



NUCLEAR WASTE SOCIÉTÉ DE GESTION  
MANAGEMENT DES DÉCHETS  
ORGANIZATION NUCLÉAIRES

June 22, 2011

Township of Creighton  
Box 100  
Creighton, SK  
SOP 0A0

Attn: Ms. Paula Muench, Town Administrator

**Re: Adaptive Phased Management Initial Screening – The Township of Creighton**

Dear Ms. Muench,

Further to the Township of Creighton's request to Learn More about the Adaptive Phased Management program and request for an initial screening, I am pleased to attach a report outlining the findings from the initial screening, as described in the *Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel* (May, 2010). As you know, the purpose of the initial screening in Step 2 of the process is to determine whether, based on readily-available information and five screening criteria, there are any obvious conditions that would exclude the Township of Creighton from further consideration in the site selection process.

As the report indicates, the review of readily-available information and the application of the five initial screening criteria did not identify any obvious conditions that would exclude the Township of Creighton from further consideration in the NWMO site selection process. The initial screening suggests that the Creighton area contains portions of lands that are potentially suitable for hosting a deep geological repository for Canada's used nuclear fuel. It is important to note that this initial screening has not confirmed the suitability of your community. Should your community choose to continue to explore its potential interest in the project, your area would be the subject of progressively more detailed assessments against both technical and social factors. Several years of studies would be required to confirm whether a site within your area could be demonstrated to safely contain and isolate used nuclear fuel.

The process for identifying an informed and willing host community for a deep geological repository for the long-term management of Canada's used nuclear fuel is designed to ensure, above all, that the site which is selected is safe and secure for people and the environment, now and in the future. The NWMO expects that the selection of a preferred site would take between seven to ten years. It is important that any community which decides to host this project base its decisions on an understanding of the best scientific and social research available and its own aspirations. Should the Township of Creighton continue to be interested in exploring the project, over this period there would be ongoing engagement of your community, surrounding communities and others who may be affected. By the end of this process, Creighton as a whole community would need to clearly demonstrate that it is willing to host the repository in order for this project to proceed.

The next evaluation step would be to conduct a feasibility study as described in Step 3 of the site selection process. This feasibility study would focus on areas selected in collaboration with the community. As your community considers whether it is interested in advancing to the feasibility study phase, the NWMO encourages you to continue community discussion and further learning about the project. Support programs are available to assist your community to reflect on its long-term vision and whether this project is consistent with achieving that vision. Programs and resources are also available to engage your community residents in learning more about this project and becoming involved. We would be very pleased to provide further information about these programs.

Once again, I thank you for taking the time to learn about Canada's plan for the safe, secure management of Canada's used nuclear fuel.

Sincerely,



Kathryn Shaver,  
Vice President, APM Public Engagement and Site Selection

c. Mayor Bruce Fidler



June 2011

# SUMMARY REPORT INITIAL SCREENING FOR SITING A DEEP GEOLOGICAL REPOSITORY FOR CANADA'S USED NUCLEAR FUEL

## Township of Creighton, Saskatchewan

**Submitted to:**

Nuclear Waste Management Organization  
22 St. Clair Avenue East, 6th Floor  
Toronto, Ontario  
M4T 2S3

REPORT



A world of  
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**Report Number:** 10-1152-0110 (6000B)

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## **EXECUTIVE SUMMARY**

On March 11, 2010, the Township of Creighton expressed interest in learning more about the Nuclear Waste Management Organization (NWMO) site selection process to find an informed and willing community to host a deep geological repository for Canada's used nuclear fuel (NWMO, 2010). This report summarizes the findings of an initial screening, conducted by Golder Associates Ltd., to evaluate the potential suitability of the Creighton area against five screening criteria using readily available information (Golder, 2011). The purpose of the initial screening is to identify whether there are any obvious conditions that would exclude the Township of Creighton from being further considered in the site selection process. The initial screening focused on the Township of Creighton and its periphery, which are referred to as the "Creighton area" in this report.

The review of readily available information and the application of the five initial screening criteria did not identify any obvious conditions that would exclude the Township of Creighton from further consideration in the NWMO site selection process. The initial screening indicates that the Creighton area contains portions of lands with geological formations that are potentially suitable for hosting a deep geological repository. Examples of these formations include the granitic Annabel Lake and Reynard Lake Plutons at the periphery of the Township. The metavolcanic rocks of the greenstone belt that dominate the geology of the Township have been found to be unsuitable due to their heterogeneity, spatial variability and potential for natural resources.

It is important to note that the intent of this initial screening is not to confirm the suitability of the Creighton area to host a deep geological repository, but rather to provide early feedback on whether there are known reasons to exclude it from further consideration. Should the community of Creighton remain interested in continuing with the site selection process, more detailed studies would be required to confirm and demonstrate whether the Creighton area contains sites that can safely contain and isolate used nuclear fuel. The process for identifying an informed and willing host community for a deep geological repository for Canada's used nuclear fuel is designed to ensure, above all, that the site which is selected is safe and secure for people and the environment, now and in the future.

The five initial screening criteria are defined in the site selection process document (NWMO, 2010) and relate to: having sufficient space to accommodate surface and underground facilities, being outside protected areas and heritage features, absence of known groundwater resources at repository depth, absence of known economically exploitable natural resources and avoiding known hydrogeologic and geologic conditions that would make an area or site unsuitable for hosting a deep geological repository.



## **1.0 INTRODUCTION**

In May 2010, the NWMO published and initiated a nine-step site selection process to find an informed and willing community to host a deep geological repository for Canada's used nuclear fuel (NWMO, 2010). The site selection process is designed to address a broad range of technical and social, economic and cultural factors as identified through dialogue with Canadians and Aboriginal peoples, and draws from experiences and lessons learned from past work and processes developed in Canada to site facilities for the management of other hazardous material. It also draws from similar projects in other countries pursuing the development of deep geological repositories for used nuclear fuel. The suitability of potential candidate sites will ultimately be assessed against a number of site evaluation factors, both technical and social in nature.

The site evaluation process includes three main phases over a period of several years, with each step designed to evaluate the site in progressively greater detail upon request of the community. These are: Initial Screenings (Step 2) to evaluate the potential suitability of the community against a list of initial screening criteria; Feasibility Studies (Step 3) to determine if candidate sites within the proposed areas may be potentially suitable for developing a safe used nuclear fuel repository; and Detailed Site Evaluations (Step 4), at one or more selected sites, to confirm suitability based on detailed site evaluation criteria. It is up to the communities to decide whether they wish to continue to participate in each step of the process.

## **2.0 OBJECTIVE OF THE INITIAL SCREENING**

The overall objective of the initial screening is to evaluate proposed geographic areas against a list of screening criteria, using readily available information. Initial screening criteria require that:

- 1) The site must have enough available land of sufficient size to accommodate the surface and underground facilities.
- 2) This available land must be outside of protected areas, heritage sites, provincial parks and national parks.
- 3) This available land must not contain known groundwater resources at the repository depth, so that the repository site is unlikely to be disturbed by future generations.
- 4) This available land must not contain economically exploitable natural resources as known today, so that the repository site is unlikely to be disturbed by future generations.
- 5) This available land must not be located in areas with known geological and hydrogeological characteristics that would prevent the site from being safe, considering the safety factors outlined in Section 6 of the Site Selection Document (NWMO, 2010).

For cases where readily available information is limited and where assessment of some of the criteria is not possible at the initial screening stage, the area would be advanced to the feasibility study stage for more detailed evaluation, if the community remains interested in participating in the siting process.

## **3.0 INITIAL SCREENING ASSESSMENT**

This section provides a summary evaluation of each of the five initial screening criteria for the Creighton area, based on readily available information. The intent of this evaluation is not to conduct a detailed analysis of all



available information or identify specific potentially suitable sites, but rather to identify any obvious conditions that would exclude the Township of Creighton from being further considered in the site selection process.

The Township of Creighton is approximately 18 km<sup>2</sup> in size and is located on the east-central edge of Saskatchewan adjacent to the Manitoba border, a few kilometres from Flin Flon, Manitoba. The nearest large center is the City of Prince Albert, about 400 km to the southwest.

### **Screening Criterion 1: The site must have enough available land of sufficient size to accommodate the surface and underground facilities.**

The review of readily available information shows that the Creighton area contains sufficient land to accommodate the repository surface facilities. Surface facilities will require a land parcel of about 1 km by 1 km (100 ha) in size, although some additional space may be required to satisfy regulatory requirements. The underground footprint of the repository is about 1.5 km by 2.5 km (375 ha) at a typical depth of about 500 m.

Review of available mapping and satellite imagery shows that the Township of Creighton contains limited constraints that would prevent the development of the repository's surface facilities. These constraints would mainly include the presence of natural features such as permanent water bodies in the area. Also, a small portion of the Township of Creighton is covered by residential and industrial infrastructure, with developments limited to roadways, the settlement area, and a tailings management facility for existing mining operations. The remainder of the Township of Creighton is largely forested with some wetlands and some areas of rock outcrop. There are areas at the periphery of the Township of Creighton that are also largely undeveloped, with limited natural or physical constraints such as topography or permanent water bodies. The review of available geological information suggests that the Creighton area contains geological formations with potentially sufficient volumes of rock at depth to accommodate the repository's underground facilities (see Screening Criterion 5).

### **Screening Criterion 2: Available land must be outside of protected areas, heritage sites, provincial parks and national parks.**

The review of readily available information shows that the Creighton area contains sufficient land outside of protected areas, heritage sites, provincial parks and national parks to accommodate the repository's facilities.

There are no known protected areas within the Creighton area with the exception of the Amisk Lake Recreational Site on the shores of Amisk Lake. It is located approximately 11 km to the southwest of the settlement area of Creighton and covers an area of less than 4 km<sup>2</sup>. Most of the land in the Creighton area is free of known heritage constraints. Known archaeological sites are small and generally concentrated around water courses and larger water bodies.

The absence of locally protected areas would need to be confirmed in discussion with the community and Aboriginal peoples in the area during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

### **Screening Criterion 3: Available land must not contain known groundwater resources at the repository depth, so that the repository site is unlikely to be disturbed by future generations.**

The review of available information did not identify any known groundwater resources at repository depth (typically 500 m) for the Creighton area. The Saskatchewan Watershed Authority (SWA) Water Well Record (WWR) database shows that all water wells known in the Creighton area are completed within overburden



sources at depths ranging from 6 to 62 m, with most wells between 20 to 30 m deep. A 3,066 m deep borehole drilled in 1965-66 into the Reynard Lake Pluton did not report encountering any groundwater flow at repository depth.

Experience in similar geological settings across the Canadian Shield suggests that the potential for deep groundwater resources at repository depths is low throughout the Creighton area. Active groundwater flow is generally confined to localized shallow fractured systems, in the upper 300 m. At greater depth, permeability tends to decrease as fractures become less common and interconnected. Groundwater at such depths is also generally saline. The absence of groundwater resources at repository depth would need to be confirmed during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

### **Screening Criterion 4: Available land must not contain economically exploitable natural resources as known today, so that the repository site is unlikely to be disturbed by future generations.**

Based on the review of available information, the Creighton area contains sufficient land, free of known economically exploitable natural resources, to accommodate the required repository's facilities.

The Creighton area has a generally low potential for oil and gas resources. While there has been historic production of base metals and gold in the Creighton area, there is currently only one known operating mine, the Callinan Mine, which is located near Flin Flon, Manitoba, and principally produces copper. All areas with metallic mineral potential within the Creighton area are associated with the metavolcanic rocks of the Flin Flon Greenstone Belt. The natural resource potential of the granitic plutons in the area is limited, except in localized areas along their margin with the greenstone belt.

Past exploration activities have identified the potential for non-metallic mineral resources, like building stone, asbestos and talc, within the Creighton area. However, the risk that these resources pose for future human intrusion at repository depth is negligible, as quarrying operations would be limited to very shallow depths. Commercial potential for peat exists in some low-lying areas but no peat extraction has occurred in the Creighton area.

### **Screening Criterion 5: Available land must not be located in areas with known geological and hydrogeological characteristics that would prevent the site from being safe, considering the safety factors outlined in Section 6 of the Site Selection Document.**

Based on the review of available geological and hydrogeological information, the Creighton area comprises portions of land that do not contain obvious known geological and hydrogeological conditions that would make the area unsuitable for hosting a deep geological repository.

The safety-related geoscientific factors outlined in Section 6 of the Site Selection Document (NWMO, 2010) relate to: safe containment and isolation of used nuclear fuel; long-term resilience to future geological processes and climate change; safe construction, operation and closure of the repository; isolation from future human activities; and amenability to site characterization and data interpretation activities. At this early stage of the site evaluation process, where limited data at repository depth exist, these factors are assessed using readily available information, with the objective of identifying any obvious unfavourable hydrogeological and geological conditions that would exclude the Township of Creighton from further consideration. They would be gradually assessed in more detail as the site evaluation process progresses and more site specific data is collected during





subsequent evaluation phases, provided the community remains interested in continuing in the site selection process.

### **Safe Containment and Isolation**

The geological and hydrogeological conditions of a suitable site should promote long-term containment and isolation of used nuclear fuel and retard the movement of any potentially released radioactive material. This requires that the repository be located at a sufficient depth, typically around 500 m, in a sufficient rock volume with characteristics that limit groundwater movement. The review of readily available information indicates that the Creighton area contains areas with no obvious geological and hydrogeological conditions that would fail the containment and isolation requirements.

The Township of Creighton is dominated by metavolcanic rocks of the Flin Flon Greenstone Belt which extends well beyond the Township boundaries. These rocks are heterogeneous and variable in type, and are arranged in layers of variable thickness and lithological compositions. Past tectonic events deformed these units, making their stratigraphic interpretation difficult. These events have also created numerous regional folds, faults and smaller scale shear zones within the metavolcanic rocks in the Creighton area. Although these metavolcanic rocks may have sufficient thickness and lateral extent, they are unlikely to be suitable for hosting a deep geologic repository for used nuclear fuel due to their heterogeneity and spatial variability.

Within the periphery of the Township of Creighton, the geology is dominated by several large granitic intrusions such as the Annabel Lake and Reynard Lake Plutons in the northwestern and western portions of the Creighton area. The thickness of these plutons has been estimated to be approximately 5.5 km. Faults have been mapped for the Annabel Lake and Reynard Lake Plutons, but are mostly concentrated near the contacts with the metavolcanic rocks of the Flin Flon Greenstone Belt. The two regional shear zones that were mapped for the Creighton area are also within the greenstone belt. The presence of smaller scale faulting in the granitic plutons, and the extent to which these faults and shears might extend to repository depth would need to be evaluated during subsequent site evaluation stages, provided the community remains interested in continuing in the site selection process.

Based on the geologic characteristics described above, and available experience from other similar granitic rocks in the Canadian Shield, the Reynard Lake and the Annabel Lake Plutons may be potentially suitable rocks for hosting a deep geological repository.

From a hydrogeologic point of view, the review of readily-available information did not reveal the existence of known deep fracture systems or deep aquifers in the Creighton area. The presence of active deep groundwater flow systems in crystalline formations is controlled by the frequency and interconnectivity of fractures at depth. Experience from other areas in the Canadian Shield, particularly for granitic intrusions (plutons and batholiths), indicates that active groundwater flow tends to be generally limited to shallow fractured systems, typically less than 300 m. In deeper rock, fractures are less common and less likely to be interconnected, leading to very slow groundwater movement.

### **Long-term Stability**

A suitable site for hosting a repository is a site that would remain stable over the very long-term in a manner that will ensure that the performance of the repository will not be substantially altered by future geological and climate change processes, such as earthquakes or glaciation. A full assessment of this geoscientific factor requires detailed site specific data that would be typically collected and analyzed through detailed field investigations.



At this early stage of the site evaluation process, the long-term stability factor is evaluated by assessing whether there is any evidence that would raise concerns about the long-term hydrogeological and geological stability of the Creighton area. The review did not reveal any obvious geological or hydrogeological conditions that would clearly not meet the long-term stability requirement for a potential repository within the Creighton area.

The Township of Creighton is located in the Reindeer Zone of the Canadian Shield, where large portions of land have remained tectonically stable for the last 1.6 billion years. There is also no evidence to suggest that the faults and shear zones identified in the Creighton area have been tectonically active within the past 1.6 billion years. The geology of the Creighton area is typical of many areas of the Canadian Shield, which has been subjected to numerous glacial cycles during the last million years. Glaciation is a significant past perturbation that could occur in the future. However, findings from studies conducted in other areas of the Canadian Shield suggest that deep crystalline formations, particularly the plutonic intrusions, have remained largely unaffected by past perturbations such as glaciation.

### Potential for Human Intrusion

The site should not be located in areas where the containment and isolation functions of the repository are likely to be disrupted by future human activities such as exploration or mining. This factor has already been addressed in previous sections, which concluded that the potential for deep groundwater resources at repository depths and known economically exploitable natural resources is low throughout the granitic plutons in the Creighton area.

### Amenability to Construction and Site Characterization

The characteristics of a suitable site should be favourable for the safe construction, operation, closure and long-term performance of the repository. This requires that the strength of the host rock and in-situ stress at repository depth are such that the repository could be safely excavated, operated and closed without unacceptable rock instabilities; and that the soil cover depth over the host rock should not adversely impact repository construction and site investigation activities. Similarly, the host rock geometry and structure should be predictable and amenable to site characterization and interpretation activities.

From a constructability perspective, limited site specific information is available on the local rock strength characteristics and in-situ stresses for the Creighton area. However, available information from geologically similar settings suggests that crystalline rock formations within the Canadian Shield, particularly within plutonic intrusions, generally possess geomechanical characteristics that are good to very good and amenable to the type of excavation activities involved in the development of a deep geological repository for used nuclear fuel.

In terms of predictability of the geological formations and amenability to site characterization activities, the review of the bedrock and Quaternary geology for the Creighton area did not indicate any obvious conditions which would make the granitic plutons difficult to characterize, although such conditions may exist in localized areas. The degree to which factors such as geologic variability and overburden thickness might affect the characterization and data interpretation activities would require further assessment during subsequent site evaluation phases, if the community remains interested in continuing in the site selection process.



## **4.0 INITIAL SCREENING FINDINGS**

This report presents the results of an initial screening to assess the potential suitability of the Creighton area against five initial screening criteria using readily-available information. The initial screening focused on the Township of Creighton and its periphery, which are referred to as the “Creighton area”. As outlined in NWMO’s site selection process (NWMO, 2010), the five initial screening criteria relate to: having sufficient space to accommodate surface facilities, being outside protected areas and heritage sites, absence of known groundwater resources at repository depth, absence of known economically exploitable natural resources and avoiding known hydrogeologic and geologic conditions that would make an area or site unsuitable for hosting a deep geological repository.

The review of readily available information and the application of the five initial screening criteria did not identify any obvious conditions that would exclude the Township of Creighton from further consideration in the NWMO site selection process. The initial screening indicates that the Creighton area contains portions of lands with geological formations that are potentially suitable for hosting a deep geological repository. Examples of these formations include the granitic Annabel Lake and Reynard Lake Plutons at the periphery of the Township. The metavolcanic rocks of the greenstone belt that dominate the geology of the Township are unsuitable due to their heterogeneity, spatial variability and potential for natural resources.

It is important to note that at this early stage of the site evaluation process the intent of the initial screening was not to confirm the suitability of the Creighton area, but rather to identify whether there are any obvious conditions that would exclude it from further consideration in the site selection process. Should the community of Creighton remain interested in continuing with the site selection process, several years of progressively more detailed studies would be required to confirm and demonstrate whether the Creighton area contains sites that can safely contain and isolate used nuclear fuel.

The process for identifying an informed and willing host community for a deep geological repository for Canada’s used nuclear fuel is designed to ensure, above all, that the site which is selected is safe and secure for people and the environment, now and in the future.

## **5.0 REFERENCES**

- Golder Associates Ltd., 2011. Initial Screening for Siting a Deep Geologic Repository for Canada's Used Nuclear Fuel – Township of Creighton, Saskatchewan. Golder Report Number 10-1152-0110 (6000).
- NWMO, 2010. Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel, Nuclear Waste Management Organization. (Available at [www.nwmo.ca](http://www.nwmo.ca))



## **6.0 REPORT SIGNATURE PAGE**

**GOLDER ASSOCIATES LTD.**

Erin A. Moss P.Eng.  
Geological Engineer

George Schneider, M.Sc., P.Geo.  
Principal

EAM/GWS/wlm

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