Agency. We concur with their analysis.<sup>4</sup>

#### **1.4 The OPG December 2016 Submission**

In the December 2016 Study of Alternatives, OPG states that it has not followed the direction of Minister:<sup>5</sup>

*[OPG:] 'OPG has proceeded based on the distinction between a feasible alternate location and a specific potentially suitable site that could be identified through a consent based site selection process. Potentially suitable sites are a subset of feasible alternate locations; among other things, these sites are specific geographic areas (our emphasis) within feasible alternate locations that satisfy initial screening and also have the consent or support of willing hosts. Since this is a study-and not a site selection process - OPG has not sought, nor has it obtained,*

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<sup>3</sup> Letter to Ms. Lauri Swami of OPG from Heather Smith of CEAA in response to the April 2016 OPG letter on Alternative Sites, September 7, 2016.

<sup>4</sup> [Page 3-4, Comments to the Minister of Environment and Climate Change on Ontario Power Generation's Response to the Minister's February 2016 Request for Additional Information on the Proposed Deep Geological Repository Project. Tanya Markvart and Morten Siersback, Feb 2017. Publication #1099y].

<sup>5</sup> OPG, "Study of Alternate Locations, Main Submission", 00216-REP-07701-00013, December 2016

*consent of a willing host or Indigenous community for any of the alternate locations discussed below....*<sup>6</sup>

And then, shortly thereafter, despite the fact that OPG does not provide or evaluate actual locations,

*[OPG:] ‘For clarification OPG is providing in this report and in the ‘Description of Alternate locations’ (OPG 2016b) technical document, specific references to actual locations. Rather, OPG has not assumed that the alternate locations would have the same geographical and hydrogeological characteristics as the Bruce Nuclear site, as requested by the Agency’.*<sup>7</sup>

The February 2017 submission by the Canadian Environmental Law Association<sup>8</sup> provides an excellent examination of the failure in the OPG choice of “region” rather than, “actual locations”; their paper also identifies the flaws in the OPG’s argument that a study of actual locations cannot be made without a site-selection process. CELA also discusses the role of alternate specific places and locations in the CEAA 2012, and the standards set by the International Atomic Energy Agency (IAEA) for detailed site assessment once a regional screening is complete.<sup>9</sup>

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<sup>6</sup> OPG, “Study of Alternate Locations...,” December 2016, p. 15.

<sup>7</sup> Ibid, p. 16

<sup>8</sup> CELA, “Comments to the Minister of Environment and Climate Change on Ontario Power Generation’s Response to the Minister’s February 2016 Request for Additional Information on the Proposed Deep Geological Repository Project,” February 2017

<sup>9</sup> CELA, “Comments to the Minister...,” February 2017, p. 6

## **2.0 CHRONOLOGICAL BACKGROUND TO THE MINISTER'S REQUEST FOR INFORMATION ON SPECIFIC COMPARATIVE ALTERNATIVE LOCATIONS**

### **2.1 The OPG's EIS 2011 for the Joint Review Panel (JRP)**

In the EIS, OPG considered, albeit poorly, alternatives and alternative means within the context of the same geographic site (i.e. the WWMF at the Bruce Nuclear Site). But nowhere within the EIS did OPG include a consideration of one or more specific geographic alternative locations.<sup>10</sup> The wording in the CEAA, the TOR and the EIS Guidelines would suggest that would be acceptable on the condition that the proponent had concluded after study that no geographic alternative locations were technically and economically feasible. There is no evidence that OPG undertook such a study and, in fact, it conceded that it did not actively solicit other potential host communities or undertake geo-scientific studies at other sites.

### **2.2 OPG Response to EIS-02-40 for the JRP (2013)**

OPG's explanation for its non-compliance with the CEAA, TOR and EIS Guidelines is rooted in the Hosting Agreement. OPG stated in the EIS:

*[OPG:] As described in Section 3.2.3, the waste management approach and site were developed through implementation of a Memorandum of Understanding (MOU) with the Municipality of Kincardine. The resulting study indicated that the Municipality is a willing host community for a DGR for L&ILRW at the WWMF. The majority of the waste to be managed in the DGR is already stored at the WWMF. The WWMF site and adjacent lands are, and have been, a nuclear facility for almost 40 years. The land is owned and managed by OPG and the site has suitable technical characteristics to safely manage the waste in the very long term and, by using a location within the Bruce nuclear site, issues associated with the off-site transportation of nuclear waste to a repository are eliminated.<sup>11</sup>*

### **2.3 CELA's Identification of the Error (2013)**

In its *Final Comments to the Joint Review Panel*, dated August 2013, presented to the JRP on October 3, 2013, CELA, along with others, identified the gap in OPG's approach and its effect, concluding:

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<sup>10</sup> See section 3.3 *Alternatives to the Project in the OPG, Environmental Impact Statement, March 2011*

<sup>11</sup> OPG, "Consolidated Responses to JRP's Information Requests for Deep Geologic Repository Project for Low and Intermediate Level Waste," p. 249. Retrieved from: <http://passthrough.fw-notify.net/download/187918/http://www.ceaa-acee.gc.ca/050/documents/p17520/89872E.pdf>

[CELA:] *The requirement for consideration of alternatives, as set out in the EIS Guidelines for the DGR assessment (section 7.2), emphasizes identification of the preferred alternative on the basis of a comparative evaluation addressing a comprehensive range of considerations and explicit criteria. These considerations clearly include environmental effects and cumulative environmental effects are, as noted above with reference to Duinker and Greig (2006), clearly the most important environmental effects to address. In environmental assessment generally, comparative evaluation of alternatives is meant to identify the most desirable option. OPG's approach, in contrast, would aim only to identify a project that is, in its view, acceptable. That is not consistent with the evident intent of the legislation, with the specific expectations in the EIS guidelines, or the general philosophy of environmental assessment where comparative evaluation of alternatives is required.*<sup>12</sup>

## 2.4 OPG Responses on Alternative Locations from November 2013 to May 2015

In November 2013 (following the first hearing), the JRP concluded that it required more information from OPG about alternatives and alternative means, including alternative locations, and issued information request EIS-12-513 to OPG. In response to this information request, OPG presented the results of a study conducted by an Independent Expert Group (IEG), regarding the relative risk of four alternatives, these being:

- 1 *'As-is' facility at the WWMF (the status quo);*
- 2 *Enhanced surface storage at the WWMF (hardened storage);*
- 3 *Proposed DGR in the Cobourg Formation at the Bruce Power site; and,*
- 4 *A conceptual DGR in granitic bedrock of the Precambrian Canadian Shield [...]*<sup>13</sup>

As to a comparison of the risk of a release of radionuclides into the biosphere between the *status quo* (1) and a conceptual DGR (4), the IEG was instructed to assume the hypothetical granite DGR site would have a similar geographical and hydrological disposition to the real Bruce DGR site as it is now understood, being defined as proximal to a (small) wetland area, a stream-and small-lake region, and a Great Lake (i.e., sited near a large lake). It was also to be assumed by the IEG that:

- The geometrical dispositions of the Bruce and Granite DGR are the same in terms of depth (about 675 m below ground surface), underground volume, the number of galleries, the number of containers to be placed, and so on.
- The physical design in both cases is similar and appropriate to the mechanical properties of the rock mass, with similar steps being taken to avoid undue damage to the rock during shaft sinking and gallery creation.
- The hoisting equipment and all the other facilities related to the movement and placement of the containers in either of the two DGRs are identical.

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<sup>12</sup> Final comments to the Joint Review Panel for the Deep Geologic Repository Project for Low and Intermediate Level Radioactive Waste Project – Environmental Impact Statement and Licence to Prepare Site and Construct Application (PMD 13-P1.80) (p. 25) Hearing Transcript, Oct 3/13, pp. 152 to 226)

<sup>13</sup> Report p.72, EIS 513, <http://www.ceaa.gc.ca/050/documents/p17520/96032E.pdf>



- The method of abandonment of the Granite DGR and the Bruce DGR is essentially the same, although perhaps with minor design differences to account for the different rock types (igneous vs. sedimentary) and stratigraphic disposition.
- Other significant characteristics not explicitly mentioned here are similar, except of course the nature of the rock and rock mass in the two sites.<sup>14</sup>

The IEG provided the following findings comparing the Bruce sedimentary rock site with a hypothetical granite site for the disposal of low-level and intermediate level radioactive waste. Each one of these technical conclusions was disputed as being vague, incorrect, or not plausible as stated during the hearing by participants. There was an extensive amount of critique of the IEG reporting, including by the JRP.

- The long-term risks of escape of significant amounts or high concentrations of radionuclides at either a properly designed Granite DGR site or the Bruce DGR site are extremely low; in both cases there are many natural barriers and processes that attenuate, retard or dilute dissolved or gaseous species that might be available for transport to the biosphere.
- Granites and other igneous rock masses are naturally fractured, and there is a high probability that a natural fracture system at a Granite DGR in the Canadian Shield has a greater transport potential than the rocks that host and enclose the repository horizon at the Bruce DGR site. A granite site DGR could therefore require more engineered barriers.
- The sediments at the Bruce DGR are homogeneous and thus their properties are quite predictable over substantial distances, and differences in hydraulic properties (permeability and porosity) over these distances (many kilometers) are almost certainly minimal because of the depositional environment and subsequent lack of tectonic deformation in the geological past.
- In a Granite DGR, the distribution of specific natural fractures or fractured zones, their properties and geometry can be complicated, creating challenges for characterisation with high degrees of certainty. The lateral predictability of sub-surface conditions over substantial distances (many kilometers) in granites is poor.
- In the case of possible radionuclide escape from a Granite DGR, the transport mechanism to the biosphere is more likely to be advective transport through natural fractures, whereas from the Bruce DGR, the transport mechanism is more likely to be diffusive transport, for at least several hundred meters of any postulated pathway. Given that diffusive transport is likely to be orders of magnitude slower than advective transport under any postulated escape scenario, the Bruce DGR has a much lower probability of release of a significant concentration of radionuclides to the biosphere.
- Compared to sedimentary rock, granitic rocks have an absence of clay minerals and thus, other factors being equal have a lower adsorptive capacity for dissolved radionuclides being transported in water.
- Compared to a sedimentary site, the gas entry pressures within fractured crystalline rock is expected to be lower, therefore in a Granite DGR site they would present less of a barrier to gas

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<sup>14</sup> IEG Report, p. 10, <http://www.ceaa.gc.ca/050/documents/p17520/99106E.pdf>

flow than the extremely low permeability and essentially unfractured rocks above and around the Bruce DGR site.<sup>15</sup>

After conducting its Relative Risk Assessment<sup>16</sup> the IEG found that:

*[IEG:] Differences in a number of individual risks between the Cobourg Formation at the Bruce site and the generic granite site are described in the comparative evaluations in Section 3. Both would be expected to perform well within the regulatory requirements for long term safety and environmental protection. The need for additional handling and transportation steps influences the comparison between the two repository options. The additional step of moving the wastes off of the Bruce site, where the wastes are presently processed and stored, requires substantially more handling and more miles of waste transportation. Longer distances will increase the risk of more conventional transportation accidents. However, the potential for radiological exposure is judged to be quite low for both handling and transportation.*<sup>17</sup>

As to the distinguishing risk factor (transportation), the IEG did not include in its assessment of the status quo that the DGR would be importing LLRW and ILRW from other OPG sites in Ontario.<sup>18</sup> Had that factor been considered, arguably the result would have been the *status quo* and the conceptual DGR are virtually indistinguishable within the context of environmental protection.

It should be noted now that the findings of the IEG for a comparison of a hypothetical granite site to the sedimentary site are almost identical to those presented to the Minister in December 2016 by OPG, indicating that little new work has been done on the comparative geologies beyond the hypothetical model since 2014. Also, the conclusions of the December 2016 submission that alternate sites were less desirable than the Bruce Site, primarily due to transportation, were largely verbatim.

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<sup>15</sup> IEG Report, p. 23 -34

<sup>16</sup> In section, 3.1

<sup>17</sup> The IEG Report, p. 53

<sup>18</sup> See page 44 of the IEG Report

### 3.0 THE JRP REPORT

#### 3.1 The JRP Report (May 2015) had its concerns with the IEG report on Alternatives:

*[JRP:] The Panel is of the opinion that the characteristics of the granite body that was subject to the OPG IEG analysis were not as favourable as those found at the Underground Research Laboratory in Manitoba. At the hearing, the Panel questioned why the OPG IEG had not made its comparison based on the specific data referred to by the Panel, particularly that of the Underground Research Laboratory. The OPG IEG was of the view that the comparison it had made was reasonable given that a site in Manitoba would not be in consideration for an OPG DGR, and given that no specific sites within the province of Ontario with accompanying community acceptance had been identified. Further, regarding the relative risk analysis of surface water receiving environments, the Panel had requested that the analysis of the conceptual DGR in granite include distinctly different surface water receiving environments, including a boreal wetland, a stream system with several stream orders, and a large lake system, analogous to a great lake. In its analysis, the OPG IEG assumed that the surface water conditions would be the same as those at the Bruce nuclear site which is a combination of the different systems. The OPG IEG did not compare the relative risk of a site that was not located adjacent to a great lake. For this reason, some participants were of the view that the OPG IEG risk analysis was flawed.<sup>19</sup>*

Despite these concerns, the JRP concluded, against the requirements of the CEAA 2012 and the EIS Guidelines to conduct a fulsome comparative analysis of locations to determine the most suitable site for the DGR:

*[JRP:] Notwithstanding the lack of a direct comparison of data for an offsite DGR in a granite formation to the proposed DGR, the Panel concludes that the proposed DGR in limestone at the Bruce nuclear site is suitable, and would be expected to perform well within regulatory requirements for long-term safety and environmental protection. The Panel accepts that a granite formation can be equally suitable, but agrees with the OPG IEG conclusion that the most significant difference between the proposed DGR and an off-site DGR would be the greater risks involved in the handling and transportation of waste to an off-site repository. Given the level of protection provided by a DGR, the risks to the surface environment are low, and the proximity to a great lake does not change this conclusion. The Panel is satisfied that OPG's preference for a DGR in the Cobourg Formation on the lands adjacent to the WWMF at the Bruce nuclear site has been sufficiently justified. The Panel is satisfied with the reasons for which OPG identified the preferred project location - that the proposed site is within the control of OPG, and that OPG was to select its preference based on its perspective.<sup>20</sup>*

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<sup>19</sup> JRP Report p. 76

<sup>20</sup> JRP Report p. 77

## **4.0 WHY A FAILURE TO STUDY ACTUAL ALTERNATE LOCATIONS IS PARTICULARLY UNACCEPTABLE**

### **4.1 Avoiding Proximity to the Great Lakes**

The failure to provide alternative locations to the Bruce Nuclear Site is of great significance considering the need to determine a location for the radioactive waste facility that could eliminate the potential for radioactive contamination of wetlands, Lake Huron or the Great Lakes.

A DGR in sedimentary rock, next to a body of fresh water that provides drinking water to 40 million people is unprecedented. The geology of the site has been tested only in the most limited ways (2 local boreholes), without the step of creation of an Underground Research Laboratory (URL) as is accepted international practice in final determination of site suitability. The JRP recognized that the Bruce DGR was based on untested and experimental siting, geology and construction methods.<sup>21</sup> OPG, the IEG and outside experts have gone on record, as have experts, that the potential for diffusive transport of radioactive contamination through air and water exists, and that the DGR will ultimately fail as it fills with water and will internally collapse in time once closed.<sup>22</sup>

Historically and conventionally speaking, the preferred host medium for long-lived nuclear waste in Canada has been the plutonic rocks in the Canadian Shield<sup>23</sup> away from population and sensitive natural features including the Great Lakes. As Sykes (2003)<sup>24</sup> notes, Ontario has significant quantities of plutonic rock for such projects as deep as is required for the DGR.<sup>25</sup> By not conducting a comprehensive examination of a reasonably feasible actual granitic location, OPG denies the Minister the information required to evaluate a site that might minimize environmental and human factors risk.

### **4.2 Recognition of Experimental Nature and Risk of DGRs**

The experimental and high risk nature of DGRs is not factored into assessment methodology of the preferred site at the Bruce Nuclear Site or at the alternate regional areas. There is no acknowledgement in its December 2016 assessment that DGRs worldwide have failed and closed, have failed and are still open, or that granitic rock is favoured, but that those in granitic rock are not complete and not operational.<sup>26</sup>

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<sup>21</sup> JRP, page (ii) The proposed DGR is an important, unique, precedent setting project. It would be the first in North America and is the first of its kind in the world to propose using limestone as a host rock formation. It is likely that this knowledge and experience gained through the Project will assist the Canadian government in its separate Adaptive Phased Management process for the long-term management of used-fuel.

<sup>22</sup> Presentation of the Stuart Hazeldine to the JRP in the "Matter of Ontario Power Generation and the Deep Geologic Repository," September 2014 PM D 14-P1.ZOA

And OPG Post Closure Report in the EIS March 2011, p. 101 and Section 4.4.1 system and its evolution report Quintesse 2011b. NWMO DGR-TR-2011-25

<sup>23</sup> Dormuth, et al. 1989, *Geological Considerations for Disposal of Nuclear Fuel Waste in Canada*.

<sup>24</sup> J.F. Sykes, 2003. "Characterizing the Geosphere in High Level Radioactive Waste Management."

<sup>25</sup> CELA (May 2012) (CEARIS #518), Retrieved from: <http://www.ceaa.gc.ca/050/documents/56770/56770E.pdf>

<sup>26</sup> DGRs in former salt mines, a previously preferred host, have closed after failing disastrously (Asse, Morsleben). There is little or no acknowledgment of the issues of risk presented by the example of the purpose-built but still incomplete Carlsbad New Mexico WIPP DGR which failed and contaminated its surroundings in 2014, with later accidents in 2015 and 2016 (mitigation and rectification costs: 648 million now, with an expectation of up to 2 billion USD). Other HLW DGRs planned or in

In the Forward of the 2013 report by the OECD and NEA (to which Canada is a party), The Economics at the Back of the Fuel Cycle, the authors acknowledge that there are no fully in-operation DGRs in the world, and that DGRs are the subject to growing uncertainty with regard to public perception, economics and technical difficulties:

*A lack of experience in the complete deployment of deep geological repositories, combined with the extensive periods required for the implementation of back-end solutions, have thus contributed to growing uncertainties about the costs associated with managing spent nuclear fuel and high-level waste. The issue has become a central challenge for the nuclear industry and a matter of continued concern and debate for the public. ... In recent years, a number of studies have also been undertaken in NEA member countries, examining the costs of the disposal of spent fuel and high-level waste.*

*However, these national studies are linked to specific policy choices, practices and regulations, with the outcomes varying significantly across countries and thus not directly comparable. Since no comprehensive overview of the overall state of knowledge on the costs of back-end solutions....<sup>27</sup>*

NWMO, OPG and the JRP were well-informed about the lack of precedent and ongoing failures of DGRs world-wide, as well as the fact that DGRs are not the logical choice for L&ILW.<sup>28</sup> OPG's EIS asserts that a DGR for L&ILW, even at an untested site, is international best practice. These factors compound the failure of OPG to adequately review specific alternative locations that might be less prone to failure, would present less risk to Lake Huron or could be less costly.

#### **4.3 Why are Accidents and Failures of Great Importance to Analysis of Options and a Range of Actual Locations?**

A key lesson learned from the DGR Waste Isolation Pilot Project (WIPP) accidents and malfunctions in 2014/15/16, is that 'events' that are 'below criteria' can have major consequences during construction and operations phases, and that emergency response procedures do not work when the operator-regulator is over-confident; in this case, planned responses did not work, and cleanup- mitigation plans were useless in face of accidents occurring at the same time (cumulative effects of accidents and malfunctions). OPG's reporting and analysis persistently discounts or eliminates from evaluation of significance of effect events that are 'below criteria'; in addition, they have not adequately modelled worst case scenarios, or multiple accidents and malfunctions occurring at one time.

OPG's conclusion was that the WIPP fire and radiological events were to be thought of as, "below criteria" related to injuries, worker exposure levels, and public exposure amounts. OPG has indicated and CNSC confirmed that such events are not expected to occur in the sedimentary DGR at Kincardine on the

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construction are experiencing difficulties including runaway costs, Forsmark Sweden technical and construction problems including partial collapse (Bure, France).

<sup>27</sup> OECD and NEA, "Foreword" *The Economics of the Back End of the Nuclear Fuel Cycle*, p. 3

<sup>28</sup> The JRP was presented with evidence at the JRP Hearings that only three international examples of deep geologic disposal existed, and that all three had failed to operate as expected. As described by Northwatch: *...there is no example of a DGR that has safely contained radioactive wastes throughout even its operational phase, let alone for the thousands of years, that those wastes pose significant risks to human health and the environment. International experience, including "best practices" demonstrate that there are more uncertainties; it does not establish that a DGR can be successfully operated and decommissioned*" Footnote: *The Waste Isolation Pilot Project and International Experience with Deep Geologic Repositories (PMD 13-P1.169)*, p. 2

Bruce Nuclear site, 900 m. from Lake Huron, and if they do, are not expected to significantly impact the repository operations (See our Section, *Mitigation Measures*).

The JRP did require the OPG to report on what it had learned about the WIPP accidents, but did not require OPG to go back and correct its approach and analysis within the context of alternative sites or means, or, failing that, decline to recommend that the project proceed. Instead, it concluded<sup>29</sup> that OPG adequately described the applicability of the WIPP incidents to the DGR at the Bruce site.<sup>30</sup>

Even though the WIPP accidents occurred during the evaluation of the EIS, the JRP did not hold OPG accountable for alternatives assessment at actual sites that could have been: in more suitable geologic substrate, on larger sites with significant buffers and room to contain emergency events, at a more remote site away from population and the Great Lakes. Therefore, there was never the opportunity to hear that an alternative remote site could have been safer than the status quo. Instead of requiring that meaningful analysis, the JRP concluded: (1) although a granite site could be an equally suitable host; (2) the status quo would be preferable to a conceptual granitic site on the basis that the latter would involve greater risk in the handling and transportation of waste to an offsite repository; and (3) given the level of protection provided by a DGR, the risks to the surface environment are low, and the proximity to a great lake does not change this conclusion.<sup>31</sup>

After more than 10 months of time to respond to the Minister, but with no more depth or meaningful additional study or information on actual alternative locations in sedimentary or crystalline rock in hand, OPG repeated the 2015 JRP conclusion almost verbatim in the December 2016 Response to the Minister.

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<sup>29</sup> JRP Report, p.243

<sup>30</sup> *The Panel is satisfied that OPG reviewed the vehicle fire and radiological release events and assessed them as credible accidents for the DGR. The Panel is of the view that lessons learned and operating experience from international radioactive waste repositories will be beneficial for the safety case of the DGR, including the development of mitigation measures and contingency planning.*

<sup>31</sup> The JRP Report, p 77

## 5.0 OPG'S SUBMISSION TO THE MINISTER<sup>32</sup>

### 5.1 Technical and Economic Feasibility at Alternate Locations.

The Minister requires an expert examination of technical and economic feasibility in order to make a decision that meets tests of accountability, risk management, decision making and reporting. In the case of a technical feasibility analysis for an actual location, scientific and socio economic factors established by the EA and other processes must be addressed before and after defining the place. Economic feasibility is the analysis of a project's costs over its life, as defined by experienced cost estimators, in comparison to its revenues and benefits, in order to determine whether it is logical and possible to complete. In order to complete such an analysis at an early stage an authoritative base of information must be established including: technical detail, duration across phases of development and life cycle, and awareness of risk. OPG so narrowly limits the definition of technical and economic feasibility that reporting and analysis are curtailed, and the definition of feasible location, even regional location, is rendered meaningless.

OPG's criteria for defining technical feasibility to establish their alternate regions is limited to two, instead of a multitude of strategic questions that must be asked to screen suitable alternates for study of feasible locations for the DGR. The questions they pose to themselves are,

- *Is the host rock geologically stable and resistant to expected geological and climate change processes?*
- *Is the depth and thickness of competent rock sufficient to host and enclose a DGR?*<sup>33</sup>

Confident that this is sufficient, OPG then establishes an inexact threshold to determine host rock suitability,

- *Geological hazard timeline established based on timeline of waste from the DGR; time frames of one million years.*<sup>34</sup>

They state that the crystalline and sedimentary rock is stable due to age: 1 billion for crystalline and 543 million for sedimentary, therefore meeting the criteria for suitability of containment for the million-year time frame.

OPG then establishes thresholds indicating that there must be a minimum of 200m and 300m bedrock thickness, because:

*[Consistent] with international practice, such wastes are planned for disposal in deeper rock formations. The minimum depth of 200-m is consistent with remaining below the extent of shallow ground water regimes. A minimum rock thickness of 300 m allows for at least a 100-m*

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<sup>32</sup> OPG, *OPG's Deep Geologic Repository for Low and Intermediate Level Waste*, "Study of Alternative Locations Main Submission," 00216-REP-07701-00013, December 2016

<sup>33</sup> OPG, "Study of Alternate Locations," 2016 p. 18

<sup>34</sup> Ibid. 18

*layer of competent bedrock to lie above and below the repository to ensure that it is fully enclosed.*<sup>35</sup>

Then they apparently screen the province to establish the two regions (called locations) that will meet these criteria and thresholds (one is south and south west Ontario, away from the Bruce site and one in central/northern Ontario), but do not say if other regions (locations) in Ontario would also bear consideration.

We do not accept OPG's definition of what constitutes a technical assessment, but drawn to critique it, we would ask these questions.

What evidence is there that all rock that meets the age criteria is consistently suitable for containment, or that the sedimentary Bruce site is suitable just by age? We know that there is none: across the regions, and across the local area close to the Bruce site, the old sedimentary bedrock is variously judged as being acceptable or unacceptable based on actual detailed characterization and testing for features that are described in the EIS such as horizontal and vertical fracture, carbon content, the presence of karst formations, the presence of soluble or porous rock, overall lack of competency, lack of cap rock, etc. What rock is not old? What kind of a threshold to determine suitability alone is 'age'? It may have existed through geologic time and previous changes in climate but that persistence alone does not demonstrate its condition or suitability as a containment resource, or its resistance to drilling and excavation.

Similarly, merely because a depth of overburden is established, does it mean that the overburden is suitable as a cap rock, or that it can be drilled through, or that the material at the desired repository level is competent rock of large enough area, or deep enough profile, to accommodate a deep cavern repository for 200,000-400,000 cubic metres of waste.

The criteria are flawed. For example the Saugeen Shores site was rejected by the NWMO for the DGR 2 because although the geology is similar to the Bruce site, 12 km away, the shale cap rock is 'not acceptable'.

In the Economic Feasibility Section, the criterion is:

- *Does OPG have the ability to finance the DGR at an alternate location?*<sup>36</sup>

The answer to this question, on all accounts is: OPG expects to be able to secure financing for the DGR at either of the alternate locations through one or more mechanisms if required. In this case, no thresholds for assessment were established, and no more is reported on this, until OPG examines the issues of transportation to alternate regions.

This blanket response on economic feasibility is entirely irresponsible. It does not, by any stretch, meet the requirements of economic feasibility analysis. It is defiant of the Minister's need to know about the economics of the status quo, and the comparative alternates.

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<sup>35</sup> Ibid, 18

<sup>36</sup> Ibid, 18



This is the little we know from other sections and other documents on the planning for cost. The life cycle cost to the end of decommissioning for the OPG DGR at the Bruce is said in the 2016 Report to be 2.4 billion dollars. The cost estimate has never been supported (see our Section, Cost and Risk). The NWMO estimates that the DGR 2 will cost, in 2015 CDN dollars, approximately 18- 24 billion dollars; although NWMO has not established a final site, and is less advanced in its design process, there is a detailed cost estimate that was prepared for the APM DGR in 2016.

How can it be reasonable that the Minister should believe that no cost for the DGR for L&ILW is too high? Is this reasonable, given the rising costs of the ongoing projects for the APM DGR (the other fund), and the decommissioning and refurbishment of the Darlington and Pickering and later Bruce Power Plants (this fund), and public outcry about electricity rates? And, where is the accurate cost of the base scenario, at the Bruce Nuclear site, to provide a comparison?

Given the financial risks in management and storage and disposal of radioactive waste the Minister was correct to insist that a serious comparative strategy considering all factors be conducted instead of OPG referring at the end of their submission to her to an unsubstantiated claim that the DGR at Bruce was economically the best option. Given the unknowns at the Bruce site, cost comparisons between legitimately feasible actual alternate locations should have been a top priority of the OPG report.

## **5.2 The Alternate Location, Project Description per OPG<sup>37</sup>**

A DGR project at the alternate location/region is meant to be the same project at the same depth, and using the same methods of construction, using approximately the same size of site as the Bruce DGR. The key differences established are the requirement for repackaging and transportation of the waste to the new site; the development of a consent based site selections process, the requirement for deep boreholes, a greater level of site characterization; property acquisition, site clearing and installation of site infrastructure; a buffer around the base of above ground was not required, and is not present at the Bruce. It assumes a site surface operating area of 40 ha, as opposed to 30ha at the Bruce site.

Project timelines are estimated to be longer due to a site selection process of 15-20 years. There would be a total projected lag of 20-30 years if a new site was required. The alternate site would include a packing, and transportation component not currently required for the baseline resulting in additional time and additional cost as well as receiving facilities.

## **5.3 Regional Characterization**

OPG's regional approach is unsupportable as a response to the Minister's requirement of actual location definition and analysis. However, if a critique was to be offered of the way in which the regions were first defined by boundaries and then characterized, the depth of the problem with alternates analysis would be even more clear.

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<sup>37</sup> Ibid, 21

There is no accurate map of Ontario and no map of Canada or North America that defines the crystalline or sedimentary regions and their relation to adjacent provinces, cities, towns, regions, watersheds, water bodies, wetlands, rivers or to the United States. The regional diagrams provided in their Section 2, Main Report, is not a map.

OPG has defined a crystalline region in central and northern Ontario that takes up a good part of the geographic area of the province and sedimentary a good portion of southern Ontario. They have tried to use GPS coordinates to plot the boundaries but failed twice, demonstrating not only failure to comply with the Minister's requirements for an actual location, but extremely sloppy workmanship.<sup>38</sup> For example, in order to define the outer limit of a crystalline region, an arbitrary point 2000 km away from the Bruce site was plotted. A pre-screening for feasible actual sites could have eliminated the farthest points in the geologic region in favour of a site or sites where geology, hydrogeology, environment and distance of travel would come together as logical study locations.

#### **5.4 Crystalline Location Characterization**

OPG's report describes key environmental features of this vast, and varied region as including: low seismic hazard (not correct across the region); places that are least 120m from any provincially significant wetland; low relief (not typical across the region); numerous small bodies of water; a covering of boreal forest (not all); clean air; shallow till; typically fractured rock (although NWMO contradicts this, allowing for only 10% fracture mitigation in their plans for the APM); Crown Land, and indigenous peoples.

Shortcomings, called, 'unique features' include: the need to construct road access; requirements for additional engineered barriers and additional grouting to control water flow; requirements of backfilling of emplacement rooms to limit free water; additional spacing between emplacement rooms, and additional waste storage rooms to make up for structural remediation.

Immediate questions that arise in this characterization are: how can this inadequate base information result in an analysis with a verifiable, repeatable result? How would actual locations, pre-screened to avoid the most significant negative attributes, have provided a different comparative base? If there is Crown Land available, why are the increased cost, and time spent in acquisition and consent (15-20 years) still considered to be negative factors? If significant testing of sites in this region has already been undertaken, why is the characterization so scant and misleading? Has NWMO not already looked at actual sites that are potentially suitable for a DGR for L&ILW? Could ILW on its own be stored in this formation, resulting in a smaller repository that was easier to construct and monitor? Why is the 680 m depth required, if there is competent bedrock cap above the 30 metres that is required by the repository level? Why isn't low population and distance from the Great Lakes defined early in the Unique Characteristics section as an attribute? Would a ramp design rather than shaft be viable in a crystalline location, providing an alternate to the shaft design methodology? Would such a site provide an option for shallower cavern placement, as is used in other countries in granite? All of these points were raised in the

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<sup>38</sup> This plotting exercise was caricatured in a Toronto Star Article in January 2017, (Jennifer Wells, Could you narrow that down more narrowly? Wed Jan 11, 2017) expressing the frustration of many in the lack of substance behind the OPG submission as a whole.

discussion of granitic hypothetical sites in the IEG reports, and subsequent Information Requests and Responses, and the characterization has not advanced since that date.

The section makes the point that:

*lands in the crystalline location are in one of the two main watersheds: the Great Lakes Basin watershed or the Hudson's Bay watershed...with appropriate geology and design the proximity of a water body to the DGR is not relevant because the movement of water or gas, even if it was released from the DGR, would not reach the water body until the radioactivity of such water or gas had diminished to the levels generally found naturally occurring throughout Ontario.<sup>39</sup>*

This is as broad and misleading a statement as any of those describing their crystalline geologic region that covers half the Province. It is repeated multiple times in the OPG report in various locations to divert criticism from their key mantra, that dispersion of radionuclides in a large body of water is a below criteria event. This is obviously not the case.

The proximity of a water body to the DGR has a great deal to do with the risk associated with its potential failure through accident or malfunction, through adverse environmental events, or through malfeasance. This is why the Minister asked for an alternate location that was away from wetlands and the Great Lakes to be identified and analyzed. The experience at WIPP, at Asse, Morsleben, Konrad and others have proven that radioactive contamination can occur quickly and without warning and be impossible to stop or clean up after years of work. Dispersal in air or in water overflow conditions up the shaft are the most likely means of contamination. In a situation where this occurs near water, as at the Bruce site, a storm water pond with limited capacity (6 days) in good weather, not frozen, would overflow and seep into ground water and toward the outflow, and into Lake Huron. Dispersion is not a suitable method of dealing with radioactive waste on any scale; it should be noted that although the 2016 report by OPG refers to an accident such as this not jeopardizing the repository operation, it does not discuss the environmental damage or human cost of a worst case scenario near a Great Lake, which has never been modelled, or which we have never seen.

Although we are aware of recent questions arising about design of methods for bridging across fractures that makes repository construction more difficult than previously assumed, the critique of crystalline geology especially its fractured nature, seems to contradict the work of NWMO in its search for an APM site. OPG has let this stand, but places no substantive support behind the option of a crystalline DGR, where transportation of waste looms large as a negative factor in cost and safety of the overall waste management process.

## **5.5 Sedimentary Location Characterization**

The region that they wish to propose as viable for study is known to us as including major population centres of Canada, and areas of great environmental, cultural, historic, indigenous and ecological sensitivity. Among the stated characteristics of the Region are low seismic activity (not the case), low level topography (not the case, as this includes the Niagara escarpment, Niagara Falls, Hamilton

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<sup>39</sup> OPG, "Alternate Locations..." 2016, p.31

Mountain and Oak Ridges Moraine); has numerous small rivers and streams and may be wet in the spring (definitely wet in spring and other seasons: for example, Greenoch Swamp, Ontario's largest forested wetland at 8094 acres, Holland Marsh, the Don River, Credit or Humber River and its tributaries, or at the three Great Lakes). It assumes that nearby watercourses are not large (vague), and that surface water quality in the area and where streams merge with other watersheds, is influenced by agriculture (not correct). Most of the sedimentary alternate location is said to be 'rural, non-urban, with former agricultural land, and no nearby industry as a source of noise or air emissions' (not correct: for example Toronto, Windsor, Kitchener-Waterloo, Hamilton, Barrie, Milton, Brampton, Brantford, etc.; and in terms of industry, it is the heartland of the Canadian manufacturing industry, with rail and automobile and air plane transportation routes that characterize the region; it is also in the closest possible proximity to American states and cities, and has an aqueous boarder, where almost 10s of millions of people reside, and where the Provincial Policy Statement and other legislative frameworks govern the industrial development sector, and where mining and noxious storage activities are prohibited by and large). The region lies 'within the Mixed Wood Plains Eco zone'; land is 'dominated by cropland and pasture' (not correct) and 'background air quality is typical of southern Ontario' (which is not defined). Such incorrect characterization for or against the region, invalidate the later OPG analysis.

And, OPG repeats the incorrect statement, which we have discussed above:

*with appropriate geology and design the proximity of a water body to the DGR is not relevant because the movement of water or gas, even if it was released from the DGR, would not reach the water body until the radioactivity of such water or gas had diminished to the levels generally found naturally occurring throughout Ontario.*

## **5.6 Environmental Assessment Analysis at Alternate Sites According to OPG**

The workmanship of the environmental effects analysis of the sedimentary region is below any reasonable standard, including the common standards of practice for environmental assessment, government standards and requirements, and the standards established by the JRP for the work of the alternatives investigation by the IEG in 2013. The critique of detail methods, thoroughness of comparative assessment has been constant in the evaluation of the work of OPG and its experts. We will not evaluate flawed methods here, but will draw some important points to attraction.

The conclusion of the OPG Alternatives report is that there would be "greater environmental effects at these alternate locations than at the DGR Project at the Bruce Nuclear site"<sup>40</sup>. As noted below in our summary of effects, the analysis is biased in favour of finding adverse effect at the alternate sites, without tracking any benefits of the regions; effects on environmental components described for the alternate sites are often contradictory, and explore a range of critique not seen in the EIS evaluation of significant adverse effects for the Bruce site. The IEP hired by OPG to review the Alternate Sites analysis did not seem to find any of the shortcomings that we have found.

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<sup>40</sup> <sup>40</sup> OPG, "Study of Alternative ...," 2016, p. 62.

The analysis does not allow for the diversity within a region; it does not reference actual sites with specific characteristics or location specific VECs; there is no framework established for determination of whether an effect is significant, insignificant, short term or lasting. There is no way to measure effect. Despite the report references to CEAA process, it is impossible to discern a methodology of approach, or to be able to validate the conclusions on a relative scale between options.

Because of the lack of specific locations, most environmental effects fall back into being common between crystalline and sedimentary regions. The effects in most cases are described as being adverse, causing increase of environmental effects over the Bruce site, while not detailing the adverse effects of the Bruce site in comparison. The effects are in summary:

- Effect on Air Quality: an effect on air quality (atmosphere) the effect is said to be temporary with an increase in emissions of combustion products, dust and other compounds such as volatile organic and greenhouse gas emissions; effect is greater than at the Bruce site.<sup>41</sup>
- Effect on all environmental components, transportation in the environment: transportation to and from the WWMF to the alternative sites will cause degradation of air quality, wildlife strikes (predominantly in the crystalline area), noise and risk to health through radiation (see radiation, below); effect greater than at the Bruce site.
- Effect of noise levels during construction: DGR related works and activities have the potential to affect noise levels ... considered noticeable...and during operations an increase of 3db or greater is predicted; same noise effect will have greater impact at the alternate sites than at the Bruce site, where there is already considerable noise; effect greater than at the Bruce site.
- Effect on groundwater quality or flow: could be greater in effect at alternative locations due to the fact that receiving bodies (water) are smaller than at the Bruce (that is, Lake Huron). However, they note, no adverse effect from changes in surface water quality likely as discharges would meet criteria established considering aquatic toxicity thresholds; effect greater than at the Bruce site.
- Effect on aquatic life: may be greater because discharge is into a smaller water body (than Lake Huron) and therefore there would be a greater concentration of discharge that could affect aquatic life; effect greater than at the Bruce site.
- Socio-economic effects: Version 1: “The DGR at an alternate location may also affect VCs within the socio-economic environment. Many effects would be beneficial, and may serve to enhance community well-being including: ...increases population ...employment ...greatest benefit to host municipality; increased education opportunities with an interest in nuclear; new direct, indirect and induced employment ...; increased business opportunities; increased tax payments to municipality...increases in the direct, indirect and induced labour income in local

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<sup>41</sup> This was not quantified or recognized as a significant effect in the Bruce site EA, or was required to be monitored and mitigated by the JRP; atmospheric degradation will affect the lake, through air borne transport and deposition.

and regional area”. Effect: positive at all sites. Version 2: “adverse effects on socio-economic, land use and cultural heritage may occur due to changes in the environment (i.e. biophysical VCs), such as nuisance effects to nearby land users and depletion of resources (e.g. forestry resources) through land clearing. These effects are considered through discussion of potential effects on the land and resource use VC.” Effect: negative at all sites.

- Effects of Radiation and Radioactivity: Version 1: “There is no potential interaction with radioactivity during the construction phase activities with the exception of potential exposure to naturally occurring radiation (i.e., radon) during excavation of the underground facilities”.<sup>42</sup> Version 2: “Waste package transportation has the potential to affect radiological dose to members of the public and non-human biota off-site. In addition, there is incremental worker dose related to the handling, packaging and transportation of waste”. Version 3: “Transportation would be carried out in accordance with the Nuclear Safety and Control Act and its regulations and other applicable regulations (e.g., as made under the Transportation of Dangerous Goods Act, 1992). Therefore no adverse effect is predicted.” Version 4: the Energy Solutions report includes a section on accidents and radiological potential accidents on the route to the alternate sites, which is considered low risk. Version 5: After closure, the radionuclides would be retained within the DGR as they decay. Any releases of radionuclides would have to occur by transport through the surrounding rock or shaft seals as dissolved or gaseous species. The sedimentary alternate location borders on the Great Lakes. Depending on the geological characteristics of the site, the proximity of a water body is not relevant because the movement of water or gas from the DGR would not reach the water body until the radioactivity of such water or gas had diminished to the levels generally found naturally occurring throughout Ontario. These processes are very slow in low permeability rock. No residual adverse effect during post-closure is expected, and predicted dose rates would be much less than the public dose criterion under normal operations.<sup>43</sup> Version 6: Overall effects on radiation and radioactivity of a DGR at the sedimentary alternate location are likely to be similar as that of the DGR Project at the Bruce Nuclear site, given the geological similarity between the locations. The DGR would introduce new radiological exposure pathways at a sedimentary alternate location which was previously not a nuclear site.

## 5.7 Specific Adverse Factors Crystalline Location According to OPG

- Transportation and Handling: The additional handling and transportation of waste from the WWMF to the DGR at the crystalline alternate location of up to 2,000 km one-way represents a likely effect on air quality and greenhouse gases. A 200 km transportation distance to the DGR at the crystalline alternate location would be approximately equivalent to an increase of 1.2 kt of CO<sub>2</sub> equivalent over the life of the project, while a 2,000 km waste transportation shipping distance would be equivalent to an increase in 11.7 kt of CO<sub>2</sub> equivalent over the life of the project. Effect greater than at the Bruce site.

<sup>42</sup> This contradicts the examples of accident and malfunction during construction and operation, discussed elsewhere in this report

<sup>43</sup> We have discussed this statement previously, seen here for the fifth time in text.

- **Water Ingress:** It is assumed that the crystalline alternate location would have higher water ingress in both the shafts and underground excavations. This would require the potential for increased pumping capacity, or alternative methods for water handling of mitigation (i.e., grouting, full hydrostatic shaft liners). Effect greater than at the Bruce site.
- **Surface Water:** The runoff from the waste rock pile and any water from underground would be discharged from the alternate location at a single spot to a local watercourse. There would likely be a measurable adverse effect on surface water quantity and flow from the discharge (i.e., increase in flow); however, the magnitude of effects would depend greatly on the specific characteristics of the receiving water body. Given the characteristics of the region, this is likely to be a local creek, lake or river. Effect greater than at the Bruce site.
- **Surface Water:** Surface water that has been collected would also have come in contact with the waste rock which could have the potential to leach metals, and would have residual blasting compounds. Effect greater than at the Bruce site.
- **Construction of Infrastructure:** Increased requirements for infrastructure construction at a remote site may also have interaction with shallow groundwater flows. It is assumed that up to 20 km of additional road may need to be constructed, and taking into consideration the variable bedrock terrain in the region, excavation or blasting for road cuts may be required. Localized dewatering may be required in the vicinity of excavations. Effect greater than at the Bruce site.

## **5.8 Specific Adverse Factors Sedimentary Location According to OPG**

- **Effect of Transportation Version 1:** “[The] potential to cause localized emissions of combustion by products and dust. Transportation would be largely along existing roads and the frequency of shipments is relatively small (2 per day) ...as compared to existing traffic levels. Therefore localized effects of transport-related emissions on air quality are not likely measureable.” Effect greater than at the Bruce site.
- **Effect of Transportation Version 2:** “The additional handling and transportation of waste from the WWMF to the DGR at the sedimentary alternate location represents a likely effect on air quality and GHGs. [...] lists amount of CO<sub>2</sub> used and compares shipping to non- shipping off site.” Effect greater than at the Bruce site.
- **Effect on Surface Water Environment, Version 1:** “Surface water adversely affected because of runoff from Waste Rock Pile (containing leached metals and residue from blasting compounds... with some level of treatment required such as a settling basin for solids removal or treatment plant. SWMP would include water from both surface and underground; runoff from the waste rock pile and any water from underground would be discharged from the alternate location at a single spot to a local watercourse, which is not likely a large watercourse. Therefore, it is expected that there may be an adverse effect on surface water quantity and flow at the sedimentary alternate location in local drainage features. As all permitting requirements would be

required to be met at discharge, no adverse effect on water quality is likely.” Effect greater than at the Bruce site.

- Waste Rock Management Pile and Surface Water Version 2: “[S]ince the alternate location is predominantly agricultural, it is assumed that the waste rock pile would be in an area that is currently farmland (contradicted by the point below) drained by either roadside drainage ditches or small natural streams... it is expected that the sedimentary alternate location drainage is not to a larger watercourse. Therefore it is expected that there may be an adverse effect on surface water quantity and flow at the sedimentary alternate location in local drainage features.”
- Effect on Terrestrial Environment: Effects on wetlands (Contradicting the evaluation of the area as farmland) (see above): the most densely populated area in Canada and many of its natural ecosystems have been converted to human uses, for agriculture and infrastructure. ... dominated by cropland, pasture and abandoned fields, with woodland cover at only 16%. The vegetation is relatively diverse and includes hardwood forest species, lowlands including floodplain forests and peatlands... (i.e., alteration due to land development pressure such as drainage for agriculture, and filling in for urban development). [...] These wetlands have the potential to be more sensitive to the incremental effects of further development such as a DGR. Effect greater than at the Bruce site.
- Effect on Geology, Hydrogeology and Soil Quality Version 1: “... have the potential to be affected by site preparation and construction activities. [...] [D]irect effects on soil quality and on overburden groundwater transport and shallow bedrock groundwater and solute transport; and indirect effects on overburden groundwater quality, on shallow bedrock groundwater quality, and shallow bedrock groundwater and solute transport.”
- Effect on Geology, Hydrogeology and Soil quality Version 2: “Overall effects: no measurable changes to soil quality, groundwater quality or groundwater flow is likely outside of the immediate footprint of the DGR. Similarly, changes in surface water quality, quantity and flow, are also not likely to be measurable as a result of the project outside the immediate vicinity of the footprint. Therefore, no indirect effect on vegetation or wildlife VCs is likely through these pathways.”
- Effect on Geology Version 3: “The main potential effects on geology [...] dewatering and the resulting zone of influence due to pumping and management of pumped groundwater, which would have direct and indirect effects on overburden and shallow bedrock groundwater quality and solute transport. [...] occurs primarily during shaft sinking in the upper more permeable portions of the geology, until the shaft liner is installed. [...] During operations, the DGR would have the potential to continue to affect groundwater flow from dewatering of underground facilities; however, volumes of water to be managed are likely to be much smaller during operations, and therefore, the potential for effects are even further reduced.”



The result of the narrative analysis of environmental effects of the Project at alternative sites is biased in favour of a false-positive result for the Bruce site. By not evaluating actual technically, economically feasible locations, no credible analysis can be done, and any conclusion desired can be engineered.

We urge the Minister to reject the report on environmental effects analysis of alternative regions.

## 6.0 COMMENTARY ON CHAPTER 7 SOCIAL LICENSE

The OPG section on Social License, by which they mean that the community has granted them license to proceed because of demonstrated willingness, is filled with misinformation. This misinformation relates to the following information from the OPG Chapter 7 in the study of Alternate Locations. OPG says,

*1. The Bruce Nuclear site has the support of the host municipality (Municipality of Kincardine).*

**Comment:** Although the Town Council has endorsed the DGR at the Bruce site, the public has never had the opportunity to vote in a legitimate referendum on the hosting issue. At the time of the Hosting Agreement, the Council reading of the motion of support in 2004 was prior to the conduct of a mandatory poll of the population; this fault has to this day been contentious because of its backwards approach to support. First the motion was read three times in council, then key nuclear stakeholders and civic leaders, including the Medical Officer of Health among others, put pressure on the workers of the community to support the motion in a February 2005 poll (see Appendix II Media Reports, OPG EIS: Glenn Sutton, Hazell Lynn, Duncan Hawthorne); the results of a poorly conducted poll that did not capture a cross section of the population were skewed to demonstrate support of the motion prior to final reading in Council. This demonstration of public support was required of the municipality by OPG before the Hosting Agreement could be signed (the deadline for signing was Feb 28, 2005). OPG paid for that poll. Extensive reporting on these events has occurred in deputations to the JRP and in media reports in 2004, 2005 and later. Later polling on the DGR issue was undertaken by Intelliplus for AECOM Canada in 2009/10 in preparation for the OPG EIS of 2011. It was also flawed. The recent Gandalf poll of Ontarians avoided a focus on the Bruce County area and diluted the cross section by ‘cross-Ontario’ polling. OPG’s reporting of the poll results (discussed below) was a distorted representation of the 2016 poll results, in favour of the DGR.

The support by the municipal council has always been linked to monetary compensation, and other aspects of individual and group support, including support for charitable organizations, educational trips for public servants to various destinations at home and abroad, etc. This type of support is chronicled in the OPG and NWMO newsletters, and has been criticized by citizens and in media, from the early 2000s.

It should be noted that when the Hosting Agreement was signed, Kincardine was very particular in its commitment that the HLW from the Bruce site and others across Canada would never be located in Kincardine, if they agreed to support the DGR for L and ILW. At that time, all reports from government sources was that HLW was to be in a repository very far away in a crystalline DGR. Council withheld that

information from the public after 2004, and later, in secret meetings of the CCAG, discussed the DGR 2 with OPG without public scrutiny.

2. *The DGR project was chosen by the municipality as the preferred method for long term management of L and ILW.*

**Comment:** 4 options for improvement of storage for L and ILW were discussed in the Golder IAS of 2004, to which OPG and Mayor Glenn Sutton were signatories. Of these 4 options, the Council with OPG support chose the one that most appealed to their sense of economic benefit to the community. The analysis of options in the Golder Report clearly states that the DGR is of the greatest economic benefit to the community. This opinion was held up as superior to other reports, including one by the Ivey Business School of 2004, commissioned by the Council, indicating a negative stigma if a DGR was built in the community of \$700,000,000. That particular conclusion of the Ivey Report was concealed from the community, and other more favourable information used to garner support for the DGR option.

3. *The host municipality has been engaged with nuclear technology for over half a century.*

**Comment:** This is correct, but the nuclear industry is still not the largest supplier of jobs in the County or the greatest generator of revenue among its population. Bruce County is diverse in agriculture, tourism, manufacturing, retail, service industry, fishing, business, construction, medical, educational, faith based, civic, public and institutional employment. Most business is sole proprietorship or small to medium size businesses. Tourism from both sides of the U.S-Canadian border has been a prime focus of life and employment, as well as a well-spring of community participation and tax base since the nineteenth century. The nuclear industry arrived in the 1950s; families, businesses and farmers, as well as First Nations peoples have been located at the area on Lake Huron within which the Bruce site is located, for hundreds, and also thousands of years. It bears mentioning that the nuclear industry, although an extremely valued and important aspect of life and employment in our communities, although personified as creating a 'nuclear oasis', and although dominant to a fault in our political leadership, is a relative newcomer to the east coast of Lake Huron.

4. *Over time the community has participated in and supported the further development of the site.*

**Comment:** This is true; it is also true that from the point in time that the nuclear industry came to the Bruce site, that there have been people who have not supported nuclear development projects at the Bruce, or feel that they have not been listened to by those in charge over issues of health, environment, safety, security and community; the peak of this lack of support is NOW, over the potential construction of the DGR at the BN site.

5. *The host community is an informed community with a significant portion of the resident population employed at the site or associated with someone employed at the site.*

**Comment:** This is largely imagined to be true, but has not been substantiated; as noted, our communities have a long history of employment outside of the Bruce, and the majority of the population of Kincardine and surrounding municipalities, rural communities and First Nations peoples do not work at the Bruce.

6. *Direct knowledge: The community is informed through regular newsletter, open houses, mobile display units, presentations to local and regional councils*

**Comment:** OPG and NWMO have spent considerable time in the preparation of leaflets, and presentation through storefronts and mobile displays of information on the DGR; they have presented their biased side of the story about the DGR, often including unsubstantiated information to municipal and county councils; they have also demonstrated regular attendance in the audience of council meetings when not presenting, and supported the candidates who are most supportive of them. The amount of money spent on the communications of the DGR message by OPG has not been disclosed, although it was asked by a Saugeen Shores Councillor of Fred Kuntz of OPG to disclose that information during a recent OPG presentation to Council. We understand Mr. Kuntz is getting back to the Councillor.

Also information gets out to some people, but not to all of the people. In particular, seasonal residents, who number in the 1000s in the municipalities, have largely been excluded from mailings or information on the DGR. In fact, most of the membership of our organization, and its allies, were totally unaware of the DGR 1 or DGR 2 until 2012, when Saugeen Shores was brought into the DGR 2 selection process. That is many years after the Hosting Agreement was signed by Kincardine and others (not the case in Saugeen Shores, which although a named party, and a recipient of funds never signed the agreement).

The newspapers and other media of the region are variously independent and not independent in relation to the nuclear power supporters of the DGR; it is known in the newspaper industry that there could be retribution against them and their advertising revenues if there is too much said against the project (or in favour of the opponents), by reporters, or in interviews about the project. Community events that are not in favour of the DGR are not often reported in newspapers, therefore the body of media clippings and news media in general, including radio, is not representative of actual citizen participation against the potential for the DGR to be licensed. Still, despite these problems of representation, those who have expressed their opinion in groups or individually against the DGR, have generally made it into the press.

Direct knowledge has also been communicated, and plans made, in non-transparent ways that have persisted since the early 2000s. The public was not aware of the DGR in Kincardine or the signing of agreements between OPG and other neighbouring municipalities because of secret, closed door meetings between OPG and councils until early 2003-04. The approach is captured in statements made by OPG and Councillor's in media reports included in the Appendix II of the OPG EIS. The Hosting Agreement and the amount of money to be granted to the municipalities came as a surprise to the County Council in those years, who argued after the fact for their inclusion in the cash for support deals that were being made by OPG with the separate municipalities.

Irregularities in transparency were reported to the JRP in the Hearings of 2013 and 2014 in relation to the secret meetings of the DGR-CCAG in Bruce County Council. In May/June of 2013, SOS and the Southampton Residents Association filed a Bruce County Closed Meeting Complaint based on an FOI of OPG notes of the meeting. These OPG notes disclosed that: OPG and the Mayors discussed the most advantageous time to launch the DGR2 APM in Bruce County, from the perspective of maximizing the Mayors' chances of re-election in 2010; that the CEO of CNSC attended a meeting of the CCAG in September 2009; and that there was other manipulation of the Mayors and 'spinning' of community acceptance. In September 2014, the JRP was asked to consider the 2014 Municipal Act Independent Investigators' Report to the Corporation of the County of Bruce Regarding the Investigation of Improperly Closed Meetings of Council (the Bellchamber Report).<sup>44</sup>

The Bellchamber Report concluded: (i) The DGR Community Consultation Advisory Group (CCAG) meetings organized by OPG and NWMO and attended by all mayors were unlawful meetings of Bruce County Council because they were not public and no minutes were kept by Bruce County staff. (ii) The meetings advanced the business or decision-making of Council (iii) Councillors were as much, if not more, influenced by decisions at CCAG meetings than at proper meetings. The Bellchamber Report conclusion was that the CCAG DGR meetings were in violation of the Municipal Act, and the reasoning of the Investigator in arriving at that conclusion, support the thesis that DGR 1 community acceptance is seriously deficient, -- neither qualitative, transparent, defensible nor repeatable.

7. *Local elected government is active and participatory,: pro-active discussions initiated by the municipality on longer term waste management options.*

**Comment:** see Items 1-6, above.

8. *Support that has been reiterated through numerous municipal resolutions, the most recent as of June 2015*

**Comment:** see Items 1-6, above, and note the following recent submission to the Minister from Peter Storck (Saugeen Shores):

"At a February 27 meeting, council for the Municipality of Saugeen Shores voted 7 to 1 in favor of a motion supporting the proposed deep geological repository (DGR). This letter will be written and sent to you by the mayor, Mr. Michael Smith. Saugeen Shores is one of four municipalities adjacent to the Municipality of Kincardine in which the Bruce nuclear generating facility is located and where the proposed DGR would be built if the project is approved. The location is approximately 30 kilometres south of the community of Saugeen Shores. The five municipalities have received money from Ontario Power Generation (OPG) following an agreement in 2004 but with the understanding those payments would continue only if all of the municipalities continue to support the project.<sup>1</sup> This financial incentive (and intimidation) ensured ongoing council support for the DGR in all five municipalities. Council for Saugeen Shores – as is true for all levels of government – was elected to represent the people they serve. But the letter you will receive from the mayor on behalf of council for Saugeen Shores **cannot be**

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<sup>44</sup> Report to the Corporation of the County of Bruce Regarding the Investigation of Alleged Improperly Closed meetings of County Council. 2014. Retrieved from: <https://www.brucecounty.on.ca/assets/files/Amberley%20Gavel%20Meeting%20Investigation%20Report%20July,%202014.pdf>

**construed to represent public support** in the community for that repository. There are three reasons for this: **First**, there is **significant local opposition** to the DGR, voiced (but not exclusively so) by two Southampton based organizations.<sup>2</sup> In addition, a poll of members of the **Southampton Residents Association** indicates that 78 per cent of members also oppose the DGR.<sup>3</sup> **Second**, the mayor and two council members worked for long periods with Ontario Hydro/Bruce Power; a potential bias that may have swayed council to support the DGR; not to mention the financial incentive (intimidation), noted above, from OPG. **Third**, no public opinion poll, survey or referendum has ever been held in Saugeen Shores. Thus, there is **no measure of community opinion, as a whole**, regarding the DGR. For these reasons, the letter you will receive from council for Saugeen Shores represents council's **own opinion** and not that of the community. For these reasons, I ask you to **discount council's letter of support for the DGR**. It is important that you do so since, although the final decision whether or not to issue a license for the DGR will be based on geoscience and an environmental assessment (including the risk to human health), it will also be a political decision based, in part, on the level of public support for the project. And because elected government is supposed (and assumed) to represent the majority of voters, it is the level of public support for the project that council for Saugeen Shores is attempting to address with their letter. Council has **no basis** for assuming the people it represents support the DGR and **should have remained silent on this issue."**

9. *For OPG and informed willing host community that seeks to participate in decision regarding facility management is the best demonstration and a key element of social license.*

**Comment:** see Items 1-6, above.

10. *For a DGR at an alternation location, OPG estimates that it would take almost 2 decades to identify a suitable alternate site through detailed site investigations and to garner a willing host community in a participatory process.*

**Comment:** this is not substantiated, nor does it bear up under scrutiny if a smaller DGR for a single type of ILW, away from population, on Crown land, away from significant VECs, was planned.

11. *OPG's plan for the safe long term management of L and ILW is supported by a majority of Ontarians, and at the same time is not an area of concern among the general population*

**Comment:** Blatantly false.

12. *The Gandalf survey of 805 Ontarians showed that more than 53% of Ontarians have heard about OPGs proposal to bury L and ILW in a DGR; 60 percent of those that heard of the project were supportive; after all of the information was given, respondents were then asked to gauge their level of support for the project and 70 percent of respondents supported the project.*

**Comment:** "OPG's Public Opinion Poll of attitudes about the DGR, from sampling through question design to reporting, is highly irregular.[...] There is no evidence to support OPG's claim that the majority of people are in favour of building a DGR on Lake Huron. [...] The only substantive finding supported by

evidence shows most Ontarians (64%) believe the DGR poses a threat to public drinking water and to the health of the Lake.”<sup>45</sup>

*13. An internet search comparing wind turbines, solar power and a deep geological repository was conducted to see what trends on Google were for those keywords; the survey showed comparatively little interest in the DGR in comparison to solar or wind energy issues.*

**Comment:** Misleading. As wind and solar energy are among the number one social media and internet searches in the western world, it is not surprising that they would dominate the field over ‘nuclear waste’, or the DGR. Furthermore, we have had, at times, over a hundred thousand visitors to our FB page per post, when we post updates on DGR1 related issues. The posts generally provoke lively discussions, with most of the feedback demonstrating opposition to the project and concern for preservation of the Great Lakes from contamination.

*14. Relationship with indigenous peoples*

**Comment:** Report will be left to the First Nations peoples for comment.

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<sup>45</sup> For more information, please see: <http://www.sosgreatlakes.org/sos-updates/2017/2/7/ontario-power-generations-report-of-findings-of-a-public-attitudes-poll-towards-the-proposed-nuclear-waste-dump-on-lake-huron>

## 7.0 COMMENTARY OF CHAPTER 8, COMMUNICATIONS AND ENGAGEMENT

On page 81 of the Main Submission on Study of Alternate Locations, OPG notes a Nov 11, 2016 meeting held at OPG headquarters on a statutory holiday, Remembrance Day. The meeting was attended by a small group of invited guests including directors of SOSGL, a local sheep farmer, members of the Inverhuron Committee, a local stakeholder, a senior representative of Canadian Environmental Law Association, a senior representative of Northwatch and a member of the Bluewater Committee. All were known to be outspoken against the DGR for legitimate reasons, and each had made presentations to the Joint Review Panel as registered participants in 2013 and 2014. Each of the attendees had expressed the intention to prepare submissions to the CEAA and to the Minister regarding the December 2016 Additional Information Package that would be submitted to the Minister, in response to her questions of February 2016. After an all-day meeting with multiple senior OPG managers, scientists and communications executives, led by the senior partner of Hardy Stevenson and Associates, there is only one line in the very short chapter on Communications and Engagement that refers to our views or contribution to the session. The line is:

*[Some] participants expressed a concern that OPG should be re-thinking the overall project and its approach to stakeholder engagement.*

That is a good way to end this Chapter.

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# **Cost and Risk**

## **1.0 INTRODUCTION**

Part of the duty of OPG was to provide actual alternate locations for the DGR 1 that were technically and economically feasible. OPG was to detail the additional incremental costs and risks of off-site transportation over and above the base cost of the DGR for L&ILW in Kincardine.

The OPG Main Submission for Alternate Locations describes transportation costs for approximately 200,000 cubic metres of Low and Intermediate Level Waste to be moved to sedimentary and crystalline regions. Their experts' calculation is based on the number of shipments and volume of waste transported by road, minimum and maximum distances, from the Bruce Nuclear Site to hypothetical sedimentary locations in southern Ontario, and to hypothetical crystalline locations in the Canadian Shield.

OPG's report includes the base case scenario for the Kincardine DGR (2.4 billion), against which the incremental alternative regional waste costs were reviewed. OPG has concluded that the DGR in Kincardine is the most economical and logical proposal for permanent storage of the 200,000 cubic metres of radioactive waste based on the relative increase in cost of transportation to alternate regions, and the cost of construction of alternate site locations that are regionally extrapolated, but are not actual sites or locations.

Over 5 years following the 2011 estimate, in a statement made during an information session held at OPG Headquarters in Toronto on November 11, 2016, Fred Kuntz was asked for the capital cost of the DGR 1 in Kincardine by Jill Taylor of SOS Great Lakes. He indicated that it was, "about a billion dollars". When asked if that estimate had been peer reviewed, he indicated that he did not know.

There is a basic flaw in OPG's argument if the proof of cost or the cost of the baseline comparator is not known, or has not been updated or reviewed. The OPG has no idea of the verified Class-5 or better capital and life cycle escalated costs are for the DGR 1 in Kincardine, in sedimentary rock next to Lake Huron, on the Bruce Nuclear Site

It has established no thresholds or criteria for costing a project that is close to licensing, which has been in the planning stage since 2002, and but which is still entirely experimental in nature. The analysis of cost and economic risk analysis has not been made public, and it is doubtful if it exists to the standards that are held for even the most inconsequential federal or provincial projects.

This submission describes critical flaws in the OPG response to the Minister that amounts to knowingly incorrect advice and unsubstantiated conclusions by OPG that assume transportation costs are the only indicator of comparative economic feasibility.

## **2.0 INITIAL FLAWS IN OPG PRESENTATION OF COSTS**

### **2.1 The Cost of the Base**

OPG has not accurately accounted for the cost of the DGR in Kincardine, and therefore has knowingly skewed the ratio of transportation and alternative siting costs, at the hypothetical alternate locations, to the advantage of their recommendation.

### **2.2 Administrative Requirements**

On February 18, 2016 the Hon. Catherine McKenna asked OPG to provide new information, rather than reiterating old information. Much of the material presented in the December 16, 2016 report to the Minister has been drawn from previous submissions, including the EIS of 2011 and the IR (Information Request) responses of 2013-4.<sup>46</sup> The conclusions on cost and financial feasibility at the Bruce site have not been refined or moderated based on any new work done by the OPG or its experts during the intervening period.

### **2.3 OPG Has Not Located the Actual Alternate Sites**

Therefore OPG has not provided an authoritative comparative model for the alternate sites: the characteristics of construction vary widely between sites, as do distances.

They do not present their criteria for assessment of the regional sites in a manner clear enough to be exacting with costs or comparisons that are credible.

In neither their report nor Executive Summary did they explain the differences or variations in the waste repository options for crystalline or sedimentary rock, or been assiduous enough to rule out locations that are not economically logical.

They do not consider the likelihood that a site for a repository would be on Crown land, therefore influencing the factor of land acquisition time and cost. Furthermore, they do not factor in the network of existing roads and infrastructure in the province that are at least as suitable for transportation as the highways and by-ways that lead to the Bruce Nuclear Site, through occupied towns and villages.

### **2.4 Lack of Authoritative Cost Modeling for Construction and Operation**

OPG has not referenced recent cost data prepared by NWMO or the Department of Energy in the United States, and refined their estimates of cost in crystalline rock for a shaft or ramped DGR, or for more suitable means of storing or disposing of the long lived high level waste at an alternate site sedimentary site.

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<sup>46</sup> OPG, "OPG Responses to the Final Sub-set of IRs from Joint Review Panel IR Package #8", CD#: 00216-CORR-00531-00171. 2013.  
<http://www.ceaa.gc.ca/050/documents/p17520/87019E.pdf>

## 2.5 Consideration for Reduction of Waste and Shipments and Size of the DGR

They have not considered the options of storage or disposal using waste separation as is now being discussed actively and cost compared in the United States by the Department of Energy<sup>47</sup> in order to achieve economical means of disposal over the next century of upcoming production.

Going back to the 2004 decision to determine which waste should stay on site in above-ground enhanced storage, and which should be transported to another means of storage or disposal, there should be a consideration of the discount of 66% of the shipments<sup>48</sup> for the waste that can remain on site, and be safely stored in above ground or shallow enhanced storage. This is the norm for other international nuclear waste sites, including the ones cited in the OPG 2016 report in Sweden, Finland and South Korea.<sup>49</sup>

## 2.6 OPG has Not Factored in Costs for Expansion for Decommissioning Waste in Transportation, Construction, Operation, and Monitoring

OPG was forced to prepare information for the JRP based on the 400,000 cubic metres of waste that is projected to come from the proposed decommissioning, and will require an expanded footprint on the Bruce Nuclear site. Why is this not accounted for in the costs of construction, transportation and decommissioning of an alternative site?

*The DGR is anticipated to start operation in the 2020's. It would operate for about 40 years, with the first waste panel filled in approximately 10-15 years and then isolated by closure walls. The next half-panel would be filled and closed off in another 10-15 years based on receipt of L&ILW from operations and refurbishment. The first station to be decommissioned will be Pickering A. This is scheduled to shut down in the 2020's. The earliest time at which decommissioning will start is the 2040's. The schedule for shipment of wastes from decommissioning to the DGR (assuming a license has been obtained) would be selected to allow isolation of a panel before repository expansion would begin. It is possible that some L&ILW from decommissioning would be placed in Panel 1 to allow either the full panel or the half-panel to be filled and closed. At that time in the 2040's or 2050's, the further emplacement of wastes into the DGR would be suspended. The construction and commissioning of the expanded DGR would proceed over a 4-5 year period. Following completion of the expansion, the repository would then resume operation.<sup>50</sup>*

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<sup>47</sup> USDOE. 2016. United States Department of Energy: Integrated Waste Management Consent Based Siting Booklet.

<sup>48</sup> See later in this document

<sup>49</sup> IEP, "International Expert Panel Views on the Ontario Power Generation Response to the Request of the Canadian Minister of Environment and Climate Change for Assessment of Alternate Locations for the Deep Geologic Repository". December 2016, p. 9 [http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/International\\_Expert\\_Panel\\_Report\\_Dec2016.pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/International_Expert_Panel_Report_Dec2016.pdf) page 9

<sup>50</sup> OPG. "EIS-12-512: DGR Expansion Plans", CD#: 00216-CORR-00531-00219. January 22, 2014, p.9 [http://www.opg.com/generating-power/nuclear/nuclear-waste-management/DGR%20pdfs/20140122\\_ResponseToIREIS-12-512.pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/DGR%20pdfs/20140122_ResponseToIREIS-12-512.pdf)

## **2.7      Precaution in Judgement of Economies of Highest and Best Use**

OPG has not factored into the equation that a project that must last for the period of institutional control (300 years) and then for hundreds of thousands of years, and is likely to cost well in excess of 10 times what they have seemingly budgeted for in 2004 dollars, might benefit from the transportation away from the largest nuclear site in the world and the Great Lakes. OPG has also failed to consider that this transportation duration is short and the cost is small, in relation to the length of time that the waste will be radioactive. The carbon footprint of the transportation could be substantially reduced, as could costs, if the precautionary approach extended to management of the short lived waste on the Bruce Site.

The economy of constructing a DGR which puts environment and public health at risk is an unsuitable assumption of lower cost equaling higher value. The evaluation of highest and best use is a sophisticated strategy that should include multiple feasible options in order to choose one that is preferred.

## **2.8      The Relative Value of Transportation**

If a project is 2.4 billion dollars (including operations from 2004 to the end of the project decommissioning), adding 1.2 billion would be adding 50% to the cost, and adding 3.5 billion would be adding about 150% to the project. That is a considerable increase. However, if the transportation and additional costs are actually known, and the DGR 2.4 billion dollar cost is outdated, and unknown, it is likely that the proportional cost of the transportation and alternate siting are not as significant as made out in this report. We have no way of knowing how inaccurately low the cost of the DGR 1 cost projection is, but we can extrapolate using a chronology of readily available information as laid out later in this commentary.

### 3.0 STATEMENT OF COSTS

OPG's Main Report: Study of Alternate Locations Main Submission<sup>51</sup>, in its Executive Summary page vi, states:

*OPG's study shows that the incremental costs for implementing a DGR at an alternate location would range from \$1.2B to \$3.5B (this is in addition to the current cost of \$2.4B (2017\$) for the DGR Project at the Bruce Nuclear site). These additional costs are attributable to the range of activities that would be required for an alternate location including a multi-year consent based siting process; acquisition of land; development and implementation of services to support facility operation; repackaging and transportation; and re-starting the regulatory approvals and licensing process.*

*OPG's study also shows that there would be considerable uncertainties associated with a DGR at an alternate location including the time required to develop and implement a consent based site selection process and achieve a willing and supportive host community, as well as the consent of Indigenous communities.[...]*

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<sup>51</sup> OPG, *OPG's Deep Geologic Repository Project for Low and Intermediate Level Waste*, "Study of Alternate Locations Main Submission", 00216-REP-07701-00013. December 2016.  
[http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/SAL\\_Main\\_Submission.pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/SAL_Main_Submission.pdf)

#### 4.0 THE INTERNATIONAL EXPERT PANEL (IEP) VIEW ON COST

The 2016 IEP study<sup>52</sup> was commissioned by OPG to peer review their conclusions. The report is exclusive of many important factors in review of economy and the success of the international examples. They were convinced by OPG of a number of factors: the BNS has absolute community consent; other sites in sedimentary locations would not get the consent of the community because they are not nuclear communities; OPG is worried about increased costs because of rising electricity rates and the burden on the consumer; and the co-location of ILW and LLW was not to be questioned.

On page 6 of their report they revealed an underlying bias in terms of politics and expediency over value and safety or suitability, as well as preconceptions that OPG has planted:

*Economic feasibility is an issue, which involves not only the differences in the cost estimates between the DGR reference project and the DGR in the alternate locations but also the considerable uncertainty on the future cost estimate since the DGR at an alternate site would mean the postponement of the start of the disposal by several decades. This uncertainty together with the obviously higher overall cost must be considered when selecting mechanisms for future financing. **IEP has been informed by OPG that the funds for the DGR have already been collected and contributed to the fully paid segregated fund. This fund is a resource in the long term and can be part of the mechanisms to cover the cost of the DGR in the alternate location.** The IEP considers that the cost estimates for transportation are well established and are likely to have low uncertainties given the OPG experience with transporting wastes from the Darlington and Pickering sites to the BNS. **The much larger cost uncertainties regarding characterization and acquisition of alternate sites in either sedimentary or crystalline regions are acknowledged in the Main Report and appear to have been based on reasonable assumptions.***

*The IEP notes that the OPG economic criterion quite reasonably relates to assessing the costs for characterizing and acquiring an alternate site to identify the need for additional funds. **A search for a site within a new location may take decades, a period during which a large sum of money will need to be collected through increased electricity rates. Over this period of time, some existing NPP will cease operations as they reach the end of their useful lives and those remaining will have to carry the financial load of paying for a future repository.***

**Are these statements true? They are not substantiated.**

Is the rush on to site material at the BNS because of Nuclear Power Plants (NPPs) going out during the time that siting would take place?

Is the reason that we should rush ahead because of rising electricity rates?

Is the sum of money that is additional really as large a proportion of the actual cost of the DGR as it is made to seem?

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<sup>52</sup> IEP, "International Expert Panel..." December 2016, p. 9

Why is it not considered that only 7% of the waste be taken off site (that is 33% of the shipments), and the rest left in surface storage on site at the BNS?

Why will the crystalline facility take 10 years longer to build if it is on Crown-owned land?



## 5.0 ENERGY SOLUTIONS REPORT: THE EXPERT REPORT FOR COST AND RISK ESTIMATE FOR PACKAGING AND TRANSPORTING WASTE TO ALTERNATE LOCATIONS DEC 2016

Energy Solutions was hired by OPG to project the costs of transportation<sup>53</sup>, not the costs of alternative sites.

In their report, Energy Solutions states,

*In all it is estimated that more than 22,000 total shipments on public roads over a 30+ year period are needed to package and transport the entire inventory of L&ILW from the WWMF to an alternate location. Of the total volume of L&ILW that would be transported to the alternate location, 93% is LLW and only 7% is ILW. Similarly, of the total number of shipments of L&ILW to the alternate location, 67% are LLW shipments and 33% are ILW shipments.*<sup>54</sup>

*This study also provides a preliminary assessment of the incremental risks associated with the packaging and road transport of the L&ILW from the WWMF and off-loading them at alternate location. Both the incremental radiological and conventional risks are assessed, including the risk of exposure to ionizing radiation during normal and hypothetical accident conditions, and the conventional risks to health, safety and the environment for such transports. The assessment concludes that the associated incremental risks are limited and bounded. They are judged to be determinate and quantifiable in terms of their probability of occurrence and their potential consequences. Further, it is judged that the profile of incremental risks can be effectively*

*managed and mitigated without undue risk to the public. The preliminary assessment of incremental risks is underpinned by data derived from 40+ years of safe radioactive material transports worldwide, and historical data for the transport of commercial cargo using heavy trucks on public roads.*<sup>55</sup>

Section 4.2, Summary of Costs, states:

*Estimated costs are provided for the two alternate location host geologies and the two assumed transport distances for each as follows:*

- 1. 100 km Transport: Alternate location in sedimentary rock located 100 km from the WWMF by road and available beginning in year 2045.*
- 2. 300 km Transport: Alternate location in sedimentary rock located 300 km from the WWMF by road and available beginning in year 2045.*
- 3. 200 km Transport: Alternate location in crystalline rock located 200 km from the WWMF by road and available beginning in year 2055.*
- 4. 2,000 km Transport: Alternate location in crystalline rock located 2,000 km from the WWMF by road and available beginning in year 2055.*

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<sup>53</sup> Energy Solutions, OPG's Deep Geologic Repository for Low and Intermediate Level Waste, "Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations," CD# 00216-REP-03450-00001-R000 December 2016 <http://www.ceaa-acee.gc.ca/050/documents/p17520/116730E.pdf>

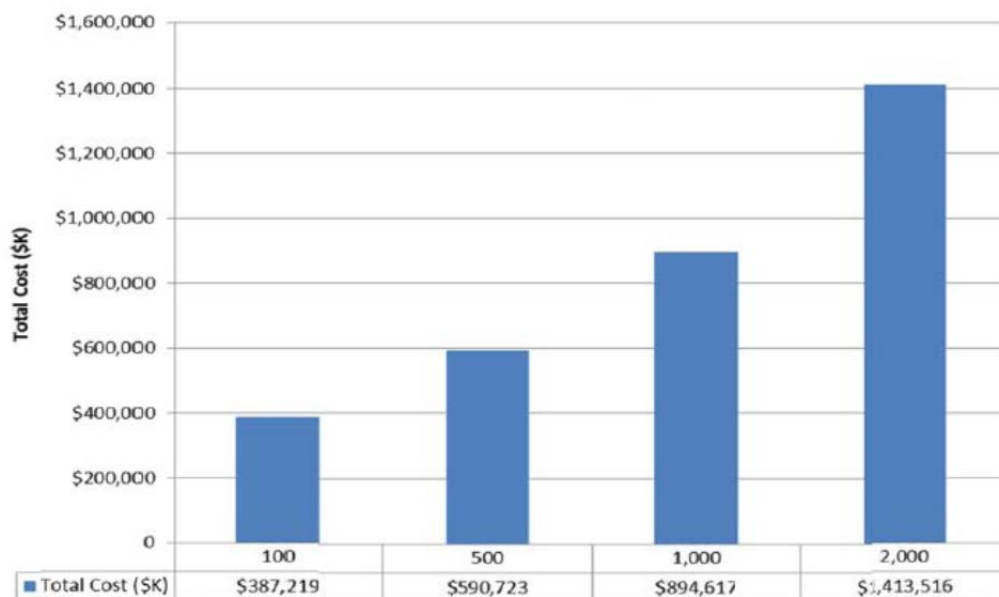
<sup>54</sup> Energy Solutions, "Cost and Risk..." December 2016, p. x

<sup>55</sup> Ibid

The cost for transport packaging supply and for packaging operations performed at the WWMF and the off-loading operations performed at the alternate location are the same for all transport distances, **accounting for the slightly larger L&ILW inventory for the year 2055 availability scenario compared with the year 2045 availability scenario**. Table 4-1 summarizes the total cost (in 2016 CAD) for packaging, transporting and off-loading the entire L&ILW inventory from the WWMF to the alternate location, for the above four transport distance scenarios. The total estimated cost includes the costs for each waste category summarized in Section 3 which are summed to obtain the combined cost for all waste categories, plus the costs associated with operations performed at the WWMF and alternate location that are common to all waste categories as described in Section 4.1.

The indicative total project cost by distance for the sedimentary rock 2045 availability scenario is shown graphically in Figure 4-1 which shows that the total project cost ranges from **\$382 million to \$493 million for the shortest 100 km to the longest 300 km** alternate location transport distances. Similarly, the indicative total project cost by distance for the crystalline rock 2055 availability scenario is shown graphically in Figure 4-2 which shows that the total project cost **ranges from \$452 million to \$1.4 billion for the shortest 200 km to the longest 2,000 km** alternate location transport distances.

#### Summary of the Energy Solutions Report <sup>56</sup>



<sup>56</sup> OPG and Hardy Stevenson & Associates, "OPG Deep Geologic Repository Information Session Notes," November 11, 2016, p. 65.

[http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/OPGDGR\\_InformationSessionNotes\\_20161111.pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/OPGDGR_InformationSessionNotes_20161111.pdf)

## 6.0 HISTORY OF COSTS FOR THE BASE CASE

### 6.1 The Cost Assessments from the Golder Report in 2004, prepared for Kincardine Council by OPG: Golder Associates Independent Assessment Study Main Volume, March 4, 2004<sup>57</sup>

The Golder Report of 2004 presented to OPG and Kincardine Council was the basis upon which Kincardine and OPG entered into the Hosting Agreement, signed in 2004.<sup>58</sup>

Section 2.6.4 of the Golder Report titled, “Deep Rock Vault,” examines the deep rock vault placement of the waste. The total incremental costs from beginning to post- construction license cost and decommissioning cost is estimated to be \$279 million for LLW only, over a period of 25 years. The incremental costs comprise approximately \$92 million for the construction phase, \$179 million for the operations phase and \$8 million for the decommissioning phase.

*The total construction and operating costs are summarized in Table 3. The Deep Rock Vaults option has the capability to accept the full range of ILW. Although the volume of ILW is smaller than the volume of LLW, the greater radioactivity level and the shape and size of the containers to be placed underground likely requires a similar volume to that required for the LLW. The additional incremental post Construction License costs for ILW could potentially be up to an additional \$200 million.<sup>59</sup>*

**TABLE 3**  
**Conceptual Cost Estimate for Deep Rock Vaults**

ITEM	\$kCAD (2002)
<i>Construction Phase</i>	
Engineering	6,671
Equipment and Materials	6,081
Construction and Installation	79,182
<i>Operating Phase</i>	
Facility Operations – Labour	100,709
Facility Operations – Materials and Equipment	51,290
Construct Caverns	26,717
<i>Decommissioning Phase</i>	
Labour	4,820
Materials and Equipment	3,006
<b>Total</b>	<b>278,476</b>

*“Table 3- These costs are in 2002 CAD and are additional to the \$21.2 assumed current annual operating costs for the status quo” [sic]*

<sup>57</sup> Golder Associates Ltd. “Final Report on Independent Assessment of Long-Term Management Options for Low and Intermediate Level Waste at OPG’s Western Waste Management Facility. Submitted to Steering Committee Municipality of Kincardine and OPG,” February 2004. [http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/IAS\\_Report.pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/IAS_Report.pdf)

<sup>58</sup> DGR Hosting Agreement between Ontario Power Generation and the Municipality of Kincardine, October 2004. <http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/HostingAgreement.pdf>

<sup>59</sup> Golder Associates Ltd, “Final Report on Independent...”, p.20-21

**This total of \$278,476,000, plus the \$2,000,000 (ILW), plus \$21,000,000 (Status Quo operations) equals \$301,476,000.**

This would bring the estimate by Golder in 2004 to end of decommissioning, including all low and intermediate level waste **to \$301,476,000 in 2002 dollars**. Golder also indicated that the plan was for short lived Low and Intermediate Waste only. OPG added the long lived Intermediate Waste inventory after 2004 (the time of the Hosting Agreement).<sup>60</sup>

## **6.2 What Were Others Saying about the Cost of the DGR 1 in 2004?**

**Kincardine Mayor, OPG and News Media Reported in 2004, prior to the Poll of Residents: April 10, 2004 Glenn Sutton, Mayor of Kincardine, writing in the Kincardine Record<sup>61</sup>**

On April 10, 2004, Mayor Glenn Sutton stated in The Kincardine Record:

*[The] long-term waste storage plan is worth an estimated \$825 million, said Kincardine Mayor Glenn Sutton, and could go as high as \$ 1 billion over the 25-year life of the project when direct and indirect costs are considered.*

**Terry Squire of OPG is reported to have said in the Walkerton Herald Times, Sept 29 2004,<sup>62</sup>**

*At a packed council chambers Monday night, Terry Squire, director of public affairs for OPG returned to Brockton to redo the presentation he had made behind closed doors a couple of weeks before. The plan calls for the construction of a deep geologic repository 660 metres below the surface. Two separate caverns would be used to store low level and intermediate level waste materials such as gloves, clothing and filters.*

*Squire assured council that no fuel would be stored at the site; he added that 95% of the material would be low level.*

*Council heard that the process had been ‘very open’ with five public information sessions held in Kincardine, Chesley, Saugeen Shores and Mildmay. [...]*

*Kincardine Councilor Howard Ribey accompanied Squire and told Brockton council that ‘a majority of council is in favour of this project’.*

*Squire said the caverns will hold 100,000 cubic metres of material –60 percent of which is already on site at the Bruce plant. The remaining 40 per cent is being shipped from nuclear*

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<sup>60</sup> 3.2.5 As noted in Section 3.2.2, initially, only alternatives for the management of LLW and short-lived ILW were considered. Once a DGR was selected as the preferred alternative (see Section 3.3), OPG decided to also include long-lived ILW in the waste inventory to be placed in the DGR .3.3.3 Deep Rock Vaults While the option would be intended to accommodate ILW the feasibility design and cost estimate did not include this waste

<sup>61</sup> OPG EIS Volume 2, Media Reports

<sup>62</sup> John McPhee, “Brockton Supports OPG plan for waste repository.” Retrieved from: [http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/Submission/03.Environmental-Impact-Statement-\(Volume-2\\_2\).pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/Submission/03.Environmental-Impact-Statement-(Volume-2_2).pdf), p. 64/900

plants in Pickering and Darlington---which have been trucking low and intermediate level waste to Bruce since the mid- 1970s. They have been stored in 'interim' containers above ground. ...

Under questioning from Councillor Chris Peabody, Squire said about 25 trucks a week travel area roads bringing the waste to the Bruce site. That number won't change with the new project.

If approved construction for the project --which Squire estimates will cost \$1 billion over the next 30 years, including grants to surrounding municipalities ---would not commence until 2012 and would not be ready for storing until 2017.

**Marie Wilson of the Kincardine News reported on Wed Oct 6 2004:**<sup>63</sup>

*The construction and operation of the deep rock vaults is expected to inject between \$864 million and \$1 billion into the local economy.*

**Ken Nash, VP of OPG is reported to have said through Liz Dadson of the Kincardine Independent reported: Wed Oct 6 2004:**<sup>64</sup>

*Ken Nash, OPG's vice president of Nuclear Waste Management, spoke at a press conference, 'the proposed \$1 billion deep rock vault project would not be built for 10 years and would have a life span of about 20-25 years, according to an independent study done by Golder Associates...'*

**6.3 Revised Cost Estimate by Golder Associates in the Environmental Impact Statement, 2011 (Section 1.2.5)**<sup>65</sup>

*1.2.5 Project Cost The construction cost of the DGR is currently estimated to be about \$1 billion. An existing segregated fund established by OPG (Decommissioning Fund), which has been accumulating funds as part of electricity rates, will be used to pay the cost of the DGR Project.*

**Table 7.10.2-1: Direct, Indirect and Induced Income Associated with the DGR Project**

Type	Income
Direct	\$408,728,000
Indirect	\$229,475,000
Induced	\$510,562,000
<b>Total</b>	<b>\$1,148,765,000</b>

Source: Appendix E of the Socio-economic Environment TSD

*Table 7.10.2-1 Direct, Indirect and Induced Income Associated with the DGR: \$1.148 billion*

<sup>63</sup> Marie Wilson, "Tens of millions to host nuclear waste facility" October 2004. Retrieved from:

[http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/Submission/03.Environmental-Impact-Statement-\(Volume-2\\_2\).pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/Submission/03.Environmental-Impact-Statement-(Volume-2_2).pdf), p. 74

<sup>64</sup> Liz Dadson, Kincardine to get compensation for hosting nuclear waste dump, payment expected to be tens of millions," Retrieved from: [http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/Submission/03.Environmental-Impact-Statement-\(Volume-2\\_2\).pdf](http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Deep-Geologic-Repository/Documents/Submission/03.Environmental-Impact-Statement-(Volume-2_2).pdf), p. 79.

<sup>65</sup> OPG, *OPG's Deep Geologic Repository Project for Low & Intermediate Level Waste*, Environmental Impact Statement Volume 1: Main Report," March 2011, p.1-12  
<http://www.acee-ceaa.gc.ca/050/document-eng.cfm?document=49818>

***IR Response EIS-05-224 by OPG to JRP (in Submission of Responses to a Sub-set of Package No. 5 CD No 00216-CORR-00531-00145) (2.075 billion) Oct 12, 2012***

***Information Request:***

*Provide additional detail concerning project costs during each temporal phase, and provide the ranges in costs for each phase.*

***Context:***

*The construction cost of the DGR is currently estimated to be about \$1 billion.” This statement does not clarify whether the \$1 billion cost is only for the site preparation and construction phase (5-7 years), or for the site preparation and construction phase plus the operations phase (40-45 years), the decommissioning phase (5-6 years) and the abandonment and long-term performance phase (institutional controls for up to 300 years). It is unclear as to what the actual total cost of the Project will be.*

**OPG’s Response:**

*The \$1 billion cost estimate stated in Section 1.2.5 of the Environmental Impact Statement (OPG 2011) is a rounded-up number for the licensing, design, site preparation and construction costs. The estimated costs for the major phases of the DGR Project are provided in the following Table:*

<b>Phase Description</b>	<b>Estimated Costs</b>
a) Licensing, Design, Site Preparation & Construction	906
b) L&ILW Retrieval and Operations	832
c) Decommissioning and Abandonment	337

*The cost estimates above are point estimates. Ranges are not available. A segregated fund, known as the Decommissioning Fund, has been established by Ontario Power Generation, and these accumulated funds will be used to pay for the DGR Project.<sup>66 67</sup>*

While the combined phase by phase costs from construction to abandonment are listed as being **2.075 billion** OPG did not answer JRP questions about a **range** of costs per temporal phase and they don’t account for who did the estimate, or exactly what it is based on. There is no mention of contingencies for redesign during the adaptive management process, or for mitigation for unforeseen events or discoveries, accidents, additional waste quantity or quality. They do not indicate if this includes the status quo of processing the waste at the WWMF for 45 years. In 2004 Golder quite specifically indicated that the costs

<sup>66</sup> OPG, “OPG Response to A Sub-set of the Joint Review Panel EIS Information Request Package #5” October 2012, p.84/90 <http://www.ceaa.gc.ca/050/documents/p17520/83291E.pdf>

<sup>67</sup> OPG’s reference cited in their response to the Information Request is as follows: “References: OPG, 2011. OPG’s Deep Geologic Repository for Low and Intermediate Level Waste – Environmental Impact Statement 00216-REP-07701-00001 R000. Toronto, Canada. (CEAA Registry Doc# 298)”

of the DGR that they were projecting would have to be increased to account for the Status Quo at WWMF. In this IR they do not specify whether this estimate is for 200,000 cubic metres of waste, or 400,000 cubic metres, or reconfirm the schedule that the JRP has stated for them in the question.

#### **6.4 Joint Review Panel Report May 2015<sup>68</sup>**

##### **Section 4.5 of the JRP, “Financial Aspects”:**

*Financial aspects include OPG’s long-term planning, as well as the financial guarantee for decommissioning following site preparation and construction.<sup>69</sup>*

##### **Section 4.5.1 of the JRP, “Project Funding”:**

*OPG stated that, in the early 1990s, it developed financial plans for long-term waste management on the basis that future generations should not bear the cost of today’s operations. OPG explained that it makes financial contributions to segregated funds dedicated solely for the long-term management of waste and for the decommissioning of its generating stations. These funds would pay the costs associated with developing and operating a facility for the long-term management of L&ILW, a facility for long-term management of used fuel, and the decommissioning of generating facilities. OPG reported that, as of end of 2009, the fund was valued at approximately \$10 billion. According to OPG, the expected cost of the project was approximately **\$1 billion**. OPG stated that it was committed to maintaining the required financial, technical and administrative capabilities to ensure the safe construction and operation of the DGR. From a financial perspective, funding for the project would be derived from OPG’s segregated Decommissioning Fund, the adequacy of which is routinely reviewed as part of the financial guarantee requirements of the CNSC.<sup>70</sup>*

#### **6.5 OPG in November 2016**

***What Fred Kuntz, OPG said on November 11, 2017 at an Information Session held at OPG Headquarters in Toronto:***

*[The cost of the construction] is around \$1 billion.*

***What the final OPG Nov 11 Information Session Notes say page 14***

***Costs and record keeping***

***Q: What percentage of the total cost for the project would the additional transportation represent?***

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<sup>68</sup> JRP, *Environmental Assessment Report: Deep Geologic Repository for Low and Intermediate Level Radioactive Waste Project*, May 6, 2015

<http://www.ceaa-acee.gc.ca/050/documents/p17520/101595E.pdf>

<sup>69</sup> JRP 2015 JRP, *Environmental Assessment*, p. 63

<sup>70</sup> Ibid



*It will cost around \$1 billion to get the facility operational under the current proposed plan. The projected transportation costs of \$0.4 to \$1.4 billion would be an additional incremental cost.*

***Q: How it is possible that transportation could cost \$1.4 billion while the originally proposed facility would only cost \$1 billion?***

*This is the estimate developed by Energy Solutions Canada and is being internally reviewed.*

***Q: Is it being peer reviewed?***

*Cost data was developed by Energy Solutions Canada and is being reviewed internally at OPG.<sup>71</sup>*

## **6.6 Costs of the Base Reported to the Minister in December 2016 by OPG**

### **The Statement to the Minister in the December 26, 2016 Submission:**

*OPG's study shows that the incremental costs for implementing a DGR at an alternate location would range from \$1.2B and \$3.5B (this is in addition to the current cost of **\$2.4B (2017\$)** for the DGR Project at the Bruce Nuclear site)<sup>72</sup>*

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<sup>71</sup> OPG and Hardy Stevenson & Associates, "OPG Deep Geologic Repository Information Session Notes," November 11, 2016, p. 14.

<sup>72</sup> OPG, "Study of Alternate Locations Main Submission," December 2016, p.vi.



## **7.0 ARE FINAL LIFECYCLE COSTS FOR THE BRUCE OR ALTERNATE SITES KNOWN?**

### **7.1 The answer is “no”**

based on the evolution of cost to date, the unknown implicit in the DGR on the Bruce or alternate sites. This relates directly to not only the relative risk of transportation cost in relation to capital cost at the alternate sites, but to the economic feasibility of a DGR for 200,000 cubic metres or 400,000 cubic metres at any of the sites.

**7.2** The OPG Annual Information Form issued August 2016<sup>73</sup> indicates that the funding mechanism for this DGR 1 project is through the segregated Decommissioning Fund, for which the Province provides a financial guarantee to the CNSC for OPG’s nuclear decommissioning and nuclear waste management obligations.<sup>74</sup> The Decommissioning Fund is based on lifecycle costs and covers decommissioning of the nuclear plants, the construction and management of the DGR 1, and some high level waste that will be left once the nuclear plants are decommissioned. All the other spent fuel waste is covered under another segregated fund. The OPG Form cites four of the risk factors faced by their corporation as: uncertainty inherent in cost estimates for nuclear waste management and decommissioning obligations; nuclear waste management operation, including proposed waste disposal facilities such as the DGR for L&ILW; changes in the opinion of various stakeholders regarding OPG’s public profile; the obligation of OPG’s shareholder, the Province of Ontario, to respond to a broad range of matters in its role as the Government of Ontario competing with OPG’s commitment to maximize the return on the shareholder’s investment in the Company.

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<sup>73</sup> Ontario Power Generation Inc. Annual Information form for the year ended December 31, 2015, issued August 12, 2016

<sup>74</sup> Ibid, 34

## 8.0 SIMILAR COST COMPARISONS

### 8.1 NWMO cost for the APM<sup>75</sup> DGR2 in Crystalline Rock

#### APM 2016 Lifecycle Cost Estimate Update Summary Report: NWMO April 2016 (APM-REP-00440-0202)

*Two used nuclear fuel inventory scenarios are considered in this analysis: the base case, 3.6 million used CANDU fuel bundles will be directed to the DGR over a 30-year placement period, and the alternate case, which allows for potential refurbishment of existing plants and/or construction of new nuclear reactors, increases this quantity to 7.2 million used fuel bundles delivered to the DGR over a 60-year period. From these two scenarios, we can reasonably estimate the costs of any used fuel arising scenarios within these two point estimates in order to support funding formula calculations and various financial scenarios. Estimated costs are stated in constant 2015 Canadian dollars<sup>76, 77</sup>.*

The revised APM reference lifecycle estimate for 3.6 million used fuel bundles is \$18, 328, 000 (2015 \$).

The estimate for the alternate case of 7.2 million used fuel bundles is \$28, 429, 000 (2015 \$).

A summary of the APM cost estimate by implementation phase and costs from the 2011 estimate are as follows in 2015 dollars:

#### **Case 1<sup>78</sup>: In Crystalline for Base Case 3.6 million used fuel bundles CANDU over 30 year placement**

Area	Cost (B\$)
Program Management	4.505 (from 2010 to 2172)
Repository	13.051 including construction: 2.822, operation: 8.067, extended monitoring: 1.2, decommissioning and closure: 0.956
Transportation	0.771 (all phases, there is a breakdown)
<b>Total</b>	<b>18.328</b>

<sup>75</sup> The term refers to “Adaptive Phased Management” used by OPG.

<sup>76</sup> NWMO, “APM 2016 Lifecycle Cost Estimate Update Summary Report,” APM-REP-00440-0202, April 2016, p. iii.

<sup>77</sup> Escalated from 2011 per page 9 of the Report: why were they not escalated to the date of the report and further into the future?

<sup>78</sup> The estimate for construction appears **very low**. The construction period is 2033 – 2042 (**9 years**). That is \$311, 000, 00 maximum (2015 CAD) for the hard construction per year. The Rainy River mine in Fort Francis NW Ontario is spending \$515,000,000 (2017 CAD) this year for an open pit gold mine. It is delayed and costs have significantly escalated causing a shakeup. From: *Northern Ontario Business* Feb 6, 2017 <https://www.northernontariobusiness.com/pdfedition>

<b>Breakdown includes:</b>	<b>(B\$)</b>
Siting	1.013
Detailed Site Characterization and Licensing	1.093
Construction	3.8 <sup>79</sup>
Operations	9.44
Extended Monitoring	1.7
Decommissioning and Closure	1.216

**Case 2: In Crystalline for Base Case 7.2 million used fuel bundles including the potential refurbishment of existing plants and or construction of new nuclear reactors, over a 60 year period.**

<b>Area</b>	<b>Cost (B\$)</b>
Program Management	5.354 (from 2010 to 2202)
Repository	21.658 including construction: 2.822 (unchanged), operation: 16.390 (doubles), extended monitoring: 1.2 billion (same), decommissioning and closure: 1.239
Transportation	1.417 (doubling) (all phases, there is a breakdown)
<b>Total</b>	<b>28.429</b>

## **8.2 Why is the NWMO Cost Analysis of Interest in the DGR 1 Base and Alternative Locations Comparative Cost Estimates?**

Key Assumptions in the NWMO Estimate (2016) <sup>80</sup>include:

- The repository will be located within a high-quality (e.g., sparsely fractured) crystalline rock geosphere.

<sup>79</sup> Of which only 2.8 billion is hard construction cost; 849 m is Program management and 131m is transportation from across Canada for 3.6 million bundles; there is an alternate cost for 7.6 million bundles; in more detail the underground excavation is **638,000 million and the shafts and headframe and hoist are 464,000 million**

<sup>80</sup> NWMO, “APM 2016 Lifecycle Cost Estimate...” April 2016

- The repository is sited in a hypothetical location in Ontario, nominally 1,000 kilometers from all Ontario-based reactor sites, as well as from the Whiteshell operations (OPG and AECL), 1,500 kilometer from the Gentilly facilities (HQ and AECL), and 2,500 kilometers from Point Lepreau (NBPN).
- All fuel is assumed to be dry and in 96-bundle modules, loaded in a Used Fuel Transportation Package (UFTP) at the waste owners' facilities and prepared for transport by the waste owner; the NWMO is the carrier as defined in Canadian transportation regulations.
- The underground portion of the APM facility is assumed to be a network of horizontal tunnels and placement rooms for the UFCs excavated at a depth of 500 metres, with vertical shafts extending to surface. During construction of the underground facilities, unsuitable rock conditions are assumed for 10 per cent of the excavations in the placement rooms.
- Following the start of operations, excavation of placement rooms would proceed concurrently with UFC placement activities, with sequencing of excavation and UFC placement activities, providing separation of these two activities from a manpower, ventilation and equipment perspective.
- Detailed site characterization will be conducted at the single site selected. Any consideration for further evaluation of more than one site would be completed as part of Phase 2 activities in advance of single site selection (i.e., additional boreholes to support site selection).
- Construction will begin in year 2033 and progress as described to deliver a functional licensed facility at end of the year 2042.
- A rate of placement equivalent to 120,000 used fuel bundles per year will be accommodated.

All of this is interesting from a cost perspective, as is the whole report, BUT it gives us other information on how NWMO/OPG are looking at the DGR for L&ILW1 and DGR for HLW:

- There is a continuance of confidence in the crystalline rock to the point where the cost estimators have been told to assume only 10% adverse conditions and fractures in the rock. That is important information for us in the battle between sedimentary and crystalline rock that is going on between CNSC and OPG. It undermines the OPG credibility in the lack of confidence in granitic.
- NWMO have assumed concurrent placement and construction.
- NWMO is also assuming a hypothetical location.

OPG may be relying on these costs and underestimating the sedimentary location. We have no access to the OPG cost estimates adding to 2.4 billion. It would be interesting to know if they have borrowed the transportation costs or cost estimators used in the Dec 2016 report, from NWMO.

### 8.3 US DOE Figures DPC-STAD cost basis summary Rev 1. Jan 2016<sup>81</sup>

In 2016 the US Department of Energy provided 16 disposal concept options for High Level Waste (HLW) to include commercial Spent Fuel in crystalline, hard rock, salt, and argillaceous rock and different types of canisters and assemblies. The DOE states that the cost of a sedimentary DGR is 18-28 billion (2016 USD), without all soft costs, life cycle, and transportation costs. This is roughly the same dollar value in billions that NWMO is using, but in Canadian Dollars for their DGR 2 for used fuel (2015 CAD) in a crystalline rock site **including** all transportation and project management, to the end of monitoring activities (149 years).

The DOE cost estimate for granitic and crystalline rock is 33% to 100% more than the sedimentary estimate, which does not seem to be accounted for in the NWMO estimate. The high level comparative for granitic DGR for HLW Used Fuel (high heat producing) is 64 billion.

## 9.0 Conclusion

- OPG has not identified actual sites or locations that are economically feasible.
- OPG has not updates costs on the DGR 1 in Kincardine possibly since 2004, and it may not be economically feasible.
- We do not have access to OPG cost estimates adding to \$2.4 billion.
- OPG has not considered waste separation when only 7% of the waste needs to be taken off site (or 33% of shipments) while the rest could be left in surface storage on BNS.
- It is possible that the proportional cost of the transportation and alternate siting are not as significant as OPG has made them out to be.
- The economy of building an experimental DGR on the shore of Lake Huron, putting the environment and public health at risk, challenges the conclusion that lower cost construction and transportation equals higher gain.
- The costs of DGRs across the globe are unchecked.<sup>82</sup>

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<sup>81</sup> SAND2016-0235 Printed January 2016. Cost Estimate in Inputs for spent Nuclear Fuel Geologic Disposal Concepts (Revision 1). Ernest Hardin and Elena Kalinina;

<sup>82</sup> Re: the OECD and NEA report, *The Economics of the Back End of the Nuclear Fuel Cycle*.

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# **Response to OPG's Updated Analysis of Packaging and Transporting Waste to Alternate Locations**

## INTRODUCTION

The identification of alternate sites and alternative means prior to final site selection is a key component of the CEAA process and of the Terms of Reference for the EIS for this project. Understanding the potential positive and negative factors and impacts on a proposed and alternate site must take into account all required factors of project effect on local and regional environments. This CEAA defined and driven method of enquiry enables informed, strategic and science-based decisions to be made, and provides the balance between alternatives that allows the choice of the best possible actual location, and means of implementation. Choosing the right site commits the proponent to a path of action. It is a threshold that one must pass in the EA process that will lead to a Ministerial or Governor in Council decision. The Minister has specifically asked that OPG define actual location options that are technically and economically feasible, and that the potential for adverse effect is measured to enable comparison between one feasible option and another feasible option. Up until this time, this robust form of analysis of alternate sites and means was sidelined as OPG chose a site that was convenient and embedded it in a hastily crafted Hosting Agreement, signed by OPG and the Mayor of Kincardine, back in 2004.

The 2016 request by the Minister of the Environment and Climate Change instructed OPG to investigate the viability of two alternate DGR locations, and to investigate alternates that were away from the Great Lakes and other significant wetlands. Specific to this Chapter of our Commentary, OPG was also requested to provide a narrative account of the environmental impacts, and the costs associated with the additional packaging and transport to alternate sites, from the Bruce site. The purpose of her request was not to provide OPG with a platform to affirm their previous assumptions about the validity of the Hosting Agreement and the convenience of on- site storage and disposal, or to fight back against the difficulties that their intransigence of position caused during the JRP hearings. The purpose of the request was to invite OPG to provide quality, baselined information and to test their assumptions, to apply the tests of the CEAA in a process of investigation so that a clear assessment could be made of their claims of the technical and economic feasibility of their DGR project at the Bruce site.

It continues to be disappointing to us that OPG misses the opportunity to look more closely at the information and insights brought forward, or to use the factors that have been established by the Energy Solutions Canada study that they paid for; but OPG chooses to represent the expert content as a burdens to the Project, using the negative effects predicted only, to form an opinion that the OPG DGR project at the Bruce Nuclear site was and remains the only cost effective, and zero “cumulative effect” solution.



## **1.0 THE FOLLOWING EXCERPTS ARE FROM THE ENERGY SOLUTIONS CANADA STUDY, AND THE OPG STUDY ON ALTERNATIVE LOCATIONS**

### **Study of Alternative Locations:**

*The DGR Project at the Bruce Nuclear site remains the preferred location based on a relative consideration of environmental effects , transportation risks, transportation and other project related costs and uncertainties; and the absence of any guarantee or improved safety or environmental quality at an alternate site<sup>83</sup>.*

### **Energy Solutions Canada: Executive Summary;<sup>84</sup>**

*The assessment concludes that the associated incremental risks are limited and bounded. They are judged to be determined and quantifiable in terms of their probability of occurrence and their potential consequences. Further it is judged that the profile of incremental risks can be effectively managed and mitigated without undue risk to the public. The preliminary assessment of risks is underpinned by data derived from 40+ years of safe radioactive material transports worldwide, and historical data for the transport of commercial cargo using heavy trucks on public roads.*

## **2.0 DILIGENCE AND COMPLIANCE REQUIREMENTS**

The first request by the Minister for additional studies and reports addresses the obligation to identify alternate sites and means by OPG. The issue goes back to the lack of alternate site investigation and diligence prior to signing of the OPG/Town of Kincardine Hosting Agreement in 2004 for construction DGR and continued through to the EIS Hearings when the JRP had to direct OPG to retain an Independent Expert Group to write a Report using the OPG Bruce Nuclear site as a comparative model. It did not succeed. The JRP Agreement requires that alternate site and means are demonstrated.<sup>85</sup>

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<sup>83</sup> Study on Alternative Locations, p. 86.

<sup>84</sup> Energy Solutions Canada, OPG's Deep Geologic Repository for Low & Intermediate Level Waste, "Cost and Risk Estimate for Packaging and Transporting Waste to Alternate Locations," OPG CD# 00216-REP-03450-00001-R000, December 2016, p. x.

<sup>85</sup> 2008 Agreement to Establish a Joint Review Panel for the DGR Project by OPG within the Municipality of Kincardine; Part IV Scope of the Environmental Assessment and Factors to be Considered in the Review; CEAA reference: Paragraphs 16 (1) (a) to (d) and subsection 16 (2) of the CEAA; 1. (f) 1. (g) 1. (h)

### **3.0 COSTS AND RISKS FOR TRANSPORTING WASTES TO ALTERNATE LOCATIONS**

The Cost and Risk Estimate for Packaging and Transporting Waste Study addresses packaging, transport, and delivery and return cycle associated with the movement of L and ILW off the Bruce site. It assumes that all L and ILW from the three Ontario nuclear generating sites will be delivered to and stockpiled at the OPG WWMF site, and from there transported to a conceptual DGR of similar size and depth at an alternate location. Risk analysis is performed based on information from verifiable transport, environmental impact and associated risk statistics. A Class 5 level (AACE) cost estimate was conducted for each of two locations for the sedimentary and granite alternate sites. Data regarding packaging, quality and quantity of waste was provided by OPG.

There are concerns that we maintain regarding event and accident characterization; in particular we are concerned that the events do not include impact or effects analysis on surface water or atmospheric VECs or their contamination during events. There is a lack of information and analysis on the socio economic and community impacts of transport across the province, or of the effect stigma or events on socio economic status; there is also an insufficient amount of information on trends of increased public and ratepayer concern over transport of hazardous materials through communities; over the need to be transparent, and the need to conform and be aware of current and emerging municipal, Provincial and federal law, regulation and policy regarding hazardous materials transport.

### **4.0 THE VALUE OF NEW INFORMATION**

The Energy Solutions Canada study provides a basic understanding of the costs, risks and environmental impact arising from activities that will occur at the Bruce site in handling and additional packaging and then the transportation to the alternate site receiving facilities. In doing so it raises important questions about the positive and negative factors of transport of waste to alternate locations. We learn from this that alternate means of long term surface storage and disposal of very low L and ILW and short lived L and IL waste are factors to consider. We make observations that point to the possibility of a centralized alternate location for short duration waste, and/or for local disposal for very low L and ILW at each of the three sites, or perhaps a combination of waste storage types/means on different sites, including at the Bruce site. A single or mixed approach could significantly reduce the requirements of packaging, the transportation quotient and the environmental effects of the alternate DGR case for L and ILW. With regard to the DGR design as currently proposed, a change favouring alternative storage options for separated short and long lived waste, could significantly reduce the size of a L and ILW DGR, and could reduce the size of or eliminate the need for a DGR, at all.

There are many ways that managing L and ILW off-site would significantly reduce environmental impact over and above advantages to transportation impact, and impact on the size of the DGR. These should be fully explored, in order to prepare a fully developed analysis of transportation and handling of waste off site, and in order to create analogues that will be able to be strategically evaluated.

## 5.0 OFF-SITE STORAGE AND DISPOSAL AND ON-SITE OPPORTUNITIES

Very short duration LLW is typically stored, separated and then disposed of in a permanent designated landfill, or recycled. Short lived L and ILW (with background radiation level decay of 300 years) is typically stored in scientifically designed and proven near surface (2 m to 300 m below grade) facilities, or in enhanced, purpose designed surface storage facilities. Examples of such facilities that are recently operational are described in the OPG EIS and the IR Responses (see, Sweden and Finland).

Near surface disposal, and even enhanced disposal, or near surface repositories are not a likely alternate on sedimentary sites that have like the Bruce site are in proximity to major fresh water bodies, or to significant wetlands on sedimentary bedrock, but such dedicated sites for ILW could likely be engineered in granite bedrock.

Unlike granitic rock, sedimentary rock (such as is found in Southern Ontario and under the 200 to 300 metre zone below OPG DGR property at the Bruce nuclear site) is characterized by complex horizontal stratigraphy, varied rock mass, high salinity at depth, near surface and transverse faults and fresh water aquifers. Leakage of contaminants from the storage or disposal area in normal or malfunction scenarios, adverse weather or accident would be conveyed to the atmosphere, ground water or proximate water body potentially in a very short period of time. Disbursal by diffusion and dilution into the lake or air above the DGR site is not a below criteria event as characterized by OPG's Independent Expert Group, or in testimony; it would have a significant adverse effect on multiple VECs.

## 6.0 ECONOMIC FEASIBILITY

OPG Study of Alternative Locations e.1.2 Economic Feasibility states,

*For the purposes of the alternate locations study, the economic feasibility criterion is: Does OPG have the ability to finance the DGR at an alternate location?*

*The threshold for the economic feasibility criterion is whether OPG reasonably expects to be able to finance the cost of the DGR at an alternate location from internal sources, or through debt financing or a combination of the two. The economic feasibility threshold is satisfied because in OPG's judgement OPG expects to be able to secure financing for the DGR at either of the alternate locations through one or more of the mechanisms, if required.<sup>86</sup>*

The above excerpt is the full text response to the Minister on economic feasibility.

A Minister's request for an explanation regarding economic feasibility and thresholds that address potential overages on the Project (one that will involve billions of dollars and take a century to complete) would seem to warrant more than a three sentence response. In fact OPG's ability to fund it is limited as are the mechanisms that are available to it. The response by OPG smacks of entitlement is dismissive and is not defensible politically or otherwise.

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<sup>86</sup> Study on Alternative Locations, p. 18

The OPG DGR 1 funding sources are unique to the OPG DGR, waste and decommissioning projects and are subject to an agreement between OPG and the Province of Ontario. The agreement describes OPG obligations to deliver the segregated fund and to manage it, and identifies OPG thresholds and where the Province kicks in. The threshold for demonstrating financial feasibility requires exceptional diligence and precision, especially from an industry (the nuclear industry) in combination with a mining industry that are both known for the extreme nature of their extended duration and budget overruns.

The expert report of Energy Solutions, for the cost of environmental effects on alternate locations in sedimentary and granitic rock, provided information (albeit for a conceptual location with no data on VECs that would be affected enroute) on transportation, mitigation of transportation, additional processes, and additional development costs. This information, although not fully developed, could have been put to use by OPG and was not. There was no comparison of the hypothetical examples and the character of additional factors, the benefits that would accrue to the Bruce site if all or part of the waste was diverted from the site. There have never been similar questions that have arisen or been answered about the DGR at the Bruce site, on issues of accident, or similar evaluation of transportation on and off site during in situ handling of the waste at the site, or at a site that contained the DGR at the Bruce. Values for addressing claims for accidents and property damage caused by unforeseen events on the DGR site, to the community and in the course of transport and stigma, have not been identified.

The OPG Report describes values identified for “other incremental costs (non-transportation)” ranging between \$0.8B and \$2.1 for alternate site development and including “site characterization of an alternate location, regulatory approvals, and site preparation and infrastructure development.” There is no baseline for this account, vis a vis the parallel costs during continued development of the Bruce DGR, before it is complete its site characterization and licensing. There is no accurate cost estimate for these ranges, and the costs are irrelevant given that there are no actual sites (in sedimentary or granitic locations) or actual distances that can be estimated to those sites. Estimates for infrastructure development are premature; land values for acquisition could be zero, or highly expensive. Estimates for administrative costs are also not based. In summary, the estimates are frivolous; to compound this, the estimates for the DGR at the Bruce, for 2.4 billion dollars life cycle cost for are also unsubstantiated. There is no basis for discussing economic feasibility of the baseline, or the alternates.

## **7.0 USES OF BASELINE PACKAGING AND TRANSPORTATION INFORMATION**

Energy Solutions Canada study provides the baseline for us to compare environmental impact risk and costs between one alternate location and another. Important questions about off site are not well answered; there is no actual location, therefore the distances costed and measured varies; the distances up to 2,000 kilometers of the whole volume raises immediate questions about whether all of the waste, or only part of the waste should be packaged and transported; is the transport of all L and IL waste to the alternate DGR the most economical, safest approach and are there alternate means that can reduce the environmental impact of the OPG DGR project on the Bruce Nuclear site.

The information provided by OPG for the study assumes that all of the L and ILW needs to be transported to fill up a DGR at the Bruce or elsewhere. This does not reflect the opportunities that could be achieved, if waste is transported in whole or in part to an alternate location.

## **8.0 PACKAGING AND TRANSPORT OF L AND ILW: THE OBLIGATION AND OPPORTUNITY TO RE-EXAMINE ASSUMPTIONS**

The international standard for storage, recycling or disposal of very low and short lived L and ILW does not require a DGR. Very low short lived L and ILW often reaches near-background radiation levels within hours or days, and may be recycled or disposed of in designated local land fill sites. The Forsmark L and IL facility at Forsmark, Sweden has been using this approach for many years.

Short lived L and ILW reaches background radiation levels in 300 years. The international standard for permanent storage and disposal is near surface storage or above ground facilities. Deep geological repositories are not used because better, more cost effective alternatives have been developed such as currently in use in Sweden, France and Belgium.

Exact numbers vary but the OPG submission estimates in the Report confirm that up to 93% of the waste proposed for the OPG DGR at the Bruce Nuclear site is very low or short lived waste by volume, and yet none of this figured in the analysis.

The business plan that justified a DGR on the OPG DGR site at the Bruce nuclear site came about 2004 and is a reflection of the politics, available technologies and economic development plan particular to that time.

In order to evaluate environmental effects on an alternate site or incremental transportation costs and risks and how to mitigate them and arrive at an informed fact based conclusion, it is important to re-examine assumptions.

Combining surface storage and disposal options with the opportunity provided by moving L and IL waste off the site creates obvious advantages as it reduces travel distance and opens up the possibility of a centralized surface storage facility.

The following series of diagrams follow the flow chart used in the expert's study and shown again in the OPG Report as Figure 3.3 (Key Steps in L & IL W Transportation from the WWMF to an Alternate Location). We have adjusted these diagrams in part to illustrate a number of points.

**Figure 1:** The diagram on the right is from the OPG Report. It depicts how the WWMF L and IL waste would be processed and deposited into the OPG DGR. What is shown below the dashed line depicts the additional packaging and handling (orange), transport to and from the alternate DGR site (purple) and the processing (blue) required before the L and IL waste is deposited into the DGR at the alternate site. A total of 22,000 trips to and from the alternate site are required to transport all the waste from the WWMF to the alternate location.

Our adjustment of the OPG Diagram to the left shows the addition of trips currently taking place from the Pickering and Darlington sites to the WWMF, a total of 300 KM each way, in order to complete the transportation diagram.

**Figure 2:** Is the same diagram, but it is further adjusted to show the effect on packaging and transport routes by shipping very LL and IL and short duration LL and IL directly from the source of the waste at

Pickering, Darlington and Bruce Nuclear sites from the WWMF to above ground storage and disposal facilities.

**Figure 3:** Describes the L and ILW production, packaging, transport, processing and storage and disposal process once surface storage is introduced. The effect of creating separate pathways for very low and short duration L and IL waste creates efficiencies that can benefit both the OPG DGR at the Bruce Nuclear sites and improve the viability of the alternate sites by reducing their size and environmental impact as they would still be needed to address long lived IL. The diagram indicates very low LL and IL not far from the nuclear facilities and short lived storage (300 year) LL and IL in an isolated, “high and dry,” centralized, surface storage facility.

The effect of using the study to inform innovation creates new opportunities to reduce the volume of waste being transported to the alternate DGR site by over 90%. Transportation distance and environmental impacts would be reduced and individual trips would be distributed between the three nuclear sites rather than concentrated about the Bruce Nuclear site. The capacity for the DGR facility could be reduced as well.

The red flow path in the diagram indicates the path for Used Fuel and High Level ILW currently stored at each site. It shows the waste in 2040 being transported alternately to a Fast Neutron Reactor site for reprocessing or being sent to a very deep DGR facility. OPG is aware of both alternatives and the research that is taking place in France, China and the USA on these important strategies to address innovations while dealing responsibly with this difficult and important issue.

## **9.0 PACKAGING AND TRANSPORT AND THE EFFECT ON DGR SIZE AND USES**

The question should be raised as to whether disposal of very low level short lived nuclear waste in a designated land fill site (such as has recently been undertaken in Port Hope) is reasonable in the case of the Bruce site in combination with other forms of waste storage and disposal to reduce cost, volume and environmental impact. Deep burial at 680 metres below grade simply does not make sense for LL and short lived ILW. A well-developed surface disposal strategy on or off site if implemented could reduce costs and lower environmental impact.

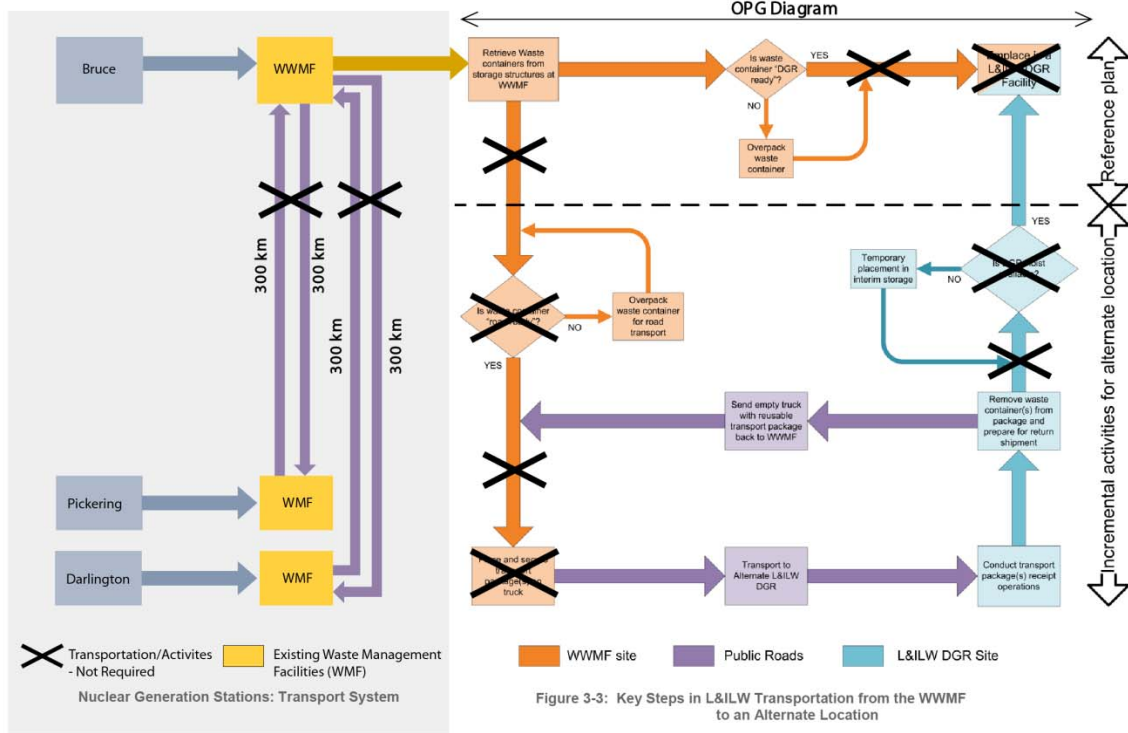
Long lived intermediate level waste is currently stored on the DGR site. From OPG estimates in the OPG Report this type of waste constitutes less than 10% of the waste volume and must be disposed of in a DGR or remediated and recycled, potentially off site.

The OPG response to the Minister on processing and transportation costs emphasize the higher challenges, risks and costs associated with moving L and IL nuclear waste materials to a DGR at distance from the Kincardine, Darlington and Pickering sites.

A practical science and research-based approach for production, operations and decommissioning generated waste that stems from an open and informed decision-making process could result in a significant reduction in the shipment to the Bruce Site, a significant reduction in the distance traveled to a disposal site, and overall a more sustainable solution, if sustainability is measured in GHG reduction.



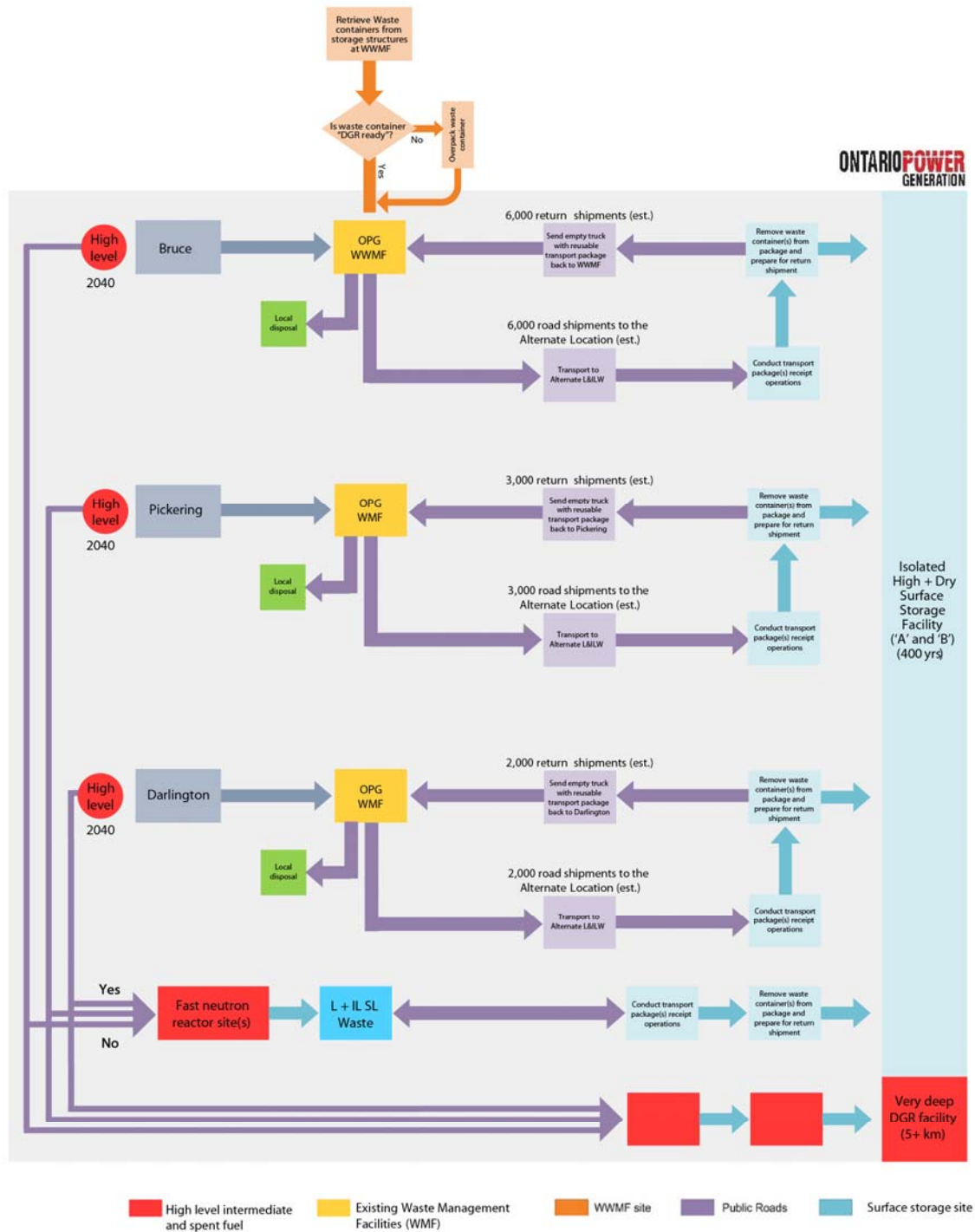
## TRANSPORT SYSTEMS TO NUCLEAR GENERATING STATIONS -02



**Figure 02 Step 1:** Showing transportation and additional processes not required. Nuclear Generating Stations indicating transportation to the WWMF on the Bruce Site, shown adjacent to the OPG's diagram "Key Steps in L&ILW Transportation from the WWMF to an Alternate Location" (Fig. 3-3, p. 26 of OPG Study of Alternate Locations - Main Submission, Dec 2016)



## TRANSPORT SYSTEMS TO NUCLEAR GENERATING STATIONS -03



**Figure 03 Step 2: Alternate Site Transportation and Processes.** Nuclear Generating Stations indicating transportation to the WWMF on the Bruce Site, shown with re-organized OPG's diagram "Key Steps in L&ILW Transportation from the WWMF to an Alternate Location" (Fig. 3-3, p. 26 of OPG Study of Alternate Locations - Main Submission. Dec 2016)

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**Response to OPG's Updated  
Analysis of Cumulative  
Environmental Effects [Doc 00216-  
REP-07701-00018]**

## OVERVIEW

In February 2016, Canada's Minister of Environment and Climate Change issued Ontario Power Generation (OPG) with three questions that she needed responses to before she would be able to make a decision on OPG's proposed Deep Geologic Repository (DGR) at the Bruce Nuclear site for its low and intermediate level radioactive wastes.

One of those questions was on cumulative environmental effects:

An updated analysis of the cumulative environmental effects of the Project in light of the results from the Phase 1 Preliminary Assessments undertaken by the Nuclear Waste Management Organization, which identified three potential host communities that fall within the traditional territory of the Saugeen Ojibway Nation.<sup>87</sup>

Many of the participants at the hearings of the Joint Review Panel on this matter in 2013 and 2014 pointed out the severe failings of the OPG's cumulative environmental effects assessment. Among these was OPG's failure to include in its assessment the Nuclear Waste Management Organization's (NWMO) plans to possibly build a DGR for the high level radioactive wastes from the used nuclear fuel bundles from throughout Canada near OPG's proposed DGR. This was seen as a very serious limitation in OPG's cumulative effects assessment. Therefore, we were very pleased to see the Minister require this addition.

Ten months later, in December 2016, OPG released its response to the Minister's question. OPG concluded:

The updated cumulative effects assessment of the APM DGR<sup>88</sup> identified no likely adverse cumulative effects given the location of the potential site for the APM DGR and the limited extent of the environmental effects of the DGR Project at the Bruce Nuclear site and the APM DGR. Moreover, the updated assessment concluded that cumulative effects as a result of malfunctions, accidents and malevolent acts from the DGR Project at the Bruce Nuclear site and the APM DGR are unlikely. Since no adverse cumulative effects were identified, an assessment of significance of cumulative effects is not required. The original conclusions presented in the Environmental Impact Statement (EIS) regarding cumulative effects of the DGR Project at the Bruce Nuclear site and other projects and activities remain valid when the APM DGR is considered.<sup>89</sup>

Unfortunately, OPG has repeated the basic flaw in its original EIS where it stated: "**No residual cumulative effects** were identified."<sup>90</sup> They now conclude: "Since **no adverse cumulative effects** were identified, an assessment of **significance** of cumulative effects is not required" [bolding added in both quotes].<sup>91</sup>

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<sup>87</sup> Letter to Laurie Swami, Ontario Power Generation, from Catherine McKenna, Minister of the Environment, Canada, Feb. 18, 2016.

<sup>88</sup> The term APM used throughout by OPG refers to "Adaptive Phased Management", a phrase used by NWMO, which includes all facilities and processes at the site related to NWMO's plans for the highly radioactive nuclear fuel bundles.

<sup>89</sup> *Updated Analysis of Cumulative Environmental Effects*, December 2016, p. v.

<sup>90</sup> *OPG's Deep Geologic Repository for Low & Intermediate Level Waste, Environmental Impact Statement: Volume 1*, March 2011, p. xiv.

<sup>91</sup> Second last sentence in quote referred to in footnote 2.

The assertion of “No residual effects” throws into question the validity of OPG’s entire environmental impact statement upon which this finding is based because nothing has no effect.

By asserting that there are “no residual effects” and “no adverse cumulative effects”, OPG’s December 2016 report in response to the Minister’s requirement begins with a premise that makes it virtually impossible for the new assessment to show any problems. It starts with an impossible “zero” for the OPG’s DGR and then adds to it another impossible “zero” for the NWMO’s DGR. **Zero + Zero = Zero.** Or even more outrageous, if there was a significant effect for the same item at the NWMO’s site, OPG would come up with a formula where **Zero + Something = Zero.** This would occur because they have set it up so that you need to have a significant residual effect at **both** sites on the **same** residual effect to get beyond zero.

If OPG had started with an assertion of “insignificant” or “acceptable” residual effects (something that we might have debated), they would create the potential for a true cumulative effects equation. This one could result in a situation where **insignificant residual effects + insignificant residual effects could equal significant cumulative effect.** This is the whole idea of a cumulative effects assessment.

For example, the Canadian Government’s *Cumulative Effects Assessment Practitioners’ Guide*<sup>92</sup> states in its introduction:

Concerns are often raised about the long-term changes that may occur not only as a result of a single action but the combined effects of each successive action on the environment.... These incremental effects may be significant even though the effects of each action, when independently assessed, are considered insignificant.

The United States Environmental Protection Agency in its guidance on cumulative impacts assessment takes an approach similar to Canada’s when it states:

The combined, incremental effects of human activity, referred to as cumulative impacts, pose a serious threat to the environment. While they may be insignificant by themselves, cumulative impacts accumulate over time, from one or more sources, and can result in the degradation of important resources.<sup>93</sup>

In the latter situation, we could debate whether the cumulative effects are truly “insignificant” or “acceptable.” But by using a “no cumulative effects” assertion (an impossible situation) OPG immediately slams the door shut on a discussion of whether the cumulative effect is insignificant or acceptable.

And so, the OPG responded to the Minister’s question by concluding: “Since no adverse cumulative effects were identified, an assessment of significance of cumulative effects is not required.”<sup>94</sup> OPG has thus avoided seriously confronting the question that the Minister posed to them.

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<sup>92</sup> 1.0 Introduction in *Cumulative Effects Assessment Practitioners’ Guide*, prepared for the Canadian Environmental Assessment Agency by the Cumulative Effects Assessment Working Group, February 1999.

<sup>93</sup> “Consideration of Cumulative Impacts,” in *EPA review of NEPA Documents*, May 1999, p. 13.

<sup>94</sup> *Updated Analysis of Cumulative Environmental Effects*, December 2016, p. v.

## 1.0 THE ORIGINAL FLAWED CUMULATIVE EFFECTS ASSESSMENT

We were instructed by the Canadian Environmental Assessment Agency to comment only on the OPG's new analyses directly related to the Minister's three questions from February 2016. Therefore, we will keep our comments thus limited.

However, because the Minister's question two on adding NWMO's possible activities to the cumulative effects assessment involves adding any findings on the NWMO effects to the cumulative effects assessment OPG had carried out earlier, we find it necessary to remind the Minister of how flawed that original assessment was. Instead of rearguing those points, we will simply provide a brief list of some of the basic flaws that have already been raised by participants in the hearings in 2013 and 2014. The following are some of the basic flaws raised earlier:

- Failure to conduct cumulative environmental effects assessment of alternative ways of addressing the problem;
- Severely limiting the geographic scope of the analysis;
- Severely limiting the possible future facilities that are included in the cumulative environmental effects assessment;
- Omitting uncertainties;
- Deleting items if OPG does not consider them to be significant.

The Joint Review Panel (JRP) contracted with environmental assessment expert Peter Duinker to provide comments to them on OPG's cumulative effects assessment. Duinker concluded that

the analysis embodied in the EIS and Consolidated Responses is:

- not credible – the work does not adhere to what I perceive to be the scientific principles of CEA;
- not defensible – the methods are not consistent with CEAA requirements and guidance;
- clear enough – I believe I could understand OPG's approach from the descriptions provided;
- reasonably complete;
- not reliable – other expert assessors could easily come to different conclusions;
- inappropriate – the methods, as shown above, are in substantive aspects incorrect.<sup>95</sup>

As a result of this seriously flawed cumulative effects assessment, OPG could not provide a valid answer to the Minister's question without basically redoing their entire assessment. The Minister's question asked the OPG to address one failure - to include the NWMO's activities, but this important addition cannot be carried out properly when the assessment has so many other omissions and flaws in it.

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<sup>95</sup> Peter Duinker, "Review of OPG's Application of (a) Environmental Assessment (EA) Methodology with Emphasis on the Prediction of the Significance of Adverse Environmental Effects, and (b) Cumulative Effects Assessment," August 30, 2013, PMD 13-P1.07, p. 12.

## **2.0 ANALYSIS OF OPG’S UPDATED ASSESSMENT OF CUMULATIVE EFFECTS: GETTING TO “ZERO”**

After looking at each situation where both the OPG DGR and the NWMO APM DGR could have an overlapping effect on the same “Valued Ecosystem Component” (VEC), OPG concludes: “No residual adverse cumulative effects of the DGR project at the Bruce Nuclear site were identified in consideration of the APM DGR.”<sup>96</sup> Their analysis gave them no basis to come to that conclusion. The following are some reasons for that.

Inadequate data on NWMO’s APM DGR to reach a “no effect” conclusion:

To help the OPG address the Minister’s question, the NWMO prepared a description of their facility for the OPG.<sup>97</sup> The NWMO titled this document “Preliminary Description.” Quite rightly, the NWMO places substantial qualifiers on their description because they are well over a decade from the stage of having a specific site or a detailed design for their facilities and operations. The NWMO qualifies its work by phrases like “preliminary,” “description at a conceptual level,” “based on what is known or reasonably expected at the present time.”<sup>98</sup>

Most of NWMO’s 31-page document is a description of their process and the “conceptual design.” They then include a brief (three and a half page) description of the types of emissions, discharges and wastes that they expect with general statements that they will meet federal and provincial regulatory limits and standards and their operating licence requirements and permits. NWMO concludes with a description of the environmental context and mitigations, which again is brief (6 pages). The NWMO does not come to a conclusion on effects.

Our comments here should not be read as a criticism of the NWMO. At this still preliminary stage, it is impossible for the NWMO to be more precise and it is impossible for them to make serious assessments of effects. To pretend to do so would be misleading.

OPG takes this “preliminary description” to come to the definitive conclusion that there would be “no cumulative effects” from the APM DGR at the OPG site. It is impossible to be that definitive on the basis of such limited information.

OPG only looks for a cumulative effect if there was a residual adverse effect for the same item at the OPG DGR site:

OPG begins its cumulative effects assessment by stating that it will only consider the possible residual effects of NWMO’s APM DGR if the OPG has already concluded that there would be residual effects at their own site.<sup>99</sup> This situation is made even worse by the fact that if the OPG had determined that a residual effect was not significant, they defined it as having zero effect.<sup>100</sup> This results in OPG immediately removing a page-long list of Valued Ecosystem Components from their analysis and from

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<sup>96</sup> OPG, *Updated Analysis of Cumulative Environmental Effects*, 2016, p. 35.

<sup>97</sup> *APM DGR Preliminary Description*, December 2016.

<sup>98</sup> *Ibid.*, p. iii.

<sup>99</sup> OPG, *Updated Analysis of Cumulative Environmental Effects*, 2016, Table 3-2, p. 10.

<sup>100</sup> The only VEC that OPG examined in this new cumulative analysis despite the fact that it was determined to have no residual effect in the earlier analysis was radiation and radioactivity.

their answer to the Minister's question. This means that, even if the NWMO's APM DGR were to have an effect that was substantial, this effect would not be considered if OPG had already decided that there would be no effect for a similar item at the OPG's site. This fits into their misguided approach of using a formula where zero plus something means "zero". As stated earlier in our analysis (see page 3), the Canadian Government and the US EPA and most other practitioners state that an insignificant effect can become significant when cumulated with another effect.

Improper limitation based on OPG's "overlapping" criteria:

OPG limits its cumulative effects impact assessment only to the following situation: "Where an effect may overlap in time and space on a VEC, the effect is described."<sup>101</sup>

Peter Duinker, the expert hired by the JRP, was particularly critical of the overlapping restrictions that OPG uses:

In my opinion, the actions and their pathways of influence on the VEC do NOT need to overlap in time ..., nor space ..., nor type ... OPG has unduly restricted its attention on CEs by insisting that only those where temporal, spatial, AND type of overlaps are involved merit assessment.<sup>102</sup>

In its response to the Minister's question on adding the NWMO's APM DGR to the cumulative effects assessment, the OPG has continued the same type of flawed analysis.

Interprets non-definitive phrases to mean "no":

The most important part of the OPG's report is section 5 Updated Assessment of Cumulative Effects in Consideration of the APM DGR. In section after section they take qualified conclusions and turn them into definitive statements of "no." For example [bolding added]:

- Conclusion on surface water: "**no likely** adverse cumulative effect" becomes "**will not** act cumulatively" later in the same sentence;<sup>103</sup>
- Conclusion on air quality: "adverse cumulative effects ... is **not likely**."<sup>104</sup>
- Conclusion on human health: "an adverse cumulative effect ... on human health is **not likely**."<sup>105</sup>
- Conclusion on radiation and radioactivity: "a cumulative effect on radiation and radioactivity as a result of the DGR Project at the Bruce Nuclear site and the APM DGR is **unlikely**."<sup>106</sup>

And yet they conclude the section by definitively saying: "No residual adverse cumulative effects of the DGR Project at the Bruce Nuclear site were identified in consideration of the APM DGR."<sup>107</sup>

To completely drop an "unlikely" effect from the analysis implies that it won't happen – that the chance of it happening is zero. The submission by Eugene Bourgeois and Anna Tilman on probabilities shows

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<sup>101</sup> Ibid., p. 5.

<sup>102</sup> Peter Duinker, July 2013, p. 10.

<sup>103</sup> OPG, *Updated Analysis of Cumulative Environmental Effects*, 2016, p. 19.

<sup>104</sup> Ibid., p. 27.

<sup>105</sup> Ibid., p. 30.

<sup>106</sup> Ibid., p. 34.

<sup>107</sup> Ibid., p. 35.



the fallacies of such reliance on probability and likelihood statements.<sup>108</sup> It may be unlikely but there could still be an impact a year from now, or a hundred years from now, or a thousand years from now. In the case of the materials we are dealing with here, the cumulative effects assessment must be aimed at protecting the environment for today, tomorrow and for the very, very, very long-term future. In addition, given the nature of the materials planned to be buried in the two proposed DGRs, one incident could be enough to have a dramatic negative impact.

Uses a restricted definition of geographic overlap and the terrain or people to be protected:

This problem shows up most strikingly in the transportation section. In the discussion of noise issues, OPG concludes that there will be no cumulative effect from transportation of trucks to the OPG DGR and to the NWMO's APM DGR in the "vicinity of Baie du Doré".<sup>109</sup>

This ignores the fact that the cumulative effects may happen along the transportation routes – not just near the OPG site. For example, the prime transportation route that OPG currently uses to get to its Bruce site is up Highway 9 through Harriston, Clifford, Mildmay, etc. If the NWMO site were to be built in the Municipality of South Bruce, this would likely mean adding truck traffic for the construction and for the delivery of used fuel bundles to the NWMO's APM DGR site to the part of Highway 9 below the APM DGR site. The environment, the people and the non-human biota along this transportation route would be subject to cumulative effects from the presence of two DGRs to the north and west of them.

Also, OPG only speaks of noise issues when referring to transportation concerns. However, the cumulative effects along the transportation route would also include air emissions, including exposure of bystanders to radionuclide releases during transportation, and increased risk of accidents with resultant exposures.

### **Malfunctions, Accidents and Malevolent Acts: A Prime Example of the Errors**

Section 6 of OPG's *Updated Analysis of Cumulative Environmental Effects* is a startling example of OPG's failure to seriously consider cumulative effects throughout this report. Using OPG's methods of downplaying the problem as just described in our comments they conclude:

If a non-radiological spill were to occur during the construction, operation or decommissioning of the APM DGR, it is expected that, similar to the DGR Project at the Bruce Nuclear site, it would be responded to quickly, and remedial actions put in place to limit effects on the environment. Therefore no adverse cumulative effects are likely as a result of a non-radiological spill.<sup>110</sup>

OPG makes similar conclusions about the possible radiological impacts.

This section is filled with words and phrases that downplay the issues. It must be remembered that malfunctions, accidents and malevolent acts are items that often occur unexpectedly.

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<sup>108</sup> Comments on Ontario Power Generation (OPG)'s *Updated Analysis of Cumulative Environmental Effects* Report, March 1, 2017, p. 5.

<sup>109</sup> OPG, *Updated Analysis of Cumulative Environmental Effects*, 2016, pp. 28 & 29.

<sup>110</sup> *Ibid.*, p. 39.

- OPG: “These scenarios [inadvertent human intrusion, shaft seal failure, poorly sealed borehole, and vertical fault scenarios] were very unlikely to occur, so the risk (probability and consequence) remained low.”<sup>111</sup>

To link low probability with low consequence is very misleading. It may take only one accident over the lifetime of the facility to have a devastating consequence for the area.

- OPG: “There were no credible malfunctions or accident scenarios that would lead to radiological impacts off-site above regulatory criteria.”<sup>112</sup>

OPG dismisses many items as not being “credible”. Again the nature of accidents and malfunctions is that many of them may not be predictable and, therefore, they would not today be seen as predictable or in OPG’s language as “credible”. Also so much of OPG’s argument is based on meeting “regulatory criteria”. The history of our regulatory system is that we keep strengthening the regulatory criteria as we come to a better scientific understanding of the negative consequences of the materials we are dealing with and of the susceptibility of the environment and human health. Therefore, we should not assume that because we are meeting today’s standards all is well. Fifty years from now or one hundred years from now will society look back at today’s standards as being primitive?

- OPG: “If a non-radiological spill were to occur during the construction, operation or decommissioning of the APM DGR, it is expected that, similar to the DGR Project at the Bruce Nuclear site, it would be responded to quickly, and remedial actions put in place to limit effects on the environment. Therefore, no adverse cumulative effects are likely as a result of a non-radiological spill.”<sup>113</sup>

“Expected that ... it would be responded to quickly” is not a high level of assurance. Many accidents have not been responded to quickly because they were not expected and there was not immediate awareness that a problem had occurred. And OPG jumps from this “expected” or hoped for situation to draw a conclusion of “no adverse cumulative effects are likely” which they translate into “no effects.”

OPG also emphasizes throughout this discussion that it is unlikely for there to be a problem at both the OPG’s DGR site and the APM DGR site at the same time. The Canadian Nuclear Safety Commission (CNSC) challenged this assumption. CNSC called upon OPG to:

Provide a narrative description and potential effects for the scenario of an undetected or new transmissive fault that cuts through both the OPG DGR and the proposed APM DGR sites in sedimentary rock, and consider these effects within the cumulative effects assessment.<sup>114</sup>

In addition, as asserted by Duinker and other environmental assessment experts, the events do not have to occur simultaneously to have a cumulative effect.

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<sup>111</sup> Ibid., p.36.

<sup>112</sup> Ibid.

<sup>113</sup> Ibid., 39.

<sup>114</sup> Letter to Canadian Environmental Assessment Agency from Caroline Ducas of the Canadian Nuclear Safety Commission, January 16, 2017, Table 2, Item CNSC-09

In another example:

- OPG: “Security measures and safeguards will be implemented at the DGR Project and the APM DGR. Combined with the distance between the projects, this would decrease the likelihood of both projects being subject to malevolent acts.”<sup>115</sup>

One cannot predict how thoroughly a “malevolent” act will be planned and, therefore, should not make the assumption that such an act might not be deliberately planned to hit both facilities at once. This section pays very little attention to the possibility of malevolent acts.

### **Cumulative Impact on Public Sense of Well-being, Safety and Security**

OPG has only one paragraph on possible cumulative effects on the sense of well-being for people living in the community. This paragraph is in the section on malfunctions, accidents and malevolent acts. OPG here says that accidents could result in “**further** erosion of people’s feelings of well-being and sense of safety and security” [bolding added].<sup>116</sup> This admission of existing erosion of people’s feelings makes it clear that this issue should have been one of the vectors that they included in the entire cumulative effects assessment and, in this case, on the effects on people if both the OPG DGR and the NWMO’s APM DGR were in the same community.

For the purpose of this analysis, OPG placed the two facilities twenty kilometres apart. A twenty-kilometre distance is close enough to consider it as one community with sub-communities within it – especially in a mixed small urban and rural area. All people within that broader community will hear of problems that arise at either of the OPG or NWMO facility.

In addition, for these events to have cumulative effects on all residents, it is not necessary for it to be the same problem occurring at both sites, and it is not necessary for the problems to be near each other time wise. People’s memories of a problem at one time will combine with their memories of the same or other problems over time causing “further erosion of people’s feelings of well-being and sense of safety and security.”

Also, cumulative impacts of negative events at the OPG DGR and the NWMO’s APM DGR could combine over time to affect the attitude of people in other parts of the province towards this community. In the previous hearing, the issue of “community stigma” was brought forward by several parties. Simply stated, it means that people from outside the community look negatively at people living within a particular geographic area because of facilities and/or events in that community that are seen to in some way degrade that community. Such stigma is something that is likely to cumulatively develop if there are negative events in the community – the likelihood of which is likely to increase if there are two nuclear waste burial facilities in the community. This stigma would add to the “erosion of people’s feelings of well-being and sense of safety and security.”

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<sup>115</sup> OPG, *Updated Analysis of Cumulative Environmental Effects*, 2016, p. 39.

<sup>116</sup> *Ibid.*

OPG says that these problems and cumulative effects can be “mitigated through further communications and educational programs by both proponents.”<sup>117</sup> They are so assured that these communications will remove the public’s concerns that there will not be a cumulative effect from accidents, etc. Despite extensive and intense public communications and outreach programs by DGR and also currently by the NWMO, substantial community concern is showing up, which indicates an “erosion of people’s feelings of well-being and sense of safety and security” even before the facilities have been put into place. One need only look at the number of people who made submissions during the OPG DGR hearings in 2013 and 2014 to get an indication of the concern. Again a large number of letters of concern have been sent to the Canadian Environmental Assessment Agency on OPG’s DGR over the past two months.

OPG’s failure to seriously consider “erosion of people’s feelings of well-being and sense of safety and security” as part of its cumulative effects assessment of having OPG’s DGR and the OWMC’s DGR near each other is a very serious omission from the “Updated Analysis of Cumulative Environmental Effects.”

### **Making Conclusions Based on Little if Any Evidence**

In an environmental assessment, a proponent is responsible for bringing forward sufficient evidence to support its conclusions. In its *Updated Analysis of Cumulative Environmental Effects*, OPG fails to bring forward sufficient evidence to come close to making the definitive sorts of conclusions that it reaches.

OPG made three main conclusions in this report.

#### OPG’s First Conclusion:

The updated cumulative effects assessment of the APM DGR identified no likely adverse cumulative effects given the location of the potential site for the APM DGR and the limited extent of the environmental effects of the DGR Project at the Bruce Nuclear site and the APM DGR.<sup>118</sup>

As shown on page 5 of this submission entitled “Inadequate data on NWMO’s APM DGR to reach a ‘no effect’ conclusion,” the NWMO’s report contains little if any evidence that could justify coming to a conclusion of “no effect” as stated by OPG. NWMO itself says in its report that its material is “preliminary” in nature. This is not strong evidence.

#### OPG’s Second Conclusion:

The updated assessment concluded that cumulative effects as a result of malfunctions, accidents and malevolent acts from the DGR Project at the Bruce Nuclear site and the APM DGR are unlikely.<sup>119</sup>

The section in the OPG’s document addressing this topic is full of assumptions but does not contain evidence to support those assumptions. For example, the OPG says that in the event of an accident, “it is

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<sup>117</sup> Ibid.

<sup>118</sup> *Updated Analysis of Cumulative Environmental Effects*, December 2016, p. v.

<sup>119</sup> Ibid.

expected that .... it would be responded to quickly.”<sup>120</sup> OPG provides no evidence to support this quick response expectation and doesn’t even define what they mean by “quickly” – within minutes? within hours? within days? They could all be called “quickly” but the consequences of these “quick” responses could be substantially different.

OPG’s Third Conclusion:

Since no adverse cumulative effects were identified, an assessment of significance of cumulative effects is not required.<sup>121</sup>

For a proponent to reach such a definitive conclusion on the basis of such clearly inadequate evidence is contrary to the most fundamental principle of environmental assessment. As a result, OPG’s conclusions in its response to the Minister’s question on cumulative effects of possibly having the NWMO DGR located in the same area as the OPG DGR should be given no credibility.

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<sup>120</sup> Ibid., 39.

<sup>121</sup> Ibid., p. v.

### 3.0 CONCLUSION

OPG's response to the Minister's question on the cumulative effects of possibly having both OPG's DGR and NWMO DGR in the same area is unacceptable. OPG concludes that "Since no adverse cumulative effects were identified, an assessment of significance of cumulative effects is not required."<sup>122</sup>

As our analysis has shown, OPG's conclusion is fatally flawed because it is full of unknowns and uncertainties. The NWMO cannot provide sufficient information at this time to come to a conclusion. Because of these uncertainties, the only valid conclusions the OPG could come to would be ones that recognize the uncertainties and accept the possibility of cumulative effects. Instead, OPG rejects all uncertainties by switching them to "no effects" conclusions. They imply, that to have any validity there has to be proof of likely damage rather than proving that there is no possibility of damage. They thus get us into a "zero equals zero" game (or a "zero plus something equals zero" game) instead of one where "insignificant effect plus insignificant effect could result in a significant cumulative effect." The latter is the approach normally accepted by cumulative effects practitioners.

By ignoring uncertainties and easily arriving at "no effects" conclusions, OPG has failed to use precautionary and prevention approaches. The precautionary and prevention approaches, now widely accepted by government<sup>123</sup> and society, are ones that assert that when there is uncertainty, we should be cautious and we should take prevention actions. These approaches are especially important in a situation where some of the materials being dealt with maintain such seriously hazardous characteristics for such long periods of time – in some cases, as stated by government, for a million years.<sup>124</sup>

Proponents often treat cumulative environmental effects assessments as a frivolous, unnecessary part of an environmental assessment. To the contrary, the cumulative environmental assessment is essential to give the public and government decision-makers the basis for coming to a conclusion on the acceptability of a proposed project in terms of its possible long-term impacts. Unfortunately, OPG's flawed cumulative environmental effects assessment cuts off this essential public discussion by asserting that there are no cumulative effects.

And so, the OPG responded to the Minister's question by concluding: "Since no adverse cumulative effects were identified, an assessment of significance of cumulative effects is not required."<sup>125</sup> OPG has thus avoided seriously confronting the question that the Minister posed to them and tried to cut off community discussion of this topic on which the Minister asked for essential information.

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<sup>122</sup> Ibid., p. v.

<sup>123</sup> See for example, "Principles and Approaches," in *Great Lakes Water Quality Agreement*, signed by the Canadian and U.S. Governments on September 7, 2012, Section 4. (i) and (j).

<sup>124</sup> See for example, Nuclear Waste Management Organization, *Choosing a Way Forward*, 2005, p. 341.

<sup>125</sup> OPG, *Updated Analysis of Cumulative Environmental Effects*, December 2016, p. v.

# **Cumulative Effects and Human Health**

**[Doc 00216-REP-07701-00018]**

## 1.0 OVERVIEW

“Ontario Power Generation Inc. (OPG) is currently seeking a licence to prepare the site for and construct a Deep Geologic Repository (DGR) for its low and intermediate level radioactive waste (L&ILW) at the Bruce Nuclear Generating Station site in the Municipality of Kincardine (the DGR Project at the Bruce Nuclear site).

As requested by the Minister of the Environment and Climate Change, OPG has completed an updated cumulative effects assessment for the DGR Project at the Bruce Nuclear site in light of recent work undertaken by the Nuclear Waste Management Organization (NWMO) with three potential host municipalities for an Adaptive Phased Management Deep Geological Repository (APM DGR). The updated assessment is based on a project description prepared for an APM DGR by NWMO for the purposes of this updated analysis and considers the three municipalities of Huron Kinloss, South Bruce, and Central Huron.

The updated cumulative effects assessment of the APM DGR identified no likely adverse cumulative effects given the location of the potential site for the APM DGR and the limited extent of the environmental effects of the DGR Project at the Bruce Nuclear site and the APM DGR. Moreover, the updated assessment concluded that cumulative effects as a result of malfunctions, accidents and malevolent acts from the DGR Project at the Bruce Nuclear site and the APM DGR are unlikely. Since no adverse cumulative effects were identified, an assessment of significance of cumulative effects is not required. The original conclusions presented in the Environmental Impact Statement (EIS) regarding cumulative effects of the DGR Project at the Bruce Nuclear site and other projects and activities remain valid when the APM DGR is considered.”<sup>126</sup>

The Canadian Environmental Assessment Agency invited the public, Indigenous groups and government bodies and other participants to review and comment on the additional information provided by OPG by March 7, 2017. It is anticipated that these comments will be taken into consideration by the Agency in its analysis and technical review of the additional information.

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<sup>126</sup> OPG Cumulative Effects Analysis - 2016



## 2.0 INTRODUCTION

Principle I of the Rio Declaration on Environment and Development states that “Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.”<sup>127</sup> “As human beings, our health and the health of those we care about is a matter of daily concern. Regardless of our age, gender, socio-economic or ethnic background, we consider our health to be our most basic and essential asset.”<sup>128</sup>

The right to health is a fundamental part of our human rights and of our understanding of a life in dignity. Internationally, it was first articulated in the 1946 Constitution of the World Health Organization (WHO), whose preamble defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. The preamble further states that “the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition.”<sup>129</sup>

“The 1948 Universal Declaration of Human Rights also mentioned health as part of the right to an adequate standard of living (art. 25). The right to health was again recognized as a human right in the 1966 International Covenant on Economic, Social and Cultural Rights. The working group has noted the underlying determinants of health to be:

- Safe drinking water and adequate sanitation
- Safe food
- Adequate nutrition and housing
- Healthy working and environmental conditions
- Health-related education and information
- Gender equality<sup>130</sup>

The Canadian environmental assessment process is key to ensuring OPG’s DGR project provides protection of human health and the environment now and in the future. Canadian legislation dictates that an EA must evaluate any potential health effects related to a change in the environment, itself the result of a proposed project. This is due to the stated meanings of the terms “environment” and “environmental effect” in the CEAA, which refer respectively to “all living organisms” and “health and socio-economic conditions”. In addition, all levels of Canadian government - territorial, provincial and federal - have endorsed the holistic formulation of the meaning of health proposed by the World Health Organization “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (Health Canada, 2004; WHO, 1987).”<sup>131</sup>

“Health is a function of highly complex systems, which can be unintentionally disrupted in unpredictable

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<sup>127</sup> Rio Declaration on Environment and Development.

<http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm/>

<sup>128</sup> The Right to Health. Office of the United Nations High Commissioner for Human Rights. Fact Sheet No. 31

<http://www.ohchr.org/Documents/Publications/Factsheet31.pdf>

<sup>129</sup> Ibid., p.1.

<sup>130</sup> Ibid., p.2.

<sup>131</sup> Human Health and Environmental Assessment in Canada: Implications for Wind Energy.

ways and result in adverse health consequences that may be serious and irreversible.”<sup>132</sup> “Substantial evidence supports the conclusion that contemporary environmental health risks result from complex interactions among genetic, nutritional, environmental and socioeconomic factors.”<sup>133</sup> As part of the Environmental Assessment a cumulative effect assessment is of utmost importance when considering the health effects of environmental change. To protect health, a well done cumulative effects assessment is necessary and a credible cumulative effects analysis is mandatory to evaluate the potential impacts on human health from this project. Unfortunately, OPG’s cumulative assessment for health effects fails to meet these standards.

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<sup>132</sup> The precautionary principle: protecting public health, the environment and the future of our children; Edited by: Marco Martuzzi and Joel A. Tickner , World Health Organization 2004, p.v.

<sup>133</sup> Ibid., p.3.

### 3.0 HEALTH EFFECTS

#### Air Quality and Particulate Matter

OPG's Cumulative Assessment Response <sup>134</sup>

*5.4.1 A residual adverse effect of the DGR Project at the Bruce Nuclear site on air quality was identified and was assessed to be not significant [OPG 2011a; OPG's response to IR-EIS-12- 510 (OPG 2014)]. The residual effect on air quality is predicted to extend just beyond the Site Study Area (i.e., just beyond the fence line of the Bruce Nuclear site) into the Atmospheric Environment Local Study Area (Figure 5-3), and is assumed to occur throughout the site preparation and construction, operation, and decommissioning phases at different magnitudes.*

*During site preparation and construction of the DGR Project at the Bruce Nuclear site, the maximum ambient concentrations are predicted to increase for nine of the air quality indicators, and the maximum ambient concentrations are predicted to be greater than their relevant federal and provincial ambient air quality criteria for 24-hour suspended particulate matter, 24-hour airborne particles with nominal aerodynamic diameters smaller than 10 micrometres ( $\mu\text{m}$ ) in diameter ( $\text{PM}_{10}$ ), and 24-hour airborne particles with nominal aerodynamic diameters smaller than 2.5  $\mu\text{m}$  in diameter ( $\text{PM}_{2.5}$ ). During operations of the DGR Project at the Bruce Nuclear site, the maximum ambient concentrations are predicted to increase for eight of the air quality indicators (the threshold for an adverse effect), but none of the predicted maximum increases is predicted to be greater than its relevant ambient air quality criteria.*

*The cumulative effects assessment for air quality described in the EIS [OPG 2011a] used the Atmospheric Environment Local Study Area as the cumulative effects study area (Figure 5-3).*

*Potential residual effects from the APM DGR on air quality have been identified during site selection, construction, operation, and decommissioning and closure of the APM DGR. The APM DGR will involve surface and subsurface investigations of the preferred site, vegetation clearing for site access, construction of surface and underground facilities, transportation of used fuel from nuclear sites to the APM DGR, vehicle and equipment use for placement of used fuel in the repository during operations, and vehicle and equipment use associated with decommissioning and closure activities. All these activities would contribute to changes in ambient air quality as a result of the APM DGR. Thus, the APM DGR is likely to have both an overlap in effect on the VEC (i.e., effects on air quality) and an overlap in time with the residual effects of the DGR Project at the Bruce Nuclear site on air quality.*

*The effects of the APM DGR on air quality are likely to be similar in nature to those identified for the DGR Project at the Bruce Nuclear site during site preparation and construction, operations, and decommissioning. However, the APM DGR will have repository construction activities throughout its operations phase, as additional placement rooms will be continuously excavated. It is estimated that approximately 1,580,000  $\text{m}^3$  of (unbulked) rock will be excavated for the APM DGR in comparison to*

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<sup>134</sup> OPG's Updated Analysis of Cumulative Environmental Effects. 00216-REP-07701-00018. December 2016

approximately 645,000 m<sup>3</sup> of waste rock that will be excavated for the DGR Project at the Bruce Nuclear site during underground construction. Thus the effects on air quality during site preparation and construction may be lower than for the DGR Project at the Bruce nuclear site, but would be higher in magnitude during the operation phase of the APM DGR relative to the DGR Project at the Bruce Nuclear site. Both projects occur within the Atmospheric Environment Regional Study Area (Figure 5-3) and therefore their effects on air quality may overlap spatially.

#### 5.4.2 Mitigation

The potential residual effects of the APM DGR are likely to occur at infrequent intervals similar to the residual effects of the DGR Project at the Bruce Nuclear site, due to the variability of hourly meteorological conditions. Good management practices and environmental management plans could be implemented to mitigate air emissions of the APM DGR, which would minimize the emissions of air quality indicator compounds throughout all phases. Applicable permits protective of the environment (e.g., an ECA from the MOECC) would be obtained, as required, for the operation of stationary sources at the APM DGR, which will require demonstration of compliance with applicable legislation (e.g., Ontario Regulation [O. Reg.] 419/05 of the Environmental Protection Act).

#### 5.4.3 Assessment of Cumulative Effects

The residual effects of the DGR Project at the Bruce Nuclear site occur within its Atmospheric Environment Local Study Area, which extends approximately 10 km around the Bruce Nuclear site. The effects of the APM DGR are unlikely to extend into the Atmospheric Environment Local Study Area as it will be at least 20 km distant and possibly as far as 86 km, depending on the location of the selected site.

It is recognized that a cumulative effect on air emissions could occur within the DGR Project at the Bruce Nuclear site Atmospheric Environment Regional Study Area (Figure 5-3) since the APM DGR will fall somewhere within one of the three communities this area and the air quality at this scale represents the effect of air emissions transported in the region; thus, there is a potential for regional spatial overlap of effects between the APM DGR and the DGR Project at the Bruce Nuclear site.

The potential residual effects of the APM DGR on air quality would occur at infrequent intervals that are unlikely to coincide with the effects of the DGR Project at the Bruce Nuclear site. They are also not likely to act cumulatively on air quality at the same receptors. It is unlikely 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 both projects, and it is also unlikely that they will persist in the atmosphere for the same duration, due to the likely variable timing of specific equipment operation and project activities. Considering the nature of the potential effects on air quality (i.e., immediately reversible), the anticipated mitigations that would be implemented at the APM DGR to meet local air quality requirements, the distance of the APM DGR from the OPG DGR Atmospheric Environment Local Study Area, the contribution of the APM DGR to cumulative effects on air quality would not be measurable (i.e., maximum cumulative concentrations of the air quality indicators resulting from the combined projects are not predicted to be higher than the maximum concentrations of the air quality indicators for one of the projects on its own).

*Therefore, adverse cumulative effects of the DGR Project at the Bruce Nuclear site in combination with the APM DGR on air quality is not likely. Based on the above, the assessment of cumulative effects in the EIS [OPG 2011a] for air quality remains valid in consideration of the APM DGR.*

## **SOSGL Literature Review: Particulate Matter**

According to the World Health Organization, clean air is a basic requirement of human health and well-being.

Particulate matter (PM) is a widespread air pollutant, present wherever people live, consisting of a mixture of solid and liquid particles suspended in the air. Its physical and chemical characteristics vary by location. Common chemical constituents of PM include sulfates, nitrates, ammonium, other inorganic ions such as ions of sodium, potassium, calcium, magnesium and chloride, organic and in addition. Biological components such as allergens and microbial compounds are also found in PM. Commonly used indicators describing PM that are relevant to health refer to the mass concentration of particles with a diameter of less than 10  $\mu\text{m}$  (PM<sub>10</sub>) and of particles with a diameter of less than 2.5  $\mu\text{m}$  (PM<sub>2.5</sub>). PM<sub>2.5</sub>, often called fine PM, also comprises ultrafine particles having a diameter of less than 0.1  $\mu\text{m}$ .

PM between 0.1  $\mu\text{m}$  and 1  $\mu\text{m}$  in diameter can remain in the atmosphere for days or weeks and thus be subject to long-range transboundary transport in the air.

Particles can either be directly emitted into the air (primary PM) or be formed in the atmosphere from gaseous precursors such as sulfur dioxide, oxides of nitrogen, ammonia and non-methane volatile organic compounds (secondary PM).

Primary PM and the precursor gases can have both man-made (anthropogenic) and natural (non-anthropogenic) sources. Anthropogenic sources include combustion engines (both diesel and petrol), solid-fuel (coal, lignite, heavy oil and biomass) combustion for energy production in households and industry, other industrial activities (building, mining, manufacture of cement, ceramic and bricks, and smelting), and erosion of the pavement by road traffic and abrasion of brakes and tires. Agriculture is the main source of ammonium.

Secondary particles are formed in the air through chemical reactions of gaseous pollutants. They are products of atmospheric transformation of nitrogen oxides (mainly emitted by traffic and some industrial processes) and sulfur dioxide resulting from the combustion of sulfur-containing fuels. Secondary particles are mostly found in fine PM.

Soil and dust re-suspension is also a contributing source of PM.<sup>135</sup>

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<sup>135</sup> WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Global update 2005. Summary of risk assessment.  
[http://apps.who.int/iris/bitstream/10665/69477/1/WHO\\_SDE\\_PHE\\_OEH\\_06.02\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/69477/1/WHO_SDE_PHE_OEH_06.02_eng.pdf); p.8.

According to the World Health Organization, “PM10 and PM2.5 include inhalable particles that are small enough to penetrate the thoracic region of the respiratory system.” The health effects of inhalable PM are well documented. They are due to exposure over both the short term (hours, days) and long term (months, years) and include:

- respiratory and cardiovascular morbidity, such as aggravation of asthma, respiratory symptoms and an increase in hospital admissions;
- mortality from cardiovascular and respiratory diseases and from lung cancer.

“Susceptible groups with pre-existing lung or heart disease, as well as elderly people and children, are particularly vulnerable. For example, exposure to PM affects lung development in children, including reversible deficits in lung function as well as chronically reduced lung growth rate and a deficit in long-term lung function (4). **There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur.** The exposure is ubiquitous and involuntary, increasing the significance of this determinant of health.”<sup>136</sup> The low end of the range of concentrations at which adverse health effects has been demonstrated is not greatly above the background concentration found in both the United States and western Europe.<sup>137</sup>

“In 2013, the International Agency for Research on Cancer (IARC) evaluated the carcinogenic effects of outdoor air pollution and particulate matter associated with outdoor air pollution. The IARC assessment focused on pollutants released as a result of anthropogenic activities, especially combustion and industrial processes. IARC classified outdoor air pollution and particulate matter associated with outdoor air pollution as Group 1, carcinogenic to humans.[3] This classification is based on sufficient evidence of an association between exposure and lung cancer in humans, and limited evidence that exposure causes bladder cancer. There was sufficient evidence supporting the carcinogenicity of various components of outdoor air pollutants (whole diesel engine exhaust, diesel engine exhaust particles, extracts of diesel engine exhaust particles, condensates of gasoline engine exhaust, extracts from coal-derived soot and wood smoke, and emissions from combustion of coal and wood) in animal studies. Finally, there was strong mechanistic evidence that outdoor air pollution (and associated particulate matter) has genotoxic effects.[3].”<sup>138</sup>

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<sup>136</sup> Health Effects of Particulate Matter. Policy Implications for countries in eastern Europe. Caucasus and central Asia. WHO 2013. p.6.

[http://www.euro.who.int/\\_data/assets/pdf\\_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf](http://www.euro.who.int/_data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf)

<sup>137</sup> Health Effects of Particulate Matter. Policy Implications for countries in eastern Europe. Caucasus and central Asia. WHO 2013. p.6.

[http://www.euro.who.int/\\_data/assets/pdf\\_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf](http://www.euro.who.int/_data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf)

<sup>138</sup> Carex Canada: Outdoor Air Pollution.

[http://www.carexcanada.ca/en/outdoor\\_air\\_pollution/](http://www.carexcanada.ca/en/outdoor_air_pollution/)

## Acrolein

OPG's Cumulative Assessment Response <sup>139</sup>

### 5.6 HUMAN HEALTH

#### 5.6.1 Potential Cumulative Effects

*A residual effect of the DGR Project at the Bruce Nuclear site was identified on the overall health of local residents and members of Indigenous communities with respect to the exposure to acrolein in air during the site preparation and construction phases (acrolein is generated by combustion sources including vehicles). However, based on the results of a human health risk assessment, the resulting health risks were considered low and the residual effect was assessed to be not significant [OPG 2011a]. The residual effect is predicted to be restricted to the Human Health Local Study Area, which corresponds to the 10 km emergency planning zone (centred at the Bruce Nuclear site), as identified by Emergency Management Ontario [OPG 2011a].*

*For the purposes of this updated analysis, the cumulative effects assessment for human health uses the Local Study Area as the cumulative effects assessment study area since the residual adverse effect of the DGR Project at the Bruce Nuclear site on human health is limited to that geographic extent.*

*The APM DGR will involve surface and subsurface investigations of the preferred site, vegetation clearing for site access, construction of surface and underground facilities, transportation of used fuel from nuclear sites to the APM DGR, vehicle and equipment use for placement of used fuel in the repository during operations, and vehicle and equipment use associated with decommissioning and closure activities. All these activities may require the use of motor vehicles which can contribute to acrolein emissions that may affect human health of local residents and members of Indigenous communities. Thus, the APM DGR has the potential to have an overlap of effect on the VEC (i.e., effects on human health) with the residual effects of the DGR Project at the Bruce Nuclear site on human health. The residual effects of the DGR Project at the Bruce Nuclear site on human health associated with acrolein in air occur within its Local Study Area. Thus, a spatial overlap of effects between the APM DGR and the DGR Project at the Bruce Nuclear site is unlikely, as further discussed in Section 5.6.3.*

*The effects assessment of the DGR Project at the Bruce Nuclear site determined that the contribution to acrolein concentrations resulting from the DGR Project at the Bruce Nuclear site is small relative to background levels. As discussed in Section 5.4, the effects of the APM DGR on overall air quality are likely to be similar in scale to those identified for the DGR Project at the Bruce Nuclear site, except that repository construction activities of the APM DGR will occur throughout its operation phase. Thus, the effects on overall air quality, including acrolein emissions, may be higher in magnitude than for the DGR Project at the Bruce Nuclear site during its operation.*

#### 5.6.2 Mitigation

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<sup>139</sup> OPG's Updated Analysis of Cumulative Environmental Effects. 00216-REP-07701-00018. December 2016

*Consideration for in-design mitigation measures, good management practices and environmental management plans could be used to mitigate air emissions of the APM DGR, which would minimize air emissions from motor vehicles throughout all phases of the project (see Section 5.4.2).*

### **5.6.3 Assessment of Cumulative Effects**

*Similar effects of the APM DGR on air quality are unlikely to extend into the DGR Project at the Bruce Nuclear site's Local Study Area as the APM DGR will be at least 20 km distant and possibly as far as 86 km, depending on the location of the selected site. However, it is recognized that a cumulative effect on overall air quality can occur within the DGR Project at the Bruce Nuclear site Atmospheric Environment Regional Study Area (Figure 5-3) since all APM communities fall within this area; thus, there is potential for a regional spatial overlap of effects between the APM DGR and the DGR Project at the Bruce Nuclear site to occur with regard to overall air quality.*

*However, the potential residual effects of the APM DGR on air quality would occur at infrequent intervals that are unlikely to coincide with the effects of the DGR Project at the Bruce Nuclear site. It is unlikely that air emissions associated with each project (including acrolein emissions) will occur at the exact same time due to the anticipated infrequent nature in air emissions across the phases of both projects, and it is also unlikely that they will persist in the atmosphere for the same duration. Acrolein's high vapour pressure indicates that it will occur primarily in the vapour phase [MOE 2005]. Acrolein will degrade and disperse in the atmosphere in a short timeframe and it is not likely to be transported over long distances.*

*Considering the nature of the potential effects on overall air quality, the expected contribution of acrolein emissions with respect to background conditions, and the location of the APM communities with respect to the DGR Project at the Bruce Nuclear site, the contribution of the APM DGR to cumulative effects on air quality, and more specifically human health with respect to acrolein in air, would be not be adverse (i.e., maximum cumulative concentrations of acrolein resulting from the combined projects are not predicted to be higher than the maximum concentrations of the air quality indicators for one of the projects on its own at a given human receptor location). Therefore, an adverse cumulative effect of the DGR Project at the Bruce Nuclear site in combination with the APM DGR on human health is not likely.*

### **SOSGL Literature Review: Acrolein**

Acrolein (systematic name: propenal) is the simplest unsaturated aldehyde. It is a colourless liquid with a piercing, disagreeable, acrid smell.<sup>140</sup>

“The principal anthropogenic source of emissions into the Canadian environment is estimated to be activities involving the combustion of organic matter. As a product of the incomplete combustion of organic matter, acrolein is released by waste incinerators, furnaces, fireplaces, power plants, burning vegetation (e.g., forest fires), combustion of polyethylene plastics, and the cooking of food. The main

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<sup>140</sup> Agency for Toxic Substances & Disease Registry.  
<https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=102>



combustion source is considered to be gas and diesel motor vehicle emissions.<sup>141</sup> Acrolein is an herbicide and algicide used in water treatment. Acrolein is a relatively electrophilic compound and a reactive one, hence its high toxicity.<sup>142</sup> Acrolein is also formed endogenously as part of physiological oxidative stress response and polyamine metabolism [23].<sup>143</sup>

According to the EPA, acrolein is considered extremely toxic; “probable oral human lethal dose is 5-50 mg/kg, between 7 drops and one teaspoon for a 70 kg (150 lb.) person. Inhalation of air containing 10 ppm of acrolein may be fatal in a few minutes. Death from cardiac failure accompanied by hyperemia and hemorrhage of the lungs and degeneration of the bronchial epithelium is possible. Acrolein causes acute respiratory and eye irritation; severe gastrointestinal distress with slowly developing pulmonary edema (lungs fill up with fluid); and skin irritation.” (EPA, 1998)<sup>144</sup>

The EPA lists acute effects of acrolein exposure as eye irritation and "annoyance"/discomfort and nose/throat irritation, decreased respiratory rate and cough. Chronic effects (noncancer) also include general respiratory congestion and eye, nose, and throat irritation. Acrolein is a strong dermal irritant with the eye being the most sensitive target for exposure. Animal studies have reported that the respiratory system is the major target organ for acrolein toxicity.

There is no available information on the reproductive effects of acrolein in humans. “In available reproductive animal studies, rats exposed to 0.55 to 4 ppm (1.3 - 9.2 milligrams per cubic meter) of acrolein by inhalation, showed no effects on the number of pregnancies, the number and weights of the fetuses, or the overall reproductive fitness of the animals. No studies were located regarding developmental effects in humans or animals after inhalation exposure to acrolein.”<sup>145</sup>

The EPA states that the potential carcinogenicity of acrolein cannot be determined because existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation routes of exposure.<sup>146</sup>

“Although direct evidence of acrolein's carcinogenicity in humans or experimental animals is considered inadequate [24], acrolein is known to induce DNA damage [25] and to form DNA adducts relevant to lung cancer and inhibition of tumor suppression [26], [27]. Acrolein has also been shown to interact with a prominent carcinogenic constituent of tobacco smoke — benzo[*a*]pyrene — to inhibit p53 tumor suppressor activity, which suggests a role for acrolein in lung cancer initiation [28].

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<sup>141</sup> WHO 2002.

<http://www.who.int/ipcs/publications/cicad/en/cicad43.pdf>

<sup>142</sup> NIH – PubChem/Open Chemistry Database.

<sup>143</sup> Acrolein and Asthma Attack Prevalence in a Representative Sample of the United States Adult Population 2000 – 2009. B. Rey deCastro.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4016153/>

<sup>144</sup> NIH – PubChem/Open Chemistry Database.

<https://pubchem.ncbi.nlm.nih.gov/compound/acrolein#section=GHS-Classification>

<sup>145</sup> NIH – PubChem/Open Chemistry Database.

<https://pubchem.ncbi.nlm.nih.gov/compound/acrolein#section=GHS-Classification>

<sup>146</sup> <https://www.epa.gov/sites/production/files/2016-08/documents/acrolein.pdf>

Attention has focused recently on the potential role of endogenous acrolein — produced as part of oxidative stress response — in a variety of neurologic disorders, such as Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis [29]–[32]. Endogenous acrolein has also been observed in connection to spinal cord injury [33], as well as myelin damage [34]. The possibly adverse neurological effects of endogenous acrolein have prompted concern about environmental exposure to acrolein, particularly through air pollutant emissions and tobacco smoke.”<sup>147</sup>

“Acrolein's role as a respiratory toxicant is well established [6], [7]. Because of its high reactivity with human tissue, inhalation of acrolein has been hypothesized to induce or exacerbate acute lung injury and chronic obstructive pulmonary disease [21]. A risk assessment for human lung function extrapolated from rat data suggested that ambient concentrations of acrolein in the United States may be associated with reduced respiratory function [35]. In a comprehensive review considering the exposure prevalence and toxic potency of hazardous air pollutants, acrolein was recommended for further research into its role in the initiation and exacerbation of asthma [36].”<sup>148</sup>

“Asthma is a chronic inflammatory disorder of the small respiratory airways. Acute episodes, or asthma attacks, in susceptible individuals are associated with airflow obstruction characterized by wheezing, breathlessness, chest tightness, and coughing. These episodes result from a combination of airway inflammation and elevated bronchial hyper-responsiveness to a variety of triggers. Important environmental triggers include ETS (environmental tobacco smoke), dust mites, cockroach allergen, outdoor air pollution, wood smoke, pets, and mold [40], [41]. As a potent respiratory irritant, acrolein may have a prominent role as an environmental trigger of asthma attacks.”<sup>149</sup>

## Noise

OPG's Cumulative Assessment Response <sup>150</sup>

### 5.5 NOISE LEVELS

#### 5.5.1 Potential Cumulative Effects

*A residual adverse effect of the DGR Project at the Bruce Nuclear site on noise levels was identified and was assessed to be not significant [OPG 2011a; OPG's response to IR-EIS-12- 510 (OPG 2014)]. The residual effect on noise levels is predicted to extend over a short distance (approximately 400 m) beyond the Site Study Area (i.e., within the Atmospheric Environment Local Study Area [Figure 5-3]), and be limited to the residences located in the vicinity of Baie du Doré. Considering the mitigation measures proposed for the DGR Project at the Bruce Nuclear site, the maximum predicted increase in noise levels*

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<sup>147</sup> **Acrolein and Asthma Attack Prevalence in a Representative Sample of the United States Adult Population 2000 – 2009**  
**B. Rev deCastro**

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4016153/>

<sup>148</sup> Ibid.

<sup>149</sup> **Acrolein and Asthma Attack Prevalence in a Representative Sample of the United States Adult Population 2000 – 2009**  
**B. Rev deCastro**

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4016153/>

<sup>150</sup> OPG's Updated Analysis of Cumulative Environmental Effects. 00216-REP-07701-00018.  
December 2016

*is predicted to be 5 decibels (dB) at receptor locations in the Baie du Doré during the quietest hour (primarily during late night/early morning hours). The residual effect is predicted to occur throughout the site preparation and construction, and decommissioning phases.*

*The cumulative effects assessment for noise levels in the EIS [OPG 2011a] identified the Atmospheric Environment Local Study Area as the cumulative effects study area (Figure 5-3).*

*Potential residual effects from the APM DGR have been identified on noise levels during site selection, construction, operation, decommissioning, and closure of the APM DGR. The APM DGR will involve detailed surface and subsurface investigations of the preferred site, vegetation clearing for site access, construction of surface and underground facilities, transportation of used fuel from nuclear sites to the APM DGR, vehicle and equipment use for placement of used fuel in the repository during operations, and vehicle and equipment use associated with decommissioning and closure activities. All these activities will also contribute to an increase in overlap in the effect on the VEC (i.e., effects on noise levels) and an overlap in time with the residual effects of the DGR Project at the Bruce Nuclear site on noise levels.*

*The potential residual effects of the APM DGR on noise levels are likely to be similar in scale to those identified for the DGR Project at the Bruce Nuclear site during site preparation and construction, and decommissioning. However, unlike the DGR Project at the Bruce Nuclear site, the operation phase of the APM DGR will include the excavation of additional placement rooms (i.e., beyond the initial panels to be built during the construction phase), and the transportation of the excavated rock to the waste rock management area at surface. Therefore, this noise source would extend throughout the APM DGR operations phase.*

*Noise generated by vehicles transporting used fuel from nuclear sites to the APM DGR would extend over the travel routes and would be intermittent in nature. Assuming road transport, it is estimated that there would be about two shipments per day of used fuel to the APM DGR on average. Due to the location of the APM DGR with respect to the DGR Project at the Bruce Nuclear site (see Figure 5-3), a spatial overlap of effects on noise levels due to road transport in the vicinity of Baie du Doré is unlikely, as discussed further in Section 5.5.3.*

### **5.5.2 Mitigation**

*Good management practices have been identified for the APM DGR [NWMO 2016] that are likely to control and attenuate noise levels throughout all phases, and ensure that they would meet applicable regulatory limits and guidelines (e.g., MOECC guidelines for noise or equivalent), and municipal bylaws, as required. Relevant permits would be acquired for the APM DGR (e.g., an ECA from the MOECC), and any conditions and additional mitigation measures identified in the permit with regards to noise emissions would be implemented, as applicable.*

### **5.5.3 Assessment of Cumulative Effects**

*The APM DGR site would be at a minimum 20 km from the DGR Project at the Bruce Nuclear site, and the Baie du Doré area that is predicted to experience the highest changes in noise levels as a result of the DGR Project at the Bruce Nuclear site. Noise levels attenuate with distance, with most of the DGR Project noise predicted to attenuate within 400 m of the Bruce Nuclear site.*

*Similar activities are anticipated to occur at the APM DGR site. Adverse effects on noise levels were considered to be likely if the predicted cumulative ambient noise levels at a receptor location change by more than 3 dB [OPG 2011a]. Given the spatial separation (i.e., >20 km) activities at the APM DGR will not contribute to ambient noise levels in the vicinity of the Baie du Doré.*

*Movement of used fuel from the Bruce Nuclear site to the APM DGR was already considered in the cumulative effects assessment for the DGR Project at the Bruce Nuclear site [OPG 2011a]. It is here also considered in this updated cumulative effects analysis along with the shipment of used fuel from other nuclear sites to the APM DGR site and other sources of noise at the APM DGR site. The estimated number of shipments per day arriving at the APM DGR (i.e., average of approximately two per day) and leaving the Bruce Nuclear site to the APM DGR site (total of 10,600 shipments over the 40 year operation phase of the APM DGR), would make a minimal contribution to overall noise levels in the vicinity of both projects. Moreover, transport of used fuel from nuclear sites other than the Bruce Nuclear site would not occur on routes close to the Bruce Nuclear site; thus, a cumulative contribution to ambient noise levels in the vicinity of the DGR Project at the Bruce Nuclear site, specifically the Baie du Doré, due to the transportation of used fuel to the APM DGR is unlikely.*

*In summary, no adverse cumulative effects are likely on the noise level VEC. This is considering the nature of the potential residual effects and anticipated mitigation associated with the APM DGR, along with the distance of an APM DGR site relative to the DGR Project at the Bruce Nuclear site, and the Baie du Doré residences in particular. The assessment of cumulative effects in the EIS [OPG 2011a] for noise levels therefore remains valid in consideration of the APM DGR.*

OPG also looked at increased noise levels and effect on enjoyment of private property in the Socio-Economic Environment Section of its cumulative effects assessment.

## **5.7 SOCIO-ECONOMIC ENVIRONMENT**

### **5.7.1 Potential Cumulative Effects**

*A residual adverse effect of the DGR Project at the Bruce Nuclear site regarding increased noise levels and their effect on the enjoyment of private property was identified. The residual effect was assessed to be not significant [OPG 2011a]. The residual effect on the enjoyment of private property as a result of the DGR Project at the Bruce Nuclear site is predicted to be limited to a small portion of the Local Study Area, specifically to the residences located in the vicinity of Baie du Doré. Considering the mitigation measures proposed for the DGR Project at the Bruce Nuclear site, the maximum predicted increase in noise levels is predicted to be 5 dB at receptor locations in the Baie du Doré during the quietest hour (as discussed in Section 5.5), which is considered a noticeable level of change that will have an effect on the enjoyment of private property. The residual effect is predicted to occur throughout the site preparation and construction, and decommissioning phases.*

*For the purposes of this updated analysis, the cumulative effects assessment for the socio-economic environment (enjoyment of private property) uses the Local Study Area, particularly the Baie du Doré residences, as the cumulative effects assessment study area since the residual adverse effect of the DGR*

*Project at the Bruce Nuclear site is limited to that geographic extent.*

*Potential residual effects from the APM DGR have been identified on the overall local enjoyment of the area during operation and decommissioning and closure of the APM DGR. Regarding potential noise sources that may have an effect on the enjoyment of the area (i.e., the vicinity of the selected APM DGR site), the APM DGR will involve transportation of used fuel from nuclear sites to the APM DGR site, vehicle and equipment use for placement of used fuel in the repository during operations, and vehicle and equipment use associated with decommissioning and closure activities. All these activities will contribute to an increase in ambient noise levels as a result of the APM DGR that may have an effect on the enjoyment of private property. Thus, the APM DGR has the potential to have both an overlap of effect on the VEC (i.e., increase in noise levels that may affect private enjoyment) and an overlap in time with the residual effects of the DGR Project at the Bruce Nuclear site on the enjoyment of private property. Given the location of the APM DGR with respect to the DGR Project at the Bruce Nuclear site (see*

*Figure 5-3), a spatial overlap of effects on use and enjoyment of property due to road transport in the vicinity of Baie du Doré is unlikely, as discussed further in Section 5.7.3.*

#### *5.7.2 Mitigation*

*Mitigation measures related to increased noise levels to be implemented for the APM DGR have been described in Section 5.5.2. Moreover, the design of the APM DGR would be developed to reflect the specific location selected for the repository and facilities as agreed with the host community. A specific location would be selected for the APM DGR if there is a sufficient degree of confidence that a safe, secure and socially acceptable transportation plan can be developed to transport used nuclear fuel to that location. NWMO would conduct transportation planning and evaluations aligned with community input [NWMO 2016].*

#### *5.7.3 Assessment of Cumulative Effects*

*The APM DGR site would be a minimum 20 km from the DGR Project at the Bruce Nuclear site, and the Baie du Doré area. Noise levels attenuate with distance, with most of the DGR Project noise predicted to attenuate within 400 m of the Bruce Nuclear site, as discussed in Section 5.5.3. It is unlikely that activities associated with the APM DGR would contribute to ambient noise levels in the vicinity of the Baie du Doré, and have a cumulative effect on the private enjoyment of the Baie du Doré area. Moreover, the transport of used fuel from the Bruce Nuclear site to the APM DGR (10,600 shipments over the 40 year operation phase of the APM DGR) would not have a measurable cumulative contribution to noise levels in the vicinity of the DGR Project at the Bruce Nuclear site and the private enjoyment of the Baie du Doré area. The additional approximately two trips per day of fuel shipments are small relative to the thousands of employees travelling to and from the Bruce Nuclear site daily. Furthermore, shipments of used fuel would not likely travel specifically on the roads closest to the Baie du Doré residences.*

*The additional transport of used fuel from other nuclear sites to the APM DGR would not occur on routes close to the DGR Project at the Bruce Nuclear site; therefore, this additional transport would not affect the ambient noise levels in the vicinity of the Baie du Doré area. Thus, this additional transport associated with the APM DGR is not expected to affect the private enjoyment of the Baie du Doré area.*

*In summary, considering the distance of an APM DGR site with respect to the DGR Project at the Bruce Nuclear site in general, and the Baie du Doré residences in particular, the minimal contribution to noise levels as a result of the transport of used fuel from the Bruce Nuclear site to the APM DGR site, and the difference in routes associated with the additional transport of used fuel from other nuclear sites, no adverse cumulative effect on the private enjoyment of the Baie du Doré area is likely.*

*Based on the above, the assessment of cumulative effects described in the EIS [OPG 2011a] for the private enjoyment of the Baie du Doré area remains valid in consideration of the APM DGR.*

## **SOSGL Literature Review: Noise**

Sound is all around us and penetrates our life everywhere. “It is an essential component of our social life. We need it for communication, orientation and as a warning signal. The auditory system is continuously analyzing acoustic information, including unwanted and disturbing sound, which is filtered and interpreted by different cortical (conscious perception and processing) and sub-cortical brain structures (non-conscious perception and processing). The terms “sound” and “noise” are often used synonymously.

Sound becomes noise when it causes adverse health effects, including annoyance, sleep disturbance, cognitive impairment, mental or physiological disorders, including hearing loss and cardiovascular disorders. The evidence is increasing that ambient noise levels below hearing damaging intensities are associated with the occurrence of metabolic disorders (type 2 diabetes), high blood pressure (hypertension), coronary heart diseases (including myocardial infarction), and stroke.

Environmental noise from transportation noise sources, including road, rail and air traffic, is increasingly recognized as a significant public health issue.

Systematic research on the non-auditory physiological effects of noise has been carried out for a long time starting in the post war period of the last century. The reasoning that long-term exposure to environmental noise causes cardiovascular health effects is based on the following experimental and empirical findings:

- Short-term laboratory studies carried out on humans have shown that the exposure to noise affects the autonomous nervous system and the endocrine system. Heart rate, blood pressure, cardiac output, blood flow in peripheral blood vessels and stress hormones (including epinephrine, nor-epinephrine, cortisol) are affected. At moderate environmental noise levels such acute reactions are found, particularly, when the noise interferes with activities of the individuals (e.g. concentration, communication, relaxation).
- Noise-induced instantaneous autonomic responses do not only occur in waking hours, but also in sleeping subjects even when they report not being disturbed by the noise.
- The responses do not adapt on a long-term basis. Subjects who had lived for several years in a noisy environment still respond to acute noise stimuli.
- The long-term effects of chronic noise exposure have been studied in animals at high noise levels showing manifest vascular changes (thickening of vascular walls) and alterations in the heart muscle (increases of connective tissue) that indicate an increased aging of the heart and a higher risk of cardiovascular mortality.

- Long-term effects of chronic noise exposure in humans have been studied in workers exposed to high noise levels in the occupational environment showing higher rates of hypertension and ischemic heart diseases in exposed subjects compared with less exposed subjects.

These findings make it plausible to deduct that similar long-term effects of chronic noise exposure may also occur at comparably moderate or low environmental noise levels. It is important to note that non-auditory noise effects do not follow the toxicological principle of dosage. This means that it is not simply the accumulated total sound energy that causes the adverse effects. Instead, the individual situation and the disturbed activity need to be taken into account (time activity patterns). It may very well be that an average sound pressure level of 85 decibels (dB) at work causes less of an effect than 65 dB at home when carrying out mental tasks or relaxing after a stressful day, or 50 dB when being asleep. This makes a substantial difference compared to many other environmental exposures where the accumulated dose is the hazardous factor, e. g. air pollution (“dealing with decibels is not like summing up micrograms as we do for chemical exposures”).

The general stress theory is the rationale and biological model for the non-auditory physiological effects of noise on man. According to the general stress concept, repeated temporal changes in biological responses disturb the biorhythm, cause permanent dysregulation, resulting in physiological and metabolic imbalance and disturbed haemostasis of the organism leading to chronic diseases in the long run.

In principle, a variety of body functions may be affected, including the cardiovascular system, the gastrointestinal system, and the immune system, for example.”<sup>151</sup>

According to the World Health Organization the non-cardiovascular effects of noise include: loss of productivity in adults, learning impairment in children including impairments in attention, memory, problem-solving ability and learning to read, and hearing impairment.<sup>152</sup>

### **Infrasound:**

Infrasound is sound which extends below the range of human hearing (from 20 Hz down to 0.001 Hz), and it emanates from many natural and man-made sources. For example, some animals, such as whales, elephants and giraffes communicate using infrasound over long distances. Avalanches, volcanoes, earthquakes, ocean waves, waterfalls and meteors generate infrasonic waves. Some sources of man-made infrasound are nuclear and chemical explosions, engines, machinery and airplanes. Infrasonic waves propagate with very little attenuation and hence are capable of propagating over great distances.<sup>153</sup>

Recent reports have indicated that low level noise or infrasound may have implications for human health.

<sup>151</sup> <http://acoustics.org/cardiovascular-effects-of-noise-on-man-wolfgang-babisch/>

<sup>152</sup> WHO. World Health Organization Guidelines on Community Noise. Schwela, 2001. <http://adc40.org/docs/schwela.pdf>

<sup>153</sup> What is Infrasound, The Department of Physics and Astronomy, The University of Western Ontario. [http://meteor.uwo.ca/research/infrasound/is\\_whatIS.html](http://meteor.uwo.ca/research/infrasound/is_whatIS.html)

Some associations were observed between exposure to low level noise/infrasound and annoyance, sleep-related problems, concentration difficulties and headache in the adult population living in the vicinity of a range of LFN sources.<sup>154</sup> The evidence related to low-frequency noise is sufficiently strong to warrant concern. “It is a special concern because of its pervasive nature, because it arises from multiple sources, and because of its efficient propagation, which is essentially unimpeded by conventional methods of either building or ear protection. Adverse health effects from low-frequency noise are thought to be more severe than from other forms of community noise. This form of noise is underestimated with the usual types of sound measuring equipment.”<sup>155</sup>

## **Radiation and Radioactivity**

OPG’S Cumulative Assessment Response<sup>156</sup>

### **5.8 RADIATION AND RADIOACTIVITY**

#### *5.8.1 Potential Cumulative Effects*

*The levels of radiation and radioactivity due to the DGR Project at the Bruce Nuclear site are predicted to be well below relevant criteria, and therefore no residual effects were identified. However, this assessment has considered the incremental effects of the APM DGR to allow comparison with regulatory standards and consideration of potential cumulative effects. Potential radiological emissions of the DGR Project at the Bruce Nuclear site and APM DGR are described below.*

*The assessment of potential exposure to workers from the normal operation of the DGR Project at the Bruce Nuclear site concluded that Nuclear Energy Worker radiation exposure as a result of the DGR Project is predicted to be much lower than OPG’s occupational dose target of 10 milliSieverts per year (mSv/a), which is below the Canadian Nuclear Safety Commission (CNSC) worker dose limit of effectively 20 mSv/a (maximum 50 mSv in one year).*

*Project-related doses to members of the public due to external radiation from the site, and from airborne and waterborne emissions from the DGR Project at the Bruce Nuclear site, are predicted to be well below the regulatory limit for members of the public of 1 mSv/a, including in the long-term after the DGR Project at the Bruce Nuclear site has been closed and sealed. The public doses were calculated assuming people lived at the Bruce Nuclear site fence line during the operating phase and directly on top of the repository in the postclosure phase; however, this is unlikely to occur. Any dose to people living farther from the site would be much smaller. Moreover, Project-related doses to members of the public are expected to be lower than the natural background dose rate of about 1.8 mSv/a (i.e., below 1 mSv/a). Therefore, incremental doses to workers and members of the public would remain well below regulatory limits, and are not considered to be adverse.*

*Aquatic and terrestrial biota receive radiation doses from exposure to radioactivity in the atmosphere,*

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<sup>154</sup> <https://www.ncbi.nlm.nih.gov/m/pubmed/26994804/>

<sup>155</sup> <http://www.nonoise.org/library/smj/smj.htm>

<sup>156</sup> OPG’s Updated Analysis of Cumulative Environmental Effects. 00216-REP-07701-00018. December 2016



*surface water and from other media into which it transfers. The effects of the DGR Project at the Bruce Nuclear site radioactivity emissions would be an increment to the baseline concentrations around the site. However it should be noted that over 50% of the waste inventory intended for the DGR is already in storage at the Western Waste Management Facility (WWMF), and will increase to 70% by the time the operations phase begins. As wastes are transferred into the DGR, the corresponding emissions from the WWMF will decrease, so any increase in environmental concentrations as a result of the DGR Project at the Bruce Nuclear site will be offset, in part, by the decrease in concentrations of emissions from the WWMF.*

*As the DGR Project at the Bruce Nuclear site emissions will be less than the current total Bruce Nuclear site emissions, a screening level estimate of the potential DGR Project at the Bruce Nuclear site effects on non-human biota was made by conservatively assuming the project causes an incremental increase in tritium and carbon-14 concentrations equal to the existing values. This conservatively assumed radioactivity release to the terrestrial and aquatic environment from the DGR Project at the Bruce Nuclear site showed that an adverse effect on non-human biota is not expected.*

*The APM DGR has the potential for radiological emissions during construction (primarily radon emitted by the host rock), operations (radon arising from transportation of used fuel from nuclear sites, and repository operation), decommissioning and closure (radon and infrastructure removal), and postclosure (release of radioactivity from underground if containers fail), and therefore may create an additive effect with the DGR Project at the Bruce Nuclear site.*

#### *5.8.2 Mitigation*

*In order for the APM DGR to receive a licence, the potential emissions from the APM DGR would have to be mitigated through site selection, engineering design and operations such that the releases did not result in doses that exceeded regulatory criteria. Mitigation measures include the selection of the site and repository depth with favorable geology, and an engineered barrier system to isolate and contain the used fuel within the repository footprint. This facility would be monitored to ensure that it met all regulatory and environmental requirements, in particular at the APM DGR site fence line. The CNSC may also conduct an independent environmental monitoring program as per its current practice around existing nuclear facilities [CNSC 2016].*

#### *5.8.3 Assessment of Cumulative Effects*

*Radiological releases from both the DGR Project at the Bruce Nuclear site and the APM DGR are expected to be much less than the regulatory limits at the respective facility fence lines, and these limits (e.g., 1 mSv/a public dose) are conservative values where no effects will be observed. Moreover, the potential APM DGR communities in Bruce County and Huron County are at least 20 km from the DGR Project at the Bruce Nuclear site. Since neither project is predicted to generate adverse radiological effects and since both projects will be located far from one another, adverse cumulative radiological effects are not likely to occur.*

*In both projects, the waste radioactivity would be largely contained within and near the repository. Due to the low permeability of the host rock, small amounts could diffuse into the surrounding host rock. This*

*could eventually lead to an increase in radioactivity in the deep groundwater systems near the repositories. These groundwater systems extend across the sedimentary rock formations in this area, and in particular would likely be connected between the area around the DGR Project at the Bruce Nuclear site, and a potential APM DGR site in the area. However these systems are highly saline (non potable) and move very slowly.*

*The effect on these groundwater systems from the DGR Project at the Bruce Nuclear site was evaluated in response to an Information Request, IR-EIS-08-397 [OPG's response to IR-EIS-08- 397 (OPG 2013)], where the radioactivity levels in more permeable groundwater systems directly below (Cambrian) and above (Guelph) the DGR Project at the Bruce Nuclear site were evaluated. The calculated levels at even 1 km distant were many orders of magnitude below any level of concern. Similar calculations have not been made for the APM DGR as it is still in the siting phase. However, in general, a similarly very small effect would be expected due to the durable containers and the low permeability of the surrounding rock formations. These indicate that any cumulative effect of slow postclosure transport of radioactivity through deep groundwater systems between the two DGRs would be very unlikely.*

*It is also important to recognize that the overall purpose of the DGR Project at the Bruce Nuclear site and the APM DGR is to isolate L&ILW and nuclear fuel waste, respectively, from humans and the surface environment. Managing these wastes deep underground in a repository will inherently result in a net reduction in potential radiological exposure to humans and non-human biota in the long term.*

*Current radioactivity levels in Lake Huron and the other Great Lakes are well below levels that would affect humans or 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 DGR Project at the Bruce Nuclear site and APM DGR will help ensure the continued protection of Lake Huron from potential radiological effects in the very long term.*

*Based on the above, a cumulative effect on radiation and radioactivity as a result of the DGR Project at the Bruce Nuclear site and the APM DGR is unlikely. The assessment of cumulative effects described in the EIS [OPG 2011a] for radiation and radioactivity remains valid in consideration of the APM DGR.*

## **5.9 SIGNIFICANCE OF CUMULATIVE EFFECTS**

*Any residual adverse cumulative effects must be assessed for significance. No residual adverse cumulative effects of the DGR Project at the Bruce Nuclear site were identified in consideration of the APM DGR. Therefore, the assessment of the significance of the residual adverse cumulative effects is not required. Follow-up monitoring is proposed for the DGR Project at the Bruce Nuclear site to confirm adverse effects do not occur and that in-design mitigation measures are effective, as described in Section 13 of the EIS [OPG 2011a]. It is anticipated that a follow-up program would be developed for the APM DGR once a site-specific assessment of environmental effects is completed.*

## SOSGL Literature Review: Radiation and Radioactivity

According to Health Canada, ionizing radiation affects living tissue at the cell level by breaking chemical bonds and altering the structure of the DNA molecules.<sup>157</sup>

There are two types of radiation effects: deterministic effects are known as early, or deterministic, effects because they can be “determined to be a direct result of radiation exposure. Deterministic effects in persons can include burns, radiation sickness, cataracts, sterility, and in extreme cases, death.”<sup>158</sup>

“Sometimes the effects of a radiation dose are not immediately observable. In these cases, there is no direct connection that can be made between the radiation dose and its possible effects. In other words, it is the probability rather than the severity of the effects that is increased. These are referred to as late, or stochastic, effects. Stochastic effects of low radiation doses can include an increased incidence of cancer in exposed persons and the possibility of genetic effects in their children.”<sup>159</sup>

According to the CNSC, World Health Organization, American Cancer Society and the Nuclear Regulatory Commission, exposure to ionizing radiation carries health risks. These risks include cancer, hereditary effects, cataracts, cardiovascular disease and stroke, immune effects, premature aging, radiation sickness, and death.

### Cancer Risks

Cancer risk data is based on studies of survivors of the 1945 atomic bombings in Japan, as well as evidence from studies on occupational workers, people exposed to radon, and victims of the Chernobyl nuclear accident. Additional information has been obtained from studies of recipients of selected diagnostic or therapeutic medical procedure.<sup>160</sup>

“*Cancers* associated with high dose exposure include leukemia, breast, bladder, colon, liver, lung, esophagus, ovarian, multiple myeloma, and stomach cancers. Literature from the U.S. Department of Health and Human Services also suggests a possible association between ionizing radiation exposure and prostate, nasal cavity/sinus, pharyngeal and laryngeal, and pancreatic cancers.”<sup>161</sup> Ionizing radiation increases the risk of certain types of cancer more than others. The thyroid gland and bone marrow are particularly sensitive to radiation. As a result, leukemia, a type of cancer that arises in the bone marrow, and thyroid cancer, are among the most common radiation-induced cancers.<sup>162</sup>

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<sup>157</sup> Cellular effects of radiation: <http://www.hc-sc.gc.ca/hc-ps/ed-ud/event-incident/radiolog/info/body-corps-eng.php>

<sup>158</sup> <http://www.hc-sc.gc.ca/hc-ps/ed-ud/event-incident/radiolog/info/body-corps-eng.php>

<sup>159</sup> <http://www.hc-sc.gc.ca/hc-ps/ed-ud/event-incident/radiolog/info/body-corps-eng.php>

<sup>160</sup> <http://www.nrc.gov/about-nrc/radiation/health-effects/rad-exposure-cancer.html>

<sup>161</sup> <http://www.nrc.gov/about-nrc/radiation/health-effects/rad-exposure-cancer.html>

<sup>162</sup> [http://www.nuclearsafety.gc.ca/eng/readingroom/radiation/radiation\\_health\\_effects.cfm](http://www.nuclearsafety.gc.ca/eng/readingroom/radiation/radiation_health_effects.cfm)

## Hereditary Effects

Birth defects include congenital malformations, CNS problems, and growth restriction.

“Animal studies, such as those conducted on fruit flies by Hermann J. Muller in 1926, showed that radiation will cause genetic mutations. However, to date there have been no known genetic effects in humans caused by radiation. This includes studies involving some 30,000 children of survivors of the atomic bombings of the cities of Hiroshima and Nagasaki in Japan in 1945 (BEIR VII).”<sup>163</sup>

The Beir VII report on the effects of exposure to low level radiation concludes that “Despite the challenges associated with understanding the health effects of low doses of low-LET radiation, current knowledge allows several conclusions. The BEIR VII committee concludes that current scientific evidence is consistent with the hypothesis that there is a **linear dose-response relationship between exposure to ionizing radiation and the development of radiation-induced solid cancers in humans. The committee further judges it unlikely that a threshold exists for the induction of cancers but notes that the occurrence of radiation-induced cancers at low doses will be small.** The committee maintains that other health effects (such as heart disease and stroke) occur at high radiation doses, but additional data must be gathered before an assessment can be made of any possible connection between low doses of radiation and non-cancer health effects. Additionally, the committee concludes that although adverse health effects in children of exposed parents (attributable to radiation-induced mutations) have not been found, there are extensive data on radiation-induced transmissible mutations in mice and other organisms. Thus, there is no reason to believe that humans would be immune to this sort of harm.”<sup>164</sup>

The Linear no- threshold (LNT) risk model is used internationally by most health agencies and nuclear regulators to set dose limits for workers and members of the public. The LNT conservatively assumes there is a direct relationship between radiation exposure and cancer rates.<sup>165</sup>

Current guidelines from ICRP and from IEER suggest that in calculating radiation protection regulations and guidelines it is important to calculate the risk to the most susceptible group and receiving the highest dose of radiation. Other factors to consider are fetal exposures and exposures to infants of mothers who are breast feeding, as the doses are potentially amplified in these situations.

“As evidenced from the BEIR VII and UNSCEAR data, it is important to include age and gender in selecting the most susceptible group. In general, this means that lifetime risks would be calculated for females, unless risks for specific cancers to which men are more vulnerable are being evaluated.”<sup>166</sup>

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<sup>163</sup> [http://www.nuclearsafety.gc.ca/eng/readingroom/radiation/radiation\\_health\\_effects.cfm](http://www.nuclearsafety.gc.ca/eng/readingroom/radiation/radiation_health_effects.cfm)

<sup>164</sup> [http://www.unscear.org/docs/reports/2010/UNSCEAR\\_2010\\_Report\\_M.pdf](http://www.unscear.org/docs/reports/2010/UNSCEAR_2010_Report_M.pdf)

<sup>165</sup> [http://www.unscear.org/docs/reports/2010/UNSCEAR\\_2010\\_Report\\_M.pdf](http://www.unscear.org/docs/reports/2010/UNSCEAR_2010_Report_M.pdf)

<sup>166</sup> The Use of Reference Man in Radiation Protection Standards and Guidance with Recommendations for Change: Arjun Makhijani, Ph.D. December 2008. Institute for Energy and Environmental Research. pp. 25 -30.

<http://kanat.jsc.vsc.edu/env1060/referenceman.pdf>

## 4.0 COMMENTS

### Air Quality and Particulate Matter

*The cumulative environmental effects assessment must consider other physical activities that have been carried out up to the time of the analysis, or will be carried out in the future, provided that these physical activities are likely to have an environmental effect on the same VCs that would be affected by residual environmental effects of the designated project.*<sup>167</sup>

OPG did not provide credible evidence that there would not be potential residual effects from the project regarding air quality and particulate matter.

OPG used outdated information in its assessment of health risks for particulate matter and other air pollutants.

OPG failed to adequately consider the potential for additive and synergistic effects on human health from increased particulate matter resulting from both projects.

OPG failed to adequately consider the additive and synergistic effects on human health from PM from both projects in conjunction with other air contaminants such as nitrogen oxides, sulphur dioxides, carbon monoxide, VOCs and polycyclic aromatic hydrocarbons.

OPG failed to consider the potential additive and synergistic effects of toxic exposures from other sources including chemical contaminants in water and in fish from the Great Lakes<sup>168</sup> in conjunction with air pollutants.

OPG failed to consider appropriate spatial boundaries given the fact that fine particulate matter can travel long distances.

OPG failed to consider that other air contaminants from both projects, such as nitrogen oxides, sulphur dioxides, carbon monoxide, VOCs and polycyclic aromatic hydrocarbons may affect human health throughout the Great Lakes basin.

OPG failed to consider the additive effects on air quality and particulate matter from the planned WWMF expansion.

OPG failed to consider the additive effects on air quality from known industrial wind farms in the county.

OPG failed to consider the potential additive and synergistic effects of climate change<sup>169</sup> on air quality and particulate matter.

OPG failed to take into account that **“There is no evidence of a safe level of exposure or a threshold**

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<sup>167</sup> Cumulative effects technical guidance 2014.

<sup>168</sup> Great Lakes Contaminants and Health Effects. Appendix A.

<sup>169</sup> Human Health Effects of Climate Change. Appendix B.

**below which no adverse health effects occur”<sup>170</sup> for PM exposure.**

OPG failed to consider the interaction of conventional non-radiological air contaminants on human health from both projects as well as the planned WWMF expansion. These include such contaminants as nitrogen oxides, sulphur dioxides, carbon monoxide, VOCs and polycyclic aromatic hydrocarbons.

OPG failed to use suitable, correct, and relevant methods (as per CEAA requirements and guidance) for its assessments and conclusions.

OPG failed to appreciate that adverse health effects from air quality may impact susceptible groups more than other human receptors. For instance, senior citizens, people with existing lung or heart problems, diabetics, children with asthma, and people who spend more time outdoors.

OPG failed to include baseline health studies for the potential populations that might be affected.

OPG failed to take into account the contaminants in the Great Lakes<sup>171</sup> now and how these chemicals may cumulatively affect human health in conjunction with air pollution, acrolein effects, noise and radioactivity from the projects.

### **Acrolein**

*The cumulative environmental effects assessment must consider other physical activities that have been carried out up to the time of the analysis, or will be carried out in the future, provided that these physical activities are likely to have an environmental effect on the same VCs that would be affected by residual environmental effects of the designated project.*<sup>172</sup>

OPG failed to adequately consider the likelihood of additive effects on human health from increased acrolein exposure from both projects as a results of combustion from motor vehicles and trucks coming and going from the projects.

OPG failed to consider the additive and synergistic effects on human health from acrolein from both projects in conjunction with other air contaminants such as nitrogen oxides, sulphur dioxides, carbon monoxide, VOCs and polycyclic aromatic hydrocarbons.

OPG failed to consider the potential additive and synergistic effects of toxic exposures from other sources including chemical contaminants in water and in fish from the Great Lakes<sup>173</sup> with acrolein related immune changes.

OPG failed to consider the additive effects on acrolein production with the planned WWMF expansion.

OPG failed to consider the effects on acrolein acting synergistically with other stressors such as a known

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<sup>170</sup> Health Effects of Particulate Matter. Policy Implications for countries in eastern Europe, Caucasus and central Asia. WHO 2013. p.6.

[http://www.euro.who.int/\\_data/assets/pdf\\_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf](http://www.euro.who.int/_data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf)

<sup>171</sup> Great Lakes Contaminants and Health Effects. Appendix A.

<sup>172</sup> Cumulative effects technical guidance 2014.

<sup>173</sup> Great Lakes Contaminants and Health Effects. Appendix A.

industrial wind farms in the county.

OPG failed to consider the potential additive effects of climate change<sup>174</sup> on acrolein production.

OPG failed to consider the effects of acrolein on susceptible groups such as smokers, asthmatics and those with other respiratory problems.

OPG failed to incorporate up to date health effects information in formulating its adverse effect report on Acrolein. Recent information indicates that acrolein is “known to induce DNA damage and to form DNA adducts relevant to lung cancer and inhibition of tumor suppression. Acrolein has also been shown to interact with a prominent carcinogenic constituent of tobacco smoke — benzo[*a*]pyrene — to inhibit p53 tumor suppressor activity, which suggests a role for acrolein in lung cancer initiation.

Attention has focused recently on the potential role of endogenous acrolein — produced as part of oxidative stress response — in a variety of neurologic disorders, such as Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis. Endogenous acrolein has also been observed in connection to spinal cord injury, as well as myelin damage.”<sup>175</sup>

OPG failed to use suitable, correct, and relevant methods (as per CEAA requirements and guidance) for its assessments and conclusions.

## Noise

*The cumulative environmental effects assessment must consider other physical activities that have been carried out up to the time of the analysis, or will be carried out in the future, provided that these physical activities are likely to have an environmental effect on the same VCs that would be affected by residual environmental effects of the designated project.*<sup>176</sup>

OPG did not provide credible evidence that there would not be residual noise related effects on human health from the project.

OPG used outdated information on the health effects associated with noise to formulate its assessment of noise risk.

OPG failed to adequately consider the likelihood of additive effects on human health from increased noise associated with construction, operation and decommissioning of the projects, whether from direct or indirect sources associated with the projects.

OPG failed to adequately consider the additive and synergistic effects on human health from PM from both projects in conjunction with other air contaminants such as nitrogen oxides, sulphur dioxides, carbon

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<sup>174</sup> Human Health Effects of Climate Change. Appendix B.

<sup>175</sup> **Acrolein and Asthma Attack Prevalence in a Representative Sample of the United States Adult Population 2000 – 2009**  
**B. Rev deCastro**

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4016153/>

<sup>176</sup> Cumulative effects technical guidance 2014.

monoxide, VOCs and polycyclic aromatic hydrocarbons, from both projects, and the stress mediated effects of noise on human health.

OPG failed to consider the potential additive and synergistic effects of noise on human health from other sources including low level vibrations and infrasound.

OPG failed to recognize that infrasound associated with the projects can travel long distances so the limited spatial boundary assessment is not valid.

OPG failed to consider the effects of noise as a result of known industrial wind farms in the county and the proposed WWMF expansion.

OPG failed to consider the potential additive and synergistic effects of climate change on noise and human health.

OPG failed to use suitable, correct, and relevant methods (as per CEAA requirements and guidance) for its assessments and conclusions.

OPG failed to appreciate that adverse health effects from noise associated with the project may impact susceptible groups more than other human receptors. For instance, senior citizens, people with existing lung or heart problems, diabetics, children with asthma, and people who spend more time outdoors.

## **Radiation and Radioactivity**

*The cumulative environmental effects assessment must consider other physical activities that have been carried out up to the time of the analysis, or will be carried out in the future, provided that these physical activities are likely to have an environmental effect on the same VCs that would be affected by residual environmental effects of the designated project.*<sup>177</sup>

OPG did not provide credible evidence that there would not be residual effects from radiation and radioactivity on human health from the projects, given the long time frame required for protection of the environment and human health.

OPG used outdated information on health risks of radiation to formulate its cumulative effects assessment.

OPG failed to adequately consider the likelihood of additive effects on human health from increased particulate matter from both projects and low-level radiation exposure.

OPG failed to adequately consider the additive and synergistic effects on human health from both projects in conjunction with acrolein and radiation exposure.

OPG failed to adequately consider the additive and synergistic effects on human health from PM from

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<sup>177</sup> Cumulative effects technical guidance 2014.



both projects in conjunction with other air contaminants such as nitrogen oxides, sulphur dioxides, carbon monoxide, VOCs and polycyclic aromatic hydrocarbons and radiation exposure.

OPG failed to consider the potential additive and synergistic effects of toxic exposure from other sources including chemical contaminants in water and in fish from the Great Lakes<sup>178</sup> and radiation exposure.

OPG failed to consider the effects of bioaccumulation and biomagnification associated with radionuclides entering the food chain through water and air.

OPG failed to consider the long term effects of exposure from low dose radiation exposure on human health with regards to genetic mutations.

OPG failed to consider the potential additive and synergistic effects of climate change<sup>179</sup> and radiation exposure from the project on human health.

OPG failed to incorporate up to date health effects information in formulating its adverse effect report on radioactivity. Information from the Beir VII study indicates that **“There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur” as outlined in the linear no – threshold model.**

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<sup>178</sup> Great Lakes Contaminants and Health Effects. Appendix A.

<sup>179</sup> Human Health Effects of Climate Change. Appendix B.

## 5.0 CONCLUSION: “FIRST, DO NO HARM”<sup>180</sup>

“CEAA 2012 aims to protect components of the environment that are within federal legislative authority from significant adverse environmental effects caused by a designated project, including cumulative environmental effects. In addition, CEAA 2012 ensures that a designated project is considered in a careful and precautionary manner to avoid significant adverse environmental effects, when the exercise of a power or performance of a duty or function by a federal authority under any Act of Parliament is required for the designated project to be carried out.”<sup>181</sup>

The Precautionary Principle in its simplest form states: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically".<sup>182</sup>

In its cumulative effects assessment, OPG failed to grasp the significance of air pollution on human health, trivialized the health impacts of noise and failed to consider additive and synergistic effects of pollutants on human health. Furthermore, OPG failed to consider the linear no threshold model for radiation exposure – that there is no safe level, and that while OPG’s projections may meet regulatory guidelines, the risk to human health remains.

Dr. Stella Swanson, research scientist, and former Chair of the Joint Review Panel for the DGR for L&ILW nuclear waste said the following: "One of the central problems in the debate about the nuclear fuel cycle is ignorance. Scientists simply do not know what the effects of chronic exposure to low-level radiation are, either in people or in other biota. We can guess, based on extrapolations from victims of high-level radiation such as atomic bombs and nuclear reactor accidents like Chernobyl. We will only begin to know for sure after several more decades have passed and a large population of exposed people has been studied. In the meantime, we have to ask: 'Do we really want to live in this uncertainty? What risks are we willing to accept as a society?'"<sup>183</sup>

The combined, incremental effects of human activity, referred to as cumulative impacts, pose a serious threat to the environment. While they may be insignificant by themselves, cumulative impacts accumulate over time, from one or more sources, and can result in the degradation of important resources”<sup>184</sup>, including human health. Unfortunately, the methods used by OPG to identify and assess

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<sup>180</sup> Attributed to Hippocrates, considered the first practitioner of the precautionary principle.  
<http://ancienthistory.about.com/od/greekmedicine/f/HippocraticOath.htm>

<sup>181</sup> Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act*, 2012 March 2015. pp. 2, 3.

<sup>182</sup> The Precautionary Principle. Hayes. P.161. 2004.

<sup>183</sup> Uranium: A Discussion Guide, *National Film Board of Canada*, 1991.

(<http://www.bullfrogfilms.com/guides/urguide.pdf>)

<sup>184</sup> Consideration of Cumulative Impacts in EPA review of NEPA Documents, May 1999, p. 13.

cumulative effects do not provide an adequate basis upon which the Minister can make a decision as to whether the project is likely to cause effects on human health and we urge the Minister to apply the precautionary principle and reject OPG's Deep Geologic Repository for Low & Intermediate Level Waste project.

## Appendix A

### Great Lakes Contaminants and Health Effects<sup>185</sup>

According to the International Joint Commission<sup>22</sup>, hundreds of chemicals have been identified in the Great Lakes ecosystem. As of 1994, 362 contaminants had been confirmed as being present in measurable concentrations in either the water or sediments or in the tissues of fish, wildlife or humans. At the time of the 1994 report, 126 substances had been linked to toxic effects on various life processes.<sup>23</sup> Some of these have been labeled “critical” and “priority contaminants” based on factors such as presence and ambient concentration in the Great Lakes environment, degree of toxicity, persistence in the environment, bioavailability, and the potential to bioconcentrate and bioaccumulate.<sup>24</sup>

The following papers, “Effects of Great Lakes Basin Environmental Contaminants on Human Health”,<sup>25</sup> “Inventory of Radionuclide for the Great Lakes, Nuclear Task Force, International Joint Commission 12/97,”<sup>26</sup> and the “Report on Bioaccumulation of Elements to Accompany the Inventory of Radionuclides in the Great Lakes Basin, Nuclear Task Force, International Joint Commission”,<sup>27</sup> have reported on the radionuclides within the Great Lakes ecosystem. These reports look at system-wide and not simply the point-source emissions that do not take into account the effects of bioaccumulation and long retention times associated with the lakes: Lake Superior- 191 years, Lake Michigan- 99 years, Lake Huron -22 years, Lake Erie - 2.6 years, Lake Ontario – 6 years.<sup>28</sup>

In its commentary on the inventory of radionuclides, the Nuclear Task Force noted that the bioaccumulation, biomagnification and transfer factors used to describe the cycling of radionuclides and their transfer along exposure pathways to biota, including humans, came from the long history of work done in oceans, estuarine, and river environments. Comparable studies for the Great Lakes fresh water were virtually nonexistent. Yet for the Great Lakes, the need for transfer factors that describe lake environments is critical. This information is still not complete.

More recently, there have been reports addressing a new category of pollutants, called “emerging contaminants of concern”. These include but are not limited to<sup>29</sup>:

- Pharmaceuticals: medications including hormones, pain relievers, psychopharmaceuticals, lipid regulators, antibiotics
- Personal care products: antiseptics (triclosan/triclocarban), sunscreen components, cosmetics
- Phytoestrogens: plant products that are similar to vertebrate hormones

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<sup>185</sup> Written Submission in Support of an Oral Intervention. JRP Hearings. Dailey, E.  
<http://www.ceaa-acee.gc.ca/050/documents/p17520/99666E.PDF>

- Brominated compounds: include PBDE flame retardants, plastic and insulation compounds
- Fluorinated compounds: perfluorinated compounds (found in surfactants, stain-resistant fabric protectors and non-stick cookware), flame retardants
- Synthetic musks: fragrances in perfumes, personal care products, home products • Chlorinated paraffins: flame retardants, sealants, plastic additives • Nonhalogenated compounds: formaldehyde, carboxylic acid • Phthalates: plasticizers
- Bisphenol A: additive to plastics • Nanomaterials: manufactured particulates less than 100 nanometers (nm) in size • Pesticides and herbicides

Large knowledge gaps exist in understanding bioaccumulation, specific exposures in the Great Lakes, sub-lethal effects and outcomes, and information regarding impacts of these emerging pollutants on a variety of organisms. New evidence suggests that combinations of emerging contaminants similar to those present in the environment may have synergistic effects greater than what is seen from the sum of individual outcomes. “This may apply particularly to chemicals that act on similar biochemical pathways in an organism because multiple low-dose exposures may collectively cause an alteration, even while individual exposures do not (e.g. Petersen and Tollefsen 2010; Rider et al. 2010). This has been found to extend to chemicals with different mechanisms of action but the same target (Rider et al. 2010). Overall, this underscores a concern that even if a single chemical has not been shown to cause a significant human or environmental health impact, its effect as part of a mixture may indeed be significant.”<sup>30</sup>

### **Health risks associated with contaminants**

All three categories of contaminants found in the Great Lakes have been associated with health problems. These include reproductive toxicity, neurologic toxicity, immunological effects, hormonal and endocrine disruption, cancer, respiratory problems and bacterial and viral infections.<sup>31</sup> Additionally, radionuclide related deterministic and stochastic health effects are possible.

Concern about contaminants in the environment, including those found in the Great Lakes basin, has recently received attention from medical organizations including the American College of Obstetricians and Gynecologists (ACOG) and the American Society of Reproductive Medicine (ASRM).<sup>33</sup> These organizations have advised their members to counsel their patients to restrain their consumption of potentially contaminated foods.<sup>34</sup>

Ontario regularly issues advisories for fish consumption from the Great Lakes.<sup>35</sup> Fish are tested for the following chemicals:

- Mercury
- Mercury, PCBs, mirex/photomirex and pesticides
- PCBs, mirex/photomirex and pesticides
- Mercury, PCBs and mirex

- Mercury, other metals, PCBs, mirex/photomirex and pesticides
- Mercury and other metals
- Dioxins and furans
- Chlorinated phenols and chlorinated benzenes
- Polycyclic aromatic hydrocarbons (PAHs)
- Dioxins, furans and dioxin-like PCBs
- PCB congeners
- Polybrominated diphenyl ethers (PBDEs) and polychlorinated naphthalenes (PCNs)
- Perfluorinated compounds (PFCs)

## Appendix B

### Human Health Effects of Climate Change<sup>186</sup>

“The impacts of climate change include warming temperatures, changes in precipitation, increases in the frequency or intensity of some extreme weather events, and rising sea levels. These impacts threaten our health by affecting the food we eat, the water we drink, the air we breathe, and the weather we experience.”<sup>187</sup>

#### Asthma, Respiratory Allergies, and Airway Diseases—

Respiratory allergies and diseases may become more prevalent because of increased human exposure to pollen (due to altered growing seasons), molds (from extreme or more frequent precipitation), air pollution and aerosolized marine toxins (due to increased temperature, coastal runoff, and humidity) and dust (from droughts). Mitigation and adaptation may significantly reduce these risks.

**Cancer**—Many potential direct effects of climate change on cancer risk, such as increased duration and intensity of ultraviolet (UV) radiation, are well understood; however the potential impact of changes in climate on exposure pathways for chemicals and toxins requires further study.

**Cardiovascular Disease and Stroke**—Climate change may exacerbate existing cardiovascular disease by increasing heat stress, increasing the body burden of airborne particulates, and changing the distribution of zoonotic vectors that cause infectious diseases linked with cardiovascular disease.

**Foodborne Diseases and Nutrition**—Climate change may be associated with staple food shortages, malnutrition, and food contamination (of seafood from chemical contaminants, biotoxins, and pathogenic microbes, and of crops by pesticides). Science research needs in this area include better understanding of how changes in agriculture and fisheries may affect food availability and nutrition, better monitoring for disease-causing agents, and identification and mapping of complex food webs and sentinel species that may be vulnerable to climate change.

**Heat-Related Morbidity and Mortality**—Heat-related illness and deaths are likely to increase in response to climate change

**Human Developmental Effects**—Two potential consequences of climate change would affect normal human development: malnutrition—particularly during the prenatal period and early childhood as a result of decreased food supplies, and exposure to toxic contaminants and biotoxins—resulting from extreme weather events, increased pesticide use for food production, and increases in harmful algal blooms in recreational areas.

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<sup>186</sup> A Human Health Perspective On Climate Change; A Report Outlining the Research Needs on the Human Health Effects of Climate Change APRIL 22, 2010 . NIH

<sup>187</sup> <https://www.epa.gov/climate-impacts/climate-impacts-human-health%20%20>

**Mental Health and Stress-Related Disorders**—By causing or contributing to extreme weather events, climate change may result in geographic displacement of populations, damage to property, loss of loved ones, and chronic stress, all of which can negatively affect mental health.

**Neurological Diseases and Disorders**—Climate change, as well as attempts to mitigate and adapt to it, may increase the number of neurological diseases and disorders in humans. Research in this area should focus on identifying vulnerable populations and understanding the mechanisms and effects of human exposure to neurological hazards such as biotoxins (from harmful algal blooms), metals (found in new battery technologies and compact fluorescent lights), and pesticides (used in response to changes in agriculture), as well as the potentially exacerbating effects of malnutrition and stress.

**Vectorborne and Zoonotic Diseases**—Disease risk may increase as a result of climate change due to related expansions in vector ranges, shortening of pathogen incubation periods, and disruption and relocation of large human populations.

**Waterborne Diseases**—Increases in water temperature, precipitation frequency and severity, evaporation-transpiration rates, and changes in coastal ecosystem health could increase the incidence of water contamination with harmful pathogens and chemicals, resulting in increased human exposure.

**Weather-Related Morbidity and Mortality**—Increases in the incidence and intensity of extreme weather events such as hurricanes, floods, droughts, and wildfires may adversely affect people's health immediately during the event or later following the event.<sup>188</sup>

### **Populations of Concern<sup>189</sup>**

Some groups of people are more vulnerable than others to health risks from climate change.<sup>[1]</sup> Three factors contribute to vulnerability: *sensitivity*, which refers to the degree to which people or groups are affected by a stressor such as higher temperatures; *exposure*, which refers to physical contact between a person and a stressor; and *adaptive capacity*, which refers to an ability to adjust to or avoid potential hazards.

- Communities of color (including Indigenous communities as well as specific racial and ethnic groups), low income, immigrants, and limited English proficiency face disproportionate vulnerabilities due to a wide variety of factors, such as higher risk of exposure, socioeconomic and educational factors that affect their adaptive capacity, and a higher prevalence of medical conditions that affect their sensitivity.<sup>[1]</sup>
- Children are vulnerable to many health risks due to biological sensitivities and more opportunities for exposure (due to activities such as playing outdoors). Pregnant women are vulnerable to heat waves and other extreme events, like flooding.<sup>[1]</sup>

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<sup>188</sup>[https://www.niehs.nih.gov/health/materials/a\\_human\\_health\\_perspective\\_on\\_climate\\_change\\_full\\_report\\_508.pdf](https://www.niehs.nih.gov/health/materials/a_human_health_perspective_on_climate_change_full_report_508.pdf)

<sup>189</sup> <https://www.epa.gov/climate-impacts/climate-impacts-human-health%20%20>



- Older adults are vulnerable to many of the impacts of climate change. They may have greater sensitivity to heat and contaminants, a higher prevalence of disability or preexisting medical conditions, or limited financial resources that make it difficult to adapt to impacts.[\[1\]](#)
- Occupational groups, such as outdoor workers, paramedics, firefighters, and transportation workers, as well as workers in hot indoor work environments, will be especially vulnerable to extreme heat and exposure to vectorborne diseases.[\[1\]](#)
- People with disabilities can be very vulnerable during extreme weather events, unless communities ensure that their emergency response plans specifically accommodate them.
- People with chronic medical conditions are typically vulnerable to extreme heat, especially if they are taking medications that make it difficult to regulate body temperature.[\[1\]](#) Power outages can be particularly threatening for people reliant on certain medical equipment.

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# **Response to OPG's Mitigation Measures**

## **1.0 INTRODUCTION**

This analysis of OPG's report will have three guiding principles:

### **1.1 Sustainable Development**

The pre-closure period includes site preparation and construction, operations and decommissioning. The post-closure period includes a period of institutional control followed by abandonment forever. The long-term nature and accompanying uncertainties and risks of the proposed DGR Project should compel the Minister to adequately consider the entire lifespan when of the project when determining whether it is or is not approved.<sup>190</sup>

### **1.2 Precautionary Principle**

The precautionary principle is invoked in decision-making in the presence of uncertainty, notably with respect the impacts of the undertaking on public health and the environment. While the JRP began to address some of these uncertainties, key necessary conditions remain that impact public health and the environment.<sup>191</sup> As well, critical "GO –NO GO" decisions are left unstated by OPG, jeopardizing public health and safety, the environment and the health of the Great Lakes.<sup>192</sup>

### **1.3 Transparency of Procedures**

JRP proposal that OPG complete the majority of conditions "to the satisfaction of CNSC" omitting critical stakeholders from these decisions.<sup>193</sup> The public must have access to, and the ability to partake in judging all information presented by OPG in the conformity to mitigation and monitoring commitments.

As well, Health Canada, Department of Oceans and Fisheries, Natural Resources Canada, Ontario Ministry of the Environment and Climate Change and the Ontario Ministry of Natural Resources, as well as other Federal and Provincial Ministries have a large stake in many of decisions on conformity to commitments.

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<sup>190</sup> Comments to the CEAA – Potential Conditions for the DGR, Dr. Markvart

<https://www.ceaa-acee.gc.ca/050/documents/p17520/102170E.pdf>

<sup>191</sup> Comments to the CEAA – Potential Conditions for the DGR, Dr. Markvart

<https://www.ceaa-acee.gc.ca/050/documents/p17520/102170E.pdf>

<sup>192</sup> PMD 14-P1.11.A, Written closing remarks by Dr. P. Storck, pg. 1,

<https://www.ceaa-acee.gc.ca/050/documents/p17520/100213E.PDF>

<sup>193</sup> CEAA – Deep Geologic Repository for Low and Intermediate Level Radioactive Waste Project – Potential conditions, <http://www.ceaa-acee.gc.ca/050%20/document-eng.cfm?document=101713>

## 2.0 Mitigation and Monitoring of Valued Components

The Mitigation and Monitoring commitments for the following Valued Components within OPG's report will be critiqued:

- Geology, Hydrology and Surface Water
- Terrestrial Environment
- Aquatic Environment
- Radiation and Radioactivity
- Atmospheric Environment
- Socio-economic Environment
- Human Health
- Ecological Features

### 2.1 Geology, Hydrology and Surface Water

- 2.1.1 Considering the Precautionary Principle and with the knowledge of effects of Climate Change, all plans for surface water, storm water management, and sump drainage water from the floor of the DGR must account for traditional '100 year storm events' that have been occurring more frequently in Canada, Ontario and specifically on the shores of Lake Huron. Apply to the following:

*MIT-G-01, 03, 07, 09; MIT-H-02, 08; MON-G-02, 03, 04; MON-R-04<sup>194</sup>*

- 2.1.2 Sustainability development and precautionary principle must dictate the size of storm water ponds and storm water procedures to ensure toxins and pollutants do not contaminate water flowing into the Lake Huron. Apply to the following:

*MIT-G-01, 03, 07, 09; MIT-H-02, 08; MON-G-02, 03, 04; MON-R-04<sup>195</sup>*

- 2.1.3 Ensure that ecological features are monitored, not only during pre-construction, construction and operation, but also during the decommissioning, and long term monitoring stages being proposed.

- 2.1.4 Water sampling and testing **must ensure** that all water released from the DGR project site via the storm water management pond and other drainage networks have concentration levels well below certificate of approval discharge criteria. (MIT-H-15 *proposed revision*)<sup>196</sup>

- 2.1.5 Department of Oceans and Fisheries and the Ontario Ministry of Natural Resources must approve of the following Mitigation and Monitoring Commitments:

*MIT-H-14; MON-H-11, 12, 13, 14<sup>197</sup>*

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<sup>194</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>195</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>196</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>197</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

## **2.2 Terrestrial Environment**

- 2.2.1 Ontario Ministry of Natural Resources is to be included as the approval body for: MON-T-01, 02, 03, 04, 07, 09; MIT-T-06,07,08,09,10<sup>198</sup>

## **2.3 Aquatic Environment**

- 2.3.1 Ontario Ministry of Natural Resources is to be included as the approval body for: MON-T-07, 08, MIT-T-10<sup>199</sup>
- 2.3.2 On-going monitoring of drainage ditches and storm water management pond is necessary for bank stability and re-vegetation. (*revise MON-W-03*)<sup>200</sup>

## **2.4 Radiation and Radioactivity**

- 2.4.1 Prior to Construction, Health Canada and Ontario Ministry of Health and Long-Term Care must carry out a comprehensive, base-line health study focusing on the health effects of radiation in the Broader Study Area potentially affected by the DGR. No health study has been carried out in Huron-Bruce Counties for over 20 years. Scientific facts must be documented within a baseline study that determines the current health impact of the Bruce Power Plant and the WWMF prior to considering the cumulative effects OPG's DGR proposal and a possible used fuel DGR in the same region. Member of the community must be involved with the design of the baseline health study which will use independent professionals to develop analytic methods to determine areas of concern and state of the health of the community.
- 2.4.2 OPG must determine and state specific "GO – NO GO" triggers that would require halting the proposed project.<sup>201</sup>
- 2.4.3 The most recent studies by CNSC (Sept. 2013) indicated that the proposed shaft seal material could only be reliable for up to 60 years<sup>202</sup>. OPG must guarantee that any proposed shaft seal will last from construction to long term monitoring. (abandonment is not a possibility)(*MIT-R-11*)<sup>203</sup>
- 2.4.4 Health Canada and Ontario Ministry of Health and Long Term Care must be included as an approval bodies for the following:  
MON-R-01, 02, 03, 04<sup>204</sup>

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<sup>198</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>199</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>200</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>201</sup> PMD 14-P1.11.A, Written closing remarks by Dr. P. Storck, pg. 1,

<https://www.ceaa-acee.gc.ca/050/documents/p17520/100213E.PDF>

<sup>202</sup> JRP transcript Oct. 29, 2013 , pp 17

<http://www.ceaa-acee.gc.ca/050/documents/p17520/95791E.pdf>

<sup>203</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

- 2.4.5 All report and assessments of radiation levels (including tritium plumes) during the life of the DGR must be made available by OPG to the public to ensure transparency.(MON-R-03, 04, 05,06,07)<sup>205</sup>
- 2.4.6 Ontario Ministry of Natural Resources will be an approval body for the following: MIT-T-06; MIT-H-12 to MIT-H-18<sup>206</sup>
- 2.4.7 Radiation monitoring during abandonment must be a condition for the construction license.(MON-R-08)<sup>207</sup>

## 2.5 Atmospheric Environment

- 2.5.1 Ontario Ministry of the Environment and Climate Change and the Federal Ministry of the Environment and Climate Change will be approving bodies for the following: MIT-A-01; MON-A-01, 03, 04,05; MON-R-01; MON-H-15<sup>208</sup>

## 2.6 Socio-Economic Environment

- 2.6.1 In describing **Human Assets, Physical Assets, Social Assets** and **Financial Assets**, OPG is short-sighted, biased and erroneous in stating that all ‘likely assets’ resulting from the DGR project would be ‘beneficial’.<sup>209</sup>
- These statements do not consider well-documented stigma effects on real estate properties that decline when nuclear waste facilities are brought into an area. Bruce, Huron and Grey Counties are vital agricultural areas. These stigma effects have been proven to exist in agricultural areas (never completed Yucca Mountain DGR), agricultural properties and agricultural products.<sup>210</sup>
  - These statements do not consider the precious Great Lakes properties that are vital tourist, vacation and residential areas for Ontarians, Canadians and United States citizens. For more than a century, the economies of Bruce, Huron and Grey counties have been dependent upon, and continue to depend upon tourism to grow their economies.
  - For over a decade, Saugeen Ojibway Nation (SON) has expressed grave concern about the stigma impact of a DGR on the sale of fishery products in the consumer market.<sup>211</sup> OPG continues to deny the existence of stigma attached to a nuclear waste facility, an effect that is well documented.<sup>212</sup>

<sup>204</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>205</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>206</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>207</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>208</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>209</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>

<sup>210</sup> **REPORT ON IMPACTS OF THE PROPOSED YUCCA MOUNTAIN HIGH-LEVEL NUCLEAR WASTE PROGRAM**, <http://www.state.nv.us/nucwaste/yucca/impactreport.pdf>

<sup>211</sup> Saugeen Ojibway Nation Closing remarks to JRP, PMD 14-P1.22.A, 2014-10-09, pp.5-7

<https://www.ceaa-acee.gc.ca/050/documents/p17520/100263E.pdf>

<sup>212</sup> **REPORT ON IMPACTS OF THE PROPOSED YUCCA MOUNTAIN HIGH-LEVEL NUCLEAR WASTE PROGRAM**, <http://www.state.nv.us/nucwaste/yucca/impactreport.pdf>

2.6.2 OPG admits that the DGR will provide very limited employment for area residents during construction and minimal, if any, employment during the sixty to one hundred years of operation and decommissioning. This is contrary to OPG's biased mitigation and monitoring commitments (table 3.8) of their report.<sup>213</sup>

2.6.3 **MIT-S-09**, from OPG's *Mitigation Measures Report* bullet 2 begins with:  
"OPG **plans** to establish a community advisory council related to OPG nuclear waste management facilities at the Bruce nuclear site..."

**This is a retraction from a commitment made during the JRP hearings 2013, at which time this was promised, since no such DGR committee existed previously. OPG attempted to deceive the JRP and the public by referencing the CCAG committee, made up of OPG executives and staff, NWMO executives, County Mayors and, on occasion, CNSC executives who held over twenty unlawful closed meetings.**<sup>214</sup>

2.6.4 With reference to all OPG mitigation and monitoring commitments: **any and all annual reports, monitoring reports and reports describing the need for mitigation measures** to be taken during the construction, operation, decommissioning or post-decommissioning monitoring phases of the DGR must be released to the public in a timely and transparent manner.

2.6.5 With reference to monitoring commitment **MON-S-01**, to ensure transparency, with respect to the DGR, all public attitude survey reports are to be made public in a timely manner.<sup>215</sup>

## **2.7 Human Health**

2.7.1 Prior to Construction, Health Canada and Ontario Ministry of Health and Long-Term Care carry out a comprehensive base-line health study focusing on the health effects of radiation in the Broader Study Area potentially affected by the DGR. No radiation health study has been carried out in Huron-Bruce Counties and especially in the hamlet community of Inverhuron where health effects would most likely to be evident. The most current comprehensive Grey Bruce Health studies were carried out twenty years ago. Scientific facts must be documented within a baseline study that determines the current health impact of the Bruce Power Plant and the WWMF prior to considering the cumulative effects OPG's DGR proposal and a possible used fuel DGR in the same region.

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<sup>213</sup> JRP report, pp.252,

<http://www.ceaa-acee.gc.ca/050/documents/p17520/101595E.pdf>

<sup>214</sup> JRP transcript Oct 30, 2013, pp. 109-114

<http://www.ceaa-acee.gc.ca/050/documents/p17520/101595E.pdf>

<sup>215</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acee.gc.ca/050/documents/p17520/116738E.pdf>



- 2.7.2 Health Canada and Ontario Ministry of Health and Long-Term Care will be included as approval bodies for the following Mitigation and Monitoring commitments: MIT-A-01 to MIT-A-06; MON-A-01 to MON-A-07<sup>216</sup>

## **2.8 Ecological Features**

- 2.8.1 Department of Oceans and Fisheries, Natural Resources Canada, Ontario Ministry of the Environment and Climate Change and the Ontario Ministry of Natural Resources will be included as approval bodies with respect to mitigation and monitoring commitments involving the effects of OPG's proposed DGR, WWMF, BNP, and the possible HLW DGR on Lake Huron and all streams, tributaries, ditches and wetlands in the area.<sup>217</sup>

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<sup>216</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acce.gc.ca/050/documents/p17520/116738E.pdf>

<sup>217</sup> OPG Mitigation Measures Report 2016, <http://www.ceaa-acce.gc.ca/050/documents/p17520/116738E.pdf>

### 3. CONCLUSIONS

The incredibly large risk to the largest fresh water body in the world, alone, is reason enough to reject OPG's proposed DGR. The **facility must maintain its integrity** in order to isolate long-lived intermediate level waste essentially forever, the length of time that these radioactive wastes remain highly toxic. The many **serious uncertainties** which OPG acknowledges in their proposal, demands the need for the greatest degree of precaution vastly more than what appears in the EIS and the commitments being proposed by OPG. This proposed project will not only forever alter the health and well-being of residents of Bruce County, the health of the Lake Huron ecosystem and the biota that it sustains, but the proposed DGR risks Great Lakes, the forty million people who draw water from the Great Lakes and the entire ecosystem that relies on the largest body of fresh water in the world. With OPG's history of lack of transparency and dishonesty with the citizens of Ontario, Canada and North America, it is essential that the public play a vital role in determining the outcome of this DGR project. Generations of innocent future citizens deserve nothing less from us.

# **Response to OPG's Major Environmental Protection Policy Issues**

In November 2015, shortly after the Hon. Catherine McKenna's appointment as Minister of Environment and Climate Change, SOS GREAT LAKES wrote a letter urging her to reject the JRP Report on any one or more of 8 Major Public Policy errors of her predecessor, CNSC, the JRP, and OPG. We urged her to recognize the conflicts between the actions and findings of the three regulators and OPG on major environmental protection policy principles espoused by her Government in the 2015 election campaign.

To date, the Minister has tried to do something about one of these issues (Alternate Sites) but has failed to say anything to the public about all of the other major issues we raised.

OPG continues to spend tax payers money bombarding the public and the Government of Canada with more and more of its false and misleading information. A good example is their recent claim that a poll conducted for them, by their owner's former campaign manager, shows that Ontarians do not care if OPG dumps Radioactive Nuclear Waste near Lake Huron. In another OPG report, OPG claims the majority of Ontarians think the DGR is a good idea. Both claims are demonstrably false. The only true, unaided finding in the poll is that 64% of Ontarians say the DGR would be dangerous to drinking water and the health of the Lake. OPG's "majority support" claim comes from responses to questions which were improperly loaded with misleading or false statements. Moreover, these loaded questions were only asked of 53% of the 805 who answered prequalifying questions a certain way. A 65-70% "yes" was 65-70% of 53% which is 34-37% of the 805 not a majority and, indeed, a misled minority. The Minister remains silent about this Poll.

The Government would be wise to start by debunking OPG's false claims now. Consider the following issues where both the Regulators and OPG are at odds with the Trudeau Government's elaborate Environmental Protection Campaign promises. Hopefully the Minister's silence on these issues is not an indication of acceptance of OPG's Alternate Facts using Alternate Law.

## **1.0 EVIDENCE-BASED SCIENCE**

Canada is not only a signatory to, but also an originator, of an International Protocol, based on experiments in Manitoba, which requires the first step, in any DGR plan, to be an Underground Research Laboratory (URL) to scientifically test the geology and methodology. The Minister's predecessor, CNSC and the JRP all allowed OPG to simply skip this test in their eagerness to act on the offer of the Mayor of Kincardine, a former OPG employee, to bring the DGR to his Town. This was done despite the fact that this would be the first sedimentary rock DGR. In 2016, in Bure France, a tunnel in a URL in sedimentary rock, collapsed, killing a worker and injuring others.

## **2.0 ALTERNATE MEANS**

The Minister has asked OPG for further information of Alternate Sites but not on the equally important statutory requirement to identify, study, and report on Alternate Means. This is especially important now for at least two reasons: 1) the rest of the world is moving away from the DGR for I&LLW in favour of surface or sub-surface, monitored storage, pending further development of recycling possibilities, and 2) the very site that OPG says is the best site for a DGR could possibly be a potential site for the alternate means of monitored surface or sub-surface temporary storage pending technological advance.

## **3.0 SUSTAINABILITY AND THE PRECAUTIONARY**

Historically, at least prior to the Harper Government, these two principles have been the foundation blocks of Environmental Assessment. OPG, CNSC, the JRP, and the Minister's predecessor have all put the Minister in a position of adopting the emasculation of both principles if she does not reject the JRP Report.

## **4.0 PUBLIC HEALTH AND SAFETY**

Canada's Environmental Impact Statement (EIS) Guidelines required much more than OPG did about Baseline Health data against which future problems could be measured. Again, the Minister's predecessor, CNSC, and the JRP let OPG get away by default. Nor did OPG, the former Minister, CNSC, or the JRP pay anywhere near the attention they should have to the fact that all DGRs have failed, especially in the US one on which OPG was modelling its proposal. The Canadian and Ontario Ministers of Health and Public Safety (all four of them) are all still MIA on the Kincardine DGR. The local Medical Officer of Health was involved, - cheerleading in the media for OPG. The OPP were involved, having been dispatched by CNSC to make early morning visits to opponents with standing at the JRP to warn them to "behave".

## **5.0 INTERNATIONAL OBLIGATIONS**

The Harper Environment Minister failed to carry out her statutory obligation under the Canadian Environmental assessment Act (CEAA) to consult and cooperate with the US, Provinces, and States bordering the Great Lakes-St Lawrence Basin as well as US Federally recognized Tribal Governments in the Basin. She disregarded all of these responsibilities. OPG, CNSC, and OPG were required to identify and consider possible cross-border adverse effects. They failed to do so. One wonders if any of them even understood their responsibilities in this regard, let alone the principle of International Comity, which the Right Honourable Joe Clark, Prime Minister of Canada, invoked in 1986 to stop the US from doing the exact reverse of OPG's plan with a potential adverse environmental effects on Canada of a US Nuclear Waste Dump near border waters.

## **6.0 PUBLIC ACCEPTANCE**

The former environment Minister and CNSC defined the potentially affected “public” as the Kincardine area, with apparently no thought of the 40 million Canadians and Americans who get their drinking water from the Great Lakes. Kincardine and five small surrounding Municipalities were paid \$35M in return for promised supportive testimony from their Mayors. The details were honed at regular meetings of OPG and the Mayors at a phony Community Consultation Advisory Group (CCAG). Its real purpose was to police the cash-for-support deal and prepare and polish the mayor’s upcoming testimony at the JRP. The meetings were later found to be unlawful by an Investigator appointed under the Ontario Municipal Act. Kincardine did two public opinion polls paid for by OPG. They were both highly questionable in methodology and wording and interpretation of results. OPG also paid for an Economic Study by the IVEY Business School commissioned by Kincardine. It forecasted a negative stigma effect of adding the DGR, to existing Kincardine Nuclear Energy installations, of \$700,000,000.00 over 30 years. It never made it to Kincardine Council or the Kincardine region public. Neither CNSC, Environment Canada or even the JRP, thought this report to be worthy of mention.

## **7.0 INCOMPLETE REPORT**

The scheme of the governing legislation (CEAA) is to place before the Minister of Environment a comprehensive report of an independent quasi-judicial administrative tribunal covering all the bases on which the proponent is to provide proof of compliance and on which the tribunal is to decide if that job has been done to their satisfaction. Then, and only then, they report their recommendation to accept or reject. This tribunal (the JRP) elected to recommend acceptance notwithstanding the fact that they were unable to make a decision on 98 issues which they wrongly delegated to others including the proponent. Their report was accordingly incomplete and ought to be disregarded for that reason alone.

## **8.0 PARTIALITY**

As a quasi-judicial tribunal, the JRP was required, at all times, to be and to be seen to be, impartial and free from any hint of anything that could create a reasonable apprehension of bias one way or another. CNSC hearings, of which this was one, are already stacked in favour of the proponent because of lack of mandatory disclosure, testimony under oath and the right to cross-examine. Cross-examination would have brought out the IVEY report. A citizen who had heard of it, and later obtained it by FOI legislation, drew it to the JRP’s attention but could pursue it no further because neither he nor any other person with standing was allowed to cross-examine. Compare, on the one hand, the voluntary recusal by Board members in a recent NEB case because of an ill-advised contact with a consultant to one of the parties, with the unquestioning acquiescence by the former Minister, CNSC, and the JRP, in President Binder’s folly, cheerleading September 30, 2009 for OPG at a secret, illegal meeting of OPG and the Mayors. One does not even have to bother looking at the other obvious indicators of bias by the JRP. Enough said.

## **9.0 COST/NEED**

The estimated cost continues to skyrocket while the need has long been established as non-existent.