DRYDEN

BLAZE YOUR TRAIL | MII-KIN-AA-KAN

NWMO Response to Questions

Council Engagement Session December 7, 2021

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SAFETY: General

1. What is the protocol for determining what the best / safest site is?

Since 2010, the NWMO has been engaged in a multi-year, community-driven process to identify a site where Canada's used nuclear fuel can be safely contained and isolated in a deep geological repository.

The site selection process emerged through a two-year public dialogue. It reflects the ideas, experience and best advice of a broad cross-section of Canadians who shared their thoughts on what an open, transparent, fair and inclusive process for making this decision would include. It is built on a set of guiding principles and was developed within our ethical and social framework. The process consists of nine steps.

The process is community driven. It is designed to ensure, above all, that the site selected is safe, secure, and has informed and willing hosts. The process must meet the highest scientific, professional and ethical standards. The safety and appropriateness of any potential site will be evaluated through a series of progressively more detailed scientific, technical and social assessments.

2. The NWMO have chosen a strategy (path) that will result in the high-level Nuclear Waste being transported, buried and abandoned. But what happens if something goes wrong e.g. a spill or God forbid, a Nuclear Waste leakage? What backup plans do the NWMO have for these scenarios?

After decades of research and demonstration, there is scientific consensus around the world that the safest method to contain and isolate used nuclear fuel is in a deep geological repository. Also, note that since used nuclear fuel is a stable solid, and it will be contained and isolated within multiple engineered and natural barriers, leaks are not anticipated.

The future repository will have to follow stringent regulations and environmental standards defined by the Canadian Nuclear Safety Commission. We strive to provide a healthy, accident- and injury-free workplace for employees and contractors, and also integrate public health and safety considerations into business practices. We currently follow all applicable regulations and legislation with respect to health and safety and emergency preparedness and response, and the same will apply to the repository.

A future CNSC operating license would require the NWMO to develop emergency plans and procedures for the repository, in concert with a risk assessment and risk management plan, to prevent, prepare for and respond to emergencies that could be reasonably expected to occur. These documents would provide detailed processes to follow in the event of an emergency. All workers are required to be trained on emergency response procedures. Emergency drills are carried out to ensure all workers understand how to respond during an emergency.

We will provide an emergency response plan to the Canadian Nuclear Safety Commission, Transport Canada and the provinces to demonstrate that appropriate measures and procedures are in place for the life cycle of the project and the transportation of used nuclear fuel. We will ensure that information is available to relevant public emergency response agencies and that they are integrated into our plans as required.

SAFETY: Earthquakes

3. A local miner says: Granite is brittle. The drilling will cause fracking – all the way down. Water will seep in at all levels. It will be safe only if the pumps keep running. And because it is located in an area where there seems to be a lot of seismic activity, the situation can only get worse. So far in 2021, there have been 19 earthquakes recorded between Thunder Bay and Wabigoon. Four of them happened within 40 km of a borehole site and an additional seven earthquakes took place within 75 km. And this happened in our Wabigoon Watershed area! How could this possibly be a suitable site for a Nuclear Waste dump?

Earthquakes are one of several factors being examined in the repository site evaluation process.

The preferred site will be selected in an area where current and future earthquake (seismic) activity will not impact the safety of the repository during the operational phase or over the very long term.

Addressing the potential impact of earthquakes involves the following considerations:

- History of seismic activity
- Presence of major faults or fractures;
- Evidence of rock displacement along old faults;
- Groundwater chemistry that can provide evidence of stability over long periods; and
- Rock strength.

Even though the repository will be sited in an area with low seismic activity, it will still be designed to withstand large magnitude earthquakes, consistent with the requirements of the relevant building codes.

SAFETY: Uranium

4. NWMO states that the uranium will be safe for thousands of years but when questioned at previous meetings nobody was able to confirm they knew what type of isotope they were storing because without knowing which isotope you store you have no way of calculating the half-life change that takes place over the years so if that is the case, how can they definitively say this is safe if they cannot determine the end state of the uranium or any of its half-life changes through time?

When the used nuclear fuel is removed from the reactor, it is highly radioactive because of the changes to its elemental makeup, but the process is actually very well understood. Fresh fuel is 88.1% uranium, 11.8% oxygen and 0.1% trace elements, but comes out of the reactor having 86.8% uranium, 11.9% oxygen and 1.3% other elements. The last group is produced in the reactor, and includes the actinides and highly radioactive fission products that make the used fuel hazardous.

With respect to isotopes of uranium, the isotopes are very well known for fresh and used fuel, too. Uranium 235 falls from 0.63% of the fuel weight down to 0.15%, while Uranium 238 drops from 87.5% to 86.6%.

In fact, all of the constituents of used nuclear fuel are very well known, down to decimal places. However, memorizing this level of detail is not necessary to understand why used nuclear fuel is hazardous in the short and long term. Simply put, it contains fission products, where the half-lives are generally shorter (i.e. seconds or less to decades) and actinides like uranium, where half-lives tend to be longer (millions of years).

TRANSPORTATION

5. While the products are transported in sealed containers, they are stored in bentonite encased enclosures. That means that somewhere in the offloading process at the repository they have to be removed from the sealed containers and prepared / stored in the bentonite encasements underground. What is that process in detail, where is it performed and what are the safety procedures in place to ensure any accident is contained? In the past NWMO has indicated this is an operational issue and not part of this consultation for site locations but I feel strongly that the public needs to be sure of ALL risks and how they are handled because we live in the proximity of any potential spill contamination site.

The used nuclear fuel bundles will arrive at the used fuel packaging plant (UFPP) in transportation containers. The UFPP will be designed to receive and repackage used nuclear fuel into long-lived, corrosion-resistant used fuel containers (UFCs) for placement in the repository.

Fuel bundles will be transferred from transportation containers into UFCs using remote-controlled equipment in protected areas called hot cells. Workers will work behind shielded walls to perform the various processing steps necessary for fuel transfer, and UFC assembly and inspection.

Shielded frames on automated guide vehicles will move the used fuel containers within the packaging plant to the various processing stations. These processing stations include:

- A closure weld station to seal the lid to the used fuel container;
- A weld machining station to machine the weld area smooth on the container;
- A weld inspection station;
- A copper cold spray station to apply copper over the closure weld;
- A copper coating inspection station; and

- A non-destructive testing station to ensure the requirements of the container are met for placement in the repository.

Once the containers have been inspected to ensure they do not have any unacceptable defects or features, they are moved to a staging area prior to being transferred to the underground repository.

6. Thank you for permitting us an opportunity to state our vehement objection to NWMO's intention to transport from southern Ontario and then bury highly radioactive nuclear waste in Sunset Country. Our interest is born of our family's ownership of cottage property since the early 1950's first at Ignace and then on Mameigwess Lake. The fourth generation of family members now grace our property. We find it inconceivable that any agency would be authorized to dispose of waste in Sunset Country, that is not only pristine and a wonder in Canada but is part of the watershed to Hudson's Bay. To then imagine that the contemplated waste is radioactive nuclear waste leaves one's senses reeling in disbelief. It would be difficult to support such an enterprise even if scientists were able to guarantee the safety of the storage, but in the face of no such assurance, how could such folly be seriously considered?

The NWMO has been mandated by the federal government to implement a plan for the safe, long-term management of Canada's used nuclear fuel.

The site selection process emerged through a two-year dialogue. It reflects the ideas, experience and best advice of a broad cross-section of Canadians and Indigenous peoples who shared their thoughts on what an open, transparent, fair and inclusive process for making this decision would include.

The process is community driven. It is designed to ensure, above all, that the site selected is safe, secure, and has an informed and willing host.

When the NWMO launched the process in 2010, twenty-two communities voluntarily expressed interest in learning about the project and exploring their potential to host it. We have only ever considered potential repository sites in areas where a community proactively invited us to work with them to determine if the project could be a fit in their location.

The NWMO expects to select a site in 2023, and following a gradual process of narrowing down, two areas remain in our site selection process: the Wabigoon-Ignace area and the Saugeen Ojibway Nation-South Bruce area, both in Ontario.

Canada's plan will only proceed in an area with informed and willing hosts, where the municipality, First Nation and Métis communities, and others in the area are working together to implement it.

Canada's approach is consistent with internationally accepted best practice around the world. Almost all countries with commercial nuclear power production are planning to build deep geological repositories to either manage their used fuel directly, or to manage the high-level waste from reprocessing. This approach is widely accepted as the safest way to contain and isolate used nuclear fuel over the very long term.

The transportation of used nuclear fuel, which is a necessary part of this project, is a highly regulated activity in Canada and internationally. The standards for transportation package testing and certification are set by the International Atomic Energy Agency and by the Canadian Nuclear Safety Commission. These standards are responsible for a 50+ year track record of transporting used nuclear fuel safely internationally and in Canada.

7. They produce nuclear waste in southern Ontario and should keep the waste of that production exactly in that location, rather than having it transported throughout our national transportation corridor and into beautiful Sunset Country. Other than profit for a few, what could possibly justify such a dangerous endeavour? Please resist any temptation to so seriously endanger the safety of many and of our essential watersheds.

Water is a life force that sustains us, flows between us, and shapes the land. Protecting water, people and the environment is a priority we share with Canadians and Indigenous peoples.

The entire purpose of Canada's plan – the reason we are investing time, effort and money to implement it – is to protect people and the environment, including water.

Canada's approach is consistent with best practice around the world. Almost all countries with commercial nuclear power production are planning to build deep geological repositories to either manage their used fuel directly, or to manage the high-level waste from reprocessing.

Today, approximately 60% of Ontario's power needs are met by nuclear power, and all of Ontario benefits from nuclear power generation and nuclear medicine, not just Southern Ontario.

Nuclear power is one of the best ways to meet the constant electricity demands of Ontario reliably, cost effectively, and without the environmental impact of greenhouse gas and carbon emissions. There is also widespread awareness of the use of radiation and radioisotopes in medicine, particularly for diagnosis (identification) and therapy (treatment) of various medical conditions. In developed countries about one person in 50 uses diagnostic nuclear medicine each year.

8. Any form of transportation to move the toxic nuclear waste from where it is being stored would use some form of energy. Ignace is 1540 km by road from the Pickering and Darlington nuclear plants and 1667 km from the Bruce nuclear plants. The Bruce nuclear power plant is within 250 km of the Pickering and Darlington nuclear power plants. Why would government move nuclear waste to a site 1540 km away from the nearest nuclear power plant when it could be moved to a site more central to all of the nuclear power plants?

Planning for the transportation of used nuclear fuel from interim storage facilities in Ontario, New Brunswick and Quebec to a deep geological repository site is a key portion of Canada's plan for the safe, long-term management of used nuclear fuel. Regardless of the eventual site location, the used fuel will need to be transported.

Globally, the transportation of used nuclear fuel has an uncompromised record of safety. Over 50 years, there have been more than 20,000 shipments worldwide of used nuclear fuel, and none have caused harm to people or the environment as a result of the release of radioactive materials.

Transportation will begin in the 2040s – once the repository is operational – but we recognize now is the time to build confidence that a socially acceptable plan can be developed with the public to move the used fuel to the repository site that is selected.

Our first priority is protecting people and the environment.

As part of the process, we engage with and seek input from Canadians, Indigenous peoples and organizations with a shared interest in future transportation.

Since 2010, the NWMO has been engaged in a multi-year, community-driven process to identify a site where Canada's used nuclear fuel can be safely contained and isolated in a deep geological repository. The site selection process emerged through a two-year dialogue. It reflects the ideas, experience and best advice of a broad cross-section of Canadians who shared their thoughts on what an open, transparent, fair and inclusive process for making this decision would include. It is built on a set of guiding principles and was developed within our ethical and social framework.

Canada's plan will only proceed in an area with informed and willing hosts, where the municipality, First Nation and Métis communities, and others in the area are working together to implement it.

9. Why is the NWMO not required to talk about the actual realities, risks and challenges of radioactive waste transportation and burial in the Canadian Shield?

The NWMO is committed to transparency, including about both risks and benefits of Canada's plan for the safe, long-term management of used nuclear fuel. This commitment goes beyond our corporate values , it's critical to the process of identifying a site. In order for communities to determine if they are willing to host the project, they need to have all the information available to them.

Globally, the transportation of used nuclear fuel has an uncompromised record of safety. Over 50 years, there have been more than 20,000 shipments worldwide of used nuclear fuel, and none have caused harm to people or the environment as a result of the release of radioactive materials.

Transportation will begin in the 2040s – once the repository is operational – but we recognize now is the time to build confidence that a socially acceptable plan can be developed with the public to move the used fuel to the repository site that is selected.

10. I have been through the NWMO "Learn More" trailer. The spent fuel rods must be very dangerous if a container weighing 30,000 lbs is needed to protect humans and the environment from 5,000 pounds of Nuclear Fuel bundles; plus the necessity for trucks to keep rolling at all times during delivery to the destination site. I can think of all kinds of scenarios where the trucks carrying the material could be snarled in traffic, have accidents, or situations where they would be stopped on a highway or in an urban area for snow removal, construction, etc. This would result in a "silent spill" of Gamma rays – an exposure to invisible radiation that could be significant, but not result in consequences appearing until years later. The NWMO Adaptive Phased Management transportation plan is highly likely to involve road or rail accidents. By road, the projected 2 to 3 trucks daily on trips of more than 2300 km for over 40 years is much too great a risk to take with our communities and environments including waterways all along the routes. Are we willing to play Russian Roulette with our lives?

Globally, the transportation of used nuclear fuel has an uncompromised record of safety. Over 50 years, there have been more than 20,000 shipments worldwide of used nuclear fuel, and none have caused harm to people or the environment as a result of the release of radioactive materials. Protecting people and the environment is our top priority.

Safety is built into every element of the NWMO's transportation program, beginning with the transportation package design. Used nuclear fuel transportation packages are designed and tested to ensure protection of the public during normal operations, as well as during accident conditions.

Before a used fuel transportation package can be used in Canada, the design must be certified by the CNSC to meet regulatory requirements, which incorporate international safety standards.

The requirements include tests designed to demonstrate the ability of the package to withstand severe impact, fire and immersion in water. These are extreme tests to demonstrate how durable packages are.

During transportation, the drivers will remain in frequent contact with the shipper, receiver, local authorities, and response forces along the transport route.

A security escort would maintain constant surveillance of the shipment. Electronic or satellite equipment will also be used to track and monitor shipments.

The NWMO will operate a central Transportation Communication & Control Centre (C&CC) located at the repository site that will provide a single point of contact for all agencies involved in transportation-related communications, and that will monitor and track used fuel shipments.

Each escort vehicle, tractor or railcar, and transport package will be equipped with a GPS unit for remote real-time tracking of their location. Additional best practices and available technologies will be reviewed for tracking and monitoring as they are proven reliable.

NUCLEAR WASTE STORAGE, DEEP GEOLOGICAL REPOSITORY & MULTIPLE BARRIERS SYSTEM

11. Why are they sealing these units underground when there is isotope potential for medical isotopes to be removed from the cells? Once they are sealed underground an isotope that can be used medically is lost forever.

Based on input from Canadians, Canada's plan requires that used nuclear fuel be retrievable throughout implementation. The plan is for the used nuclear fuel to permanently remain safe in the repository; there is no intent to retrieve it. However, if it is determined in the future that used fuel should be retrieved, we can safely access and remove it from the repository.

Safety is the first priority, and we will ensure that any features designed to facilitate retrieval of used fuel will not compromise safety of the engineered-barrier system or deep geological repository. Before operations begin, we will demonstrate both placement and retrieval of used fuel containers.

The technology to retrieve used nuclear fuel has been developed at the conceptual level and demonstrated at surface and underground research laboratories such as the Äspö Hard Rock Laboratory in Sweden. The Canister Retrieval Test at the Äspö Hard Rock Laboratory is one example of full-scale demonstration of used fuel retrieval technology.

The NWMO will continue to study and develop technologies for the retrieval of used fuel during implementation of Canada's plan.

While used nuclear fuel will be retrievable throughout all phases of implementation, the process of retrieval will become progressively more demanding and resource intensive as the used fuel containers are sealed in the placement rooms and the access tunnels and shafts are eventually backfilled and sealed. The future decision to close the deep geological repository will only be made once society and government institutions and processes of the day agree that this should happen.

12. Air travel is considered the safest form of transportation, much safer than vehicular, but tragically, there are still accidents due to human error or mechanical issues. Does NWMO have an emergency plan for accidents that could occur from reactor site packaging, overland transport, repackaging for possible, interim shallow cavern burial, and finally, during permanent placement in the deep geological repository? If/when a leak occurs in this deep geological repository, what will be the mode of action? Will NWMO put in this big of an effort to dig it all up and remove it and fix the leak or haul it away?

[This question is similar to #2, so the answers are also similar]

Firstly, temporary shallow storage is not part of the NWMO's implementation plan – we do not expect to need this option because used fuel will remain at interim storage facilities until the repository is operational. Secondly, used nuclear fuel is a stable solid, and it will be contained and isolated within multiple engineered and natural barriers, so leaks are not anticipated.

In Canada, the emergency management community has adopted a standard approach for responding to incidents. Federal, provincial and local governments use a comprehensive approach to emergency management, which includes having in place measures for prevention, mitigation, preparedness, and response and restoration activities for all modes of transportation.

The NWMO will provide an emergency response plan to the Canadian regulatory agencies to demonstrate that appropriate emergency measures are in place. The purpose of the emergency response plan is to ensure co-ordination among the NWMO, provincial and local first responders, as well as federal agencies. It should be noted that first responders have general training on response protocol for dangerous goods, and any supplemental training or awareness programs would build on this knowledge base. Additionally, specialized teams with expertise and training in response and recovery would be dispatched by the NWMO in the event of an accident involving a transportation package.

We strive to provide a healthy, accident- and injury-free workplace for employees and contractors, and also integrate public health and safety considerations into business practices. We currently follow all applicable regulations and legislation with respect to health and safety and emergency preparedness and response, and the same will apply to the repository.

13. How long will the waste be stored above ground until the deep repository is completed; timeline?

Canada's used nuclear fuel will continue to be stored in the interim, above-ground storage facilities where they are currently housed until the deep geological repository is completed and transportation can begin. That is scheduled to begin in the 2040s.

14. What kind of testing has Finland done to study the safety of the copper canisters for storing high level nuclear waste?

General information on the Finnish program for the long term storage of used nuclear fuel can be found here and information on their disposal cannister can be found here.

With respect to work in Canada on copper, we have a very robust research program that has been focused on copper in a Canadian deep geological repository. Based on decades of work, we published a peer-reviewed article in a prestigious scientific journal (Progress in Materials Science, Volume 118, May 2021) that summarizes many individual studies on copper. The article demonstrates that the copper is a safe material to use for containers, and can be expected to last.

Read the article here: An evaluation of corrosion processes affecting copper-coated nuclear waste containers in a deep geological repository

15. Why would this be considered safe now, especially since it has been proven to fail in past attempts?

There are repositories for radioactive waste operating safely in a number of other countries right now, including Sweden, Finland, South Korea, and the US. These operating repositories sometimes differ from ours – for example they aren't all as deep as the one we are planning – because each is designed for its own specific location and purpose:

- The United States' Waste Isolation Pilot Plant near Carlsbad, New Mexico (680 m deep) contains high level waste from their defence program;
- Sweden's Final Repository for Short-lived Radioactive Waste in Östhammar is about 100 km north of Stockholm (in rock 50 m beneath the Baltic seabed);

- Finland's Operational Waste Repositories are at Olkiluoto in Eurajoki and at Hästholmen in Loviisa (both in rock about 100 m deep); and
- Korea's Gyeongju nuclear waste disposal facility is in North Gyeongsang province (80 m deep).

In addition, almost all countries with commercial nuclear power production are planning to isolate the waste by-product of their nuclear fuel cycle in a deep geological repository. Two countries – Finland and Sweden – have approved sites and in Finland construction is well underway and operations are expected to begin within the next few years. Extensive research for many decades has demonstrated that this plan is a safe and effective means of protecting people and the environment in Canada.

There are two storage sites that tend to be used as examples of having 'failed'. The first is in Germany and called Asse II. This was a former salt mine and was never designed as a used nuclear fuel repository. Used fuel was placed in the former mine in the 1960s and 1970s. Groundwater seeped into the mine and came in contact with containers. The German government took control of the mine and tasked the Federal Office for Radiation Protection with its decommissioning. There were no injuries due to radiation at this site.

The second site is the Waste Isolation Pilot Plant (WIPP) in New Mexico. In 2014, one drum leaked at this facility due to the waste being incorrectly packaged. Within the facility, the Continuous Air Monitoring system did the job it was designed to do -- it detected the presence of radioactivity and immediately switched the air flow to a high-efficiency filter system that captured most of the radioactivity. There was a small release in radiation, but there were no injuries and radioactivity at the facility's surface remained well below regulatory limits. The WIPP facility has reopened and continues to operate safely today. It's important to note that WIPP manages a different kind of waste than the NWMO will be managing – the specific chemicals involved in this incident are unique to the US weapons program, and CANDU used fuel is not reactive.

16. The nuclear industry, since its inception of nuclear reactors, have kept secret the fact that nuclear energy is NOT a clean energy. The waste from this process is the most toxic, deadly, material on earth. They have continued to operate regardless, and the Nuclear Waste created during the process of providing electricity was contained on site near the reactors. That Nuclear Waste, including high-level nuclear spent fuel waste, continues to pile up – 50,000 tons of it. The NWMO, in their "Learn More" education sessions have stated that all the Nuclear Waste created so far could be "packed into eight hockey rinks, piled up to the top of the boards." That's not much! That's probably smaller than one of their parking lots. Anyway, they have stated that Hydro Electric companies can manage at their nuclear plant sites the Nuclear Waste which will continue to accumulate for another 175 years. My question is: What's the hurry? Don't give up on the scientific community. Why kick the can down the road – leaving it to our grandchildren and gr-gr-gr-grandchildren to solve! Let's leave it in storage where we can keep an eye on it should any problems arise.

Canada's plan emerged through a three-year dialogue with Canadians and Indigenous peoples about the values and priorities they saw as important in managing used nuclear fuel. The message was clear – this generation, which benefits from the electricity that generates the used fuel, has a responsibility to do something about this issue now, and not to pass it on as a burden for future generations to manage.

The plan is also consistent with best international practice. There is scientific consensus that storing used nuclear fuel in a deep geological repository is the safest path forward, and nearly all countries with commercial nuclear power programs are planning a similar approach.

SITE SELECTION PROCESS

17. I am struggling with the NWMO Adaptive Phased Management Plan approval site selection process, for the issue of Consent and Willingness of a Community. What does 'consent' mean? How will it be determined?

Consent will be determined by the potential host communities. Ignace has decided this will take the form of a resolution from council after a multi-pronged engagement approach with residents. After gathering input from the community, those results will be collated and then a resolution will be presented. In South Bruce, willingness will be determined using a by-election with a question on the ballot after a draft hosting agreement has been established between the municipality and NWMO. The First Nations involved will also have their own processes for willingness.

The NWMO has always said the decision about willingness to host the project belongs in the hands of communities themselves. It's up to the community to decide the best way to define their willingness, whether or not they are willing, and how they will express that willingness.

18. On the Ignace website, the proposed process for community involvement indicates that they have hired Hardy Stevenson & Associates to assist in the process. On the Client webpage for Hardy Stevenson & Associates, NWMO is listed. Ignace is not. Has Hardy Stevenson & Associates been retained by Ignace? Was the firm recommended by NWMO?

That question should be directed to the Township of Ignace.

19. What is the current relationship between NWMO and Hardy Stevenson & Associates? This is of concern to me because in the proposed Ignace plan I found, the interaction between the consultants and the community is not a paper and pencil exercise but rather a more informal method of chats and coffee meetings. The optics of the methodology coupled with the past/present relationship with NWMO do not give me a high level of confidence in the results.

Hardy Stevenson & Associates is one of many professional consulting firms the NWMO periodically retains.

20. Although I spent some time online trying to get answers to the items below, I was not successful and would hope the current status of the Ignace community involvement process and the Crown Land usage question, might be part of a status update from NWMO. For clarification: I found the information on the Ignace website a bit confusing. There appears to be 2 surveys: one asking what process should be used to determine “Willingness” and one asking for comments on the proposed consultation process. Is the first survey now outdated and Ignace is moving ahead with the proposed consultation process?

In 2021, surveys were issued by the Township of Ignace, and those have now closed. Ignace will continue to connect with residents in numerous ways to get their input on the proposed plan to host a deep geological repository. Ignace Township will collate community input and inform the NWMO whether their community is willing.

21. Are the powers to be willing to conduct a public vote on this proposal and the results posted with names disclosed so future generations and inquiries that ask how this ever came to be can be answered?

The NWMO has always said that it is up to the potential host communities to determine how they will measure community willingness. In the case of Ignace, the township will continue to connect with residents in numerous different ways to get their input on the proposed plan to host a deep geological repository. Ignace Township will collate community input and inform the NWMO whether their community is willing. In South Bruce, their council has announced that they will hold a referendum on willingness in 2023. The First Nations involved will also have their own processes for willingness.

ENVIRONMENTAL STEWARDSHIP

22. What right do the people of the Dryden area have to decide the fate of the environment of NOW and beyond for hundreds of generations to come?

At the NWMO we believe it is everyone's responsibility to protect the environment. Every citizen, every community and every organization can do their part to protect the environment for the long term.

The NWMO's priority is protecting people and the environment, and the plan we're implementing is an important national environmental infrastructure project. Building a deep geological repository will safely contain and isolate Canada's used nuclear fuel for millennia, rather than passing it on as a burden for future generations to manage.

23. If Climate Change is allowed to move forward unchecked and many areas become flooded and inhabitable, does it make sense to risk the contamination of our watershed for future generations?

The entire purpose of Canada's plan – the reason we are investing time, effort and money to implement it – is to protect people and the environment, including water.

Fuel stored at surface is more vulnerable to future climate change impacts compared to used fuel stored deep underground. In addition, the design of the future repository will consider potential impacts from various climactic influences such as floods, tornados, earthquakes and glaciations.

Click here to read more about a climate change study that took place in the Ignace area

24. In Canada we have twenty-one percent of the world's fresh water. Think of it – twenty-one percent of the world's most precious resource! NWMO wants to risk that by burying high-level nuclear waste in the Canadian Shield of Northwestern Ontario where two major watersheds converge. What other strategic approach could be considered for safe and long-lasting management?

The entire purpose of Canada's plan – the reason we are investing time, effort and money to implement it – is to protect people and the environment, including water.

There is global scientific consensus that deep geological repositories are the safest way to protect people and the environment, including precious water resources. While used nuclear fuel is safely managed today, it's widely recognized that the interim storage methods we use now are not appropriate for the many thousands of years it remains hazardous.

The long-term plan will see it moved from the surface, further from bodies of water than where it is stored now, and placed within a system of barriers to ensure safety for generations. The project will be subject to a rigorous regulatory decision making process, and can only go ahead if it can be demonstrated as safe for people and the environment, including water.

Canada's approach is consistent with best practice around the world. Studies conducted around the world have concluded used nuclear fuel and high-level waste should be contained and isolated in a deep geological repository. Almost all countries with commercial nuclear power production are planning to isolate their used nuclear fuel, or the high-level waste by-products from reprocessing their fuel, in a deep geological repository.

25. One item I haven't heard mention much is water quality if there is a truck accident near the repository site (which there will be) or a leak in the repository. Right now the Wabigoon Reserve gets its water from Dinorwic Lake, as do I, and it is among the best water in Canada. What will happen if there is a leak in the repository or there is a waste truck accident in the area? Rt. 17 is a terribly accident-prone highway. Most everyone upstream of Dryden would lose their water supply. I know the Dryden water is already contaminated with Uranium and Mercury but that is no reason to make Dryden and everyone downstream worse. As far as the property values and taxes being higher, this is a specious argument as no one wants to live downstream from a nuclear waste facility and property prices and taxes would probably go down. It may not be a problem if the repository is sound but this is a huge watershed and effects potentially everything to Hudson Bay. Would we want to be known as, "Sunset Country, home to Canada's nuclear waste dump. No fishing, radioactive fish"?

The entire purpose of the project is to protect people and the environment, including water. Water protection is embedded in everything that we do.

In the over 50-year history of transporting used nuclear fuel internationally and in Canada, there has never been a transportation package damaged to the point where radiological release has resulted in human or environmental harm. This is because of the stringent regulations in place and the robust package design.

Transportation packages are designed and tested to withstand severe accident conditions, and offer a very high degree of assurance that a package cannot be breached.

In any accident scenario, procedures outlined in the transportation emergency response plan would be followed. The plan would detail the response actions that should take place, resources available to mitigate the situation, and ultimately, how to return the accident site to normal.

If there was an accident and the package fell into water, the most likely result would be no release of radioactivity. Even so, the NWMO has heard that people are interested in understanding more about the implications of these types of extreme accident scenarios. As described in Section 3, the NWMO's future work will include more detailed studies of accident scenarios, including assessing potential radiological doses to members of the public and workers in these very unlikely events.

It is important to note that used nuclear fuel is a stable solid – not a liquid or a gas, and it is not flammable or explosive. Because of this, it also does not readily react or break down in water. This means that even in the virtually impossible scenario that a container was somehow breached, widespread contamination would also be very unlikely.

26. What environmental oversight does / or did Finland have in regard to starting a DGR site?

That would be a question for Posiva, our counterpart in Finland to answer. You can find information about their program on their website.

BOREHOLE DRILLING

27. My concern is work permits may be refused if the project / work / etc. "……is likely to create a threat to public safety or to a material resource….". If permits have been issued, does this imply the Ministry does not perceive nuclear storage as a threat? This question belongs to the Ministry, but I would like to know the status of the drilling permits so I can proceed or not.

The NWMO has followed and would continue to follow all regulatory requirements for work conducted now and in the future.

The Ministry of Natural Resources and Forestry (MNRF) granted the NWMO permission to proceed with borehole drilling on Crown land in northern Ontario, after successfully fulfilling its legal duty to consult with Indigenous communities. MNRF's granting of permission in this case was only required as the owner of the Crown land.

The NWMO has also sought MNRF permission for broader technical site evaluations on Crown land in northern Ontario, including the installation of shallow groundwater monitoring wells and microseismic monitoring stations, and conducting seismic surveys

Once a site is selected, the proposed project will also undergo rigorous scrutiny through the Impact Assessment Agency of Canada project. That process would include a number of federal ministries who would be involved in the review of their particular areas.

SMALL MODULAR REACTORS (SMRs)

28. The biggest problem to achieving year-round feasibility is typically energy in the form of both heat and power. Currently, many communities burn diesel to provide their heat and/or power, and greenhouses are incredibly energy-intensive and would substantially increase the carbon burden unless a more sustainable solution is found. Many common energy sources, such as solar, wind, and geothermal, are not viable in the Far North. Small Nuclear Reactors, or SMRs, however, are being innovated to the extent that they can utilize "spent" nuclear rods, such as those being proposed in the deep geological repository in our region. These reactors also have been shown to not melt down, but rather self-stabilize, even if their cooling is cut.

Once the rods are utilized in these SMRs, instead of the "spent" rods being radioactive for 300,000 plus years, their radioactivity is reduced several orders of magnitude and reportedly only would have to be stored for approximately 300 years. This could potentially clean up our nuclear waste issue, while also converting dangerous "nuclear waste" into "nuclear fuel".

Would the NWMO be willing to work with AgriTech North on utilizing these innovative solutions to provide year-round source of heat and power for greenhouses in Northern communities, delivering food security and sovereignty throughout Canada while reducing the toxicity and essentially "cleaning up" the nuclear waste instead of having to worry about storing the rods for 300,000 plus years? Would the NWMO be willing to financially contribute to this process since it would be substantially less expensive and risky than long-term storage?

If Canada chooses to reprocess nuclear fuel in the future, it would be a joint decision by the nuclear energy producers, the associated provincial governments and the federal government – not the NWMO.

The Nuclear Waste Management Organization (NWMO) is responsible for implementing Canada's plan for the safe, long-term management of used nuclear fuel – including that created using new or emerging technologies such as small modular reactors (SMRs). Studies conducted around the world have concluded that high-level waste from reprocessing should also be contained and isolated in a deep geological repository.

If SMRs proceed in Canada, the NWMO will work with utilities and government to safely manage whatever high-level waste that results from this process. If some used fuel is identified for reprocessing, it could be diverted from the repository instead of being placed and retrieved at a later date.

A fundamental tenet of Canada's plan is incorporating new knowledge including technological advances. No matter the source of the fuel, safety is, and will always be, our top priority.

To learn more, we would encourage the public to read NRCAN's recently published draft policy on radioactive waste.

Questions from GeneWatch UK

GeneWatch UK is a not-for-profit policy research and public interest group, who investigates how genetic science and technologies will impact on our food, health, agriculture, environment and society.

At the request of Dryden stakeholders, the following safety concerns as raised by GeneWatch UK in 2010 regarding nuclear waste storage and the proposed DGR are brought forward for a response from the NWMO.

1. **Temporary shallow storage at the deep geological repository is optional and not currently included in the Nuclear Waste Management Organization's implementation plan. If this provision, which continues to appear in NWMO documentation, is implemented, it may allow for shallow storage of high-level nuclear waste at the central site before the DGR is even constructed.**

A NWMO report from 2017 Progress Through Collaboration Triennial Report 2014 to 2016 stated that there is a:

"Provision for optional temporary shallow storage at the central site, if needed"[1]

[1] Temporary shallow storage at the deep geological repository is optional and not currently included in the Nuclear Waste Management Organization's implementation plan.

That footnote is included in the original report. The NWMO has been consistent in stating that temporary shallow storage is not part of the NWMO's Implementation Plan. No high-level nuclear waste would be stored at a site before a deep geological repository is constructed. The purpose of a deep geological repository is to safely isolate used nuclear fuel to protect people and the environment.

2. Copper or steel canisters could corrode quicker than expected.

The NWMO has carried out, and continues to conduct, rigorous testing on our used fuel containers. This includes identifying potential corrosion processes, evaluating the risk of each corrosion mode affecting the container lifetime and performance, and to identify and address any knowledge gaps.

Based on these studies, we have found the risk of corrosion to the outer copper coating and inner carbon steel vessel to be very low. We continue to study these processes to improve our understanding. We also need to confirm that the chemistry at depth in our specific sites is consistent with our expectations. Some examples of reports on our work are listed below:

Articles:

- Hall, D., M. Behazin, W.J. Binns and P. Keech. 2020. *An evaluation of corrosion processes affecting copper-coated nuclear waste containers in a deep geological repository*. Progress in Material Science, #100766.
- Internal Corrosion of Used Fuel Container (PDF)

3. Intense heat from radioactive decay, along with corrosion and gas generation, could compromise backfill material.

The repository design and safety case are developed to ensure that temperatures generated will not impact the ability of the multiple-barrier system or the surrounding rock to contain and isolate the used nuclear fuel.

Specific design requirements include a repository layout and container spacing that prevent temperatures from going above 100 degrees Celsius on the container surface. The containers of used nuclear fuel would reach their highest temperatures less than 100 years after being placed in the repository. Temperatures would then gradually decrease to levels near those existing before repository construction.

Multiple Barrier System

4. **Build-up of gas pressure could damage barriers and force radionuclides through rock fractures.**

While it is true that corrosion of metal can produce significant amounts of hydrogen, for the copper coated container used by the NWMO, this is not an issue, because the copper does not corrode in the oxygen-free water that will be present around the repository. As a result, there will be no buildup of gas in the repository from corrosion of the copper container.

Safety studies however consider the what-if case that all containers fail and there can be hydrogen gas generation from the inner steel container. In this case, gas pressure is expected to initially build up within the clay, but then be released before any damage would occur and the clay will reseal. This behavior has been demonstrated in various full-scale tests; indeed the ability of bentonite to reseal is a significant reason for its use as an engineered barrier. The primary question then is related to transport of gaseous radionuclides; however the amount of these in the fuel is small and safety studies have not identified any concern in generic site studies to date. This will be confirmed as part of the safety case for specific site.

5. **Chemical effects are poorly understood re: formation of compounds that could hasten transport of radiotoxic elements such as plutonium.**

Chemical effects on the formation of compounds and on transport of radionuclides of most concern are well understood.

It will be important to understand the groundwater chemistry at the potential repository locations, to support site-specific assessments of the potential for radionuclide transport at each location.

The NWMO continues to work with our international colleagues, and in Canada with researchers at the University of Guelph, to improve our understanding of the chemistry of relevant elements in groundwater.

This work is underway now through the boreholes and site characterization work. In general, NWMO will consider both the expected chemistry of radionuclides at the site, and also consider cases where the radionuclides are much more soluble than expected, in order to understand the safety of the site.

For more information, visit the Nuclear Energy Agency.

6. **Fractures and faults may be unidentified or misclassified – radionuclides could be released into groundwater.**

The repository will be located deep underground in a suitable rock formation, which must meet site selection technical criteria for the development of a robust safety case. This approach is consistent with international best practice and is the culmination of more than 30 years of research, development and demonstration of technologies and techniques.

Detailed site characterisation will continue after a potential location has been chosen. Characterisation work will build confidence in our understanding of the fault and fracture systems in the study area. The design of the repository vault will take this into consideration and ensure that the underground layout is appropriately distanced from all fault zones. This will be confirmed during excavation, when intercepting a fault zone would be obvious and specific room location and excavation as well as container placement can be adjusted.

Safety: Protecting People and the Environment

7. **Excavation of repository will damage adjacent zones of rock – could create fast routes for radionuclide escape.**

Excavation Damage Zones (EDZ) are a phenomena well understood when excavating an underground facility or mine. It is anticipated that excavation of the repository will damage the neighboring rock due to the stresses from excavation, stress within the rock, and thermal stress from increased temperatures within the vault. The repository will be designed and constructed to minimize this damage; for example, designing the repository layout and container spacing to limit peak temperatures, and constructing the vault using special excavation methods.

Project Facilities

8. **Future glaciations could cause faulting of rock, barrier rupture and penetration of surface water.**

The NWMO also recognizes future glaciations as the most significant event which could impact the repository. For this reason, we consider glaciation and its effects on the repository at many stages in our work.

We know from evidence at other locations that the deep geosphere can provide isolation from glaciation, unlike surface or near-surface waste storage. The particular rock formations we are presently examining are about 400 million-years-old (southern Ontario), or about 2.7 billion-years-old (northwestern Ontario) and have experienced nine major glaciation periods in the past one million years.

During site investigations we look for evidence, for example, of how deep into the rock glacial meltwaters have travelled in the past, and for evidence that the rock around a potential repository location has been stable to past earthquakes, which may have happened during the retreat of these continental ice sheets.

As part of assessing the safety of a site for the repository, for example, we examine how future glaciations could change the stresses in the rock, how much erosion can be expected to occur at the site, whether permafrost could extend to repository depths, and how the groundwater movement could change.

These studies, together with the characteristics of the rock and the engineered design, will help us confirm that a repository will safely function at the selected site over the next million years.

For more information on NWMO's work on climate change, read the report Climate Change Variables for a Deep Geological Repository (Ignace Study Area)

9. Earthquakes could damage containers, backfill, and rock.

Earthquakes are one of several factors to be examined in the repository site evaluation process. The preferred site will be selected in an area where current and future earthquake (seismic) activity

Addressing the potential impact of earthquakes would involve the following considerations:

- History of seismic activity;
- Presence of major faults or fractures;
- Evidence of rock displacement along old faults;
- Groundwater chemistry that can provide evidence of stability over long periods; and
- Rock strength.

The repository will be sited in an area with low seismic activity and will be designed to withstand large magnitude earthquakes.

10. Future generations could unknowingly dig a shaft into the rock around the repository, or a well into contaminated groundwater above it.

Our site selection process seeks to identify a site where human intrusion is unlikely, for example, there are no valuable resources. Since a deep geological repository is located approximately 500 m below the surface, it is far deeper than groundwater resources

After decommissioning and closure of the repository, institutional controls will be in place for an extended period of time to prevent future society from inappropriate use of the land. Institutional controls are commonly used worldwide to ensure that people and the environment are protected after decommissioning facilities associated with the use, storage, or disposal of hazardous materials.

For the repository, such controls could include both active measures such as monitoring and surveillance, and passive measures that do not require activities on the site. Passive measures could include local land use restrictions and preservation of knowledge and memory through public records/archives.

The NMWO participates in the Nuclear Energy Agency's international collaboration on Preservation of Records, Knowledge and Memory Across Generations, which explores various topics such as markers, archives and key information files that would include information transferred across generations, transfer of responsibilities, and others.

11. The BEIR VII report reaffirmed the conclusion of the prior report that every exposure to radiation produces a corresponding increase in cancer risk.

For information on radiation health effects, please follow this link to the Canadian Nuclear Safety Commission's webpage: Radiation Health Effects - Canadian Nuclear Safety Commission

12. MTO Truck Collision Statistics - Nipigon to Ignace.

Averages per year: 2016 - 2017

- 198 total collisions per year
- 62 truck collisions per year
- 32% of total are truck collisions

Globally, the transportation of used nuclear fuel has an uncompromised record of safety. Over 50 years, there have been more than 20,000 shipments worldwide of used nuclear fuel, and none have caused harm to people or the environment as a result of the release of radioactive materials.

Transportation will begin in the 2040s – once the repository is operational – but we recognize now is the time to build confidence that a socially acceptable plan can be developed with the public to move the used fuel to the repository site that is selected.

Transportation will not begin for another 20 years. At this point in time modes, routes, and traffic flow to either of the sites could be significantly different. Therefore, the NWMO is focusing our current efforts on:

1) technical work to demonstrate how we can meet regulatory requirements; and
2) engagement work to understand social concerns and considerations.

There is a strong regulatory framework that will hold the NWMO to a high set of international safety standards regardless of which site is selected. We are also engaging on public expectations related to transportation, which includes addressing concerns related to highway safety. As our transportation planning continues to develop over time and we get closer to the 2040s, NWMO will undertake logistics studies to support decisions about modes and routes that take into account regulatory requirements and social concerns and considerations.

We will also continue to remain informed on developments in the area of radioactive materials transportation and specifically some of the operational considerations and constraints that are utilized by the industry in order to ensure the safety of transportation. At this time, this can include for example constraints around driving under certain weather conditions, requirements for fitness of duty of drivers, extensive driver training programs, various instrumentation installed in vehicles to enable real-time monitoring amongst other provisions.

13. **Rolling Stewardship: A Better Approach? Do I want to be one of the small handful of people who decided for the first time in Canadian history, that it is perfectly good practice to abandon long-lived human-made radioactive waste materials? Do I truly believe that our present knowledge of science, technology and nature is sufficient for me to be certain of the validity of this course of action for the next 100,000 to 1,000,000 years?**

Today used nuclear fuel is safely managed at licensed facilities at reactor sites on the surface, but it is widely recognized this is not a practical or appropriate approach for the many thousands of years the material remains hazardous, because it requires active, ongoing intervention.

Rolling stewardship means maintaining an effective storage regime now, while keeping options open about how to deal with the waste in the future. It is not seen by any country as an acceptable strategy to rely on in the long term.

People across Canada agree that we must take responsible action now – rather than leaving it for the next generation.

There is a strong global scientific consensus that deep geological repositories are the best method to protect, people, water and other environmental features over the very long-term. This approach is the culmination of more than 30 years of research, development and demonstration of technologies and techniques,

This consensus is supported by groups like the European Commission, the Nuclear Energy Agency of the Organization for Economic Co-operation and Development, the Blue Ribbon Commission on America's Nuclear Future and the International Atomic Energy Agency, which includes Canada and the US among its 171 member states. It is the method being implemented by all countries with commercial nuclear power programs around the world.