

# South Bruce Nuclear Exploration Project

## Summary Report on Safety and the Natural Environment Studies

2024



# Introduction

The Municipality of South Bruce is one of two final potential host locations that the Nuclear Waste Management Organization (NWMO) is considering for a Project that includes a deep geological repository (DGR) to store Canada's used nuclear fuel and the Project's associated surface facilities.

This report provides a current summary of studies carried out by the NWMO related to community safety and protection of the natural environment, as well as their associated peer reviews. These studies were prepared to help South Bruce make an informed decision about the Project.

The results of these studies are being used by the NWMO to build confidence that the Project can be implemented safely. The studies have been authored by independent subject matter experts on behalf of the NWMO. The environmental studies carried out to date have provided initial descriptions of the existing natural environment, both below ground (the geosphere) and above ground (the biosphere).

Using these initial descriptions, further studies have identified and assessed:

- The suitability of the geosphere to support the Project.
- The potential Project effects on the biosphere during its construction, operation, and closure phases.
- The Project's potential radiological effects.
- The Project's safety hazards and the mitigation measures required to protect the community and environment during each of the Project's phases over its lifespan.

The NWMO studies have been subject to a thorough peer review process. This independent assessment of findings and recommendations ensures the Project is consistent with South Bruce's Guiding Principles.

The Guiding Principles were developed to guide discussions between the NWMO and the Municipality of South Bruce. Through comprehensive community input and feedback on what South Bruce residents cared most about in relation to the Project, 36 Guiding Principles were created. These Guiding Principles focus on safety for people and the environment, ensuring the Project brings meaningful benefits to the community, and ensuring that the Municipality has a voice in decision-making.

The Guiding Principles have been grouped into seven themes:

- Safety and the Natural Environment (with the NWMO's current findings highlighted in this report).
- People, Community and Culture.
- Economics and Finance.
- Capacity Building.
- Services and Infrastructure.
- Governance and Community Engagement.
- Regional Benefits.

The Project's Peer Review Team (PRT), made up of independent experts from professional consultancy firm GHD, has produced three technical peer review summary reports for the NWMO's studies. They are companion pieces that provide detailed information in support of this *Summary Report on Safety and the Natural Environment Studies*. The companion reports are described further in this summary.

In 2023, GHD, on behalf of the Municipality of South Bruce, published a *Summary of Socio-economic Community Studies and Peer Review Findings* report, which provides recommendations from the PRT to ensure the Project is consistent with the six other Guiding Principle themes, the baseline conditions of the community, and its potential socio-economic effects on the Municipality of South Bruce and its neighbouring municipalities.

These reports, as well as their supporting studies, peer reviews, and the Guiding Principles are available to view at: [www.southbruce.ca/Studies](http://www.southbruce.ca/Studies).

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# Project Background and Infrastructure

In Ontario, nuclear power is used to meet approximately 50 percent of our daily electricity demand. Currently, used nuclear fuel is safely stored in above-ground facilities. The NWMO is proposing to securely isolate this used fuel in a hard bedrock formation within a facility called a deep geological repository (DGR). In addition to the DGR, the Project would include surface facilities, an excavated rock management area (ERMA), and a Centre of Expertise to be located at or near the site in a willing host community.

The NWMO has identified a potential site for the DGR and surface facilities, located near Concession 8 and Sideroad 25 North outside of Teeswater. Further conceptual design and final layout for the Project's facilities will be completed after the final site for the DGR is selected. The NWMO proposes the following elements as part of the Project at or near the identified site.

## Deep Geological Repository

The DGR, as it is currently proposed, will be a network of underground tunnels and placement rooms constructed below the ground's surface in rock known as the Cobourg Formation. It will be designed to safely contain and isolate used nuclear fuel over the long term. The final layout will depend on site-specific factors including site characteristics, the final design of the barrier system and final safety considerations.

Fuel bundles will be secured in a used fuel container, made of steel with a copper coating. These containers will be enclosed in bentonite clay and stored in repository rooms in the DGR.

## Surface Facilities

The DGR's surface facilities will include three vertical shafts, which access the repository to transport used fuel and storage equipment, and offer ventilation. Facilities will also include security areas, administration facilities, quality control laboratories, a sealing materials production plant and a used fuel receiving and packaging plant. The entire site will be surrounded by perimeter security fencing.

These facilities will process approximately 120,000 used fuel bundles per year. Once the bundles arrive at the site

they will be repackaged into durable, corrosion-resistant used fuel containers, and transferred underground for placement in the DGR.

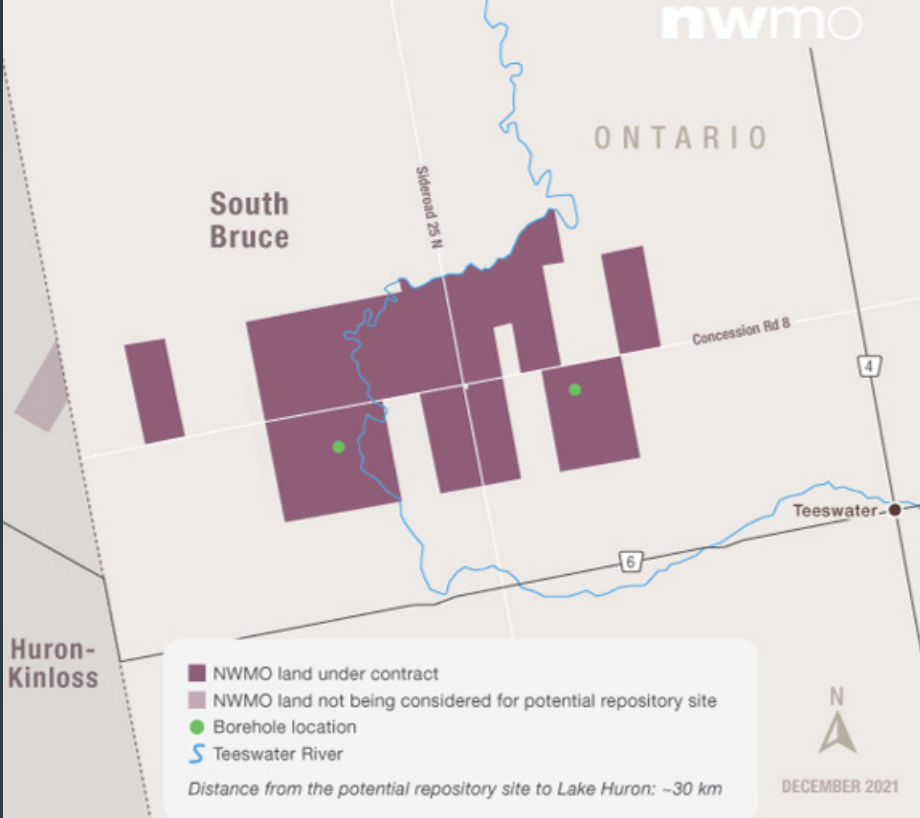
## Excavated Rock Management Area

The Excavated Rock Management Area (ERMA) will be located outside the security fenced area. Excavated rock will be transported to the ERMA during the Project's construction and operation phases.

Rock excavated from the DGR will be stored in lined cells and a portion of the rock may be used to produce different grades of aggregate for use in the Project. Once excavation and construction of the DGR is complete, the ERMA will be covered and planted with native plant species.



The NWMO has identified a potential site for the DGR and its surface facilities in South Bruce, located near Concession 8 and Sideroad 25 North outside of Teeswater. Final layout for the facilities will be completed after the final site is selected. (Image provided by NWMO)



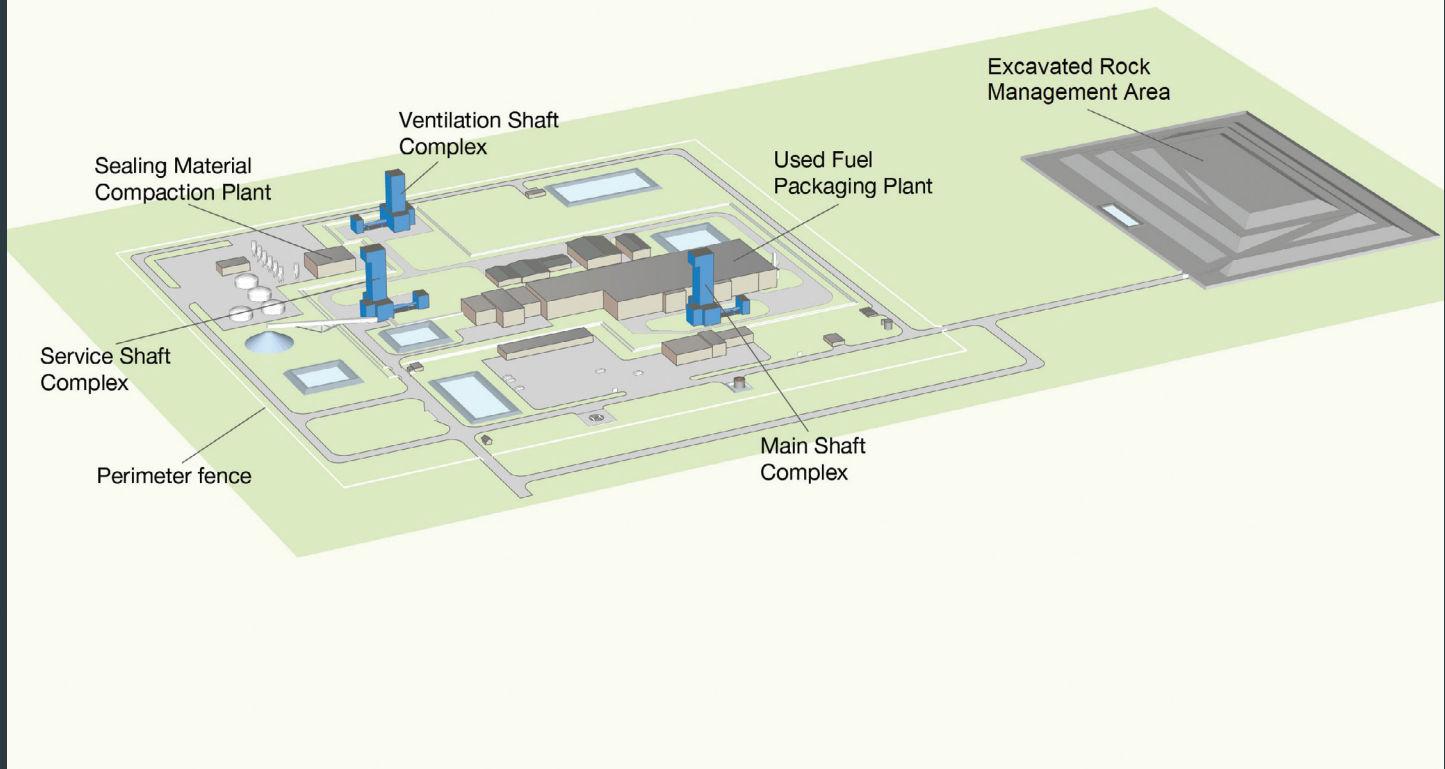
During the project's construction and operation phases, excavated rock will be transported to the Excavated Rock Management Area.

## Project Phases

The Project is scheduled to be executed in four phases:

Phase 1	Phase 2	Phase 3	Phase 4
2025 – 2035	2036 – 2042	2043 – 2092	2093 – 2162
Pre-construction planning/ design	Construction of DGR and surface facilities	Operations, including receiving and placing waste in the DGR and expansion of the underground facilities	Extended monitoring  2163 – 2192  Decommissioning

Diagram of the Project site's surface facilities. Not to scale. (Image provided by NWMO)





## What's Next?

The studies outlined in this document are part of an ongoing site assessment process to evaluate community and environmental safety. Further technical work will include additional site studies on the geosphere and biosphere, safety analysis and environmental reporting. If the South Bruce site is selected, the findings of these peer-reviewed studies will be presented to Canadian regulators as part of a federal Impact Assessment, followed by a series of licence applications.

The Project's safety assessment will be advanced as the engineering design for the site is developed and more information on the site and its existing environmental conditions becomes available. This process takes years before construction approval may be received.

If the South Bruce site is selected, the NWMO will use the preliminary conceptual layout to develop a site-specific design. This will include how the surface facilities are arranged within NWMO lands, which roads will be used to access the site, and where the ERMA will be located. An assessment of site servicing options will be completed for potable water supply, sanitary wastewater, electrical power, natural gas and high-speed internet.

After construction and operation, a period of continued monitoring will be in place to ensure the site continues to remain suitable for the storage of used nuclear fuel.

### **Impact Assessment:**

Conducted by the Impact Assessment Agency of Canada and the Canadian Nuclear Safety Commission (CNSC), the Project's integrated federal Impact Assessment would examine the Project's positive and negative environmental, economic, social and health impacts in support of sustainable development. The assessment would regulate the use of nuclear energy and materials to protect health, safety and the environment.

### **Project Licensing:**

The CNSC would inspect and evaluate how licencees ensure compliance with regulatory requirements, perform field inspections in licensed facilities, review licencee self-reporting and follow up to ensure that corrective actions are implemented, if required.

*Typical landscape at the South Bruce site in southern Ontario. (Image provided by NWMO)*



# Building Confidence in Safety

The fundamental safety objective of the Project is to protect humans and the environment from the effects of radioactive or hazardous substances present in the used fuel. The used fuel's radioactivity is initially hazardous, but naturally decreases over time. The DGR, including its engineered and natural barriers, provides long-term containment and isolation while this natural radioactivity decay occurs.

Within the Guiding Principles' Safety and Natural Environment theme, Principles #1, #2 and #3 respectively call for the NWMO to demonstrate that:

- The Project will be subject to the highest standards of safety across its lifespan of construction, operation and into the distant future.
- Sufficient measures will be in place to ensure the natural environment will be protected, including the community's precious waters, land and air.
- The used nuclear fuel can be safely and securely transported to the repository site.

The NWMO's ongoing, evidence-based approach to build confidence in safety for members of the community and the natural environment is continuously evaluated within the context of three main components:

- The site's existing, natural geological characteristics found beneath the ground's surface (or the area's "geosphere").
- The natural and engineered barriers to mitigate the release of radioactive or hazardous materials.
- The expected levels of radiation to people and the environment.

The NWMO has prepared multiple third-party studies, which were peer-reviewed, beginning in 2021. The results of these studies, which assess community safety and describe the natural environment, are used to build confidence in safety for the Project. In building this confidence a portion of these studies involved collecting data and describing the natural environment. If the Project is located in South Bruce, this work will continue through to the Project licensing and design phase.

## About the NWMO's Natural Environment Study Program

The initial environmental characterization reports prepared within the NWMO's Natural Environment Study Program are foundational studies that cover a large geographic area. They are being used to direct more specific natural environment studies for future years and to inform how the Project is sited and designed. Findings will be continuously updated as more information becomes available through additional work conducted.

By identifying species of plants and animals in the area, as well as the water quality found in local rivers and streams, the NWMO will be able to assess what impacts the Project may have and develop appropriate mitigation measures (also known as the Project's "change assessment").

### Key Terms Used to Describe the Natural Environment

**Geosphere:** The soil, groundwater, rocks and minerals that make up the earth within and around the Project's site.

**Biosphere:** The global ecosystem made up of living organisms and non-living factors that provide these organisms with energy and nutrients.

**Environmental Media:** The biophysical environment (air, land and water) above the ground's surface.

**Biodiversity:** The plant and animal species and the environments they need to survive, including vegetation and soils; fish; birds, wildlife and their habitats; species at risk; and riverbanks and wetland environments.



To date, numerous geosphere and biosphere reports have been prepared by the NWMO and its consultants. In addition to reviewing reports, the PRT has reviewed workplans and observed field investigations to ensure the Project is consistent with the Guiding Principles.

These independently peer-reviewed NWMO reports include:

1. **Geosphere Studies** – Studies which characterize and assess the ability of the site’s geologic setting to safely contain and isolate the used nuclear fuel. This includes the depth of the host rock formation, its volume and expanse, the chemistry, structure and physical properties of the host rock’s minerals, the composition of groundwater, and the ability of the host rock to withstand natural stresses. The studies answer the question, “How does the DGR’s surrounding earth, bedrock, minerals and strategic geologic location help make the Project stable and safe during its lifespan and beyond?”
2. **Environmental Media Baseline Report** – Summarizes studies that describe the baseline environmental conditions by exploring the physical and chemical properties of the area. It answers the question, “What’s in the air, soil, water and food?” The Environmental Media Baseline describes the air (air quality, noise and light), land (ground composition and surface soil) and water (surface water and drinking water quality).
3. **Biodiversity Baseline Report** – Summarizes studies that characterize the baseline biodiversity conditions by exploring the types of species existing in the area. It answers the question, “What are the area’s habitats and ecosystems made up of?”

Each of the following sections summarize the NWMO’s updated safety assessment and the work undertaken to date to characterize the natural environment. They also include peer review findings of the NWMO’s work.

## Confidence in Safety Report

The NWMO’s current *Confidence in Safety Report – South Bruce Site (2024)* evaluates the site characteristics that contribute to Project safety and the suitability of the area for the DGR’s development, with results summarized as of mid-2023.

The safety assessment considers, among other things, information developed through the geologic characterization and environmental baseline programs (geosphere and biosphere). It also evaluates potential radiological and non-radiological effects on humans and the environment.

Overall, based on the initial geosphere characterization work and the DGR’s preliminary conceptual design developed, the NWMO is confident that the DGR can be constructed at the South Bruce site in a manner that would provide safe long-term management of Canada’s used nuclear fuel. This is based on:

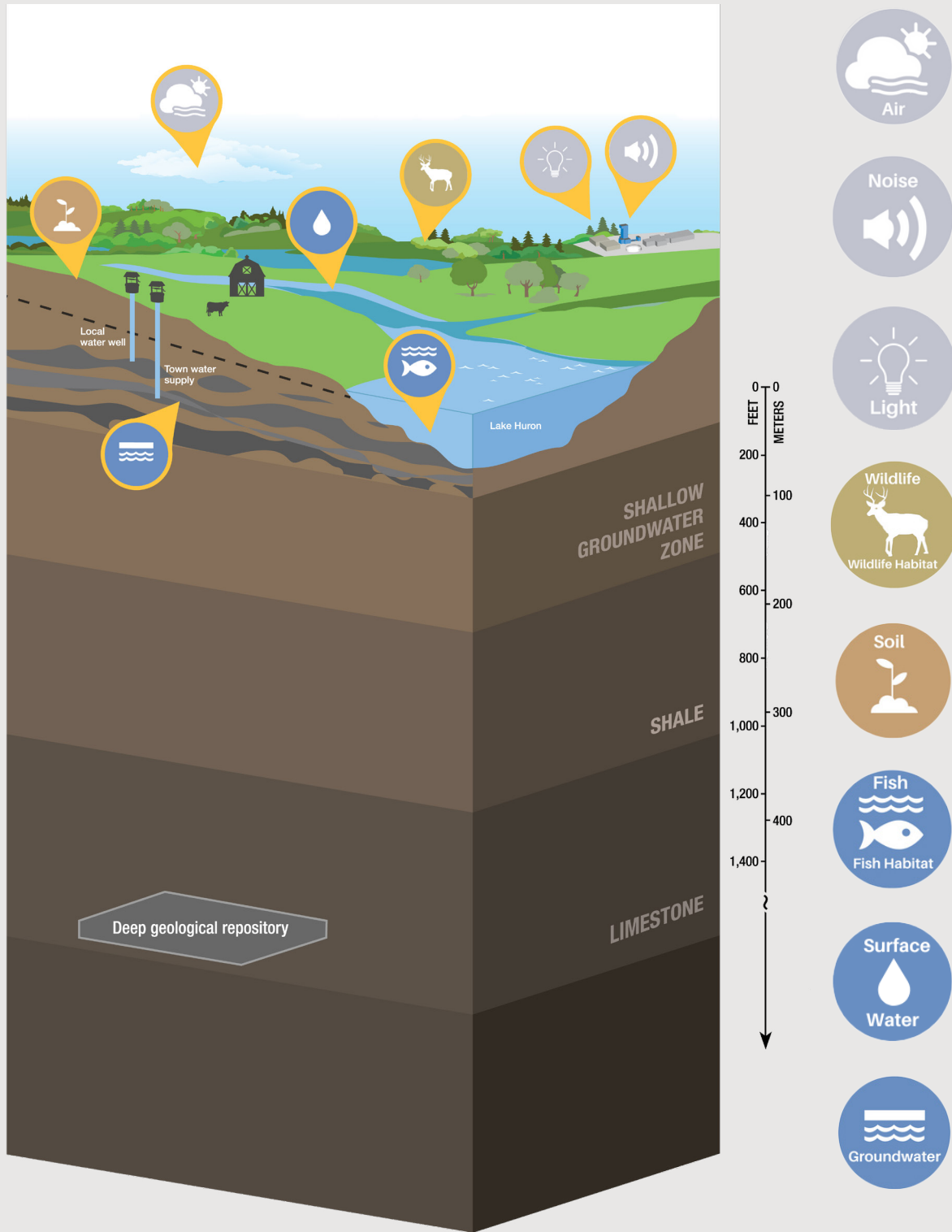
- The favourable characteristics and stability of the site’s underground rock composition.
- The low risk of future human intervention or intrusion within the DGR.
- The predictable nature, uniform thickness, and suitable groundwater characteristics of the bedrock.
- The robust nature of the multi-barrier system used to hold the fuel.
- The ability to safely construct and operate the DGR.
- The ability to safely transport used fuel to the site.
- The ability of the facility to meet regulatory criteria for safety and environmental protection.

In addition to the geosphere and biosphere characterizations, the NWMO’s assessment also considered the space needed above ground for the Project’s infrastructure, transportation system capabilities and risks, emergency response, natural and engineered barrier durability, expected radiation exposure levels, and monitoring. These components are discussed further in the following sections.

The NWMO anticipates that the site will meet the regulatory requirements for safety and environmental protection that is consistent with Canadian regulations and international guidance for licensing. Baseline monitoring has already started, and the site will be monitored for decades during site characterization, preparation, construction and operation before a decision is made to close the repository.

## Characterization of the Geosphere to Support Confidence in Safety

The multi-year geosphere studies and associated technical documents produced by the NWMO, and reviewed by the PRT, provides the community with a description of the scope of work that has been undertaken. It contributes to developing an understanding of the Project site’s setting, including the earth’s physical structure and substance (geology) and the water underneath the earth’s surface (hydrogeology). The work is being carried out to characterize and assess the ability of the DGR’s setting to safely contain and isolate the used nuclear fuel.



Types of Environmental Media around the proposed DGR. Conceptual model not to scale. (Image provided by NWMO)

The NWMO has identified the following factors required for the assessment:

- The depth of the host rock formation.
- The volume and expanse of the host rock at the depth of the repository.
- The chemistry, structure and physical properties of the host rock's minerals (mineralogy).
- The characteristics of the groundwater that exists within the host rock and the groundwater's composition at the depth of the repository.
- The host rock's ability to withstand natural stresses.

The NWMO has determined that the geologic setting of the South Bruce site is fundamentally favourable due to:

- The presence of a 400-metre thick succession of sedimentary rocks, including the approximately 40-metre thick Cobourg Formation at a depth of 650 metres. This is bound by more than 200 metres of shale above and 150 metres of limestone below, indicating a natural barrier system that has the appropriate depth, breadth and volume to isolate the DGR from surface disturbances.
- No active geological faults or unfavourable characteristics, indicating long-term stability.
- No presence of Cambrian sandstone that water can easily travel through and very low expected groundwater flow at the DGR's depth, indicating long-term containment and isolation capability.
- No evidence of glacial or recent water that has infiltrated the bedrock of the natural barrier system.
- The capability of the Cobourg Formation to remove the heat generated by the radioactive decay of the used fuel, and to withstand the natural and thermal stresses caused by the DGR.

The NWMO has determined that the stability of the area's geologic setting is fundamentally favourable due to:

- The age of the Cobourg Formation and the rocks above and below it (aged 444 to 460 million years).
- The stable, seismically quiet setting of the Canadian Shield, which is far from tectonic plate boundaries that are prone to earthquakes and volcanic activity.
- No evidence that the location is susceptible to extreme rates of erosion, uplift, or gradual caving or sinking that would significantly disturb the geosphere over the next million years.

- The Cobourg Formation's history and borehole sampling results that demonstrate its isolation from the normal pressures of the near-surface environment for millions of years.
- Modelling that estimates the DGR's containment and isolation will be maintained at its proposed depth both during and after future glacial events, such as an ice age.

The results of this work, along with monitoring and testing, provide the basis for the NWMO to conclude that:

- The depth of the host rock is sufficient for isolating the repository from human and natural surface disturbances.
- The volume of available competent rock should be sufficient to host the repository.
- The rock mineralogy and groundwater chemistry should not adversely impact the used nuclear fuel's multiple barrier system and are favourable to minimizing radiation movement.

The NWMO has determined that more site characterization is needed should the South Bruce site be selected as the final location for the Project. Ongoing studies are being carried out to advance the site characterization, understand environmental baseline conditions, and assess engineering, design and safety. This work is aimed to address the current geologic data gaps and uncertainties that have been identified thus far.

### Peer Review Findings

The PRT found that the geosphere studies completed to date provides useful information that supports the future conceptual design and modelling of the DGR, and supports the NWMO's conclusion that the DGR could be constructed at the South Bruce site with natural barriers in place.

The PRT determined that the information acquired through these current studies will help the Municipality of South Bruce build confidence in safety and make an informed decision about whether the Project is suitable for their community, if they are willing to host it, and under what circumstances and terms.

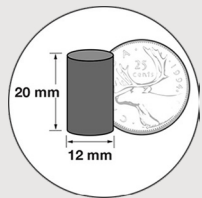
The PRT also determined that the geosphere studies demonstrates progress toward addressing Guiding Principle #2 (sufficient measures will be in place to ensure the natural environment will be protected).

The PRT has identified important data gaps, such as how the individual results from each area of study (geosphere, environmental media and biodiversity) may integrate with each other. This holistic understanding of all program areas is important in providing a complete, contextual view of how the community and natural environment will be protected should the Project be implemented at the South Bruce site. As this is a multi-year program, peer review of the geosphere-based studies will continue in 2024 as the NWMO's work is carried out and reporting is made available.

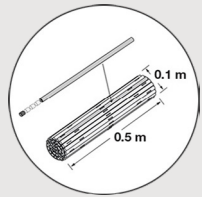
## Fuel Bundles' Multi-barrier System

In addition to the natural barrier system provided by the geosphere, the DGR will include a multi-barrier system to ensure the used fuel is protected. Each barrier will act as part of a system, while also providing its own unique and standalone level of protection.

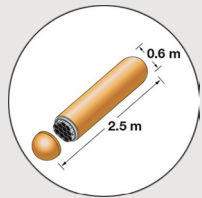
Five barriers are proposed to protect the fuel:



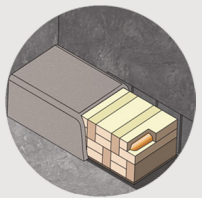
**Barrier One:** A **nuclear fuel pellet**, roughly the size of a quarter, holds the fuel in ceramic material which does not dissolve in water. The pellet is resistant to wear and high temperatures and is baked in a furnace when created to produce its high density.



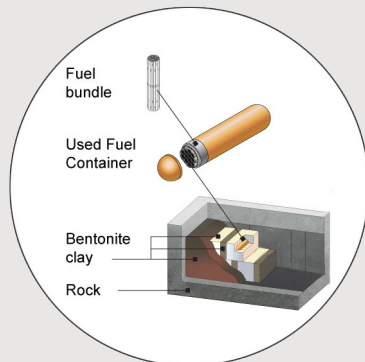
**Barrier Two:** The pellet is then contained and isolated within a **fuel element and fuel bundle**, made up of a corrosion-resistant alloy (combination of metals) called Zircaloy.



**Barrier Three:** The fuel bundle is placed in a **used nuclear fuel container** that is coated with copper to prevent corrosion. The copper coating prevents any water near the container from reaching the fuel.

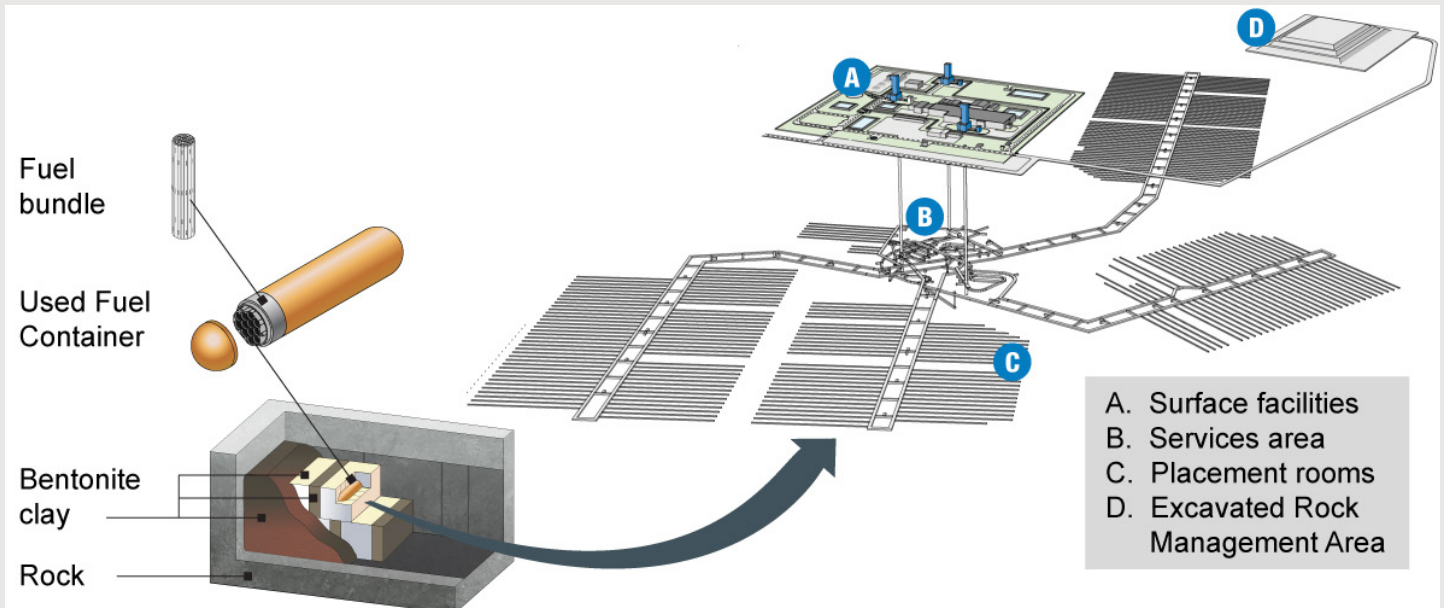


**Barrier Four:** The container is encased in **bentonite clay**, a natural material that is a powerful barrier to water flow. The clay swells and seals when exposed to water and helps isolate any radioactive materials in the unlikely event they were to escape from the container.



**Barrier Five:** The **geosphere** (natural barrier of rock and minerals in the earth) protects the repository from disruptive natural events, water flow and human intrusion. It will safely contain and isolate the used nuclear fuel.





A three-dimensional look at how the used nuclear fuel bundles will be encased within the multi-barrier system. The bundles will be located deep underground in placement rooms beneath the DGR's surface facilities, alongside an underground services area. (Image provided by NWMO)

## Potential Radiological Exposure - Preliminary Radiological Safety Study

The NWMO's *Preliminary Radiological Safety Study* (August 2023) provides information on the Project's potential radiological effects on the safety of current and future South Bruce residents and those close to the site. It also provides a description of the facility's safety features, including mitigation and follow-up measures, if needed.

Based on the assessment to date, the NWMO is confident that the DGR could be constructed at the South Bruce site in a manner that would protect people and the environment and provide safe long-term management of Canada's used nuclear fuel. The NWMO is continuing to enhance their understanding, and therefore confidence, to support site selection and the regulatory decision.

The NWMO states that Canada has a history of safe performance at its nuclear stations where used nuclear fuel is currently stored and that dose rates and emissions from the waste management areas have consistently remained below regulatory limits.

### Radiation Mitigation and Safety Measures During Operation

During the Project's operation phase, estimated to begin in 2043, used nuclear fuel will be present on site. All above-ground activities, involving the handling of radioactive material, will take place within the Used Fuel Packaging

**Radiation** is energy in the form of moving waves or streams of particles. Ionizing radiation has enough energy to create ions, which can be harmful to humans. This type of radiation is found in cosmic rays, gamma rays and x-rays.

**Radioactivity** is what happens when atoms spontaneously and randomly disintegrate. This is usually accompanied by the emission of radiation.

Plant. Within the plant, operators will abide by many safety measures throughout the receiving and storing processes. After receiving fuel at the site, workers will repackage, seal and inspect the fuel to safely store it away. Plant operators will then transfer the fuel into the site's underground facility and store it in the repository. The repository's rooms will be sealed once full.

Potential radiation sources include direct radiation from the fuel bundles, as well as small amounts of gas or particulates that may be released from fuel during handling.

During operation, the Project will feature a variety of mitigation and safety measures:

- The fuel handling areas will be constructed with thick, concrete walls.
- The fuel containers will be sealed and handled using automated fuel handling systems.

- The site will use air ventilation systems, which will be regularly filtered and monitored.
- The site access will be controlled with an emergency preparedness plan, as well as health, safety and radiation protection programs.
- The plant will employ dry decontamination and cleanup methods, a water treatment system, controls on emissions, a shutdown capability, and regular maintenance.

The site will also feature monitoring and inspection procedures, including the use of internal monitoring systems, programs and equipment, as well as independent third-party monitoring, initial and ongoing safety assessments, and regulatory reviews and inspections.

### Post-closure Phase and Safety Measures

The Project's operation phase will continue from 2043 to 2092. In 2093 (specific date to be confirmed), the Project will enter its extended monitoring phase and in 2163 (specific date to be confirmed), the Project will enter its decommissioning and closure phase.

Following decommissioning and closure, the post-closure phase will begin. Its start date is yet to be determined. This phase of monitoring will last as long as needed to verify that the repository is operating safely. The repository will be designed in such a way that there will be no need for human intervention and maintenance.

During the Project's post-closure phase, safety measures will stay in place, such as radiation monitoring and on-site land use controls. Through the composition of the site and the engineered make-up of the facility, additional safety measures will be inherent to the Project's design. These safety characteristics include the depth of the repository and its isolation from the surface, as well as the multi-barrier design within which the used nuclear fuel is stored.

The geology of the site (rock stability and favourable underground conditions), sealed tunnels, boreholes and shaft (sealed at closure), and the decreasing radioactivity of the used fuel will all contribute to post-closure safety.

### Peer Review Findings

The PRT agreed that the *Preliminary Radiological Safety Study* provides the community with a good description of the basics of potential radiological impacts of the Project and appropriately describes the multiple natural and engineered barriers that will be in place to mitigate exposure to unacceptable levels of radiation.

The PRT determined that the current conceptual design indicates that the radiological risk to the community is

low, and that doses to the public will remain well below regulatory dose limits. An additional study will be needed once the site-specific conceptual design is complete to describe the mitigation and/or follow-up measures to be taken if an increase in risk is identified during any phase of the Project. As well, additional studies, scheduled during Project licensing, will be needed to assess the capabilities and capacity of the Municipality to respond to potential radiation-related injuries and emergencies.

### Deep Geological Repository Conceptual Design Report

The NWMO's *Deep Geological Repository Conceptual Design Report* (2021) describes conceptual designs prepared for a DGR facility in either a crystalline or sedimentary rock setting. It is assumed that the facility will receive 5.5 million used CANDU (Canada Deuterium Uranium) fuel bundles over a 46-year period.

The report describes the required facilities and infrastructure needed to safely receive, package and place the used nuclear fuel in the underground repository. At the end of emplacement and after extended monitoring, the DGR will be decommissioned and closed. All underground rooms, tunnels and the three shafts will be permanently sealed.

The report further describes how worker safety will be addressed under the site's conceptual design. Through the radiation protection systems and programs inherent in the site and through emplacement procedures, workers won't ever be in contact, or in the same space, as radioactive materials.

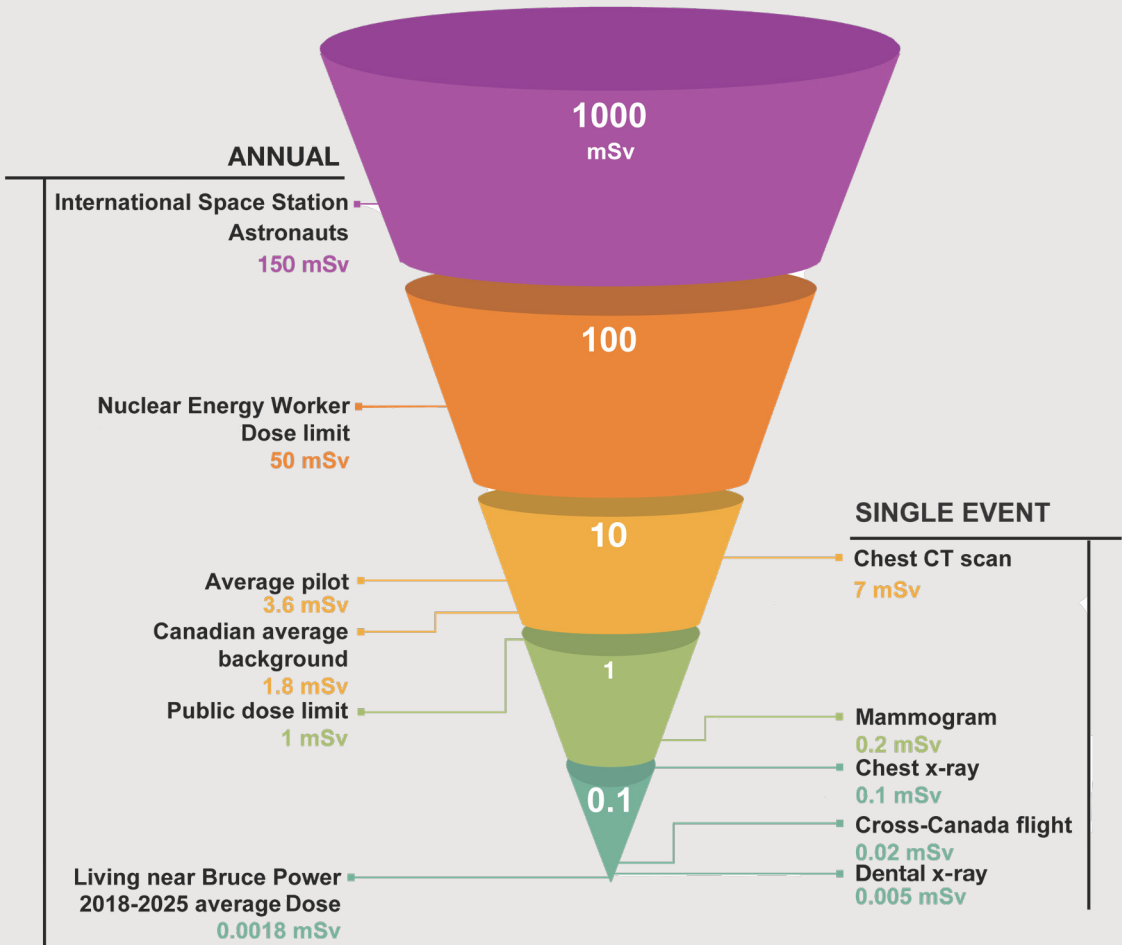
### Preliminary Radon Assessment for a Used Fuel DGR Report

The NWMO's *Preliminary Radon Assessment for a Used Fuel DGR Report* (December 2020) provides an initial assessment of the naturally occurring risk of radon during construction and operation of the Project. Excavation of rock can expose workers to naturally occurring radon and this risk is unrelated to, and not affected by, the handling of used nuclear fuel.

The assessment was carried out to determine whether there is a health hazard to workers and a need for radon monitoring or any action to comply with applicable regulations. The assessment concluded that there will be no significant radon hazard to the workers or public during construction and operation of the DGR. The maximum

# Common Radiological Doses (mSv)

Levels of common radiological doses and limits (in mSv) found in standard activities or situations. (Image provided by NWMO)



estimated concentrations near the public, assumed to be at a distance of 100 metres from the release point, are expected to be at least 100 times smaller than the average outdoor radon concentration in Ontario.

This means that with a maximum expected radiation dose of approximately 0.02 millisievert (mSv) per year, at a point 100 metres from the site, the radiation level is significantly lower than the dosage threshold which would begin to lead to observable health effects or to an increase in the likelihood of cancer. Researchers with Charles Sturt University's Medical Radiation Sciences program estimate that the risk of an increase in the likelihood of cancer increases five per cent at a dose of 100 mSv. Radiation sickness symptoms are observed at 1,000 mSv.

## Peer Review Findings

The PRT agreed that radon exposure to workers during construction and operation will be low. However, the PRT pointed out that radon doses must be determined and monitoring will be required due to regulatory requirements. If radon concentrations are higher than estimated, remediation action must be taken.

The PRT recommended that monitoring be done, at minimum, in all locations where workers may be exposed to some levels of radon, with particular attention paid to unventilated or low ventilated areas underground, as well as the ventilation shaft. The PRT also recommended that given the low cost and ease of radon monitoring, the NWMO should place facility boundary monitors to respond to community concerns.



## Emergency Services Study Report

The objective of the *Emergency Services Study Report* (October 2022) was to assess the effects of the Project on emergency services within the Municipality of South Bruce and County of Bruce during the Project's construction and operation phases.

The report concluded that upper- and local-tier municipal Emergency Response Plans will need to be updated to consider the Project's impacts. In addition, equipment, human resources and training will be required for these municipalities to handle Project-based emergencies for events potentially involving radioactivity.

Within the region there are useful examples of Emergency Response Plans for a large, above-ground nuclear facility (Bruce Power) and a large underground mine facility (Goderich Salt Mine). Bruce Power has

developed memorandums of understanding with many municipal emergency response organizations and health organizations, which would serve as a good model for the NWMO.

The report states there is sufficient information for the NWMO to develop, update and/or implement Emergency Response Plans and sign memorandums of understanding with neighbouring communities before construction.

### Peer Review Findings

The PRT agreed with the report's conclusions and stated that there is insufficient information at this stage to determine the Project's effects on the local emergency service requirements. Further studies, scheduled during the federal Impact Assessment and licensing, will be needed to determine the necessary emergency response provisions for the Municipality of South Bruce and County of Bruce.



*The Emergency Services Report concluded that municipal Emergency Response Plans will need to be updated to consider the Project's impacts. (Image provided by Municipality of South Bruce)*



# Understanding and Describing the Natural Environment

The Municipality's Guiding Principles call for the NWMO to demonstrate that the natural environment will be protected, including the community's precious waters, land and air throughout the Project's construction and operation, and into the distant future. The NWMO must also minimize the footprint of the repository's surface facilities as much as possible and ensure public access to the Teeswater River is maintained (Guiding Principle #6).

To understand and describe the natural environment before implementation of the Project, the NWMO developed three programs: Geosphere Studies, Environmental Media Baseline Program and Biodiversity Impact Studies.

These programs all work to describe (or "characterize") the natural environment, with the resulting data used in the NWMO's analysis in its safety assessment. This data contributes to helping the NWMO generate a baseline understanding of the existing environmental conditions and helps its researchers build confidence in safety for the community and for the natural environment during the Project's lifecycle.

The independent PRT developed three corresponding reports that evaluated the NWMO's work performed as part of these programs to the end of 2023:

- *2023 Technical Peer Review Summary Report: Geoscience Study Work*
- *2023 Technical Peer Review Summary Report: Biosphere – Environmental Media Baseline Program*
- *2023 Technical Peer Review Summary Report: Biosphere – Biodiversity Impact Studies*

These reports are available to view online at [www.southbruce.ca/Studies](http://www.southbruce.ca/Studies).

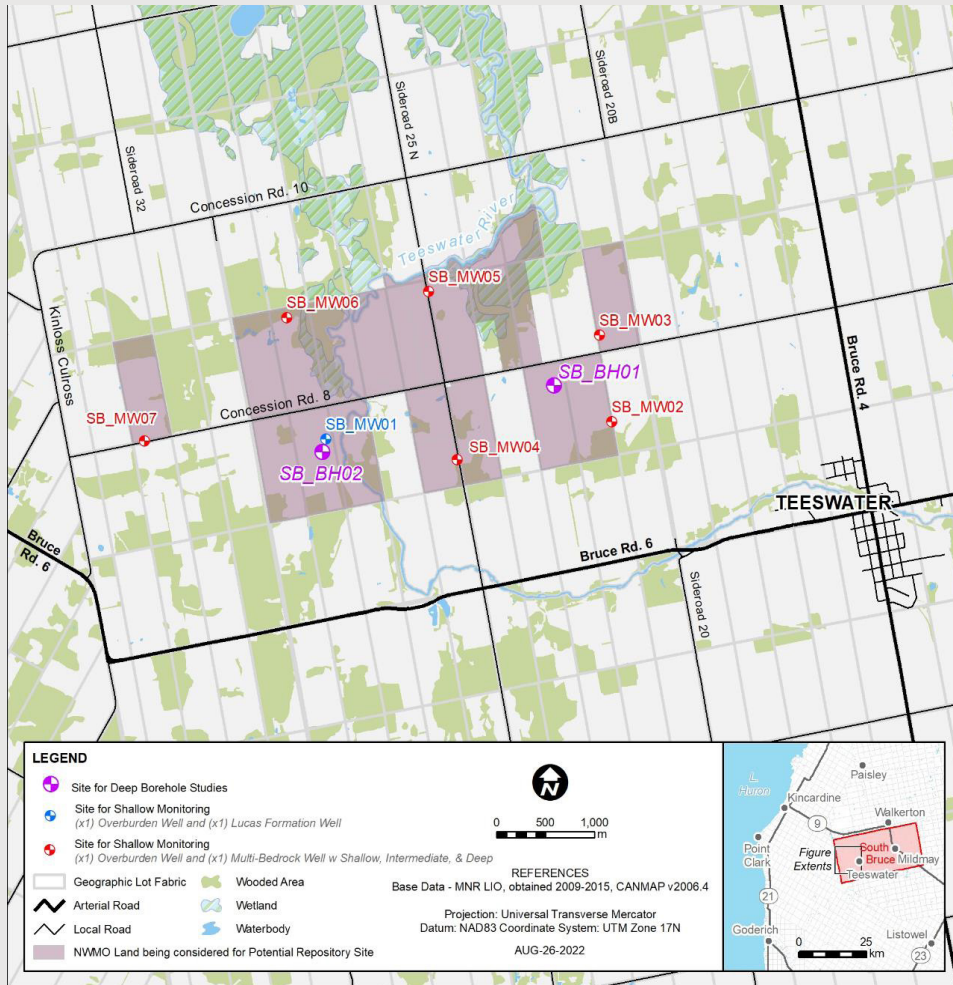
## Geosphere Studies

The NWMO has investigated the critical factors contributing to the safe long-term geological containment and isolation of the used nuclear fuel at the South Bruce site, as well as its stability. Geologic investigations carried out by the NWMO to date include the following work:

- Drilling two deep boreholes to depths of over 800 metres.
- Installing a deep, long-term monitoring system.
- Installing a network of shallow groundwater monitoring wells.
- Installing a network of micro-seismic stations and conducting seismic monitoring.
- Completing a 3D seismic survey.
- Hydraulic testing of lower sections of the bedrock.
- Determining the chemistry, structure and physical properties of the rock's minerals and groundwater.
- Assessing the potential presence for petroleum resources within the regional area.
- Carrying out initial noise, vibration, and dust baseline monitoring.

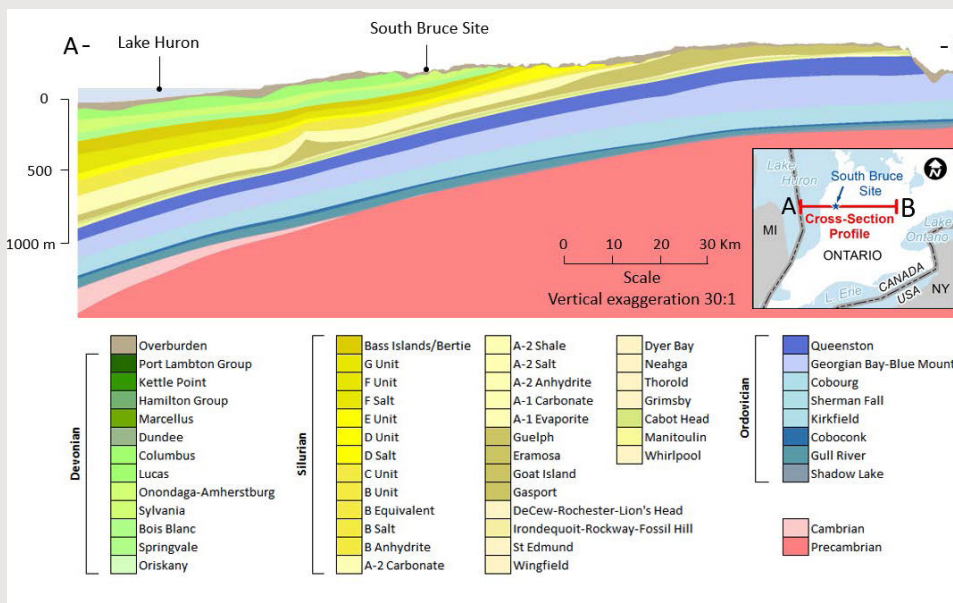
Boreholes 1 and 2 and the corresponding deep bedrock geologic and hydrogeologic testing locations are shown on the next page. The location of the shallow monitoring wells are also identified and are used for investigating and understanding surface soil, saturated soil, shallow bedrock and shallow groundwater conditions.

The study of the area's rock layers and layering (or "geologic stratigraphy"), as illustrated by the NWMO, is also provided.



Location of the South Bruce potential repository site, including NWMO-owned or leased lands shaded in purple, the locations of the deep boreholes, and shallow groundwater monitoring wells. (Image provided by NWMO)

Two boreholes were drilled to depths of over 800 metres and six monitoring wells were installed around the site's rock and soil (or overburden). Researchers carried out monitoring for seismic activity and initial noise, vibration and dust baseline measurements.



Vertical cross-section of the Michigan Basin in southern Ontario, showing the basin's main rock formation layers. (Image provided by NWMO)

At the South Bruce site's depth of 650 metres, the repository would be installed within the Cobourg Formation, surrounded by underground rock composition that has favourable characteristics and stability for hosting the used nuclear fuel.

## Peer Review Findings

Peer reviews conducted to date have included the review of work plans, observations of field work, and a review of reports made available. In 2023, the PRT completed a review of 20 geosphere study reports.

The PRT found that the NWMO's geosphere-based studies are understandable and provide information to enhance the development of a conceptual site model. The team concluded that the technical testing and reporting gaps found in the reports developed in 2022 and 2023 should be addressed as the geosphere studies continue and additional technical reporting becomes available.

The PRT emphasized that it is important to understand the area's earth composition and groundwater, as well as the ability or inability for groundwater to move between the potable groundwater zone and the deep formations surrounding the DGR. This information will form a key component of the overall conceptual site model currently being developed. It will need to be identified and explored further by the NWMO, integrated with the results of the Environmental Media and Biodiversity Programs.

The PRT determined that the current geosphere work and associated reporting demonstrates progress toward addressing Guiding Principle #2 (sufficient measures will be in place to ensure the natural environment will be protected throughout the Project's lifespan). The PRT will continue in 2024 to review Project change assessment work.

## Environmental Media Baseline Program

The purpose of the Environmental Media Baseline Program is to describe (or "characterize") the biophysical environment. It is focused on environmental components that have the potential to be impacted by the Project. The data collected as part of the program would support the development of a conceptual site model which would provide a more comprehensive understanding of the area's earth and groundwater, any groundwater to surface water interactions, and how the conceptual model can be further refined to account for shallow groundwater, underground soil and bedrock components.

The specific objectives of the program are to:

- Collect important statistical data that is relevant to stakeholders and rights-holders, maximizing the use of local and Indigenous knowledge.

- Collect data that will provide adequate information for future modelling and the preparation of a federal Impact Assessment.
- Maximize opportunities for community involvement in sampling, if desired.
- Provide an understanding of potential cumulative effects.

The Environmental Media Baseline Program was designed as a three-year program with field data collection starting in September 2021. It focuses on natural environment components that have the potential to be impacted by the Project, including the earth's soil and bedrock, area surface water, groundwater, drinking water, air, noise and light.

The first year's results, which included data collection of surface water quality, hydrology and drinking water quality, showed that some of the water quality parameters tested were found to be at levels outside of regular standards before potential development of the Project. Additional information collected during the second and third years of the program will be highlighted in future reports and will include components that were not part of the first year's studies.

The full extent of cumulative impacts has not yet been explored, but the NWMO has provided a high-level understanding of how the Project may affect the environment and identifies potential mitigation measures to manage those changes, such as:

- Minimizing water crossings and avoiding streams, wetlands, and sensitive habitats where possible.
- Using sewage treatment systems to reduce the release of contaminants and monitoring treated sewage.
- Installing appropriate erosion and sediment control measures.
- Placing the ERMA in a location that minimizes the potential for impacts to the Teeswater River and other streams and wetlands.
- Performing leach testing to understand the potential release of metals, minerals or salts from the exposed rock, and determining if a liner system is required.
- Managing precipitation that flows from the ERMA's rock and directing it to a stormwater retention pond if it does not meet appropriate guidelines before discharging to a waterbody.
- Implementing dust control measures.





Aquatic habitat mapping in the Teeswater River. (Image provided by NWMO)

## Peer Review Findings

The PRT concluded that the Environmental Media Baseline Program and its reports provide the community with a good description of the scope of work being undertaken to understand and characterize the environmental baseline conditions prior to the development of the Project. The PRT requested consistency in the level of detail provided in the work plans and reports prepared by NWMO. The PRT also suggested that additional detail be provided to gain a better understanding of how the baseline biophysical environment information will be integrated with the results of the Biodiversity and Geosphere programs to prepare an overall conceptual site model for the DGR site setting.

The PRT will continue to work with the NWMO to review work plans and field observations for air quality, noise, light and ground sampling as they become available in 2024. The PRT stated that the data collected demonstrates progress in addressing Guiding Principle #2 (sufficient measures will be in place to ensure the natural environment will be protected).

## Biodiversity Impact Studies

Biodiversity refers to the variety of life on Earth and includes all living organisms and their interactions with each other and the environment. Biodiversity is important for maintaining the ecosystem and for human and spiritual well-being.

The NWMO's Biodiversity Impact Studies (BIS) program is a study of:

- The ecosystem's components.
- The inherent benefits that the ecosystem brings to humans and the environment (known as "biodiversity values"). The benefits include provisioning services (e.g., fuel wood, fish used as food, plants used for medicine), cultural services (e.g., ceremony, traditional land use, recreation), regulating services (e.g., flood control, pollination, air purification), and supporting services (e.g., functional habitat that supports other services and species, nutrient cycling).
- How these biodiversity values inform Project planning and the development of mitigation strategies to reduce any potential negative impacts from the Project.
- Highlighting Project areas that can contribute to biodiversity.

The BIS program considers the biodiversity values that are relevant, important, and potentially impacted by the Project. This is done to predict the significance of any Project-related impacts and determine the optimal mitigation measures required if the site is selected.

The NWMO developed the following goals and objectives for its *2023 BIS Baseline Report*:

- Present preliminary baseline information on habitats and areas of ecological importance to biodiversity values and key species of interest.
- Provide data around the composition and number of species to indicate areas that may host more or fewer species.
- Provide relevant maps and lists that can be used to further design future studies, support engagement around the program, and help inform infrastructure design and placement.

The program's collection of field data began in July 2022. The studies consist of various aspects of the natural environment and focus on the following components that have the potential to be impacted by the Project, including:



- Wetlands and riverbanks
- Lakes, ponds, streams and rivers
- Fish and fish habitats
- Land mammals and semi-aquatic mammals
- Amphibians and reptiles
- Insects, snails and slugs (land invertebrates)
- Birds, bats and wildlife
- Wildlife habitats
- Species at risk
- Vegetation

Based on the *2023 BIS Baseline Report*, the study area surveyed had a significant number of existing, human-caused disturbances, such as those from logging activity, agriculture and rural development. An exception is the Greenock Swamp Wetland Complex, which is classified as a provincially significant wetland. Researchers found habitats for birds and bat activity, as well as evidence of white-tailed deer markings, which demonstrates the area's potential use by various wildlife species. Nearly all forested areas contained ash trees with evidence of Emerald Ash Borer. Some beech bark disease was also noted.

Twenty-three significant habitat areas containing rare or large numbers of wildlife, species at risk or other species of conservation concern were found, along with 39 special concern and rare wildlife species. Nine were detected in the Project's area of interest (potential site location). Project activities may result in some interactions with wildlife and changes to the physical environment, which may result in the loss of some fish and wildlife habitat.

Reports categorized aquatic habitats into watercourses (streams and rivers), waterbodies (lakes and ponds), and wetlands (marshes and swamps). Researchers used DNA barcoding to identify the species present and found over 500 different species, including five species at risk and six invasive or potentially invasive species.

The data suggests that a diverse range of species use aquatic habitats and their surrounding areas. In addition, two important fish habitats were found in the study area, along with amphibian breeding habitats and movement corridors. The data collected will be used to inform future studies that build upon this foundational data and inform the NWMO as to which habitats are deemed important and which barriers or obstacles may be explored further.

## Peer Review Findings

The PRT determined that the NWMO's BIS program demonstrates progress in addressing Guiding Principle #2. The PRT will continue to work with the NWMO to review work plans and reports that will be updated in 2024 as more data is collected.

The PRT emphasized that impacts from contaminants within the area's environmental media will also be relevant to the Biodiversity Impact Studies via a potential decreased survival or reproduction rate of species. As such, the conceptual site model and the environmental media should be considered holistically when determining how the Project interacts with the area's biodiversity values and ecosystem resources.

In addition, the full extent of cumulative impacts has not yet been explored, but the NWMO's *Biodiversity Impact Studies – Southwestern Ontario Region: 2022 Change Assessment Memorandum* examines potential interactions between the Project and biodiversity values that could result in changes.

The memorandum outlines any known biodiversity sensitivities within and around the study area based on existing foundational data. For any negative interactions, mitigation measures will be proposed, such as:

- Following best management practices for protecting species of interest, important habitats, wetlands and riverbanks, and the ecosystem's function and benefits.
- Designing infrastructure and activities to avoid important habitats.
- Minimizing areas to be cleared or infilled to only the extents necessary.
- Minimizing the breaking up of habitats by restricting activities within the Project's footprint.
- Implementing prescribed setbacks to protect important habitats and adjacent lands.
- Measures to reduce light, noise, vibration and human interactions with key ecosystem values.
- Preventing the introduction and spread of invasive species.
- Avoiding activities that could impact species of concern and their habitats during sensitive periods, where possible.

## Program Review and Next Steps

As the geosphere, biodiversity and environmental baseline programs are multi-year initiatives, the PRT understands that additional data will be collected. Reports produced in 2024 will be reviewed by the PRT, as they become available, to assist South Bruce in understanding the relevant environmental media and biodiversity parameters.

The PRT will also review field observations related to these data collection activities, as well as the NWMO-provided *Program Review Report*. This review will assess the data collected to date and recommend any adjustments to the program design for implementation in 2025. The *Program Review Report* for the South Bruce site will be provided pending the willingness decision.

## Summary and Conclusions

These safety and natural environment-based studies aid the NWMO and the Municipality of South Bruce in understanding what conditions are present in the natural environment in and around the site, and how confidence in safety is being built.

Safety is multi-layered and complex. The NWMO's various safety and natural environment studies provide important information on how the community and the environment would be protected from the effects of radioactive or hazardous substances present in the DGR's used fuel, as well as from potential impacts during the Project's construction, operation and post-closure phases. Through built and natural barriers, such as the multi-barrier fuel protection system, the intrinsic characteristics of the site, its intentional design elements, the area's favourable geological characteristics, the DGR's deep positioning in the ground, and its activity monitoring, the NWMO's confidence in safety increases.

Additionally, the Project can take lessons learned from similar sized facilities, such as Bruce Power (above-ground) and the Goderich Salt Mine (below-ground), when developing Emergency Response Plans. There will be effects on emergency services and systems in South Bruce, leading to updates required for local municipalities' emergency plans, as well as updates for additional equipment, human resources and training for health authorities, that are required to manage potential Project-based emergencies for events potentially involving radioactivity.

Through their work, the NWMO is developing a clearer picture of the characteristics, features, and baseline conditions of the study area's natural environment and can start to develop a better understanding of how the Project may impact the environment. Should the South Bruce site be selected as the Project's location, future federal Impact Assessment work will use these and future study results to better define how the natural, built, and human environments may be affected.

The PRT found that the data collected to date by the NWMO provides progress in demonstrating confidence in safety around the Project for humans and the natural environment with applicable mitigation measures and best management practices implemented. As a result, the PRT is supportive of the Municipality continuing to work with the NWMO, recognizing that further scheduled studies, workplans and reports must still be completed and evaluated. The PRT recommends that the Municipality continue to evaluate satisfaction with respect to their Guiding Principles around Safety and the Natural Environment as future NWMO studies, scheduled during the federal Impact Assessment and Project licensing, are completed. A more detailed conceptual design model for the South Bruce site must also be developed and assessed to continue to build confidence in safety.

The integration of individual study findings and natural environment descriptions is an important next step. As natural environment studies continue into 2024, the PRT will continue to work closely with the NWMO to review the data, interpretation of that data, and study findings to ensure progress in addressing the Guiding Principles.

# Appendix

## Study / Program Authors and Peer Review

<b>Study / Program Name</b>	<b>Proponent</b>	<b>Study / Program Authors</b>	<b>Peer Review</b>
<b>Confidence in Safety - South Bruce Site</b>	NWMO	NWMO (based on work by several third-party consultants)	GHD Ltd.
<b>Preliminary Radiological Safety Study</b>	NWMO	Arcadis	GHD Ltd.
<b>Deep Geological Repository Conceptual Design Report</b>	NWMO	AECOM Canada Ltd.	N/A
<b>Preliminary Radon Assessment for a Used Fuel DGR Report</b>	NWMO	NWMO (based on work by several third-party consultants)	GHD Ltd.
<b>Emergency Services Study Report -Southwestern Ontario Community Study</b>	NWMO	DPRA Canada Inc., Independent Environmental Consultants (IEC)	GHD Ltd.
<b>Geosphere Studies Program and Associated Components</b>	NWMO	Geofirma Engineering Inc., Nanometrics, Cambium Consulting and Engineering, Geologic Survey of Canada, Tulloch Engineering Inc.	GHD Ltd.
<b>Environmental Media Baseline Program and Associated Components</b>	NWMO	Canada North Environmental Services, Geosyntec Consultants International, Inc., Independent Environmental Consultants (IEC), Zajdlik & Associates Inc., Saugeen Valley Conservation Authority, Natural Resource Solutions Inc. (NRSI), TULLOCH Environmental (a division of TULLOCH Engineering Inc.)	GHD Ltd.
<b>Biodiversity Impact Studies Baseline Program and Associated Components</b>	NWMO	Zoetica, Saugeen Valley Conservation Authority, North/South Consultants Inc., North-South Environmental Inc., Natural Resources Solutions Inc., Morrison Hershfield, SLR Consulting, Stantec, TULLOCH Environmental (a division of TULLOCH Engineering Inc.)	GHD Ltd.

Safety and natural environment studies are available online at [www.southbruce.ca/Studies](http://www.southbruce.ca/Studies).

## **Community participation is key to an informed decision, a message from the Municipality of South Bruce**

Community engagement and consultation on the Project has been ongoing.

In 2021, an independent consultant, GHD Ltd., gathered public feedback on how the community wanted to measure its willingness to be a host, and what it needed to know to make that decision. Based on this input, Council voted in December of that year, that willingness should be decided by public referendum. This was reaffirmed by the current Council in 2022.

Prior to this, community input helped develop 36 Guiding Principles that sum up the community's expectations for the Project and guide our engagement with the NWMO.

We encourage you to learn about and explore the Project with us, as we look at what it could mean for our community.

For more information, please contact:

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