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The Review of Options for Long-term Management of OPG's Low- and Intermediate-Level Waste

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ABSTRACT

This paper describes the process through which OPG and the Municipality of Kincardine jointly studied options for the management of low- and intermediate-level radioactive waste (L&ILW) at OPG's Western Waste Management Facility. OPG currently operates an interim waste processing and storage facility at the site and Kincardine, as the host municipality, approached OPG with an interest in studying long-term options. OPG and Kincardine signed a Memorandum of Understanding to conduct such a study. Representatives of the Municipality and OPG visited operating L&ILW management facilities in Switzerland, France, Sweden and the United States and met with local authorities at the host communities.

A consultant was contracted to conduct an Independent Assessment of the three options being considered: enhanced processing and long-term storage, covered above-ground concrete vaults and a deep geologic repository. The consultant reviewed geotechnical feasibility, safety, and potential environmental, social and economic effects for each of the options. While the Independent Assessment Study concluded that each of the options is feasible for some or all of the low and intermediate level waste the Municipality indicated a preference for the deep geologic repository option.

1.0 Background

In Canada, the producers of low and intermediate level radioactive waste are responsible for management of that waste, both in the short term and the long term. Currently there are no disposal facilities for these wastes in operation in Canada.

OPG has been managing its low- and intermediate-level radioactive waste (L&ILW) at the Western Waste Management Facility (WWMF) since the mid-70s. The WWMF is located on the Bruce Nuclear site, home to the eight reactors of the Bruce A and B Nuclear Generating Stations. Low- and intermediate-level waste is transported by truck from the Pickering and the Darlington Nuclear Generating Stations to the WWMF where it is processed and stored in interim storage facilities. L&ILW from the Bruce Power generating station is also processed and stored at the WWMF. The Bruce Power generating stations are owned by Ontario Power Generation and,

since 2001, has been leased to Bruce Power to operate. Through a contracting arrangement, OPG assumes ownership of radioactive waste from Bruce Power and manages the waste.

The WWMF is located entirely within the 932 hectare Bruce Power site, which is in the Municipality of Kincardine. The WWMF includes storage of low-level radioactive waste in low-level storage buildings, intermediate-level waste in in-ground containers, above-ground storage structures and trenches, and used fuel in dry storage containers housed in the used fuel dry storage building. The WWMF is an interim storage facility.

The Municipality of Kincardine is located on the Lake Huron shoreline in Bruce County. It consists largely of rural land uses which are designated in the Bruce County Official Plan as rural, agricultural, major open space, natural environment areas, shoreline development areas, special policy area and Inverhuron Provincial Park. The economic base for Bruce County is diverse and includes agriculture, tourism and recreation, a service sector, manufacturing, light industry, fishing and some aggregate resource extraction. The Bruce Power site is the largest single employer in the County with more than 3,000 employees.

The nearest primarily urban areas to the Bruce Power site are the towns of Kincardine and Saugeen Shores, located approximately 20 km southwest and northeast, respectively. The population of the Municipality of Kincardine is estimated to be 11,000 [1]. There are also approximately 650 seasonal residences within the Municipality.

Lake Huron is used locally for fishing for personal consumption, sport, and commercial harvesting, and recreational swimming and boating. The cooling water discharges from the Bruce Power generating stations provide year-round sport fishing opportunities. The lake provides water supply to the larger adjacent communities such as Saugeen Shores and Kincardine by means of water supply plants. Most of the rural population near the Bruce Nuclear site obtains their water from wells.

2.0 Introduction

In 2002, the Municipality of Kincardine approached OPG seeking to enter into an agreement to study options for long-term management of low- and intermediate-level radioactive waste at the existing Western Waste Management Facility (WWMF). Those discussions lead to the signing, in April 2002 of a Memorandum of Understanding (MOU) between OPG and the Municipality of Kincardine. The purpose of the MOU was for OPG, in consultation with the Municipality of Kincardine, to develop a plan for the long-term management of low- and intermediate-level waste at the Western Waste Management Facility. The work plan under the agreement included:

- A review of the technical feasibility of the long-term management options for low- and intermediate-level waste at the WWMF
- A socio-economic impact assessment in the Municipality of Kincardine of the existing operation of the WWMF and of the potential long-term options
- A review of European and American models for long-term management of low- and intermediate-level wastes, including site visits to look at issues such as technical infrastructure and community compensation.

It should be noted that the Memorandum of Understanding was an agreement to consider options and to develop a plan. It did not commit either party to pursuing any of the options. Studies associated with the MOU considered four generic options: continuation of the existing interim storage facilities, enhanced processing and long-term storage, covered above-ground concrete

vaults and a deep geologic repository. A Steering Committee was established with four representatives from the Municipality of Kincardine and three from OPG. The Steering Committee met regularly to develop and advance the work plan.

3.0 Implementing the MOU

3.1 Site Visits

Representatives of the Municipality of Kincardine visited low- and intermediate-level waste storage and disposal facilities in Europe and in the United States. The purpose of the fact finding visits was to review best practices in low- and intermediate-level waste management from a technical perspective and to review government approval processes for low- and intermediate-level waste facilities. Kincardine officials also wanted to meet with local officials to discuss their experiences associated with siting a long-term radioactive waste facility in their community and with the public community consultation methodologies related to the siting process and the facilities.

Operating sites inspected were similar to those being considered for use at the WWMF. The group toured the following facilities:

- Zwilag, Switzerland (enhanced processing and storage facility)
- Centre de l'Aube, France (covered above-ground concrete vault for low-level radioactive waste)
- SKB Facility, Sweden (in crystalline rock 60 metres below the Baltic Sea for low- and intermediate-level waste)
- Barnwell, South Carolina, USA (trench disposal of low-level waste)
- Waste Isolation Pilot Plant, Carlsbad, New Mexico, USA (Deep Geologic Repository for transuranic waste, 2,150 feet below ground in a salt formation)

In addition to the above facilities visited, discussions were also held with NAGRA officials regarding the previously proposed geologic repository for low- and intermediate-level waste at Wellenberg (Switzerland).

The visitors observed that each facility was planned to address the specific circumstances; they recognized that a proposed facility at the WWMF may not exactly resemble any of the existing sites. It was evident that low- and intermediate-level waste can be readily contained in the same facility depending on its design, and that facilities may be planned to store only operational waste or to take decommissioning waste as well. The storage options used varied from site to site, however processing, including incineration, compaction, concrete liners and water collection systems, were generally included.

Site selection processes varied for each of the facilities. In some cases the site selection process included a referendum and in others did not. Once the site selection was confirmed, local support was reported at each of the facilities. It was observed, particularly in circumstances where there was a hosting agreement, that while the nearby residents often supported the facility, there was often more opposition to the siting at greater distances from the site where benefits such as employment and hosting payments were not factors.

The site communities each received benefits beyond enhanced taxation, real property taxes and business licence taxes. In all cases the social and economic well being of the host municipality is enhanced by the presence of the radioactive waste management facility. It was a surprise to the

Canadian delegation to learn that an increase in local visitor traffic resulted from locating the radioactive waste facility.

Regardless of other factors, such as type of waste stored, technology used, compensation, or opposition, at all sites safety was paramount resulting in excellent safety records in all facilities.

3.2 Geotechnical Feasibility Study [2]

In support of the Memorandum of Understanding with the Municipality of Kincardine, OPG retained a consulting company to assess the geotechnical feasibility of constructing a long-term waste facility at the WWMF. The study, which was based only on existing, available data and did not include any original field investigations, comprised three activities:

- Assess geological, hydrogeological and geotechnical conditions at the WWMF
- Assess the design basis and geotechnical design requirements for each of the generic permanent waste repository options
- Assess the geotechnical feasibility of successfully adapting the generic concepts to the WWMF

Further the geotechnical feasibility study was conducted in two stages:

- A preliminary screening to eliminate those concepts that were unsuitable to the WWMF site
- A more detailed assessment of the potentially acceptable concepts

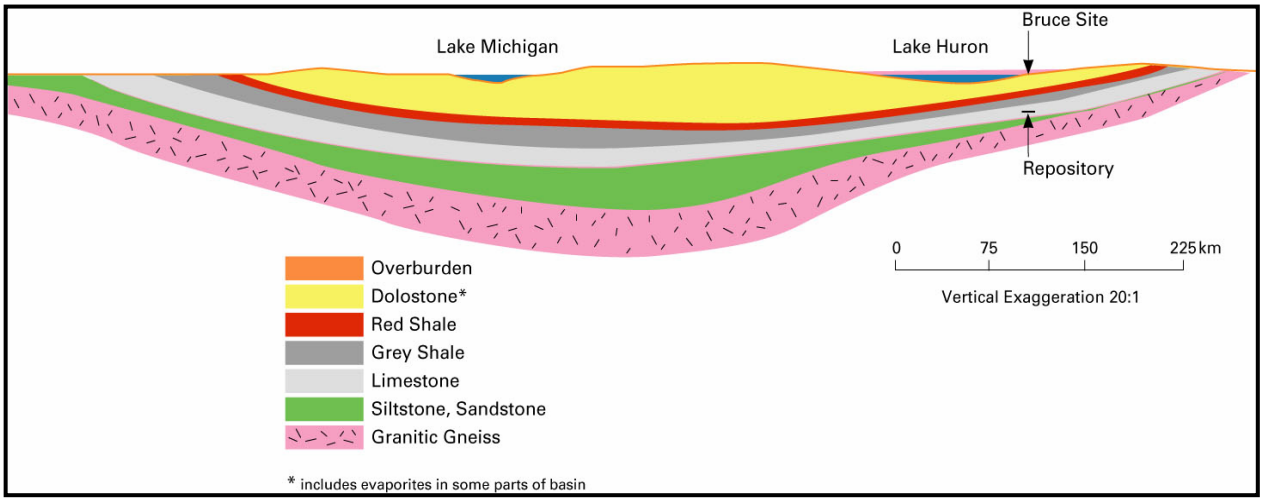
Based on the results of the geotechnical feasibility assessment, and a review of precedent experience with underground openings in Southern Ontario in equivalent geomedia, it was determined that at least the following two of the generic waste options considered are feasible at the WWMF:

- Covered above-ground concrete vault disposal facility
- Deep geologic repository in either Queenston (red shale) or Georgian Bay (grey) shale formations which are projected to underlie the site at a depth of 425 to 600 m or the Lindsay or Verulam limestone formations which are projected to underlie the site at a depth of about 630 to 750 below ground surface (see Figure 1).

Other options may also be geotechnically feasible.

More detail on the geotechnical feasibility assessment will be provided in the paper "*Proposed Deep Geologic Repository for Low- and Intermediate-level Radioactive Waste at the Bruce Nuclear Site*", being presented by Richard Heystee at this conference.

Figure 1
Geologic Setting



3.3 Preliminary Safety Assessment [3]

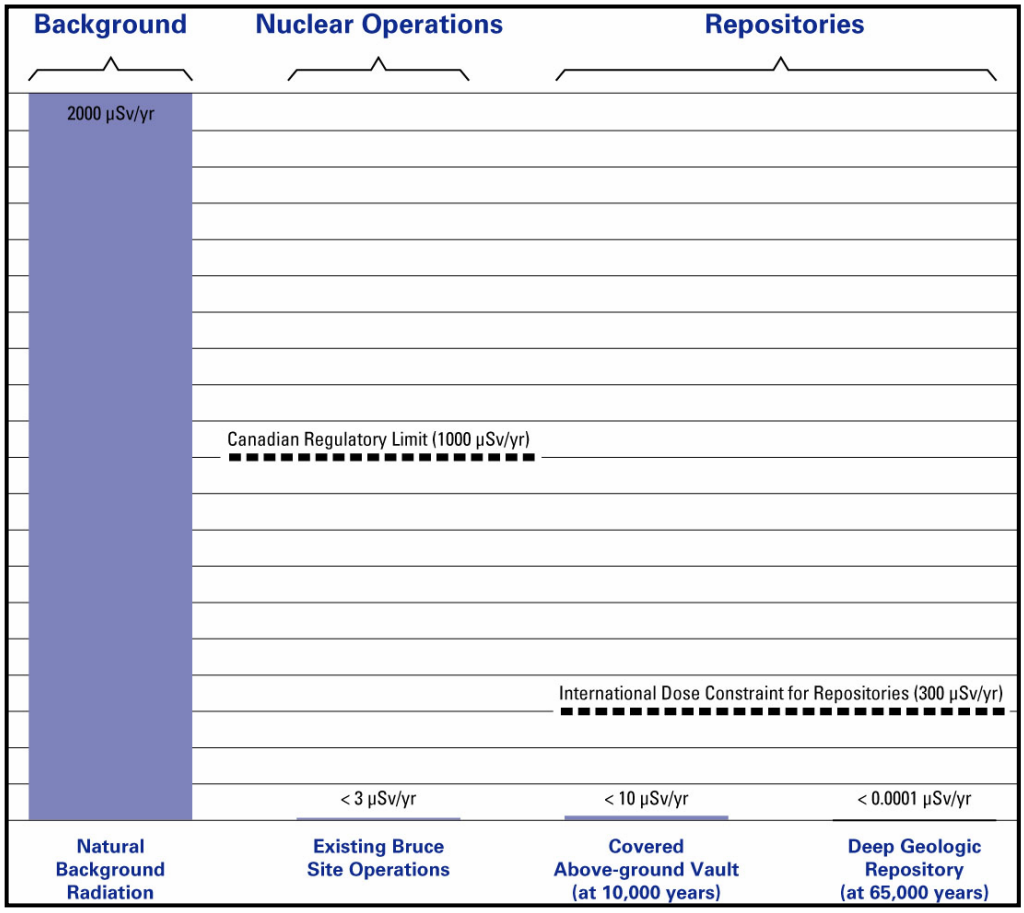
The WWMF is located on the Bruce Nuclear site. The safety performance of all facilities located on the site is calculated by estimating the annual dose that would be received by hypothetical individuals who live, work, or partake of recreational activities near the site. The WWMF makes a very small contribution to the overall dose to the critical group. The dose to the critical group in 2003 from the Bruce Power site was less than 3 µSv per year.

On behalf of the Municipality of Kincardine and OPG, Quintessa Limited (UK) completed preliminary safety assessments of permanent repository concepts for the long-term management of low-level radioactive waste (LLW) at OPG's Western Waste Management Facility. This preliminary safety assessment of LLW concepts focused on two geotechnically feasible repository concepts considered in a companion study by Golder Associates:

1. Covered Above Grade Concrete Vault (CAGCV). CAGCV is similar to an existing LLW facility at Centre de l'Aube in France.
2. Deep Geologic Repository (DGR) in either shale (425 m to 500 m deep) or limestone (630 m to 670 m deep). DGR is similar to an existing LLW facility at Forsmark in Sweden.

Based on the assumed geologic and hydrogeologic conditions at the Bruce site, Quintessa's safety analyses indicate that a Covered Above Grade Concrete Vault could be designed and constructed to meet the ICRP 81 safety criterion of 3×10^{-4} Sv/year. The very low dose predictions for a Deep Geologic Repository in either shale or limestone indicate that the deep repository concepts would meet the ICRP 81 safety criterion by a very large margin.

Figure 2
Safety Assessment Results



The ability of the repository to accept ILW was assessed qualitatively. As a result of the very low permeability of the host rocks, the deep repository concept in shale and limestone were judged likely to meet the radiological protection criteria adopted for this study for a wide range of ILW. Quantitative analyses would be needed to confirm this.

These safety assessment studies will need to be updated based on future site-specific geotechnical investigations and/or design updates as a part of the regulatory approvals process associated with proceeding with a L&ILW repository at the site.

More detail on the safety assessment results is being presented at this conference in the paper "Preliminary Post-Closure Safety Assessment of Repository Concepts for Low Level Radioactive Waste at the Bruce Site, Ontario", by R.J. Little, H. Leung, J.S.S. Penfold and M.J. Egan.

4.0 Cost [4]

The Independent Study Assessment included a review of conceptual costs for each of the options. The cost estimates were limited to design, construction and operation of the long-term management facilities and directly associated infrastructure and include low-level waste only. The cost estimates did not include pre-construction costs for site characterization, licensing,

environmental assessment, taxes, or costs under the host community agreement. The options considered could accommodate varying proportions of the intermediate-level waste, so the cost estimate does not include intermediate-level waste.

The conceptual costs in Table 1 are incremental to those of continuing the current storage operation.

Table 1
Conceptual Cost Estimate

Option	Design Life	Total Incremental Cost ($Can Million 2002)
Enhanced Processing and Storage	100 years	$128
Covered Above-ground Concrete Vault	300 years	$275
Deep Geologic Repository	>> 500 years	$279

5.0 Independent Economic and Social Analysis

5.1 Public Attitude Research

The purpose of the economic and social analysis was to provide information on the potential effects of the proposed long-term L&ILW facility on:

- Residents attitudes and behaviours toward the community
- Economic effects on local businesses and on the municipality
- Tourism and agriculture

The approach to the study consisted of the compilation of existing data on population and economic base for the Municipality of Kincardine and neighbouring municipalities to provide baseline information. Public attitude research was conducted to provide information on the potential for the proposed long-term waste management facility to have an effect on public attitudes and behaviours. The research was gathered through a telephone survey of adults, eighteen or older. The study included determining current attitudes of residents to their community and examining any potential for those attitudes to change as a result of the proposal to permanently store low and intermediate level waste at the WWMF.

A survey was conducted with tourists visiting the area, to determine whether the proposal would affect their attitude to vacationing in the area.

Public attitude and tourism research indicated that none of the options considered would have significant adverse effects on residents', businesses', or agricultural operators' feelings of personal safety, community satisfaction and with the agricultural operators change their commitment to farming.

Over 75 per cent of Kincardine respondents were very or somewhat confident in the existing technologies for processing and treatment of low- and intermediate-level waste. Residents did

not anticipate any changes to their behaviour to result should a long-term low- and intermediate level waste management facility be located at the WWMF. Tourism research indicated that none of the options would be expected to have a measurable effect on visits to Kincardine or on tourist activities.

5.2 Economic Effects [5]

The economic analysis consisted of economic modelling to quantify the effects of each of the options on local spending and employment.

The economic analysis did not identify any negative effects associated with the options. There would be economic benefits to Kincardine and the surrounding communities, including increased local spending and direct, induced and indirect employment incremental to that associated with the operation of the WWMF.

Table 2
Economic Benefits

Option	Direct Project Employment (Person Years)	Indirect Employment (Person Years)	Induced Employment (Person Years)	Direct Project Expenditures (Million $)	Income Related Spending in Kincardine (Million $)
Status Quo	2,511	3,658	2,480	648	81
Enhanced Processing*	2,883	4,216	2,852	775	93
Surface Vaults*	3,658	5,363	3,596	921	118
Deep Vaults*	3,627	5,270	3,565	890	115

- Includes expenditures for the Status Quo Option

5.3 Community Consultation – IAS [6]

As a part of the Independent Assessment Study, community information and consultation programs were undertaken. The objectives of the program were to inform the local community about the discussions on the options for long-term low- and intermediate-level waste management and for stakeholders to provide their input and discuss any concerns that they had. The Study Area selected was the Municipality of Kincardine, municipalities adjacent to Kincardine, and local First Nations.

Community Consultation included briefing presentations to municipal councils, meetings with elected representatives and other interested parties such as the local Medical Officer of Health, and regulatory agencies such as the Ministry of Environment, and Canadian Nuclear Safety Commission. Following the presentations, a newsletter was distributed to residences in the municipalities. Open Houses were announced through newspaper advertisements in May of

2003. Five Open Houses were held in the Study Area. The Open Houses were informal, with presentation panels on easels, copies of the newsletter, fact sheets to provide information on different aspects of the Independent Assessment Study, and representatives of the Consultant, OPG and Kincardine were available to speak about the study.

In total 77 visitors attended the Open Houses, approximately half of these attending the Open House in Kincardine, the Municipality which that approached OPG to study hosting the facility. The vast majority of those attending the Open Houses did so to obtain additional information about the proposed project and how it might affect them or their community. Areas of interest included concerns about potential health and safety issues, potential impact on ground water and flooding of the caverns. Not all of those attending the Open Houses were fully supportive. Comments about the use of nuclear fuel as a source of power were registered and concerns about the potential for high level waste to be managed at the proposed facility were also expressed. It is generally understood that the wastes that have been produced to date must now be addressed for long-term storage.

Overall, visitors were pleased with the presentation material and the efforts to involve them in the study.

6.0 Environmental Protection Feasibility

An environmental screening to examine the potential effects of each of the three options on the environment, at the construction and operations phases, was completed.

Potential adverse effects identified at the construction phase included dust, noise, increase in traffic, potential disturbance of wildlife habitat, decrease in tourism and perception in the community. Potential effects during the operations phase included those identified during the construction phase as well as potential radioactive emissions to the environment and radiation exposures to workers and the public.

The environmental protection feasibility assessment concluded that while each of the three options has the potential to cause effects on the environment, all identified potential effects can be appropriately managed using proven mitigation and management methods. No significant adverse residual environmental effects are expected to result for any of the options.

7.0 Municipality Prefers DGR

Following a review of the Independent Assessment Study Report, municipal support was indicated at the April 21, 2004 Council Meeting at which the following resolution was carried:

Resolution #2002 – 232
"that Council endorse the opinion of the Nuclear Waste Steering Committee and select the "Deep Rock Vault" option as the preferred course of study in regards to the management of low and intermediate level radioactive waste".

Although the vote was not unanimous, the two who did not support the motion did not oppose the waste facility, rather that there would not be a community referendum to seek residents' feedback on the proposal. Instead it was decided to conduct a telephone poll of residents to seek their opinion.

The Council's decision to support the DGR as its preferred option was based on the following key points:

- It provided the highest level of safety of any option.
- There will be a rigorous environmental assessment and Canadian Nuclear Safety Commission regulatory process that includes opportunities for public input before construction is approved.
- The deep geologic repository will permanently isolate the low and intermediate level waste stream, much of which is already stored on site.
- It provides significant economic benefit to the residents of our municipality.
- No high level waste or used nuclear fuel would be allowed in the facility.

8.0 Community Support

Following the Council Resolution to support the DGR as the preferred course of study, Kincardine and OPG negotiated a Hosting Agreement. This agreement is the subject of a paper presented by A. Castellan at this conference, "The OPG/Kincardine Hosting Agreement for a Deep Geologic Repository for OPG's Low- and Intermediate-Level Waste". One of the criteria in the Agreement for OPG to proceed to the next stage of the regulatory process for the proposed DGR was that the Municipality demonstrate community support. The Municipality of Kincardine decided to contract an independent consultant to conduct a telephone poll. The initial thought of allowing a single vote for each household was quickly changed to allow each resident of Kincardine eighteen years of age or older to participate as a result of feedback from the public.

Kincardine recognized the need to provide residents information on the proposal to assist them in making a decision in the telephone poll. OPG assisted the Municipality in their communication program.

8.1 Consultation Centre

In October 2004, immediately following the signing of the Hosting Agreement, a storefront Community Consultation Centre was opened in the downtown core of the Municipality. The storefront was staffed by representatives of Kincardine and OPG Thursday through Saturday from mid-October2004 through January 2005. The storefront provided an opportunity for local residents to obtain information about the DGR proposal, and to provide feedback to the Municipality and to OPG and to discuss any issues and questions that they had. A newsletter was distributed to residences in Kincardine to provide an update on the status of the proposal and to announce the opening of the storefront and the web page.

Attendance at the Community Consultation Centre was steady throughout the period, averaging about ten visitors a day. The number of supporters of the proposal and that of those with concerns or opposition were approximately the same through the consultation. Issues discussed included:

- Potential for high level waste to be disposed at the facility (the agreement states that high level waste will not be disposed at this facility)
- Potential for contamination of ground water, drinking water and Lake Huron
- Risk of the repository to flood
- Health and safety risk to future generations

Through the consultation period, speakers were available to make presentations at community and service group meetings. Fact sheets were also published in the local newspapers providing various perspectives on the proposal, such as a Geoscientist's perspective, a Public Health Official's perspective and statements from a Professional Engineer and the Consultant who managed the Independent Assessment Study and commonly heard Myths and Facts about the proposal. In the final week before the telephone poll was to begin, a pamphlet which included information used at the storefront, was distributed to residences within the Municipality.

8.2 The Polling Process

It was decided at the outset of the poll that both year-round and seasonal residents would be eligible to participate in the survey. Seasonal residents, who typically use their properties more in summer, were contacted by mail and permanent residents were contacted by telephone. As many as ten phone calls were made to each residence, until the pollster either spoke with a resident or was able to leave a message providing a toll-free number to which participants could respond at their convenience. The telephone poll was conducted over a three week period. Households which had not responded or received a message during the telephone poll received a mailed ballot after the telephone period of the poll ended. An advertisement was placed in local newspapers requesting those who did not have access to a phone, or who have an unlisted telephone number, to participate in the survey through a toll-free number.

8.3 The Question

The poll was conducted by telephone. A pollster read the attached preamble to participants and then asked them the question below.

Preamble
The Kincardine Council has expressed its support for the long-term management of low and intermediate nuclear waste in a deep geologic repository to be owned and operated by Ontario Power Generation at the Western Waste Management Facility located at the Bruce site.

Council's decision was based on the following key points:

- It provides the highest level of safety of any option.
- There will be a rigorous environmental assessment and Canadian Nuclear Safety Commission regulatory process that includes opportunities for public input before construction is approved.
- The deep geologic repository will permanently isolate the low and intermediate level waste stream, much of which is already stored on site.
- It provides significant economic benefit to the residents of our municipality.
- No high level waste or used nuclear fuel would be allowed in the facility.

In summary, Council believes it is important to solicit the views of residents.

Question
Do you support the establishment of a facility for the long-term management of low and intermediate level waste at the Western Waste Management Facility?

Participants were given the option of voting **YES, NO** or **NEUTRAL.**

8.4 Results of the Poll

The Consultant announced the results of the poll at a Kincardine Council meeting. A total of 72 per cent of eligible residents participated in the survey. Of those, 60 per cent voted YES, 22 voted NO, 13 were NEUTRAL and 5 didn't know or refused to participate. An independent auditor conducted a limited process audit of the poll and found the poll to have been conducted in accordance with the planned process.

Following the announcement of the results, the Kincardine Council passed a resolution accepting "the results of the community consultation to be a clear mandate from permanent and seasonal residents, 18 years of age and over, for the establishment of a deep geologic repository for the storage of low and intermediate level nuclear waste".

9.0 References

1. Canadian Census. 2001. Government of Canada.
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5. Independent Assessment Study Report. Golder Associates. February, 2004.
6. Report on Open Houses Community Consultation Program Long-Term Management of Low and Intermediate Level Waste. June 2003. Golder Associates.