

nwmo

NUCLEAR WASTE  
MANAGEMENT  
ORGANIZATION

SOCIÉTÉ DE GESTION  
DES DÉCHETS  
NUCLÉAIRES

# Understanding

the

The Future Management  
of Canada's Used  
Nuclear Fuel

# Choices

# Executive Summary

*Understanding the Choices* is the NWMO's second discussion document, an important milestone in a three-year study (2002-2005) designed to recommend to the Government of Canada an approach to managing Canada's used nuclear fuel for the long term.

**The report begins with an examination of the values and priorities of Canadians, and how the NWMO has used this understanding to build a framework to assess and compare management approaches.**

Used nuclear fuel is primarily a by-product of nuclear electricity production. Small amounts also result from research and the production of medical isotopes. Ontario, which has 20 nuclear reactors at three generating stations, is the largest producer of nuclear electricity in Canada. New Brunswick and Quebec each have one nuclear reactor for electricity generation. The Canadian Nuclear Safety Commission (CNSC) ensures that all of Canada's used nuclear fuel is fully accounted for and safe in interim storage facilities at the reactor sites where it is produced. However, this was always intended to be a temporary measure.

For decades, Canadians have benefited from nuclear power. Responsible stewardship requires that we look beyond today in managing the waste that has been produced. Like many countries, Canada is now carefully considering the appropriate approach for managing used nuclear fuel over the long term.

The Government of Canada passed legislation in 2002 that set a decision-making framework. Under the *Nuclear Fuel Waste Act*, the Government requires the owners of this waste to create an organization that will study the options and recom-

mend a long-term management approach. The Nuclear Waste Management Organization (NWMO), the organization created in response to the *Act*, is required to study approaches based on three methods: deep geological disposal in the Canadian Shield; centralized storage, above or below ground; and storage at nuclear reactor sites. We may also study other methods. We must submit our study to the Minister of Natural Resources Canada by November 15, 2005.

The NWMO has committed to the collaborative development of a preferred management approach. As such, our study seeks the input and advice of the public and experts throughout the process. With each of our milestone study documents, the NWMO describes what it has heard from the public and experts, articulates its thinking to date, and invites comment and further direction from Canadians.

*Understanding the Choices* continues the dialogue begun with our "conversations with Canadians" and the launch of our first discussion document released in November 2003, *Asking the Right Questions?* In our first discussion document, we asked Canadians if we were capturing the key questions which should be asked and answered in the analysis and study of potential methods for the long-term management of used nuclear fuel.

Over the past year, we have laid the foundation to consider the relative strengths and limitations of alternative management approaches. We have done this through our ongoing dialogue with both experts and the public, and through our continuing efforts to identify and use the scientific and technical expertise available in Canada and abroad.

**In Part 1 of *Understanding the Choices*, we report back on the direction we have received from our engagement and research activities to date.**

**Understanding Canadian Values.** From the outset, we recognized the need for the NWMO study to be driven by the values of Canadians. In our first discussion document, we introduced ten key questions that reflected the concerns, priorities, and implicitly the values of Canadians as expressed to us in our early conversations with them. To gain a more in-depth understanding of citizens' values, and to identify these values explicitly, the NWMO initiated three core and parallel activities:

- We launched a National Citizens' Dialogue to better understand citizen values, through a collaborative research project with the Canadian Policy Research Networks (CPRN). This Dialogue brought together 462 unaffiliated Canadians from all walks of life representative of the public at large. Over the course of the day-long sessions, participants articulated six core values which should direct the long-term management of used nuclear fuel.
- Our initial dialogue with aboriginal peoples has identified the principles inherent in Aboriginal Traditional Knowledge. We need to be responsive to their emphasis on planning within very long time horizons.
- Our NWMO Roundtable on Ethics has created an "Ethical and Social Framework" to help direct our activities as well as the assessment of management approaches. The Roundtable provides a constant reminder of the ethical imperative.

Reflecting on the comments of Canadians, it is apparent that although we share certain values and objectives which should inform the NWMO's study, there are also tensions. Throughout the dialogue we have heard an emerging sense that the assessment of management approaches will necessarily involve difficult decisions about priorities, and the conditions under which trade-offs among objectives would be appropriate.

This cumulative insight from Canadians on their values and ethical considerations provides a cornerstone for the study as we proceed with the assessment of management approaches.

**Reporting Back on the Initial Framework.** In response to *Asking the Right Questions?* we have received important comment and advice. These have come from web-based submissions, public opinion research and face-to-face dialogues and workshops. Overall, people told us that the ten key questions proposed in our first discussion document capture the key issues and considerations that should be addressed in our study.

At the same time, people told us that more study is needed before completing any assessment of management approaches. In particular, they asked us to consider the following issues further:

- A more precise description of the nature of the hazard posed by used nuclear fuel to human health and the environment;
- A more precise account of the nature of the risk posed by transportation of used nuclear fuel;
- Clarification on what "social acceptability" or "public confidence" will entail;

- How the assessment is affected by the volume of used nuclear fuel which ultimately needs to be managed;
- Opportunities to reuse or recycle used nuclear fuel; and
- Opportunities to site a deep disposal repository in geologic media other than that noted in the *Nuclear Fuel Waste Act*.

**Reporting Back on the Technical Methods.** In *Asking the Right Questions?*, we identified 14 potential methods for managing used nuclear fuel. For the most part, Canadians agreed that our focus should be on the three methods requiring study under the *Nuclear Fuel Waste Act*. That said, several methods were flagged as appropriate for further study or maintaining a “watching brief”. In this regard, partitioning and transmutation is of particular interest to Canadians, to explore the possibility of reusing the used nuclear fuel or reducing the hazard it presents.

**In Part 2 of *Understanding the Choices* we provide fuller descriptions of the approaches on which we will now focus our study. To further our dialogue with Canadians, we report on how the framework to assess the approaches has evolved since our first discussion document. Finally, we present a practical demonstration of this framework through a preliminary assessment of the management approaches.**

Early in 2004, the NWMO assembled a multi-disciplinary group of individuals as an Assessment Team to: 1) translate the ten questions presented in the first discussion document into an assessment framework, taking into account the public and expert comment on those questions; and 2) conduct a preliminary assessment of alternative approaches.

We asked the Team to use a methodology that would allow for a holistic assessment – one that would systematically integrate social and ethical dimensions with technical, economic, financial and environmental considerations. Finally, we requested that the Team produce a report that would set out its thinking clearly as they discussed and debated the options. In so doing, they could share transparently with Canadians the range of considerations – including the challenges – encountered in undertaking the assessment.

The work of the Assessment Team has contributed two very important elements to the study.

First, it has created a preliminary description of the strengths and limitations of the management approaches, for consideration and dialogue among Canadians. In advancing our understanding of some of the distinguishing features of the options, it provides the context for a substantive discussion with Canadians on how to consider the relative risks, costs and benefits of the alternative management approaches.

Secondly, through the broad and integrative approach taken, the work has brought into focus some of the difficult choices and trade-offs which will need to be addressed as part of the assessment of the approaches.

*Highlights from the Assessment Team's work are presented in Figure E-1 on the following page:*

### Figure E-1 Preliminary Findings of the Assessment Team

#### Strengths and Limitations of Alternative Methods

In summary, the Assessment Team found that each of the options specified in the *Nuclear Fuel Waste Act* has specific, and quite different, strengths and limitations. No method perfectly addresses all of the values and objectives important to Canadians.

In the words of the Assessment Team, we present the strengths and limitations identified through the Team's assessment:

#### At-Reactor Storage

**Advantages:** No transportation of used nuclear fuel would be required as the used fuel would remain next to where it is generated. Each of these sites already houses nuclear installations, so there is nuclear expertise on site and in the existing communities. These communities are familiar with the presence of nuclear facilities, including storage of used nuclear fuel. Further, the ability to monitor the performance and the flexibility to adapt to changing conditions should be facilitated. The science and technology required are well in hand.

**Limitations:** The key disadvantage, shared with centralized storage, is the need for continuing administrative controls and operations, including the necessary funding, for the thousands of years the used nuclear fuel remains hazardous. Unlike centralized storage, at-reactor storage means continued management at a number of sites, each of which has, as its primary focus, the production of power, not the long-term management of used nuclear fuel. These reactor sites were selected for their suitability for reactor operation, not for very long-term storage of used nuclear fuel. The used nuclear fuel will remain hazardous well beyond the almost certain shutdown and ultimate abandonment of the nuclear reactor sites. At-reactor storage would result in very long-term used nuclear fuel management at a number of sites located next to important bodies of water. This raises security, environmental and safety issues and adds significant uncertainty given the potential for changes in institutions and governance and the likelihood of extreme natural and human induced events over such an extended time.

### Centralized Storage

**Advantages:** Centralized storage, either above-ground or shallow below-ground, would allow for the site selection solely on the basis of used nuclear fuel management. If done well, siting can be achieved with community participation. These are both key potential advantages compared to at-reactor storage and apply to the siting of a deep-geological repository as well. Such a site could be either at an already existing nuclear site, if suitable, or at a different site should that prove more advantageous. With the option of shallow below-ground storage, some of the security concerns can likely be abated. As with at-reactor storage, the required science and technology are well in hand.

**Limitations:** Centralized storage shares with the at-reactor storage option the key disadvantage of requiring effective and continuing administrative controls and operations, including the required funding, for thousands of years. It also would require the identification and development of a site with potentially contentious community involvement. Transportation of the used nuclear fuel to the site would be required with its attendant risks and costs.

### Deep Geological Repository

**Advantages:** The deep geological repository option results in the eventual permanent emplacement of the used nuclear fuel which reduces or may eliminate the necessity for long-term institutional and operational continuity and financial surety. As a consequence, after emplacement and closure, provision of long-term resources and funding are not required, although further actions are not precluded. The site is chosen with specific features as a requisite and, if done well, can be achieved with community participation. The intrinsic geologic, hydrologic and other features of the site, in combination with engineered features such as long-lived waste packages and material buffers, isolate the used nuclear fuel from the accessible environment for the very long time periods that they remain hazardous. Deep emplacement reduces security concerns, both before and after closure.

**Limitations:** Advance “proof” that such a system works is not scientifically possible because performance is required over thousands of years. Detailed scientific studies, models and codes form the foundation of the assurances of performance provided to regulatory authorities and interested organizations and individuals. Monitoring becomes more difficult as the used nuclear fuel is emplaced deep underground and as the site is backfilled and closed. At this stage adaptability and flexibility are also reduced as retrieval of the used fuel, for example, becomes much more difficult, costly, and hazardous. Siting must pay particular attention to intrinsic geologic features, perhaps limiting options more than for storage alternatives. As with centralized storage, community participation in regard to siting could be contentious and transportation of the used nuclear fuel will be required.

**In Part 3 of *Understanding the Choices* we take stock of what we have learned to date and identify a path forward for the next phase of our study.**

**A Responsive Framework.** Acknowledging the advice of the public and experts, and the work of the Assessment Team, we have developed an assessment framework to guide the next phase of the NWMO's work. This framework will be the foundation of the assessment of the approaches and the launching point for the exploration and design of implementation plans. *The framework is summarized in Table E-2.*

The dimensions of a preferred management approach are beginning to emerge through our dialogue with Canadians. Canadians want to see the development of a long-term strategy or plan. But they also want action to be taken now on the first steps of that plan. This will be done in a way that ensures that future generations will be able to make decisions that reflect their own values and priorities. The preferred approach must be adaptable, able to incorporate new knowledge as it becomes available. This might best be accomplished by a phased approach that provides for decisions to be taken in steps over time. Finally, the preferred approach will necessarily entail a robust system of governance and measures to ensure that citizens understand the issues, remain informed and have a voice in decision-making.

#### **Preliminary Requirements of a Preferred Management Approach**

- **Adaptability**
- **Phased decision-making**
- **Robust system of governance**
- **Opportunities for citizen engagement**

**NWMO's Work Continues.** In the coming months, the NWMO's work will focus on several matters. First, we will continue to elaborate the specific characteristics of each management approach under study. This will include further work on the economic and financial considerations for each approach, and on potential economic regions for implementation of the different approaches. We will consider the questions of types and volumes of waste to be managed and opportunities for recycling. We will be examining in more depth issues related to the hazard associated with used nuclear fuel, transportation implications of the options, and obligations associated with an international nuclear weapons non-proliferation regime.

We will also be examining the different types of geologic media that might provide feasible options for safely and securely hosting a repository or centralized storage option. While we must study the option of deep geological disposal in the Canadian Shield, we recognize that in recent years different types of geologic media have been studied and are under consideration in other countries.

Secondly, we will begin work to develop possible implementation plans for the management approaches. Implementation plans will address, at a minimum, mechanisms for ongoing societal involvement, oversight and monitoring systems, institutional design including human resource capacity, and principles to guide site selection.

Once we have completed this work, and have consulted and received comments regarding *Understanding the Choices*, we will begin to develop our draft recommendations. We plan to share our draft recommendations in early 2005 in a draft study report, after which we will seek further comment and direction from Canadians before we formulate our final recommendations.

**Table E-2 What Needs To Be Considered? The Assessment Framework**

Value and ethical considerations are by design embedded in the eight objectives which comprise the assessment framework. The original Ten Questions have been converted into eight objectives and associated guiding principles and influences. The influences are described in Part 2 of this document.

	A Foundation of Values and Ethics (*)
<b>Citizen Values</b>	<p><b>Safety From Harm</b> An overarching requirement. First and foremost, human health and the environment must be safe as possible from harm, now and for the future.</p> <p><b>Responsibility</b> We need to live up to our responsibilities to ourselves and to future generations, and deal with the problems we create.</p> <p><b>Adaptability</b> We need to build in capacity to respond to new knowledge.</p> <p><b>Stewardship</b> We have a duty to use all resources with care and to conserve, leaving a sound legacy for future generations.</p> <p><b>Accountability and Transparency</b> To rebuild trust. Governments are ultimately accountable for the public good concerning safety and security but must involve citizens, experts and stakeholders in any decision-making. Honour and respect must be shown to all.</p> <p><b>Knowledge</b> We need to continue to invest in informing citizens, and in increasing knowledge, to support decision-making now and in the future.</p> <p><b>Inclusion</b> The best decisions reflect broad engagement and many perspectives; we all have a role to play.</p>
<b>Ethical Principles</b>	<p><b>Respect for life</b> in all its forms, including minimization of harm to human beings and other sentient creatures</p> <p><b>Respect for future generations</b> of human beings, other species, and the biosphere as a whole</p> <p><b>Respect for people and cultures</b></p> <p><b>Justice</b> across groups, regions, and generations</p> <p><b>Fairness</b> to everyone affected and particularly to minorities and marginalized groups</p> <p><b>Sensitivity</b> to the differences of values and interpretation that different individuals and groups bring to the dialogue</p>
	(*) Drawn from National Citizens' Dialogue, Roundtable on Ethics and Aboriginal Traditional Knowledge.

Specific Objectives	
	From the ten questions posed by Canadians, and the foundation of values and ethical principles expressed by citizens, eight specific objectives have been developed which will guide our work.
<b>Fairness</b>	To ensure fairness (in substance and process) in the distribution of costs, benefits, risks and responsibilities, within this generation and across generations. The selected approach should produce a fair sharing of costs, benefits, risks and responsibilities, now and in the future. In addition, fairness means providing for the participation of interested citizens in key decisions through full and deliberate public engagement through different phases of decision-making and implementation.
<b>Public Health and Safety</b>	To ensure public health and safety. Public health ought not to be threatened due to the risk that people might be exposed to radioactive or other hazardous materials. Similarly, the public should be safe from the threat of injuries or deaths due to accidents during used nuclear fuel transportation or other operations associated with the approach.
<b>Worker Health and Safety</b>	To ensure worker health and safety. Construction, mining, and other tasks associated with managing used nuclear fuel can be hazardous. The selected approach should not create undue or large risks to the workers who will be employed to implement it.
<b>Community Well-being</b>	To ensure community well-being. Implications for the well-being of all communities with a shared interest (including host community, communities in the surrounding region and on the transportation corridor, and those outside of the vicinity who feel affected) should be considered in the selection and implementation of the management system and related infrastructure. A broad range of implications must be considered including those relating to economic activity, environmental disruption and social fabric and culture.

Specific Objectives (continued)	
<b>Security</b>	To ensure <b>security of facilities, materials and infrastructure</b> . The selected management approach needs to maintain the security of the nuclear materials and associated facilities. For example, over a very long timeframe, the hazardous materials involved ought to be secure from the threat of theft despite possibilities of terrorism or war.
<b>Environmental Integrity</b>	To ensure <b>environmental integrity</b> . The selected management approach needs to ensure that environmental integrity over the long term is maintained. Concerns include the possibility of localized or widespread damage to the ecosystem or alteration of environmental characteristics resulting from chronic or unexpected release of radioactive or non-radioactive contaminants. Concerns also include stresses and damage associated with new infrastructure (such as roads and facilities) and operations (e.g., transportation).
<b>Economic Viability</b>	To design and implement a management approach that ensures <b>economic viability of the waste management system while simultaneously contributing positively to the local economy</b> . Economic viability refers to the need to ensure that adequate economic resources are available to pay the costs of the selected approach, now and in the future. The cost must be reasonable. The selected approach ought to provide high confidence that funding shortfalls will not occur that would threaten the assured continuity of necessary operations.
<b>Adaptability</b>	To ensure a <b>capacity to adapt to changing knowledge and conditions over time</b> . The selected management approach should be able to be modified to fit new or unforeseen circumstances. The approach should provide flexibility to future generations to change decisions, and not place burdens or obligations on future generations that will constrain them. The approach should be able to function satisfactorily in the event of unforeseen "surprises".
	A more elaborated discussion of the many influences with an impact on each of the objectives is presented in Part 2 of <i>Understanding the Choices</i> .

**We invite all interested Canadians to participate in shaping our study and our recommendations.**

**Engaging Canadians.** With this discussion document, we now focus our discussion with Canadians on the many elements of the assessment of management options, as we seek to fully understand the choices.

We continue to seek advice from the public and experts. We will be undertaking activities to directly engage the public, residents of nuclear site communities, aboriginal peoples, and interested organizations and individuals in many regions across Canada. There are many topics we would like to discuss.

**Is the assessment framework comprehensive and balanced? Are there gaps, and if so, what do we need to add?**

- We want to know if the assessment framework drawn from the original ten questions and the dialogue which followed fully captures the key priorities and perspectives of Canadians.

**What are your thoughts on the strengths and weaknesses of each management approach: deep geological disposal; centralized storage; and reactor site storage?**

- We would like to discuss the relative strengths and limitations of each of the approaches which are the focus for the study. Does the preliminary assessment accurately describe all of the considerations?

**Are there specific elements that you feel must be built into an implementation plan? What are your thoughts on what a phased approach must include?**

- Beyond the relative strengths and limitations of the approaches, we welcome input on the elements of an implementation plan for any preferred approach. To date we have heard that irrespective of the management approach which is ultimately selected, it will need to be adaptable and will need to be implemented in a phased manner.

**NWMO invites all interested individuals and organizations to get involved.**

Make a submission, share your comments with other interested Canadians and make your voice heard at our website, [www.nwmo.ca](http://www.nwmo.ca).

You can review our public engagement plans, discussion documents, reports and research which are available on our website at [www.nwmo.ca](http://www.nwmo.ca).

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