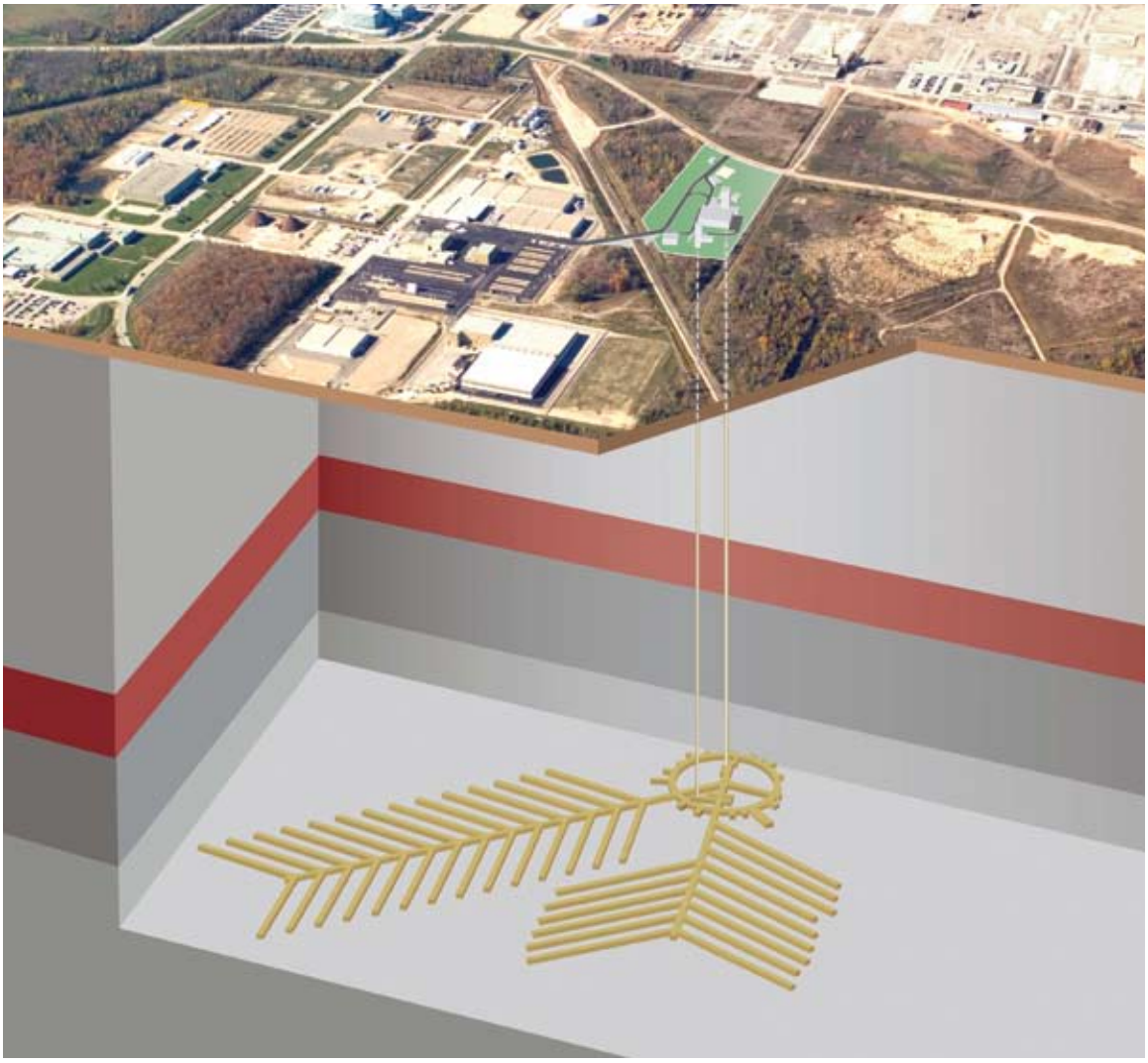
DEEP GEOLOGIC

REPOSITORY

FOR OPG's LOW & INTERMEDIATE LEVEL WASTE



KEEPING YOU INFORMED

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NUCLEAR WASTE MANAGEMENT ORGANIZATION

SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

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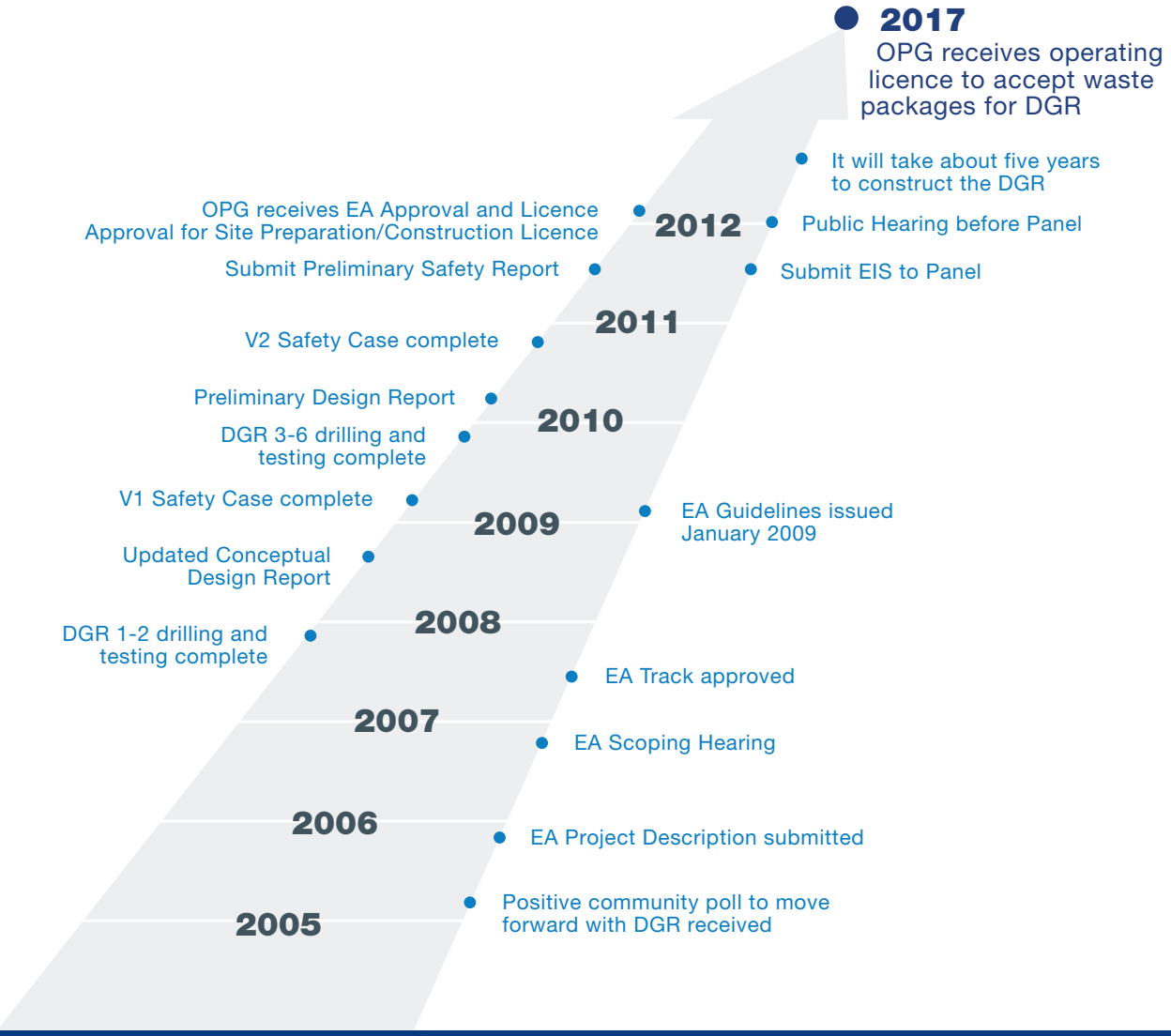
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Dear Stakeholder:

The Nuclear Waste Management Organization (NWMO) is pleased to provide you with this information on the proposed Deep Geologic Repository (DGR) project – a long-term management facility for low and intermediate level nuclear waste only. The NWMO is seeking regulatory and licensing approval for the project on behalf of Ontario Power Generation (OPG) who is the owner and licensee of the DGR. NWMO and OPG believe the DGR is a safe and environmentally responsible approach to managing the existing and future low and intermediate level nuclear waste from OPG's 20 reactors.

A formal environmental assessment and licensing process began for the DGR in 2005 and is expected to take six to eight years. A public hearing before a joint review panel will be held around 2012. Community consultation will provide many opportunities for members of the public to be informed and express their views on the proposal. This booklet is designed to provide you with an overview of the proposed DGR. For more information about the DGR, please visit **www.nwmo.ca/dgr**, call 519-368-1639 or email **mwilson@nwmo.ca**.

Project and Regulatory Process



For more information about the DGR regulatory process visit **www.nuclearsafety.gc.ca or www.ceaa-acee.gc.ca**

DGR Project Moving Through EA/Licencing Process

2005	Regulatory process to receive a licence to construct a DGR begins with the submission of the DGR Project Description to the Canadian Nuclear Safety Commission (CNSC) who must approve the licence
2007	DGR project was referred to a Joint Review Panel Environmental Assessment (EA) under the Canadian Environmental Assessment Act in June by the federal Environment Minister. The Joint Review Panel process allows a panel of three to consider both the Environmental Impact Statement (EIS) and the application for site preparation/construction licence
2008	Environment Minister and CNSC jointly issued draft guidelines for EIS and Joint Review Panel Agreement in April for public review. Participant funding awarded to six parties to assist with participation in public review
2009	Final guidelines were issued in January
2009+	Work continues to verify the Bruce site as a suitable location for the DGR and to analyze any potential effects on the environment from the DGR
2011	Results from geoscience, engineering and design, safety assessment, environmental field work and communications will be reflected in the EIS to be submitted to the Joint Review Panel along with the Preliminary Safety Report
	EIS will be available for public review
2012	A public hearing to hear feedback from individuals and groups will be held. The panel will make a recommendation to the Minister of Environment on the suitability of the EIS. The minister then takes it to Cabinet for the final decision. EIS must be accepted before a site preparation/construction licence can be issued

How will the project be funded?

- Construction and operation of the DGR is estimated at $1 billion with about $600 million of that slated for construction
- Under the Ontario Nuclear Funds Agreement, a segregated fund has been established for the long-term management of low and intermediate level nuclear waste from OPG reactors and the decommissioning of nuclear power plants. The DGR is already fully funded

Western Waste Management Facility (WWMF)

- OPG's WWMF, located in the Municipality of Kincardine, has safely managed low and intermediate level nuclear waste since 1974 and can continue in this role for many decades
- The WWMF manages all of the low and intermediate level nuclear waste from the Bruce, Pickering and Darlington generating stations. It also manages the low and intermediate level nuclear waste from the Douglas Point Generating Station, located at the Bruce site
- The WWMF manages high level nuclear waste from Bruce Power, while Darlington and Pickering have facilities for managing their own high level nuclear waste
- The DGR will provide safe long-term management for all of the low and intermediate level nuclear waste currently managed at the WWMF including waste from the future operation of OPG's existing reactors

Western Waste Management Facility

1: **10 Low Level Storage Buildings**
2: **Quadricells**
3: **Waste Volume Reduction Building**
4: **Transportation Package Maintenance Building**
5: **Used Fuel Dry Storage Facility**
6: **Refurbishment Waste Storage Buildings**
7: **In-Ground Storage Containers**
8: **Future Low Level Storage Buildings 11 & 12**

What is Low Level Nuclear Waste?

Low level waste is received at the WWMF

- Low level nuclear waste consists of common industrial items that have become contaminated with low levels of radioactivity during routine clean-up and maintenance at the nuclear generating stations
- It includes mops, rags, paper towels, temporary floor coverings, floor sweepings, protective clothing and hardware items such as tools
- It consists of paper, plastics, metal, rubber, cotton and other miscellaneous materials
- Low level nuclear waste can be safely handled using normal industrial practices and equipment without any special radiation protection

What is Intermediate Level Nuclear Waste?

Intermediate level nuclear waste is inserted into in-ground storage containers at the WWMF

- Intermediate level nuclear waste requires shielding to protect workers during handling
- Intermediate level nuclear waste typically includes ion exchange resins, filters and irradiated core components associated with refurbishment waste
- Approximately 290 m^3 of intermediate level nuclear waste is received each year at the WWMF
- Approximately five per cent of all waste (excluding used fuel) received at the WWMF is intermediate level nuclear waste

What is High Level Nuclear Waste?

Used fuel dry storage containers

- High level nuclear waste consists of fuel bundles that are used in the reactors to produce energy for electricity
- Fuel bundles spend a minimum of 10 years in large pool-like structures filled with water called fuel bays before they are placed in robust dry storage containers made of steel and concrete that provide shielding
- **Used Fuel will not be placed in the DGR.** It is stored on an interim basis at the site where it is generated
- The Nuclear Waste Management Organization has the responsibility for implementing Adaptive Phased Management – a long-term management plan that is intended to, with collaboration, continuous learning and adaptability, eventually lead to the construction of a geologic repository for all of Canada's used fuel

For more information about the NWMO and Adaptive Phased Management, please visit **www.nwmo.ca**

What is Refurbishment Nuclear Waste?

A steam generator is transported to the WWMF for interim management

- Refurbishment nuclear waste consists of low and intermediate nuclear waste generated from the refurbishment of reactors
- Intermediate refurbishment nuclear waste consists of irradiated core components such as pressure tubes, calandria tubes and end fittings that are safely managed in shielded containers inside a concrete refurbishment waste building
- Low level refurbishment nuclear waste consists of steam generators that are safely managed in a concrete refurbishment waste building

Transportation of Nuclear Waste

- Low and intermediate nuclear waste has been transported from the Pickering and Darlington generating stations to the WWMF for over 35 years
- Transportation of nuclear waste is regulated by the Canadian Nuclear Safety Commission (CNSC)
- No release of nuclear materials has ever occurred during transportation of the waste
- Training about the transportation of nuclear materials is provided to First Responders all along the transportation routes
- OPG has a Transport Canada emergency response plan in place with highly trained responders

A Community Partnership

In 2002, the Municipality of Kincardine and Ontario Power Generation signed a Memorandum of Understanding (MOU). The MOU set out terms to assess the feasibility of the long-term management of low and intermediate level nuclear waste at the Western Waste Management Facility located within the Bruce site.

- Under the MOU, Golder Associates conducted an Independent Assessment Study, which looked at the feasibility of various long-term management options for low and intermediate level nuclear waste at the Bruce site. It also included a preliminary safety assessment and took into account information from a study based on existing geological, groundwater and geotechnical information related to the Bruce site
- Three options were deemed to be technically feasible, safe and without significant social, economic or environmental impacts: enhanced storage and processing, above ground concrete vaults and deep geologic repository
- The Independent Assessment Study compared the options and included consultation with the local community and stakeholders
- In 2004, Council for the Municipality of Kincardine endorsed the DGR over all of the other options, by resolution, because of its greater safety margin
- In 2005, an independent polling of both permanent and seasonal residents was conducted in Kincardine which showed a majority of residents supported going forward with the DGR

Hosting Agreement

Key features:

- With the support of the community, OPG will obtain regulatory approvals to construct the Deep Geologic Repository for low and intermediate level nuclear waste

- Kincardine, Saugeen Shores, Huron-Kinloss, Arran-Elderslie and Brockton to receive $35 million (2004 dollars, inflation protected) paid over 30 years subject to achieving key milestones:
  > Environmental Assessment Guidelines
  > Environmental Assessment Approval
  > Construction Licence
  > Operating Licence

- The Municipalities will choose how to use the funds for the benefit of their communities

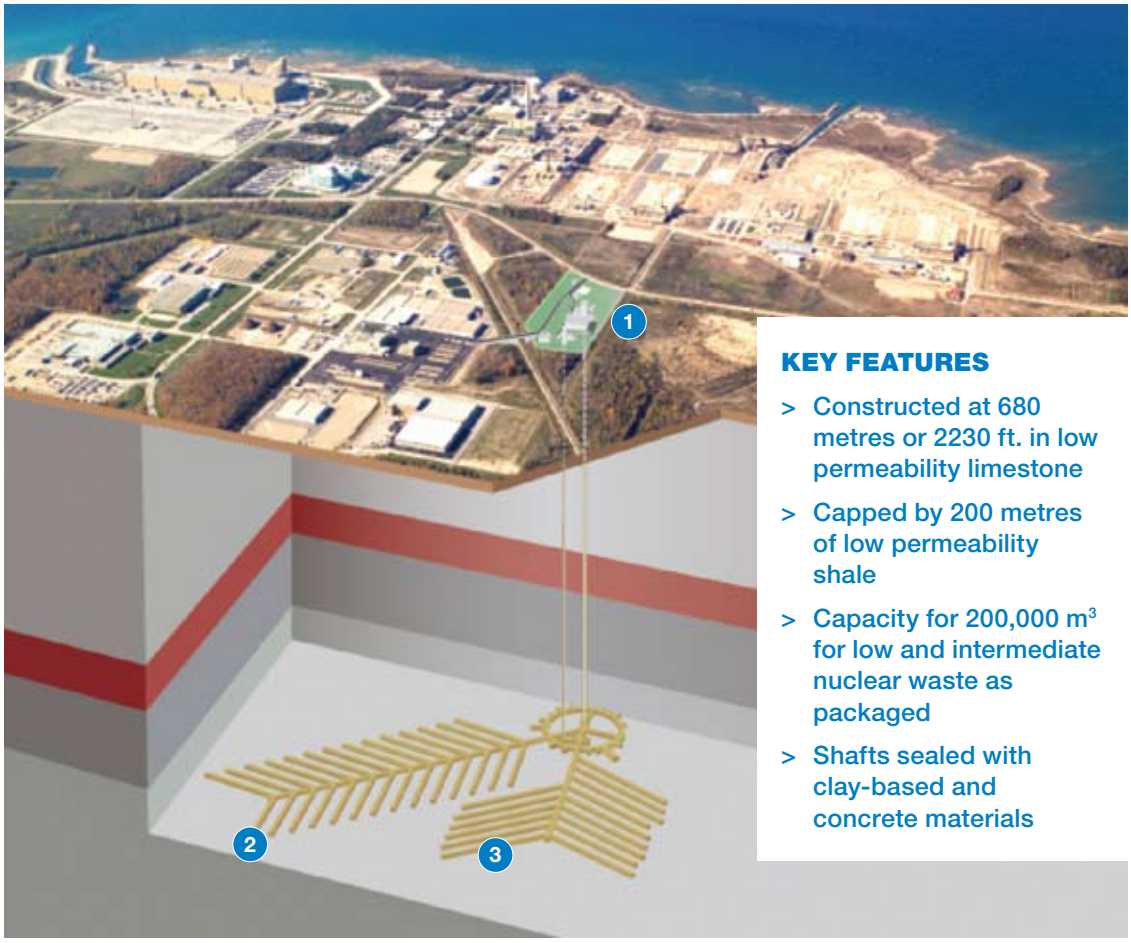
- Provision for 200,000 m^3, as packaged, of low and intermediate level nuclear waste produced until 2035 during reactor operations from OPG's 20 reactors, including refurbishment and decommissioning waste

- Provision to negotiate repository expansion for additional low and intermediate level nuclear waste for new build reactors in Ontario

- No used nuclear fuel will be placed in the Deep Geologic Repository

- Property Value Protection Plan

Proposed Deep Geologic Repository at OPG's WWMF



KEY FEATURES

- Constructed at 680 metres or 2230 ft. in low permeability limestone
- Capped by 200 metres of low permeability shale
- Capacity for 200,000 m^3 for low and intermediate nuclear waste as packaged
- Shafts sealed with clay-based and concrete materials

1: **DGR surface facilities**

2: **LLW emplacement room**

3: **Resin Liner Shields within ILW emplacement room**

DGR Conceptual Engineering Design

- Rock excavation will be primarily by roadheader
- The main shaft will provide personnel access and waste handling, and a second shaft will provide exhaust ventilation and an emergency escape route
- Excavated rock will be stored on-site
- Surface facilities will include a headframe building, and an adjoining building for waste package receipt and staging
- Construction will take about five years
- A 40-tonne hoist will move waste and personnel between the surface and repository levels
- Underground facilities, located in the ring tunnel, include waste receiving, a control room, equipment room, geoscience laboratory, refuge stations, cafeteria and showers
- Low and intermediate level nuclear waste will be managed in separate emplacement rooms. The rooms will be excavated in limestone and will have concrete floors
- Once filled, each room will be isolated by a wall, but not backfilled

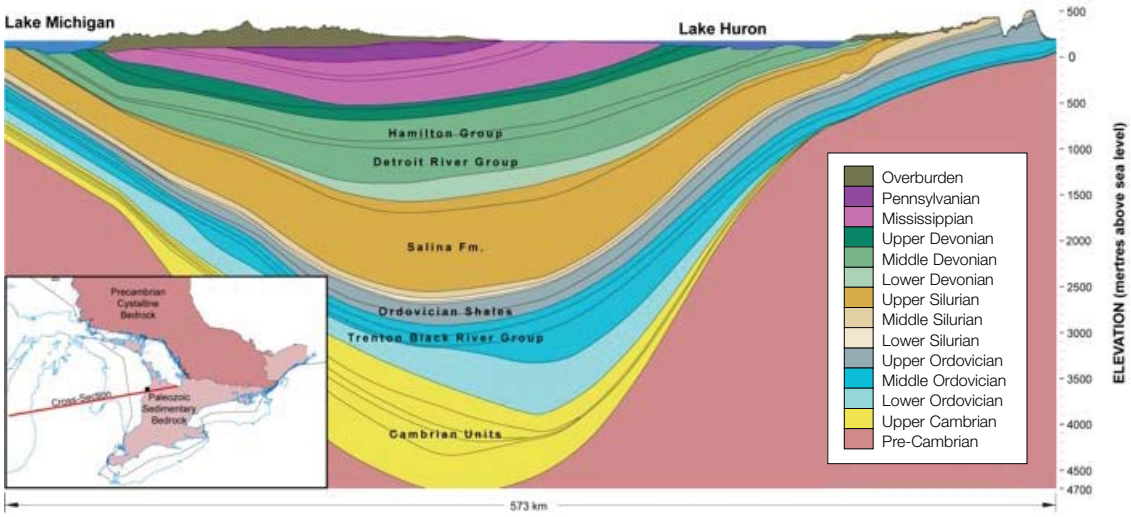
Roadheaders will be used to construct access tunnels and emplacement rooms

Geoscience Attributes

PREDICTABILITY

- Borehole coring indicates a consistent bedrock “column” beneath the Bruce site comprised of 34 horizontally-layered and laterally extensive bedrock formations of Cambrian to Devonian age (543–350 million years)

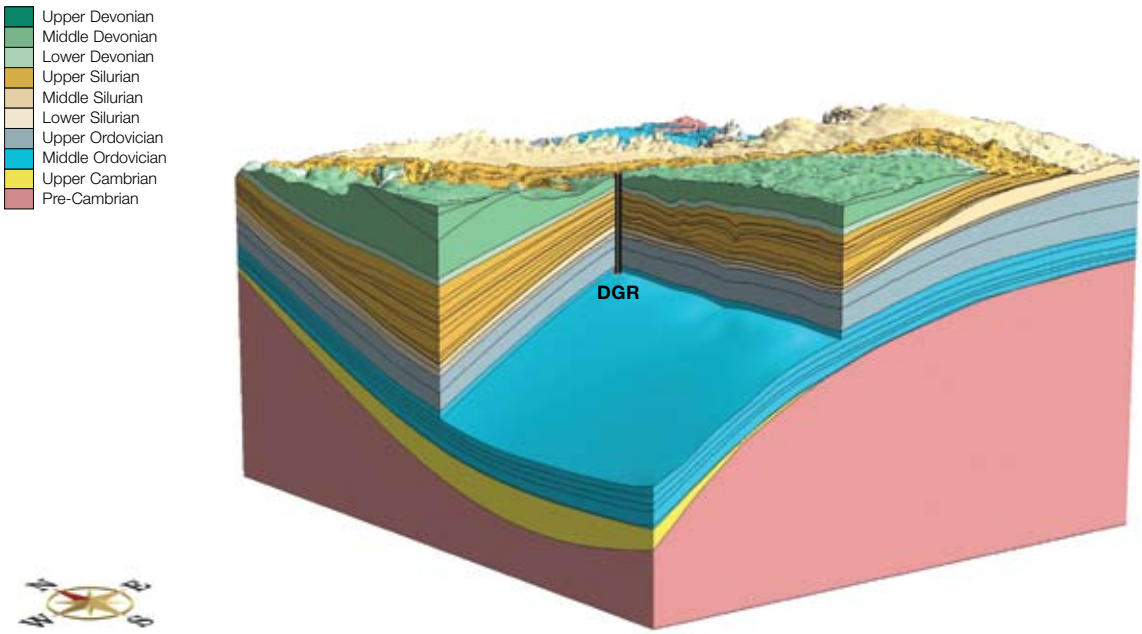
- Sedimentary bedrock layering, observed beneath the Bruce site, reflects the regional geologic knowledge that these layers extend laterally for great distances of up to hundreds of kilometres beyond the Bruce site



Geologic cross-section of Michigan Basin

MULTIPLE NATURAL BARRIERS

- The diagram below portrays the various geologic layers present at the Bruce site
- The DGR is surrounded by multiple layers of low permeability sedimentary rock. The horizon immediately above the repository is comprised of a 200-m layer of low permeability Ordovician age (450 Million years) shale located about 440 m below ground surface
- A sequence of shales, dolostones and evaporties, including the Silurian age (420 million years) Salina Formation (190 m thick) above the Ordovician shale, also possesses low permeabilties

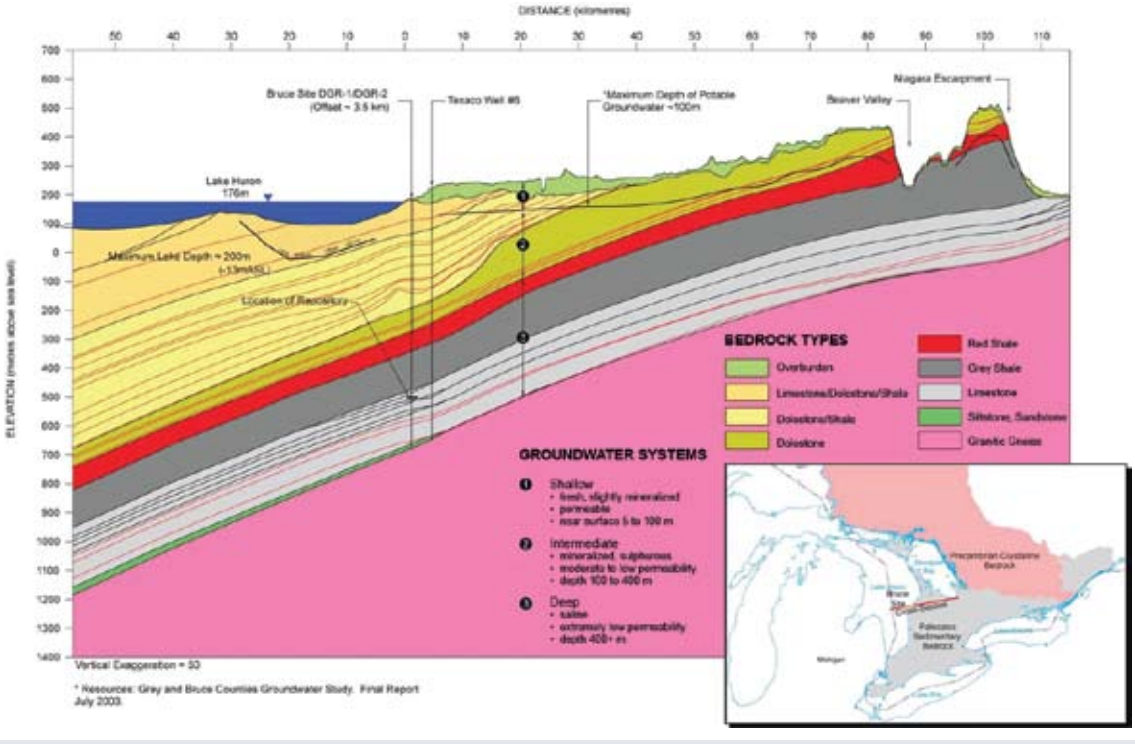


Regional study area 3-dimensional model of bedrock stratigraphy

Geoscience Attributes

NATURAL BARRIERS TO PROTECT GROUNDWATER AND SURFACE WATER

- Drinking water found in the upper 100 m is extremely well isolated from the DGR
- Water found at the repository depth has a salt content eight times that of seawater, an indication it has been trapped within the rock layers for millions of years, from the time when it was part of an ancient sea bed
- Pore water found at 680 m doesn't flow, but is sluggish and stagnant



DGR will protect Lake Huron

- The DGR will be located about one kilometre inland from Lake Huron
- The deepest point of Lake Huron at about 200 m (660 ft.) is well isolated from the DGR by over 400 m (1320 ft.) of rock layers

SEISMICALLY QUIET

Low level seismic monitor

- The Bruce region, located in the stable interior of the North American continent, is seismically comparable to the stable Canadian Shield. Historic records of seismic activity do not reveal events exceeding M5, within a radius of more than 150 km of the Bruce site, in the past 180 years

- A network of three low-level seismicity monitors was installed within a 50-km radius of the DGR site in 2007. Reports compiled by the Geological Survey of Canada from this network have not detected any seismic activity greater than M2.5 within a 150-km radius of the site. Seismic activity at a M2.5 level would not generally be felt by an individual at the surface. This network of seismic monitors will be utilized in the development of a detailed seismic model of the area

Geoscience Attributes

NATURAL RESOURCE POTENTIAL

- No significant oil or gas was encountered in three vertical boreholes drilled on site, nor in several historic oil and gas wells drilled within 10 km of the Bruce site. There are no known industrial minerals that are unique to the site and cannot be obtained from elsewhere

TRANSPORT DIFFUSION DOMINATED

- Low bedrock permeabilities measured in deep boreholes drilled at the Bruce site are consistent with an environment where the movement of radionuclides is only possible through diffusion

- Numerical simulations of the regional and site-scale groundwater systems conducted by the University of Waterloo support the assertion of a stable, diffusion dominant system enclosing the repository

GEOMECHANICALLY STABLE

- Core samples obtained during deep borehole drilling at the Bruce site exhibit compressive strength which exceeds original understanding based on existing regional, geologic information
- The DGR opening, constructed in the Cobourg Formation beneath the Bruce site, should be dry and stable
- The Darlington Nuclear Generating Station's cooling water intake/discharge tunnels, constructed in the Cobourg Formation 30 m beneath Lake Ontario, provide evidence that the formation can sustain a stable, dry opening with minimal rock support

Construction during Darlington cooling water intake tunnel

Geoscientific Site Characterization

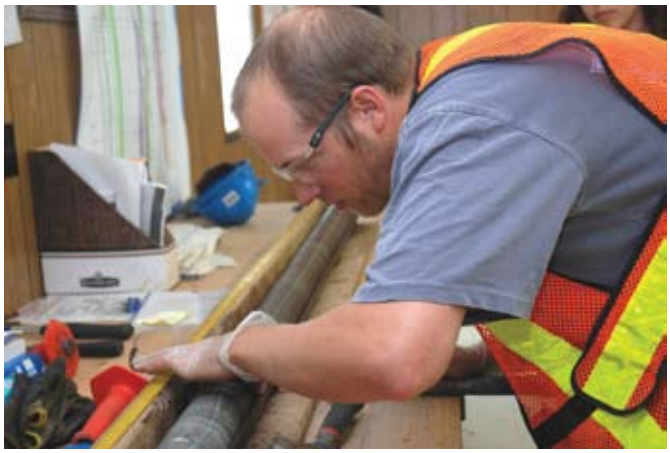
PHASE ONE

A four-year, step-wise series of scientific investigations began in 2006 to verify the ability of the geology at the Bruce site to safely isolate and contain low and intermediate level nuclear waste. Phase One included the following test programs:

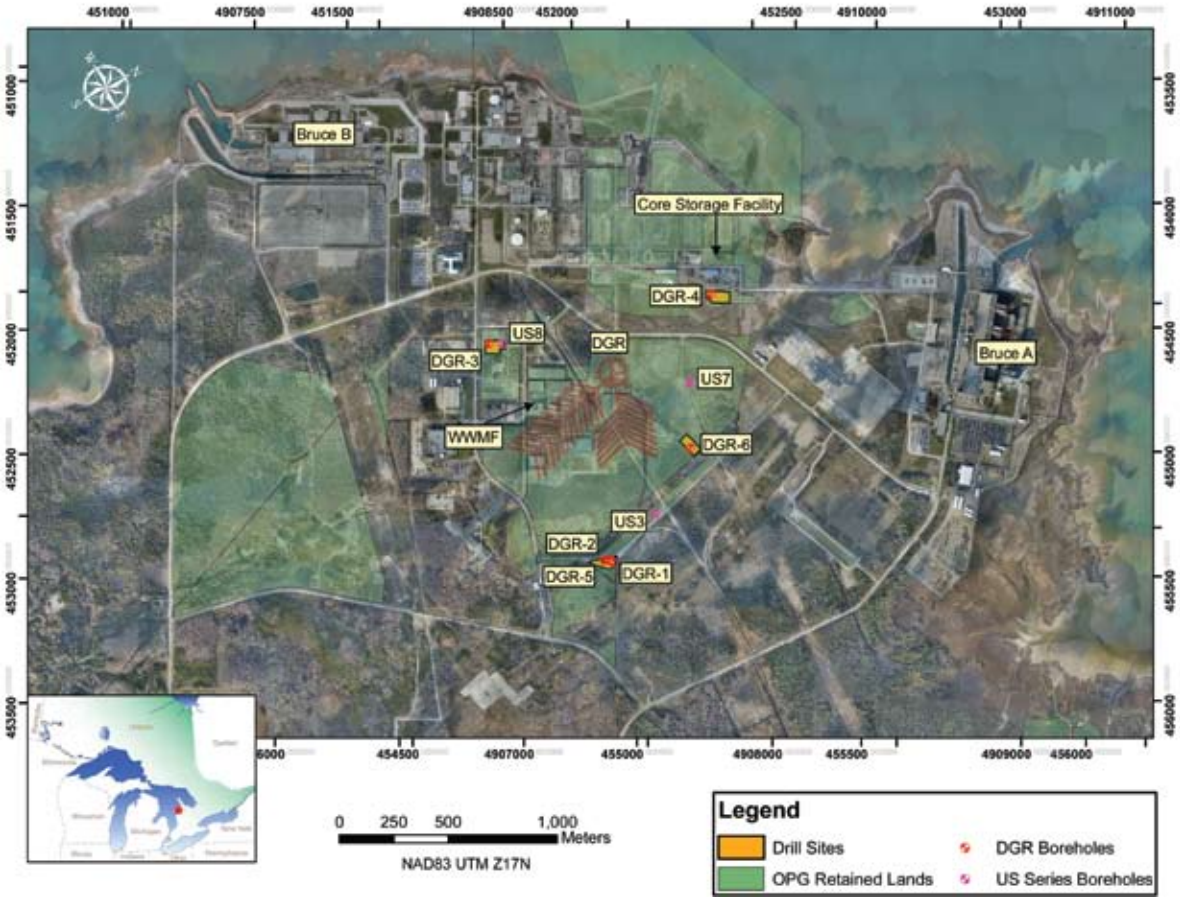
- 2D seismic reflection survey to image the sedimentary bedrock
- Three low-level seismographs installed at three locations within a 50-km radius of the Bruce site to monitor low level seismic activity
- Drilling and coring of vertical boreholes DGR 1 to 463 metres and DGR 2 to 863 metres to provide rock core samples for laboratory tests to measure physical and chemical rock properties
- Downhole geophysical logging of boreholes with various instruments to determine the different layers (formation contacts), rock density and porosity
- Hydraulic borehole testing to measure bedrock formation permeabilties
- Installation of Westbay multi-level groundwater monitoring equipment to allow long-term monitoring of deep groundwater conditions

PHASE TWO

- Phase Two of the Geoscientific Site Characterization began in April 2008 with the drilling, coring and instrumentation of two additional vertical boreholes at separate sites
- DGR 3 and DGR 4 were drilled to about 860 m in 2008
- Two additional steeply inclined boreholes will be drilled, cored and tested in 2009
- Triangulation of the boreholes provides evidence as to the nature and predictability of the stratigraphic, geochemical, and hydrogeologic properties of horizontally-layered limestone and shale rock formations



Deep Borehole Drilling Data Supports Historical Understanding of Site



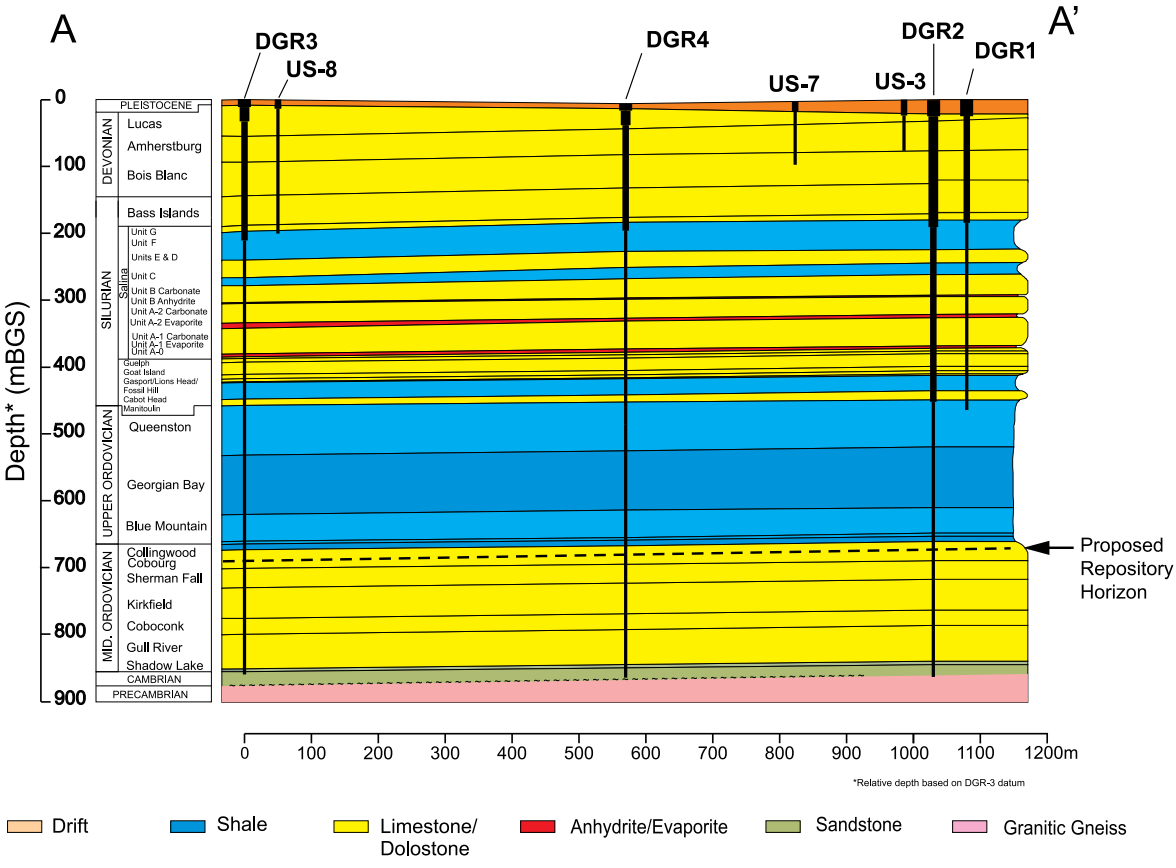
Six boreholes are positioned in a triangle formation outside of the DGR footprint to maintain the integrity of the proposed DGR site

Geoscientific investigations to date, in support of the existing regional and historical information about the site, have shown that the geology is:

> predictable
> geomechanically stable
> seismically quiet
> characterized by natural barriers which can isolate and contain the waste
> without natural resource potential

Further studies and research will add to the body of data already assembled.

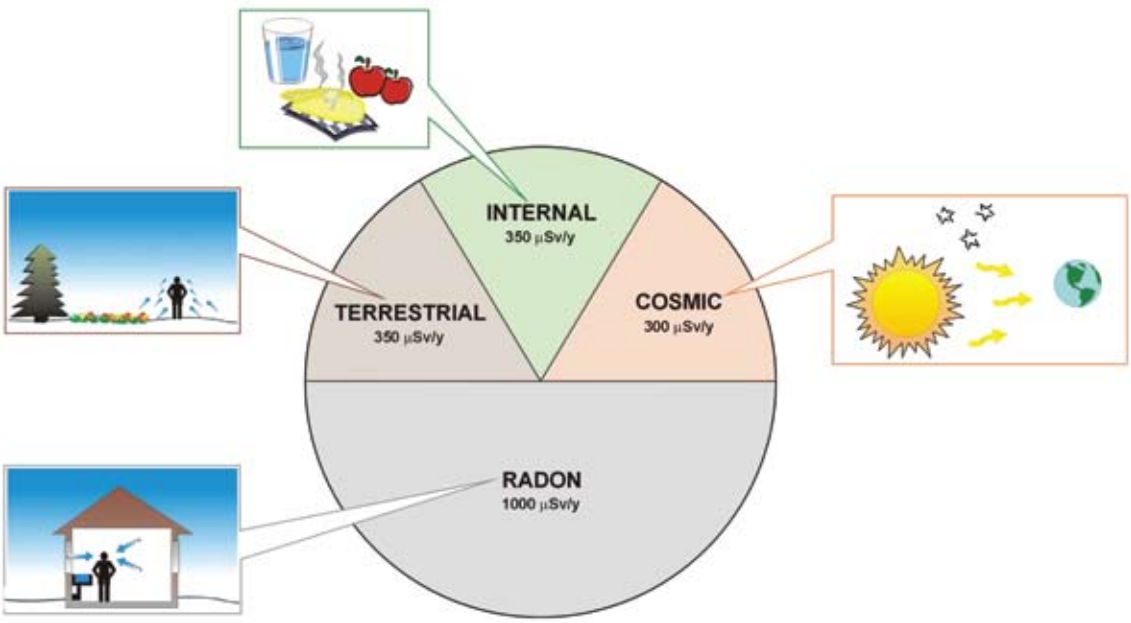
Borehole Stratigraphy Diagram



Geologic cross-section as shown on DGR Borehole Location Plan

Radiation Safety Background

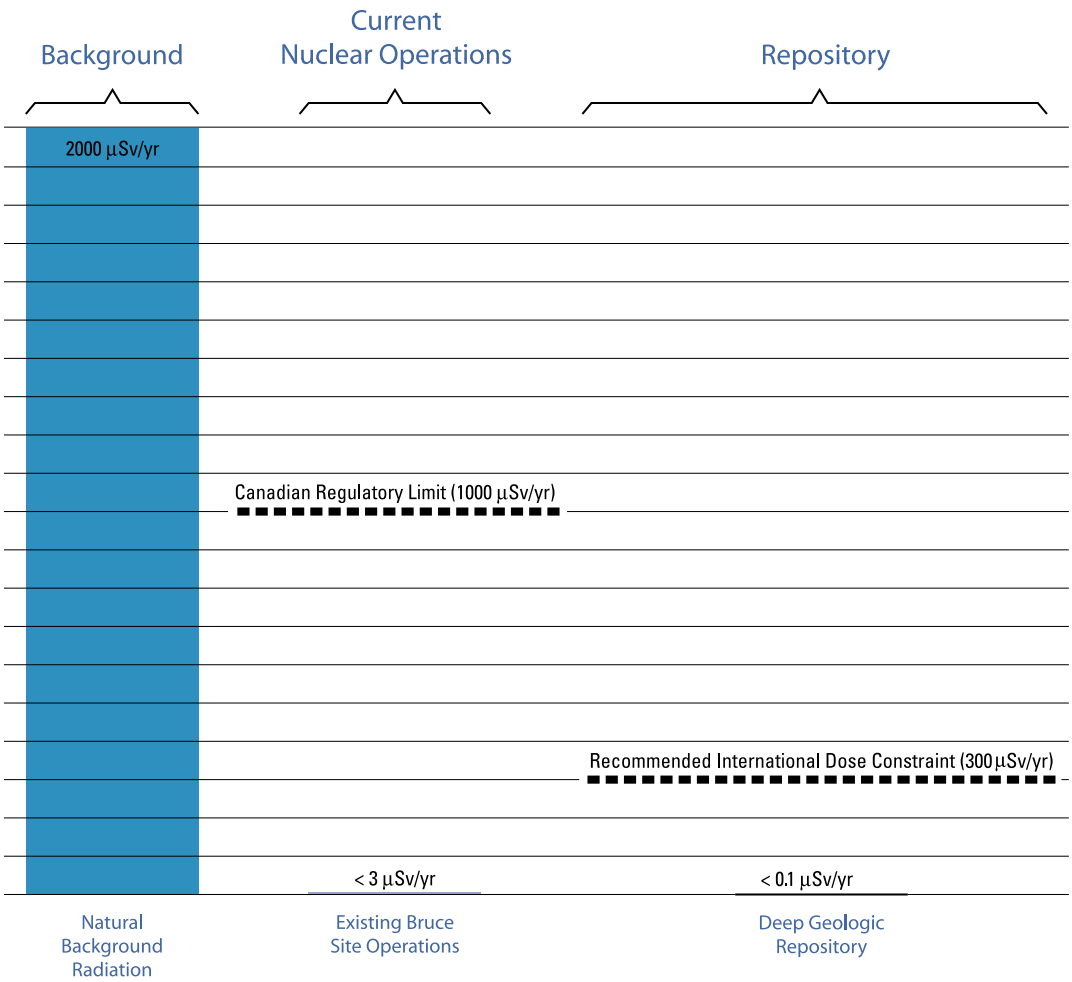
- Sievert is a unit of measure used to describe the effective dose of ionizing radiation received by people. Dose is often expressed in millionths of a Sievert, or microSievert (μSv)
- Natural background radiation averages about 2,000 μSv per year. This represents the amount of radiation dose that the average person in Canada receives each year from all natural sources
- The radiation received from a chest x-ray is 60 μSv
- Dose rate to the public, living at the site boundary, from the Bruce site activities is less than 3 μSv per year. Dose rate to the public, living at the site boundary, from the WWMF is less than 0.1 μSv per year



This diagram shows the range of sources of natural background radiation in Ontario. People are exposed to radiation from a number of natural sources such as the sun and the bedrock, and human activities such as medical examinations and power generation.

Preliminary Safety Assessment

- The safety assessment of the DGR is being completed by a team led by Quintessa Limited, a consulting firm based in the United Kingdom, which specializes in safety assessment of waste management facilities
- This chart shows the dose rate estimates for the Deep Geologic Repository. Maximum estimated doses to humans are well below the international standards and natural background levels
- A detailed safety assessment is well underway, using the latest scientific information from the Bruce site and design information



Safety Assessment

- Safety assessments assess the potential impacts of the DGR both during the operational as well as the period after the underground portion is closed, far into the future

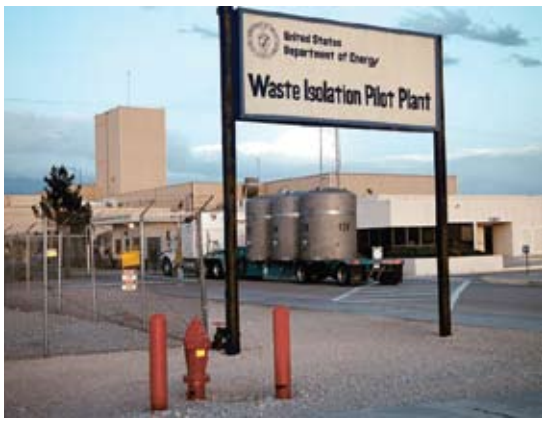
- Observations from preliminary results from 2003 and 2007 indicate:
  - > Host rock is effective in retarding radionuclide movement
  - > The majority of radioactivity will decay in and around the repository
  - > Radionuclides will diffuse through the rock layers at extremely slow rates (less than one metre per 1000 years)
  - > Estimated dose to the public after 100,000 years is less than 0.1 µSv per year, well below the recommended international dose constraint

- Updated safety assessments will consider:
  - > Normal operation and accidents
  - > Pre-closure and post-closure periods
  - > Potential effects on humans and biota

International Experience with Repositories

A proven history with low and intermediate level waste

- The DGR has benefited from first-hand visits to long-term management facilities in Sweden, Finland and the United States. Information learned about surface facilities, repository access, hoisting, lay-out and material handling is being utilized in the design of the DGR. Such international collaboration is extremely beneficial in terms of experience, the exchange and analysis of reports and visits with key personnel
- The Forsmark facility in Sweden opened in 1988 and is located at the Forsmark nuclear power station site
- The Olkiluoto (VLJ) facility in Finland began operation in 1992 and was excavated to a depth of 70 to 100 m underground in crystalline rock. It is located near the Olkiluoto nuclear power station
- The Waste Isolation Pilot Plant (WIPP) located in New Mexico, United States is excavated to a depth of 600 m in a bedded salt formation and has been operating safely since 1999



Left: **Sweden's Forsmark Repository** Right: **Waste Isolation Pilot Plant in New Mexico**

Independent Review and Oversight

- A Geoscience Review Group (GRG) was established in 2005
- GRG members have, between them, over 100 years of work experience in international nuclear waste programs in Japan, Hungary, Switzerland, Sweden, Finland, Korea, USA and UK
- By providing peer review and oversight, the GRG ensures the DGR project will benefit from international experience in all aspects of the geoscientific site characterization

Geoscience Review Group: **Dr. Joe Pearson (USA), Dr. Derek Martin (Canada), Jacque Delay (France) and Dr. Andreas Gautschi (Switzerland) examine core samples taken from beneath the Bruce site**

Keeping You Informed

- Consultation with the public will continue throughout the six to eight year regulatory process at an intense level through newsletters and publications, open houses, website, speaking engagements, attendance at public events with mobile exhibit, briefings with key stakeholders including municipal, provincial and federal politicians, and media

Consultation with Aboriginal Peoples

- A Protocol agreement, signed by Saugeen Ojibway Nations (SON), OPG, and NWMO, provides a framework for SON's participation in the regulatory approval process and for the DGR project

- Discussions with the Historic Saugeen Métis and the Métis Nation of Ontario about the proposed DGR project have been initiated to facilitate their participation in the regulatory approval process

For more information please visit **www.nwmo.ca/dgr**