OPG's DEEP GEOLOGIC

REPOSITORY

FOR LOW & INTERMEDIATE LEVEL WASTE

Preliminary Decommissioning Plan

March 2011

Prepared by: Nuclear Waste Management Organization
and Candesco

NWMO DGR-TR-2011-39

NUCLEAR WASTE MANAGEMENT ORGANIZATION SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

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EXECUTIVE SUMMARY

This Preliminary Decommissioning Plan (PDP) describes the plan for the decommissioning of the Deep Geologic Repository (DGR) Facility. It has been prepared in support of an application for a licence from the Canadian Nuclear Safety Commission (CNSC) to prepare the site and construct the facility. The PDP describes planning work that has been completed in order to comply with the Canadian Standards Association (CSA) Standard N294-09 and CNSC Regulatory Guide G-219. This plan describes the intended approach based on current information that would be taken to decommission all structures, systems and components (SSCs) found within the DGR site. This document is not intended to provide a detailed plan for the eventual decommissioning of the DGR Facility, but to demonstrate that decommissioning can be completed, with existing technology in a manner that ensures the protection and safety of workers, members of the general public and the environment as well as the long-term security of the Low and Intermediate Level Waste (L&ILW). It also provides a basis for the estimated cost of the decommissioning. These objectives would also be achieved if the decision was made to decommission the facility prior to use for its intended purpose of L&ILW emplacement, with the only difference being the absence of radiological hazards, thus simplifying the decommissioning procedure.

It is expected that decommissioning will begin following a period of monitoring and surveys after all of the wastes have been emplaced. The transition to decommissioning will be focused on maintaining safety and security at the facility. The subsequent decommissioning work will ensure that the waste (L&ILW), with the exception of the waste rock pile, is permanently secured in the repository and the site is restored, including re-vegetation of the site. Throughout the decommissioning activities, surveys will be performed to keep the working environment safe from radioactive and hazardous materials. Ontario Power Generation (OPG) will retain sole responsibility for the security of the DGR site during decommissioning. Upon completion of the decommissioning work, final surveys will be performed to verify that the decommissioning has resulted in a physically, radiologically, chemically, biologically and environmentally safe site. Hence, it is expected that after decommissioning any accessible areas on the DGR site will be free of radioactivity, hazardous chemicals, and biological hazards and that any environmental contamination will have been remediated. An end state report will be prepared to summarize the decommissioning work and its final outcomes. It is assumed that a period of institutional controls, expected to last up to 300 years, will follow the decommissioning. OPG will retain responsibility for the site until a Licence to Abandon has been obtained.

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1. INTRODUCTION

This Preliminary Decommissioning Plan (PDP) describes the plan for the decommissioning of the Deep Geologic Repository (DGR) Facility. It has been prepared to meet the Class I Nuclear Facilities Regulations, clause 3(*k*) and supports the application for a licence from the Canadian Nuclear Safety Commission (CNSC) to prepare the site and construct the facility. This document is not intended to provide a detailed plan for the eventual decommissioning of the DGR Facility, but to demonstrate that decommissioning can be completed, with existing technology in a manner that ensures the protection and safety of workers, members of the general public and the environment as well as the security of the Low and Intermediate Level Waste (L&ILW). It also provides a basis for the estimated cost of the decommissioning.

This plan includes or references the following:

- A description of the site and the structures, systems and components (SSCs) to be decommissioned;
- A description of the decommissioning scope, objective, end state and strategy;
- A description of the activities performed during the decommissioning;
- A schedule for decommissioning activities;
- An estimate of the decommissioning cost;
- A discussion of the human factors considerations involved in the decommissioning;
- An estimated inventory of the hazardous and radioactive wastes that will be generated during decommissioning;
- An assessment of the potential environmental impacts of decommissioning;
- An assessment of the radiological, chemical and industrial safety hazards involved in the decommissioning;
- A brief discussion of administrative aspects of the decommissioning such as quality assurance, documentation and records; and
- A commitment to periodically review and, if necessary update this PDP.

The PDP complies with the Canadian Standards Association (CSA) Standard N294-09 (CSA 2009) and CNSC Regulatory Guide G-219 (CNSC 2000). Appendix A contains a mapping of how the content of the PDP aligns with the clauses set out in these two documents. Appendix B describes the decommissioning of the DGR Facility if it has to be decommissioned following construction and prior to waste emplacements. This is to fulfill the requirements of the General Nuclear Safety and Control Regulations, clause 3(1)(*l*), in support of a financial guarantee to be provided for the activity to be licensed.

1.1 Planning Assumptions

Planning for decommissioning is an ongoing process and planning assumptions are expected to change with evolving technologies, international and operational experience, regulations, and cost estimates. This PDP describes the preliminary plan as it exists at the time of writing. This document will be reviewed and revised periodically in order to incorporate any changes in the planning assumptions.

A Detailed Decommissioning Plan (DDP) will be prepared prior to the commencement of any decommissioning activities. Appropriate methods and technologies available at that time will be reviewed, adopted and described in the detailed plan.

The Bruce nuclear site contains a number of other licensed nuclear facilities such as the Western Waste Management Facility (WWMF) and the nuclear generating stations, in the immediate vicinity of the DGR Facility location. Although the DGR Facility is located within the existing Bruce nuclear site boundary, the planning envelope for other facilities is different. Decommissioning of the other licensed nuclear facilities is outside the scope of this plan.

Planning for decommissioning of the DGR Facility is based on the following fundamental assumptions:

- Decommissioning will start following the end of waste emplacement operations and a period of monitoring and surveys;
- Underground facilities will be sealed from entry and waste emplaced in the DGR will remain in the facility emplacement rooms in perpetuity;
- The ventilation shaft infrastructure will be dismantled and the shaft will be sealed;
- The main shaft infrastructure will be dismantled and the shaft will be sealed;
- Surface infrastructure and buildings will be dismantled and removed;
- Ontario Power Generation (OPG) will retain ownership of the DGR Facility site area during all stages of and following decommissioning; and
- A period of institutional controls, assumed to last up to 300 years, will follow the decommissioning work.

2. SITE LOCATION AND CHARACTERISTICS

The DGR is the long-term management solution for the operational and refurbishment L&ILW currently stored at the WWMF, as well as the L&ILW produced as a result of continued operation of OPG-owned or operated nuclear reactors. The DGR Facility will be built adjacent to the area currently occupied by the WWMF, within the Bruce nuclear site and approximately 1 km inland from Lake Huron. The location of the proposed DGR Project is in the Municipality of Kincardine about mid-way between Kincardine and Port Elgin, at a longitude of 81°30‘ west and a latitude of 44°20‘ north, on the eastern shore of Lake Huron (see Figure 2.1).

The facility will consist of surface infrastructure, a main shaft, a ventilation shaft and underground emplacement rooms and infrastructure. The surface infrastructure is designed for the receipt of waste packages and their transfer to the underground repository via the main shaft.

OPG plans to start transferring L&ILW stored at the WWMF for long-term management at the DGR Facility in 2018.

2.1 Deep Geologic Repository Site

The DGR site is adjacent to the existing WWMF as shown in Figure 2.2 and it is within the secured Bruce nuclear site, which provides security control on access to the facility at all times. This site was selected for the DGR Project based on studies which confirmed that the site has characteristics which make it suitable for the long-term management of L&ILW (OPG 2011a).

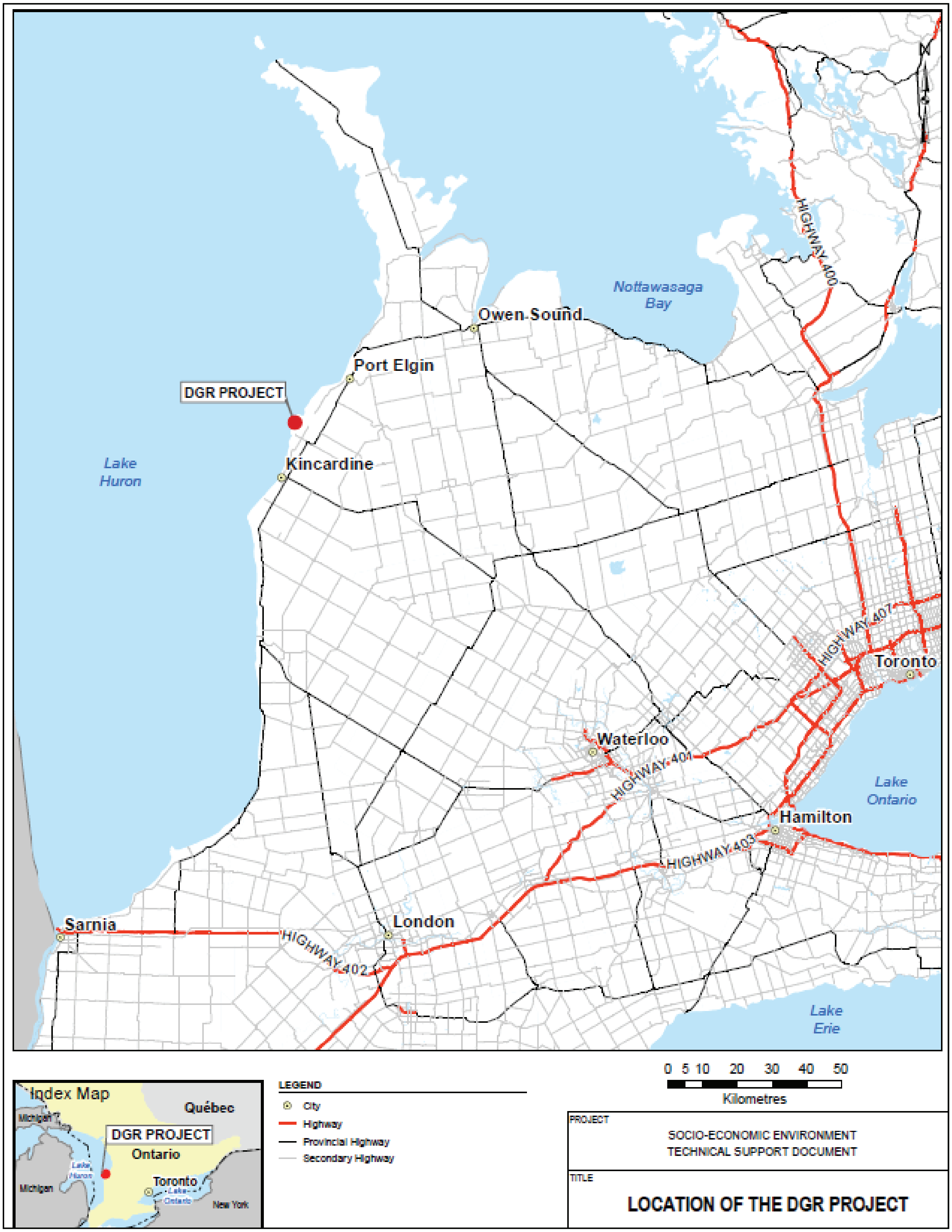
The geology at the site is favourable for a L&ILW deep geologic repository. The bedrock formations at repository depth are about 450 million years old and they have remained intact through mountain building events at their margins, deep sedimentary burial, uplift and erosion, earthquakes and multiple glaciations. Water quality in the shallow aquifers will be protected by a 200 m thick shale cap rock located directly above the DGR horizon. This layer hydrogeologically isolates the shallow water supply aquifer and protects it from the deep saline groundwater system. The deep groundwater is highly saline and therefore has no potential as a source of potable water. The area is seismically stable and is located in one of the lowest seismic potential zones in Canada.

2.2 Environment

2.2.1 Geophysical Environment

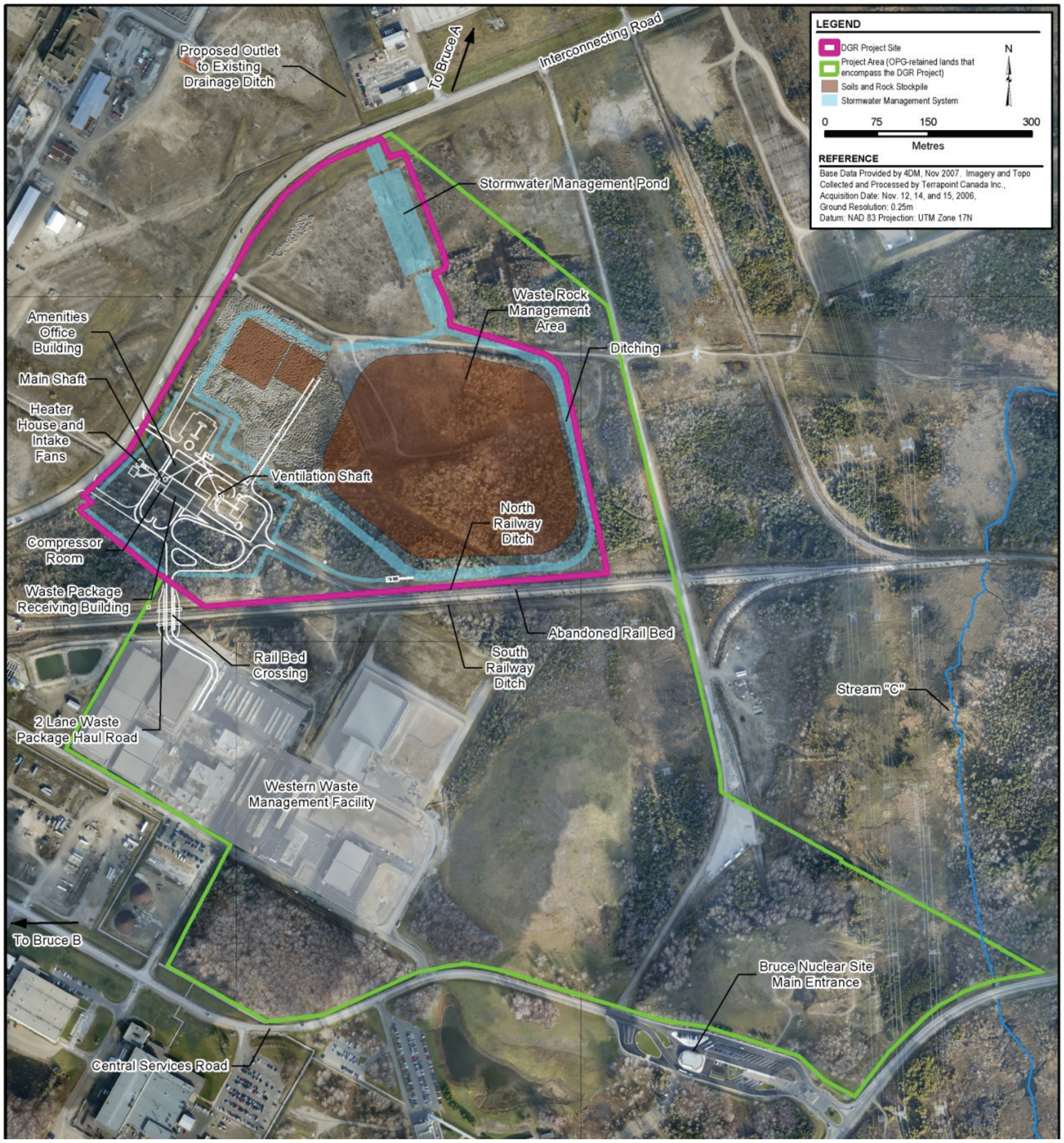
2.2.1.1 Geology

The Bruce nuclear site is located in southern Ontario along the south-eastern rim of the North American Craton. Within the central part of this area, a southwest-northeast trending elongated feature known as the Algonquin Arch forms a crystalline basement and separates two major sedimentary basins. To the southeast of the Arch is the Appalachian Basin or Allegheny Trough and to the northwest, the Michigan Basin where the DGR site will be located (OPG 2011a).



Note: Figure is from AECOM (2011).

Figure 2.1: Location of the Proposed DGR Project

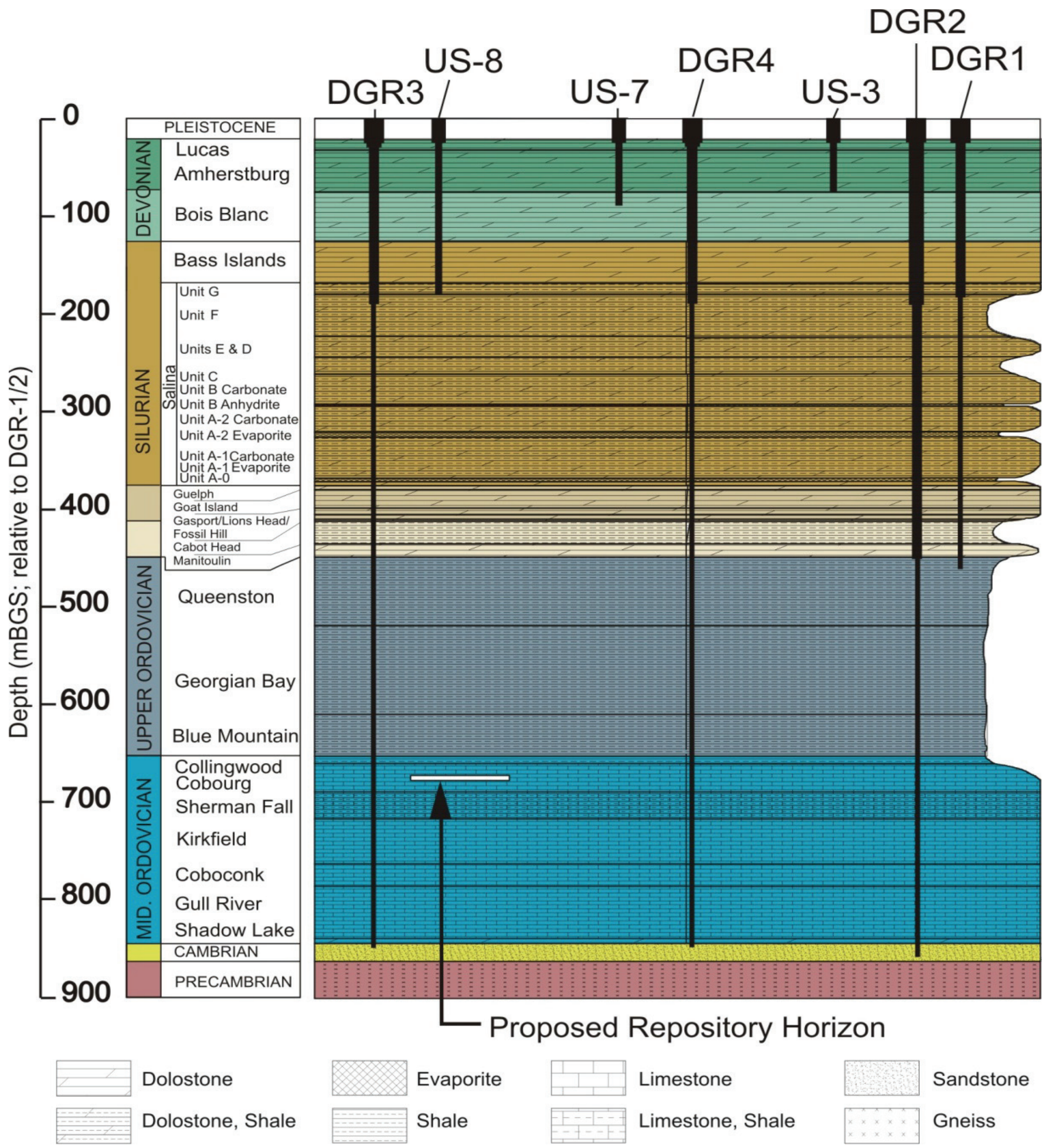


Note: Figure is from OPG (2011b).

Figure 2.2: DGR Facility Project Site

Drilling, logging, and testing of boreholes at the Bruce nuclear site led to the identification of 34 distinct Paleozoic bedrock formations, members, or units of approximately 840 m cumulative thickness beneath a thin veneer (7 to 20 m) of Pleistocene overburden and unconformably overlying Precambrian granitic gneiss. A characterization of the stratigraphic sequence is provided in Figure 2.3.

The reference Paleozoic sequence, comprises 104.0 m of Devonian dolostone, 323.7 m of Silurian dolostone, argillaceous dolostone, shale and evaporite, 211.8 m of Upper Ordovician shale, 179.1 m of Middle Ordovician argillaceous limestone, 5.2 m of Ordovician siltstone and sandstone, and 16.9 m of Cambrian sandstone. The DGR underground facilities will be located within the upper portion of the Middle Ordovician argillaceous limestone package in the Cobourg Formation (Figure 2.3).



Note: Figure is from OPG (2011a).

Figure 2.3: Site Stratigraphy

The following is a brief summary of the rock units encountered at the DGR site.

The Pleistocene overburden typically comprises 1 to 3 m of surficial fill and sand and gravel unit interpreted as former beach deposits overlying 5 to 21 m Elma-Catfish Creek till, a clayey silt to sandy silt glacial deposit.

The Devonian dolostone interval includes the highly permeable rocks of the Lucas, Amherstburg, and Bois Blanc Formations. The Lucas Formation has stromatolitic laminations and abundant calcite-filled fractures. The Amherstburg Formation is extensively fractured. The Bois Blanc Formation is a dolostone with wavy argillaceous laminae throughout. A major erosional unconformity occurs at the base of the Devonian interval.

The Silurian interval includes the Bass Islands Formation, the Salina Group of 12 Units, and the underlying Guelph, Goat Island, Gasport, Lions Head, Fossil Hill, Cabot Head, and Manitoulin Formations.

The Ordovician rocks encountered are sparsely fractured and generally of very low permeability and porosity. The Upper Ordovician interval includes the shale-dominated Queenston, Georgian Bay, and Blue Mountain Formations. Through the middle of the Queenston Formation is an interval rich in green shale with medium- to coarse-grained, grey fossiliferous, limestone interbeds.

The Middle Ordovician interval includes sparsely fractured low permeability and low porosity argillaceous limestones of the Trenton and underlying Black River groups. The Trenton Group includes the Cobourg (and upper Collingwood Member), Sherman Fall, and Kirkfield Formations. Only one tight fracture, with seeping oil hydrocarbon, was observed in all DGR cores from the Cobourg Formation. The Black River Group, in comparison to the Trenton Group, has a lower argillaceous content overall and has a prevalent petroliferous odour with minor oil hydrocarbon seeps throughout. It comprises the Coboconk, Gull River, and Shadow Lake Formations. The base of the Shadow Lake Formation marks an unconformity with the underlying Cambrian.

The Cambrian is a fine- to medium-grained, silty sandstone and sandy dolostone with clasts of the underlying granitic basement, abundant calcite infilled veins, and glauconite stringers. Its base is a quartzose sandstone and its upper portion is up to 100% dolomitized. Only a very small portion of the underlying Precambrian basement was intersected during drilling. It is described as a pink to grey, fine- to medium-grained, felsic granitic gneiss with extensive alteration along its upper contact and has a well-defined tectonic foliation marking an erosional unconformity with the Cambrian.

2.2.1.2 Hydrogeology

Hydraulic conductivity of the deposits and bedrock below the Bruce nuclear site extend over several orders of magnitude. The highest permeabilities occur in shallow bedrocks and surficial deposits that are close to the surface. As described in Chapter 4 of the DGR Preliminary Safety Report (OPG 2011a), permeability decreases with increasing depth below ground surface level.

2.2.1.3 Seismicity

The Bruce nuclear site lies within the tectonically stable interior of the North American continent, which is characterized by low rates of seismicity. Historical records since the late 1800s and the monitoring results from the seismograph stations around the Bruce nuclear site are discussed in Chapter 4 of the DGR Preliminary Safety Report (OPG 2011a). Most recorded events have a magnitude of less than M3 with rare occurrences of larger events within a 150 km radius from the Bruce nuclear site. Twenty-six events have been detected in this region since 1952 with a maximum magnitude of 4.2 measured 15 km north of Meaford near Owen Sound. The historical record is considered to be relatively complete for events of about M > 3.5. It has become more complete for lower magnitude events over the last 10 years owing to the increased station density in the region. An objective of this new array is to capture microseismic events in the immediate area for the delineation of seismogenic features deep in the bedrock. The data collected since installation suggests that, in general, the regional study area experiences sparse seismic activity and there are no major seismogenic features or active faults of concern.

2.2.2 Topography

The topography of the Bruce nuclear site is classified as smooth to gently undulating, and the relief varies between elevations of 176 m along the shoreline (Lake Huron level) to 195 m along the shoreline within areas above the Nipissing Bluff.

Lake Huron is the only major water body near the Bruce nuclear site. The site itself is located on Douglas Point which extends about 2 km into the lake. Douglas Point is bounded by Baie du Doré to the north and Inverhuron Bay to the south. There are two other small bays located along the shoreline of Douglas Point; Macpherson Bay is located on the northern side of the point between Bruce Nuclear Generating Station A and the former heavy water plant while Holmes Bay is located along the Inverhuron Provincial Park shoreline on the southern side of the point.

There are no major rivers near the Bruce nuclear site but there is an extensive network of small rivers and creeks feeding into Lake Huron. There are two small east-to-west drainage courses entering the lake adjacent to the Bruce nuclear site. Underwood Creek empties into the Baie du Doré to the north, while the Little Sauble River, which forms the southern boundary of Inverhuron Provincial Park, empties into Inverhuron Bay to the south.

The Douglas Point headland is a natural geographic transition point along the whole eastern Lake Huron shoreline. The shoreline configuration changes at Douglas Point from smooth shoreline (to the south) to rough shoreline (to the north). There are no major embayments along the whole eastern shoreline of Lake Huron to the south of Douglas Point. Baie du Doré is the first protected embayment, the next one being 40 km north (Chief's Point Bay) at the base of the Bruce Peninsula. The Baie du Doré wetland immediately adjacent to Bruce nuclear site is a provincially significant wetland, which supports both provincially rare and endangered species, along with fish spawning and rearing habitat (OPG 2011a).

2.2.3 Existing Land Use Adjacent to the Bruce Nuclear Site

Municipality of Kincardine zoning bylaws identify the Bruce nuclear site as "General Industrial" and permit a variety of land uses related to electrical and heat energy production, transmission, and distribution. Land use adjacent to the Bruce nuclear site is consistent with rural development within the township, consisting of agricultural, recreational and rural residential use. OPG owns a considerable amount of land adjacent to the Bruce nuclear site and outside of the Bruce nuclear site boundary, creating a non-residential buffer consisting mainly of unoccupied bush and/or swamp and, to the south, the Inverhuron Provincial Park. Inverhuron Provincial Park had been restricted to day-use park for more than 30 years but, in 2005, the park resumed operation as an overnight camping park. The Bruce ECO-Industrial Park is a 485 ha serviced industrial park located to the southeast of the Bruce nuclear site. The majority of the land in the Bruce ECO-Industrial Park is designated as either Industrial, or Natural Environment. A small portion of the land is designated as Open Space.

Within a 50 km radius of the Bruce nuclear site, there are approximately 250 000 ha of arable farmland in Bruce County. More than 60 percent of the County's land area is dedicated to the agricultural industry. Structures in the vicinity of the Bruce nuclear site include seasonal and permanent year-round dwellings, and agricultural buildings (OPG 2011a).

2.2.4 Terrestrial Environment

2.2.4.1 Vegetation

The Bruce nuclear site is located within the Huron-Ontario section of the Great Lakes – St. Lawrence Forest Region (OPG 2011a). This physiographic region is generally characterized by sugar maple and beech climax forests, often in association with green ash, white ash, yellow birch, wild black cherry, American basswood, and red, white and bur oaks. Eastern hemlock, eastern white pine, and balsam fir are frequently located in drier or upland areas, while eastern white cedar is frequently recorded along swampy depressions. Vegetation resources beyond the Bruce nuclear site but within the general area include agricultural, scrub, old field successions, open woodlots, wetlands, maple/beech/ash woodland and cedar woodland. Mature forests are a scarce resource near the Bruce nuclear site due to extensive farming.

An Ecological Land Classification (ELC), using the ELC system for southern Ontario, identified the following broad categories of vegetation found within Bruce nuclear site: alvar, beach, cultural barren, cultural grassland, cultural meadow, cultural thicket, forest, industrial barren, industrial lands, marsh, swamp and open water. The ELC mapping for the site was initially carried out in 2001 and was updated in 2007. For the OPG retained lands that encompass the DGR site and that are not under industrial use, just over 20 ha (43%) are occupied by cultural plant community types and just under 28 ha (57%) support naturally-occurring plant community types. Approximately 24 ha (84%) of the naturally-occurring vegetation is forest. Small marsh and swamp areas are also present (OPG 2011a).

2.2.4.2 Fauna

Wildlife habitats at the Bruce nuclear site are limited by their small size, high degree of fragmentation and disturbed nature. These areas are capable of supporting wildlife that are not dependent on forest interior; however, they are part of habitat areas used by species with larger territorial ranges. Networks of small naturalized ditches that are intermittently wet provide corridors for wildlife movement.

Field studies undertaken at 13 locations on the Bruce nuclear site in spring 2007 and 2009 reinforced historical findings. Spring peeper, northern leopard frog, chorus frog, gray treefrog, American toad, and green frog were identified as actively breeding within the Bruce nuclear site. Spring peeper and chorus frog were identified as actively breeding within the lands that encompass the DGR. A new species for the Bruce nuclear site, western chorus frog, was added to the species list in 2009. Breeding activity was found to be most common in wetland areas within the Bruce nuclear site with the greatest amount of surface water.

Basking turtle surveys, based on reconnaissance of areas of open water and wetlands within the Bruce nuclear site, were completed in 2009. Thirty individuals were recorded over the course of the field season: 29 midland paint turtles and one common snapping turtle. The surveys indicated the preferred basking turtle habitat on the Bruce nuclear site occurs in the pond located near the landfill in the southeastern corner of the site. Few basking turtles were recorded using the OPG-retained lands that encompass the DGR.

Incidental observations of mammals within the Bruce nuclear site as part of field studies undertaken in 2007 included beaver, eastern cottontail rabbit, coyote, grey squirrel, snowshoe hare, striped skunk, weasel and white-tailed deer. Most mammals were observed in the wooded area at the southwest corner of the Bruce nuclear site, adjoining Inverhuron Provincial Park. Incidental observations within the OPG-retained lands that encompass the DGR included several occurrences of white-tailed deer in the wooded areas north of the railway ditches and southwest of the WWMF toward Tie Road, and two striped skunks south of the WWMF. In recent years (e.g., 2006, 2009), transient individual American black bears have been observed on the Bruce nuclear site.

A breeding bird survey carried out in 2007 observed 37 birds, representing 21 different species exhibiting breeding behaviour, in the OPG-retained lands that encompass the DGR. American redstart was the most commonly observed bird species within this area, followed by eastern wood-pewee and red-eyed vireo. The breeding bird survey was updated in 2009. Species at risk identified during the surveys were limited to two black-crowned night herons observed flying over the site in 2009 and a common nighthawk observed in Inverhuron Provincial Park.

A wild turkey habitat use and suitability survey conducted in February 2007 revealed that at least two distinct flocks of 20 to 30 birds occur on the Bruce nuclear site. Turkey roosting on the site is habitat-specific, with a preference for a combination of open field areas edged by a mix of larger deciduous and coniferous tree stands. No roosts were identified within the lands that encompass the DGR.

Aquatic habitat reconnaissance and fish identification was conducted in 2007 and 2009. Stream C, designated by the Fisheries and Oceans Canada as a cold water fish habitat, has a fish community composed of a diverse assemblage of cold water and warm water species including rainbow trout, brown trout, smallmouth bass, and various sucker and cyprinid species. Fish community investigations conducted in the south railway ditch in June 2000 indicate that the ditch supports a warm water fish community including bluntnose minnow, fathead minnow, northern redbelly dace, central mudminnow, brassy minnow and brook stickleback. All of the fish sampled are hardy species that thrive in slow flowing, boggy conditions with extensive aquatic vegetation growth. These species are common and widespread throughout central and southern Ontario (OPG 2011a).

2.2.5 Aquatic Environment

The Bruce nuclear site is located on the eastern shore of Lake Huron. To the west and northwest, Lake Huron stretches uninterrupted for approximately 130 km. The southern end of the lake is near Sarnia, Ontario. Port Hope, Michigan, United States (US), 98 km southwest of the Bruce nuclear site, is the nearest land across the lake.

Lake Huron is nearly 230 m deep but approximately 40 percent of lake is less than or equal to 40 m deep; these shallow areas include Georgian Bay, the North Channel north of Manitoulin Island, Saginaw Bay in the south-west and a narrow band along the entire perimeter of the lake. The deepest waters are found in the Manitoulin Basin, south-west of Manitoulin Island, and in the Southampton Basin which reaches a depth of nearly 200 m about 35 km north-west of the Bruce nuclear site. The Goderich Basin to the east and southeast of the Bruce nuclear site reaches depths of about 100 m. The Goderich Basin is separated from the deeper Southampton Basin by the Alpena-Amberley Ridge which runs from near Alpena, Michigan at its north-western end to near Amberley, Ontario (about 25 km south of the Bruce nuclear site) at its south-eastern end. The lake bottom off the Bruce nuclear site descends steeply toward the depths of the Southampton Basin northwest of the site and it reaches a depth of 100 m about 6 km off shore (NOAA 2010).

Nearshore currents in Lake Huron have been measured during the ice-free period since the early 1970s. Current direction in the region is predominantly parallel to the shoreline with a northeastern direction being the most common. Currents to the southwest also occur but on a less frequent basis.

Lake Huron is used locally for sport and commercial fishing, as well as recreational swimming and boating. The modestly warmer waters from the once-through cooling water discharges from the Bruce Nuclear Generating Stations A and B provide year round sport fishing opportunities. The Baie du Doré wetland adjacent to the Bruce nuclear site provides habitat suitable for warm-water and cool-water fish spawning and rearing.

2.2.6 Human Environment

The DGR site is located in the Municipality of Kincardine in the southern portion of the County of Bruce. In 1999, as a result of municipal restructuring, Tiverton, Bruce Township, Kincardine and Kincardine Township were amalgamated to become the Municipality of Kincardine. In addition, as of January 1, 1999, Port Elgin, Saugeen Township and Southampton were amalgamated to become the Town of Saugeen Shores. Population decreased slightly from 1996 to 2001; however, the population recovery from 2001 to 2006 has resulted in a 1.6% increase (OPG 2011a). According to the most recent Census (2006), the Municipality of Kincardine population is 11,173 people, and the population base of Saugeen Shores is 11,720 people.

2.2.7 Aboriginal Communities

The traditional territory of the Ojibway in the Saugeen region covers the watersheds bounded by the Maitland River to the south and the Nottawasaga River east of Collingwood on Georgian Bay. The area includes the Bruce Peninsula, all of Grey and Bruce Counties, and parts of Huron, Dufferin, Wellington and Simcoe Counties. The Bruce nuclear site is located within this traditional territory.

Saugeen Ojibway Nation (SON) is the collective name for two First Nations with reserve lands in the area. They share the same Aboriginal and treaty rights, including the right to commercially fish in the waters surrounding the Bruce Peninsula. The Chippewas of Saugeen First Nations Reserve No. 29 is located adjacent to the town of Southampton, about 30 km north of the Bruce nuclear site. Based on the 2006 Census, the estimated population living on-reserve is 760. The Department of Indian and Northern Affairs estimated that an additional 836 members live off-reserve, many within the traditional territory in Bruce County.

The Community of Chippewas of Nawash Unceded First Nation is located at the Cape Croker Reserve No. 27 on the east shore of the Bruce Peninsula, north of the Town of Wiarton. The population on this reserve was estimated to be 591 in the 2006 census with an additional 1338 members living off-reserve, many within the traditional territory in Bruce County.

The Métis people who most likely have an interest in the DGR project are those that have traditionally lived alongside the SON, hunting, fishing, harvesting and trading. Specific community activities were affiliated with the Hudson’s Bay Company post at the mouth of the Saugeen River, the Owen Sound area, and the historic Bruce Peninsula portage route that facilitated travel between the main basin of Lake Huron and Georgian Bay. These Métis people may be represented by either a local Métis Nation of Ontario (MNO) council or by the Historic

Saugeen Métis, which is not affiliated with the MNO. According to the 2006 Census information from Statistics Canada, 360 Métis persons reside in Bruce County and 825 reside in Grey County. The Métis people participate fully in the community, and are integrated into the regional population.

The First Nations and the Métis make significant use of Lake Huron for traditional and commercial harvesting of fish. The First Nations' economies also rely on tourism, agriculture, construction, cottage rental and native craft manufacture and sale. Both First Nations have developed a wide range of community services. They obtain water from on–reserve wells, from the lake or from nearby communities. Their ongoing use of their traditional lands and waters includes personal and communal commercial harvesting of traditional foods and medicines.

The OPG-retained lands on the Bruce nuclear site have been assessed several times for the potential to contain Aboriginal heritage resources. Two archaeological sites are recorded in the Ontario Ministry of Culture's Ontario Archaeological Sites Database within the Bruce nuclear site boundary. Both sites are along the Nipissing Great Lakes strandline-sand dune complex. Neither site is located in the OPG-retained lands that would encompass the DGR Facility.

2.2.8 Community Relationships

The Bruce nuclear site is one of the largest centres for energy production in the world. The local employment has increased since the restart of Bruce A Units 3 and 4 and the refurbishment of the remaining two Units 1 and 2. The Bruce nuclear site is Bruce County's single largest employer. The Bruce Power workforce is made up of about 4000 personnel. Approximately 150 OPG employees work at the WWMF site. Approximately 90 percent of the workers employed at the Bruce nuclear site live in the South Bruce Country area, and about 75% of those workers live in either the Town of Saugeen Shores, or the Municipality of Kincardine.

Operations taking place at the Bruce nuclear site remain the major economic influence in the area. However, the economy of Bruce County is diverse, and includes agriculture, tourism, recreation, services, small manufacturing, and some resource extraction. A consortium of private companies together with OPG and the Ontario Energy Corporation has developed an industrial and agricultural park, known as the Bruce ECO-Industrial Park, just outside of the Bruce nuclear site. About 100 people are employed in a number of small industries at the Bruce ECO-Industrial Park.

3. DESCRIPTION OF THE FACILITY

The primary components and systems of the DGR Facility as well as the design features, among other things, that are relevant to the decommissioning are highlighted below. The DGR design is described in detail in Chapter 6 of the Preliminary Safety Report (OPG 2011a).

The DGR Facility consists of surface infrastructure, shared services and underground structures and excavations. The key features of the DGR surface infrastructure include:

- Main shaft area;
- Ventilation shaft area;
- Waste Rock Management Area (WRMA); and
- A road connection to WWMF.

The key features of the underground infrastructure include:

- Main shaft;
- Ventilation shaft;
- A services area with refuge stations, lunchroom, administrative and maintenance rooms;
- A ramp to access the two shaft bottoms from the DGR level; and
- Two panels of emplacement rooms, which will be arranged parallel to each other, and tunnels to access them.

The following sections provide a more detailed description of the shafts, structures and main features of the surface and underground facilities and infrastructure. As noted above, a detailed description of the DGR surface and underground facilities is provided in the DGR Facility Preliminary Safety Report (OPG 2011a).

3.1 Surface Infrastructure and Buildings

The general layout of the DGR surface facilities and infrastructure is shown in Figure 3.1.

3.1.1 Main Shaft Area

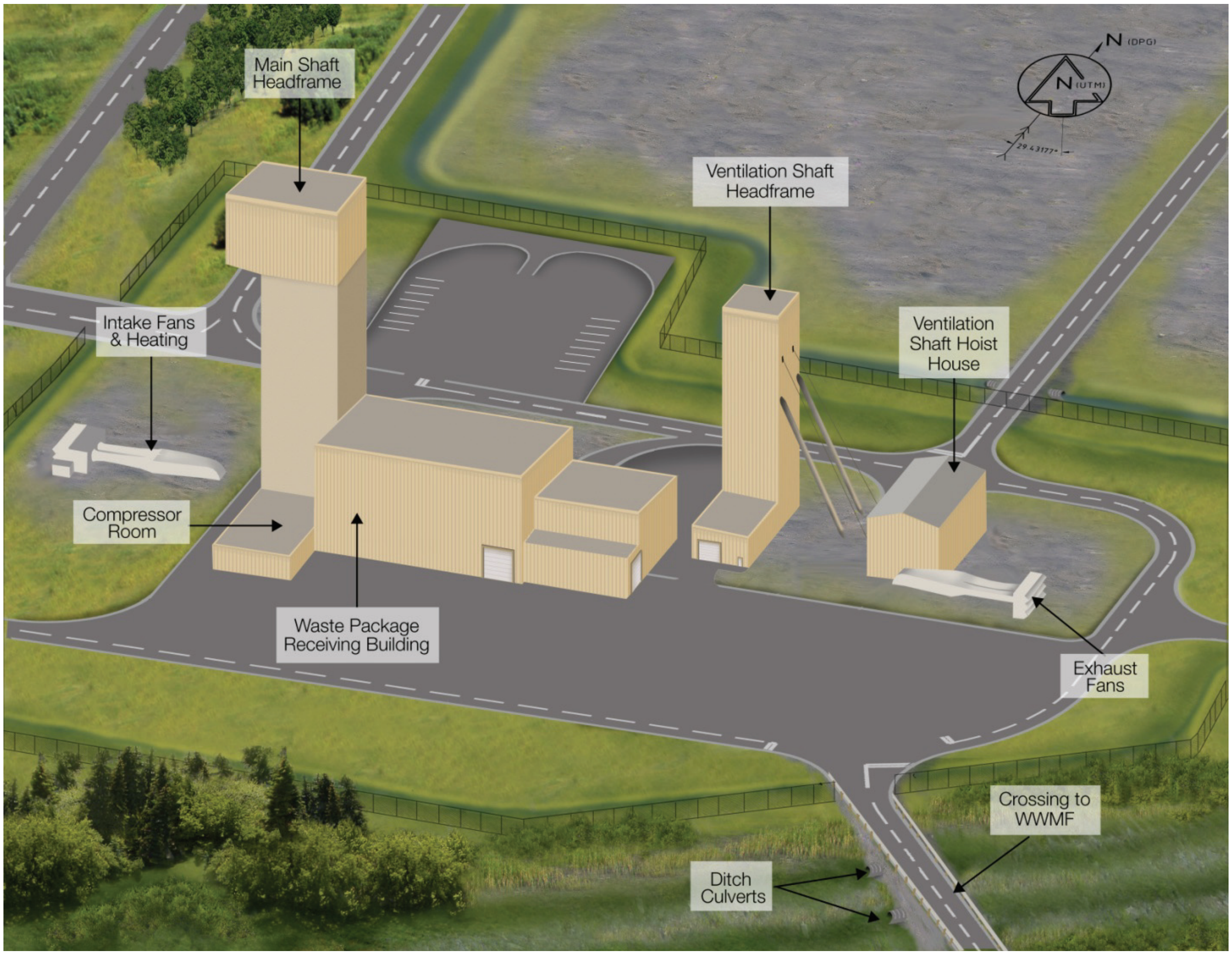
The main shaft area includes the following key structures and services, each of which is described in this section:

- The main shaft headframe;
- The Waste Package Receiving Building (WPRB);
- A maintenance and storage area;
- A compressor building;
- Intake fans and heater house; and
- Main control room, and amenities and offices building.

The main shaft provides primary access to the underground repository and the main shaft headframe houses hoisting equipment to lower and raise conveyances for transporting personnel, equipment and waste packages.

The office, main control room and amenities building will be used for administrative purposes, control and monitoring of the DGR and receiving visitors to the DGR Facility.

The intake fans and heaters will feed air to ventilate the DGR into the downcast main shaft.



Note: Figure is from OPG (2011a).

Figure 3.1: General Layout of the DGR Surface Infrastructure and Buildings

3.1.1.1 Main Shaft Headframe and Hoist

The main shaft headframe is a reinforced concrete structure, nominally 63 m high. It contains tower mounted Koepe friction hoists installed in the permanent condition. The headframe design is such that, with a planned maintenance system in place, the structure will not require major refurbishments for the 100-year design life of the DGR Facility.

Stairs and intermediate floors and platforms are provided for access and maintenance requirements. An elevator has been included to service the various floors in the headframe and to provide access to the hoist room.

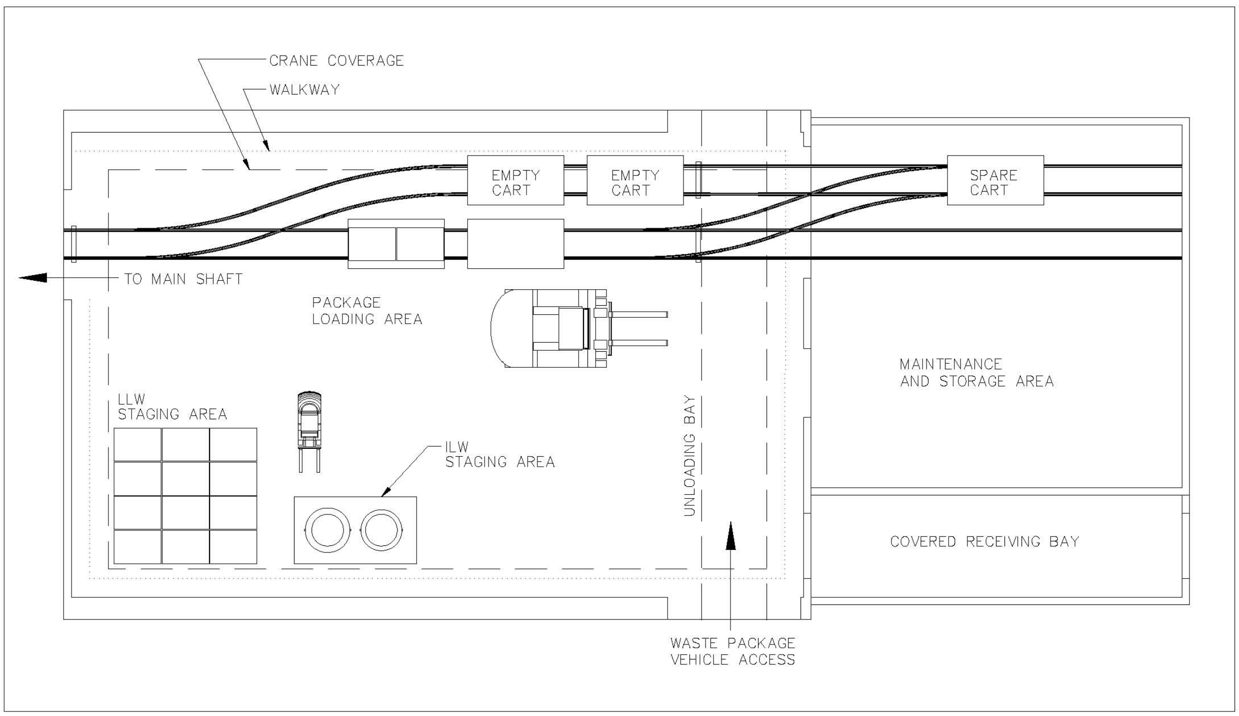
The main shaft hoist room is located at the top of the main shaft headframe and has nominal external dimensions of 15 m x 22 m with a height of 12.5 m. A 50-tonne overhead travelling crane is mounted in the hoist room. This hoist room houses all the controls and electrical equipment necessary to operate the hoists along with a local operating station.

3.1.1.2 Waste Package Receiving Building

During operations, the WPRB will receive the waste packages from the WWMF and stage them for transfer onto the main shaft cage. The WPRB will be connected to the main shaft headframe. The main WPRB plan area is 40 m long by 25 m wide with a height of approximately 20 m and will be constructed as an insulated and clad steel frame structure. The preliminary design of the WPRB is shown in Figure 3.2. The WPRB includes the following features:

- A waste package staging and inspection area;
- An unloading bay and truck dock;
- Radiological detection equipment (e.g., small article monitor) for worker safety and to prevent the spread of contamination;
- 40-tonne overhead crane; and
- Access to the adjoining maintenance and storage area and amenities and offices building.

Localized shielding will be incorporated into the WPRB wall design adjacent to the staging area, as required, to protect workers in adjacent offices and main control room to comply with radiation protection requirements and guidance.



Note: Figure is from OPG (2011a).

Figure 3.2: WPRB Layout

3.1.1.3 Maintenance and Storage Area

The maintenance and storage area adjoined with the WPRB is used for minor repairs and preventative maintenance tasks for the shaft components and equipment used within the WPRB. The area is part of the WPRB steel clad building with access from within the WPRB, as well as, door access along the east wall.

3.1.1.4 Compressor Building

The compressor building located close to the main shaft houses a compressor in an acoustic enclosure that will provide compressed air for surface and underground maintenance. In the event of an underground emergency, these compressors will be used to provide breathing air to the underground refuge stations.

3.1.1.5 Repository Ventilation and Heating

The function of the two surface intake fans is to provide airflow for the DGR. The function of the electric surface heaters is to raise the ambient temperature of winter air drawn in by the intake fans to a minimum temperature of 5°C. The footprint of the heater house is nominally 7 m x 10 m and interfaces with the intake plenum.

3.1.1.6 Office, Main Control Room and Amenities Building

The office, main control room and amenities building is a steel framed, insulated and clad structure attached to the north side of the main shaft headframe. The approximate size of the building is 25 m x 15 m x 3 m high. The main control room, forming a part of the office area, is equipped with computing, control, and monitoring equipment to marshal all signals and data transmitted from surface and underground.

The amenities area has a small bank of lockers for DGR Facility visitors. There is also a decontamination area (i.e., a shower) that would be used in the unlikely event that a person is exposed to loose radioactive material. A small parking area is provided outside the building to accommodate movements of DGR Facility staff and vehicles transporting visitors. Other facilities provided include a training/visitor area, lamp room, monitoring area and storage.

3.1.2 Ventilation Shaft Area

The ventilation shaft area includes the following key structures:

- Ventilation shaft headframe and collar house;
- Ventilation shaft hoist house; and
- Exhaust fan building.

The ventilation shaft exhausts the repository ventilation and is used as a second egress.

3.1.2.1 Ventilation Shaft Headframe and Collar House

The ventilation shaft headframe is nominally a 43 m high, insulated and clad steel structure.

Stairs, immediate floors and platforms will be provided for access and maintenance requirements. There is also an elevator in the ventilation shaft headframe.

A collar house is attached to the ventilation shaft headframe. The insulated and clad steel-framed collar house will be used for general maintenance and storage of shaft hardware and equipment spares. The internal dimensions of the collar house will be nominally 15 m x 10 m and 5 m high. The building contains electrical panels, lighting, roll up door, a monorail, equipment and materials required for maintenance personnel.

3.1.2.2 Ventilation Shaft Hoist House

The ventilation shaft hoist house is nominally 13 m x 24 m and 11.5 m high and constructed as an insulated and clad steel frame structure. It houses a 3.66 m diameter double drum hoist driven by a direct coupled motor. The hoist consists of two separate drums mounted on a single drum shaft. The building contains all the electrical equipment and control station, roll up doors for access and 8-tonne monorail for installation and maintenance of the hoist.

3.1.2.3 Fan Building

The repository's primary ventilation fans are installed in the exhaust fan building. This building houses three fans of the same specification. The structure will be steel with cladding.

3.1.3 Shared Services

A number of shared services are located on the DGR site as follows.

- The electrical supply and emergency power consists of Class IV electrical power that will be supplied to the facility by a 13.8 kV high voltage transmission line. An emergency diesel generator system, complete with load bank, is installed to assure safety in the event of a grid power failure. The diesel fuel storage tank is an above-ground double walled tank and connected directly to the generator.
- The DGR Facility communications system includes the surface and underground infrastructure required for telephones, wireless radios, business network, and process control network.
- The potable and service water used at the surface facilities is supplied through the existing infrastructure at the Bruce nuclear site.
- All human effluent collected from the surface facilities is collected and discharged into the existing sewage system at the Bruce nuclear site.
- A stormwater management system that consists of directing all stormwater run-off from the DGR Facility site as well as any groundwater pumped to surface from underground shaft sumps via ditches to the stormwater management pond for treatment to remove suspended solids. The pond discharge water will be directed into a ditch that ultimately discharges into Lake Huron.

3.1.4 Connection to WWMF

A crossing is required to provide direct access between the WWMF and the DGR Facility over the abandoned railway right-of-way. The crossing features a connecting two-lane road situated on a fill embankment over the existing ditches and railways. A 20 m embankment is planned to accommodate wide road lanes (4 m minimum), shoulders (1.5 m minimum), a walking area (2 m on each side), adequate space for snow storage (1.5 m minimum) during winter operation and a concrete barrier (1 m) on both sides of the road.

3.1.5 Waste Rock Management Area

The waste rock generated as a result of excavation of the shafts and the repository will be managed on the DGR site in the WRMA. Approximately 832,000 m^3 of rock will be managed over the long-term at the WRMA.

The WRMA is located adjacent to the surface facilities and provides an area for long-term management of argillaceous limestones (approximately 9 ha). The overall footprint of the WRMA, including the stormwater management system, is approximately 17 ha.

3.2 Underground Facilities

3.2.1 Main Shaft

The main shaft will interface with the surface facilities through the WPRB.

The main shaft will be split into three parallel compartments:

- Main shaft cage compartment is the largest and in the centre of the shaft, it includes cables for communications, hoist signalling, and fire detection;
- Main cage counterweight compartment which includes a service water line; and
- The auxiliary cage and auxiliary cage counterweight compartment is the north of the main cage and it includes a dewatering line, compressed air line and power feeds.

The main shaft contains a concrete liner designed for the varying conditions from the shaft collar to the shaft bottom. The liner is a critical component of the long-term support of the shafts, as well as, minimizing water inflow into the shaft. Approximately 120 steel sets, nominally 6 m apart, are installed along the length of the shaft.

Figure 3.3 shows a plan view of the main shaft.

3.2.2 Ventilation Shaft

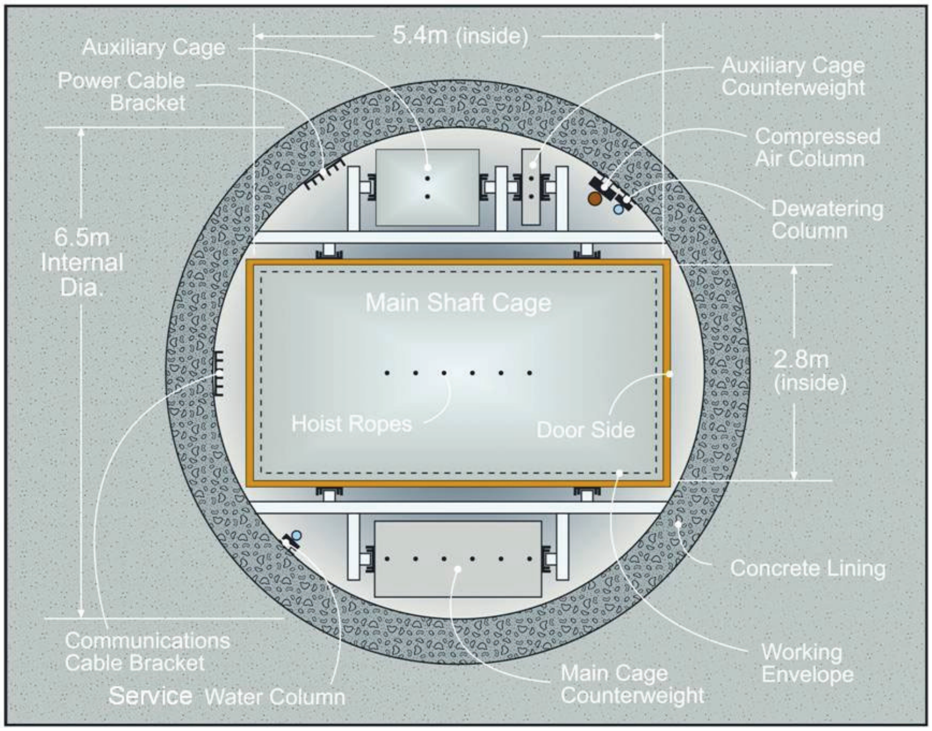
The ventilation shaft is nominally 745 m deep with the diameter set by exhaust ventilation air flow and construction requirements, requiring an internal finished shaft diameter of 5 m. The shaft is split into compartments as follows:

- Cage and skip compartment which also contains a dewatering line, service water line, compressed air line, power feeds, and cables for communications, hoist signalling and fire detection; and
- A compartment for upcast ventilation which also includes a dewatering line.

The ventilation shaft is equipped with one set of main steel buntons, which divides the shaft into two compartments. Approximately 125 steel sets, nominally six meters apart, are installed along the length of the shaft.

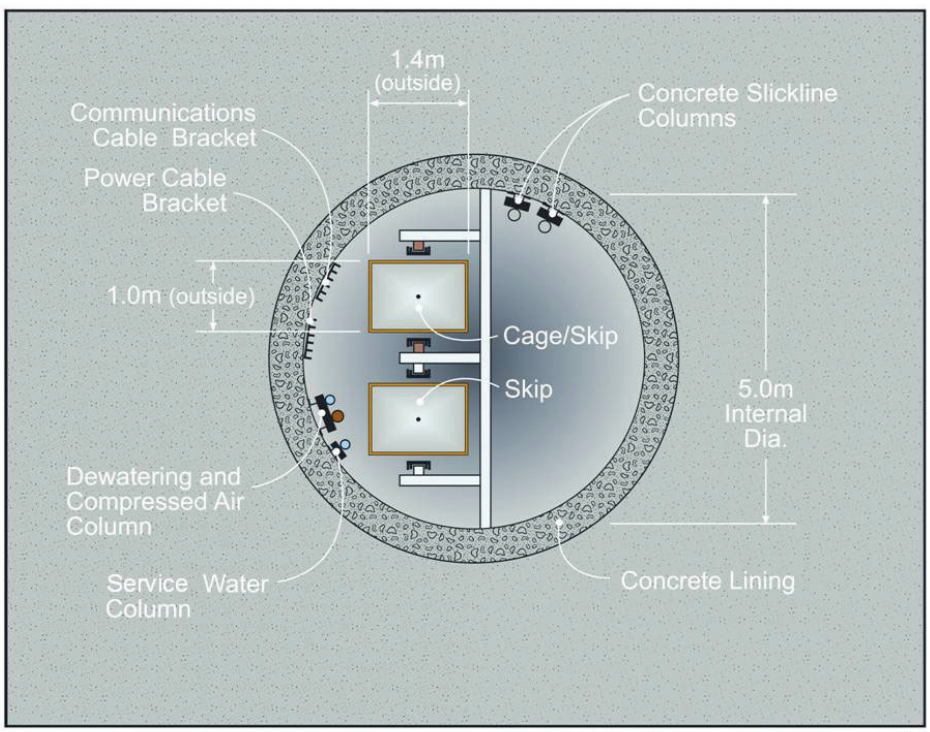
The ventilation shaft liner will be similar to the main shaft liner described in Section 3.2.1.

Figure 3.4 shows a plan view of the ventilation shaft.



Note: Figure is from OPG (2011a).

Figure 3.3: Plan View of the Main Shaft



Note: Figure is from OPG (2011a).

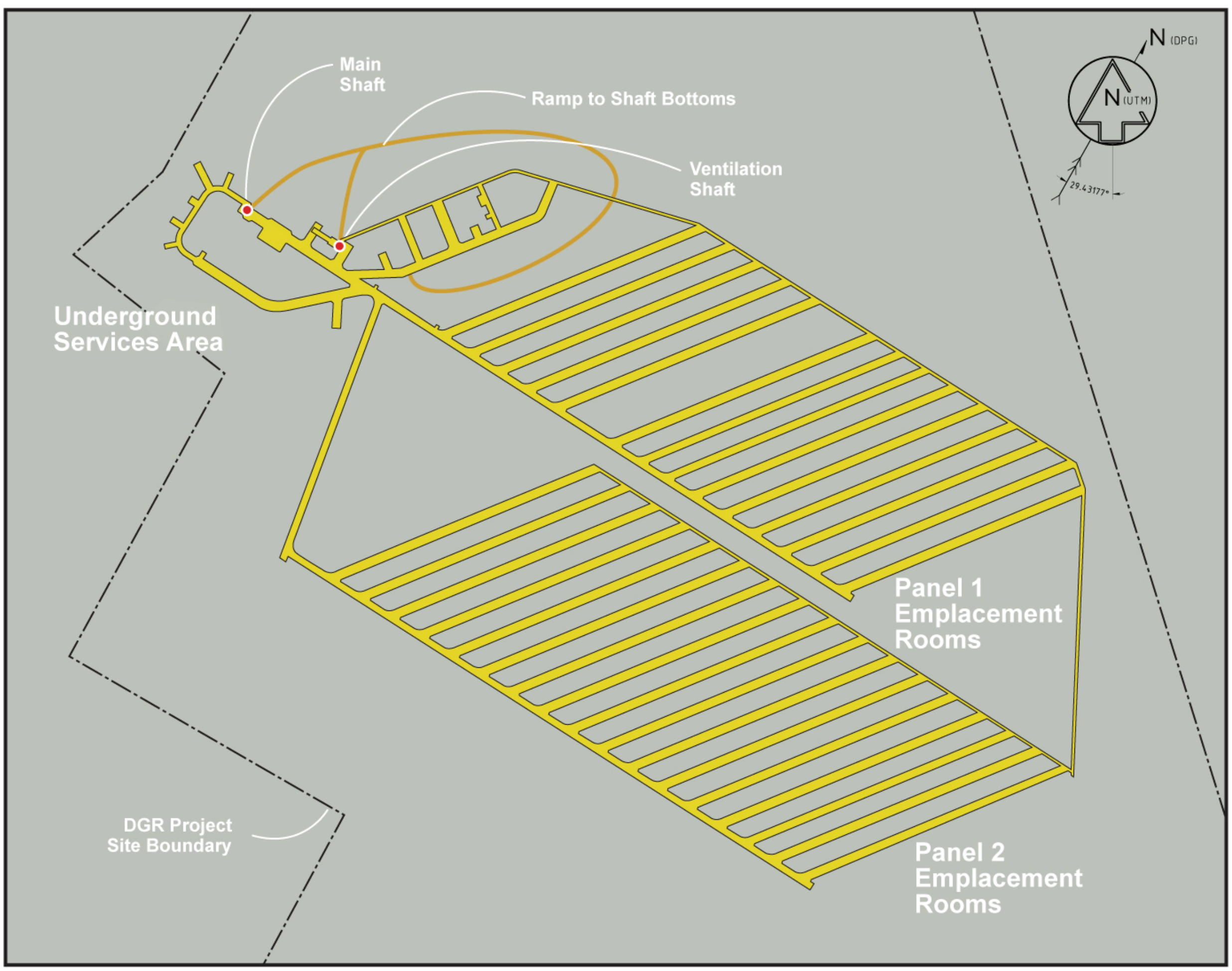
Figure 3.4: Plan View of the Ventilation Shaft

3.2.3 Underground Repository

The underground repository is comprised of several primary components that provide for access, support, services and the emplacement of the waste packages. These components include the following, in addition to the main and ventilation shafts described above, shown in DGR base case layout (see Figure 3.5):

- A services area;
- A ramp to the bottom of the main and ventilation shafts;
- Access tunnels;
- Panel 1 emplacement rooms; and
- Panel 2 emplacement rooms.

The main item to note for the decommissioning is the provision for the closure walls that will be installed during operations and that are identified in the figure and described in this section.

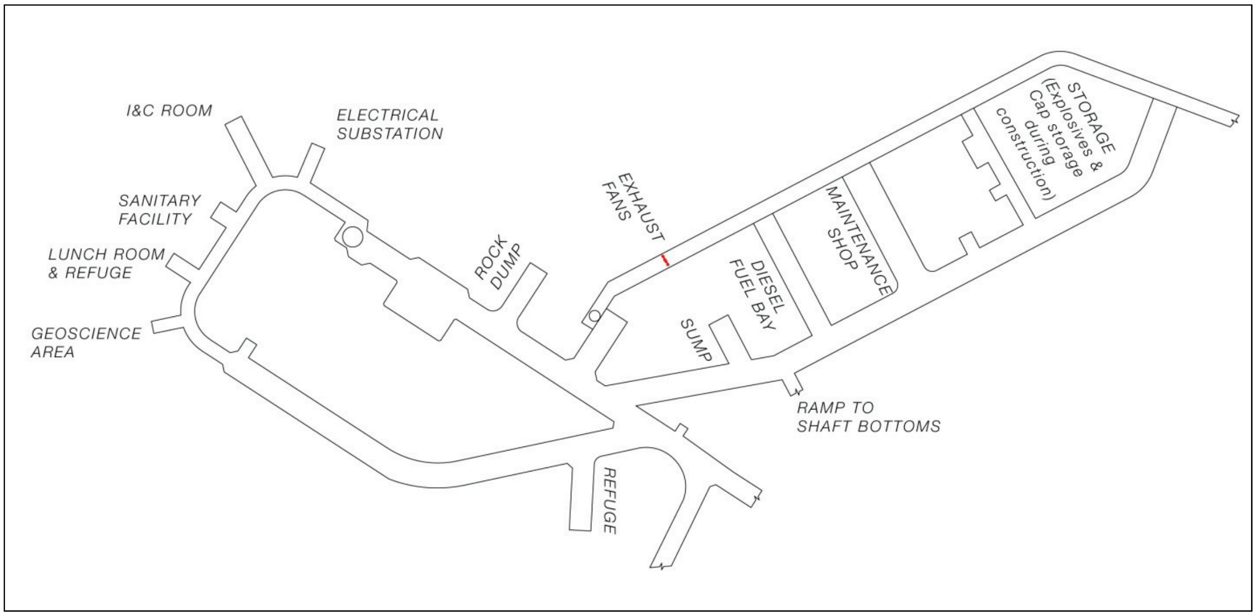


Note: Figure is from OPG (2011a).

Figure 3.5: DGR Base Case Layout

3.2.3.1 Underground Services Area

The underground services area is laid out with the concept of locating both the main and ventilation shafts in close proximity and "clustering" the service or ancillary rooms in a common area. The services area contains a sanitary facility, a lunch room and refuge station, electrical rooms, a mobile equipment maintenance shop, an underground refuelling station, geoscience area and stores (see Figure 3.6). The refuge station is located in a non-operational area and provides accessibility from/to the main shaft.



Note: Figure is from OPG (2011a).

Figure 3.6: Underground Services Area

3.2.3.2 Main Access-ways

The main access-ways consist of the services area, the Panel 1 access tunnel, and the Panel 2 access tunnel. The main access tunnel dimensions are based on several factors, which include:

- Waste package tramming and turning circle dimension requirements;
- Development equipment requirements;
- General operating and maintenance envelope requirements; and
- Ventilation air velocity.

3.2.3.3 Closure Walls

After a group of rooms have been filled with waste packages and following the determination that there is no need to retrieve the waste for any reason, a closure wall will be constructed in the access tunnel to fully isolate this group of rooms. The underground space behind the closure wall will not be ventilated. These closure walls will be designed to limit release of tritiated air, natural and waste-generated methane, and other off-gases from waste packages (e.g., H_2 and CO_2), as well as potentially contaminated water. In the remote event that explosive gases build up behind the closure wall and an explosion occurs, the air blast from the explosion would be contained by the closure wall.

3.2.3.4 Emplacement Rooms and Access Tunnels

The underground DGR layout will consist of two panels of waste emplacement rooms. Panel 2 will have seventeen rooms and one closure wall to be installed once the rooms are full. Thirteen of the seventeen Panel 2 rooms are to be filled first with Low-Level Waste (LLW) materials. Panel 1 will have fourteen rooms and two closure walls to be installed once the rooms are full. The furthest nine rooms of Panel 1 will receive a mix of L&ILW, while Intermediate-Level Waste (ILW) materials will be placed in the closest five rooms.

3.2.3.5 Low and Intermediate Level Waste

The L&ILW packages that are placed in the facility will become a permanent part of the facility and they will remain in place after decommissioning. The anticipated inventory of operational and refurbishment wastes in the facility at the time of shutdown has been described in detail elsewhere (OPG 2010) but it is expected to include:

- LLW such as steam generators, active liquid waste sludge and resins, non-processed wastes (drums and other packages), compacted and baled wastes, incinerator bottom ash and baghouse ash; and
- ILW such as refurbishment wastes (pressure tubes, end fittings, calandria tubes and calandria tube inserts), irradiated core components, filters and filter elements, ion exchange columns and resins (moderator, primary heat transport, etc) and CANDECON resins.

The design capacity of the DGR Facility is nominally 200,000 m^3 of packaged L&ILW.

The radioisotope inventory of the waste in the facility at the time of shutdown is expected to include carbon-14 (approximately 42% of the total activity), niobium-94 (28%), nickel-63 (18%), tritium (8%), cobalt-60 (2%), zirconium-93 (1%) together with a variety of other radioisotopes. The non-radioactive constituents of the wastes are expected to include metals (iron, copper, nickel, chromium and lead) and small quantities of polyaromatic hydrocarbons, chlorinated aromatic compounds such as chlorinated benzene and phenol compounds, polychlorinated biphenols, dioxins and furans. The CANDECON resins are also expected to contain approximately 50,000 kg of the chelating agent EDTA.

3.3 Future Plans and Current Status

Development of the DGR Facility is currently in the Regulatory Approvals phase. A preliminary design has been developed and an application has been made to the CNSC for a licence to prepare the site and construct the facility. A public involvement program is underway and many information sessions have been held. The DGR Facility is scheduled to go in service in 2018, following construction and commissioning.

4. PRELIMINARY DECOMMISSIONING

4.1 Scope of the Preliminary Decommissioning Plan

This plan describes the anticipated approach to the decommissioning of all SSCs located within the security fence that will surround the DGR Facility. It also presents the plan to seal the main and ventilation shafts. The SSCs include:

- Underground infrastructure:
  - Underground repository;
  - Main shaft;
  - Ventilation shaft;
- Surface infrastructure and buildings:
  - Main shaft area;
    - Main shaft headframe;
    - WPRB;
    - Intake fans and heater house;
    - Office, main control room and amenities building;
    - Maintenance and storage area;
    - Compressor building;
  - Ventilation shaft area;
    - Ventilation shaft headframe and collar house;
    - Ventilation shaft hoist house;
    - Exhaust fan building;
  - Connection to WWMF;
  - WRMA; and
- Shared services.

This plan does not describe the decommissioning of any nuclear facility that is outside of the boundary of the DGR Facility (see Figure 2.2).

4.2 Objectives of Decommissioning

The objectives of the decommissioning are covered below.

1. Permanently retire the DGR Facility from service at the end of its service life in a manner that ensures that the health, safety and security of workers, the public and the environment are protected.
2. Install passive engineering features (containment, sealing, structural stability and a design to minimize inadvertent intrusion) that ensure that:
   - The waste is contained until most of the radioactivity, and especially that associated with shorter-lived radionuclides, has decayed;
   - The waste is isolated from the biosphere; substantially reducing the likelihood of inadvertent human intrusion into the waste;
   - Significant migration of radionuclides to the biosphere is delayed until a time in the far future when much of the radioactivity will have decayed; and
   - Levels of radionuclides eventually reaching the biosphere are such that possible radiological impacts in the future are acceptably low.
3. Restore the site to the desired end state, described below.

4.3 End-State of Decommissioning

Decommissioning will be complete when the waste is permanently secured in the repository, the shafts have been sealed and secured, the surface facilities have been stripped and dismantled, and the surface landscape has been restored. This will constitute the final end state. After completion of the decommissioning work, the site will be subject to a period of institutional controls.

4.3.1 Physical

After completion of the decommissioning work:

- The underground facilities will be secured and sealed from entry, isolating the waste emplaced there;
- The ventilation shaft and main shaft will be stripped of infrastructure and damaged rock and sealed;
- All surface facilities will be decontaminated as necessary and all surface facilities will be demolished to grade; and
- Waste rock piles will remain in place and be vegetated.

The buildings and structures to be decommissioned are listed in Section 4.1.

4.3.2 Radiological

Upon conclusion of the decommissioning work, all accessible areas of the facility will be free of all nuclear substances. The only nuclear substances remaining at the facility will be the L&ILW emplaced in the DGR, which will be isolated in the underground emplacement rooms.

4.3.3 Chemical

Upon conclusion of the decommissioning work, all hazardous chemicals that were used during operation of the DGR Facility will have been removed from the site. Any chemical contamination identified during the decommissioning Environmental Assessment will have been remediated to the levels prescribed in the Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (Ministry of the Environment 2009), which discusses surface soil and groundwater criteria for industrial land use for non-potable groundwater condition.

4.3.4 Biological

The site is currently free of biological hazards and will remain so upon completion of the decommissioning.

4.3.5 Environmental

Any soil or water contamination caused by operation of the DGR Facility found to exist on the site will be remediated to the criteria presented in the Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (Ministry of the Environment 2009), which discuss surface soil and groundwater criteria for industrial land use for non-potable groundwater condition for coarse textured as well as medium and fine soils.

The debris generated by demolition during the decommissioning work will be removed from the site for recycling or disposal as appropriate.

4.3.6 Future Use

After completion of the decommissioning work, it is anticipated that OPG will retain ownership and maintenance of the property. The site will be subject to a period of institutional controls (see Section 5.8) currently assumed to last up to 300 years.

Upon completion of the decommissioning, OPG will apply for a Licence to Abandon the DGR as described in Section 8 of the Class I Nuclear Facilities Regulations (Government of Canada 2000).

4.4 Decommissioning Strategy

The reference decommissioning strategy following operation of the facility is based upon the fundamental assumption that no radioactive wastes emplaced in the DGR will be removed as part of the decommissioning.

The decommissioning strategy will be based on a combination of prompt decommissioning and in-situ confinement as defined in CSA Standard N294-09 (CSA 2009). The approach for surface infrastructure and buildings as well as selected underground facilities will be prompt decommissioning. Infrastructure supporting the main shaft and the ventilation shaft will be dismantled and emplaced in the repository if contaminated and where possible. The approach for the wastes emplaced in the underground structures will be in-situ confinement. A concrete monolith will then be installed at the base of the main shaft and the ventilation shaft sealing the access ways. The main shaft and the ventilation shaft will both be permanently sealed. Surface infrastructure and buildings will be dismantled and removed. The decommissioning work will be followed by a period of institutional controls.

The DGR Facility is unique in that it combines aspects of mining with a nuclear facility. Even though the DGR Facility does not meet the legal definition of a mine, Ontario Regulation 240, Mine Development and Closure (Government of Ontario 2007) under the Mining Act does, provide for the installation of concrete caps atop decommissioned mine shafts. In general, a reinforced concrete cap, certified by a qualified professional engineer is placed atop decommissioned mine shafts. The caps installed atop the Main and Ventilation Shafts will be consistent with the requirements given in Ontario Regulation 240.

4.4.1 Canadian and International Experience

Decommissioning procedures for mines are well established, and there is extensive previous experience in mine closure in Canada. Ontario Regulation 240, Mine Development and Closure (Government of Ontario 2007) under the Mining Act prescribes the requirements for closure of a conventional mine in Ontario. The regulation requires that a closure plan be prepared detailing the intended rehabilitation measures and expected site conditions following rehabilitation. Schedule 1 of the regulation is the Mine Rehabilitation Code of Ontario, which provides detailed requirements for rehabilitation of shafts.

Decommissioning that involved aspects of mining and radioactive materials was carried out at several uranium mines owned and operated by Rio Algom Limited in Elliot Lake, Ontario (BHP Billiton 2001). All of the nine uranium mines once in operation there have now been closed and decommissioned. Those that have undergone decommissioning since 1990 include the

Stanleigh, Quirke and Panel mines, which ceased operations in June 1996, August 1990 and August 1990 respectively. The issues identified with operation of the uranium mines are not relevant to the decommissioning of the DGR Facility.

In decommissioning the Quirke, Panel and Stanleigh mines most visible surface structures were removed, the underground areas were sealed, mine entrances were sealed and the land was re-contoured and re-vegetated to reflect its natural state. The tailings remaining from mine operations were covered with water. The decommissioning strategy used was a combination of prompt-decommissioning of the surface and underground infrastructure with in-situ confinement of the tailings. This is very similar to the decommissioning strategy chosen for the DGR Facility.

Decommissioning experience from the Atomic Energy of Canada Limited (AECL) Underground Research Laboratory (URL) near Pinawa, Manitoba, can also provide useful information. The URL was used to perform research regarding deep geologic repositories, and no spent fuel or high-level radioactive materials were ever placed there. While two underground radioisotope laboratories were present they were already closed and decontaminated. As a result the site was no longer licensed by the CNSC when decommissioning occurred. It was determined that the URL decommissioning project was much more closely related to a mine shutdown than a nuclear decommissioning project, therefore it was subject to Provincial Mining Acts and Regulations (Government of Canada 2008).

Decommissioning of underground facilities has also been considered in other countries. Some of the relevant experience includes the following.

- Waste Isolation Pilot Plant (WIPP) in the US, where a full design has been produced and approved, and the intension is to permanently enclose the radioactive waste disposed of at this facility in the underground repository (US DOE 2009).
- Morsleben Repository in Germany, for which the decommissioning plan includes sealing and filling the repository, permanently enclosing the L&ILW stored there (Preuss et al. 2002).
- The Agence nationale pour la gestion des déchets radioactifs (ANDRA) conceptual design for a spent fuel repository sealing system in France (ANDRA 2005).

This review of the Canadian and international experience suggests that shaft sealing is a feasible approach to decommissioning a facility such as the DGR and that:

- Multiple materials serving repetitive functions should be incorporated into the design to maximize redundancy;
- Bentonite-based materials are universally recognized as a suitable primary sealing material, and should be utilized in the DGR sealing system;
- Engineered and compacted native material should be used as a tertiary seal (fill) in the upper reaches of the DGR shafts, where the restriction of radionuclide flow is not a concern; and
- Concrete bulkheads should be part of the primary and secondary sealing system and should be keyed into the shaft walls to increase the structural integrity of the sealing system.

5. DESCRIPTION OF DECOMMISSIONING WORK

This chapter describes the major activities that will be performed during the course of decommissioning work at the DGR Facility. The sequence and activities of the work are presented in the form of work packages. This chapter does not present detailed procedures for each activity. These procedures will be included in the DDP that will be prepared at the beginning of the decommissioning process.

The dates for decommissioning will follow from the date a decision is made by OPG to permanently shut down the DGR Facility. It is assumed that this decision will be made sufficiently far in advance to enable the activities detailed herein to be completed according to the preliminary schedule.

The decommissioning work plan includes a number of work packages as follows.

1. Preparing for shaft sealing.
2. Decommissioning of the underground services area (constructing the ventilation shaft monolith).
3. Decommissioning and sealing the ventilation shaft.
4. Constructing the main shaft monolith.
5. Decommissioning and sealing the main shaft.
6. Decommissioning surface facilities.
7. Waste rock management area.

The main activities associated with the work packages are described in the following sections. Supporting health and safety programs and procedures are described in Chapter 10. However, in cases where unique hazards are associated with specific decommissioning items, they are identified in this chapter. In these instances, worker safety provisions are also described.

The preliminary schedule for decommissioning the DGR Facility is shown in Figure 5.1.

5.1 Decommissioning Phases

The decommissioning phases for the DGR Facility are:

- Preparation for Decommissioning (including application and receipt of licence to decommission and all those actions taken in advance of shutdown to prepare for the decommissioning of the facility, shutdown occurs during this phase);
- Site and Facility Preparation;
- Site Decommissioning (including shaft sealing);
- Site Restoration;
- Final Release Surveys; and
- Abandonment.

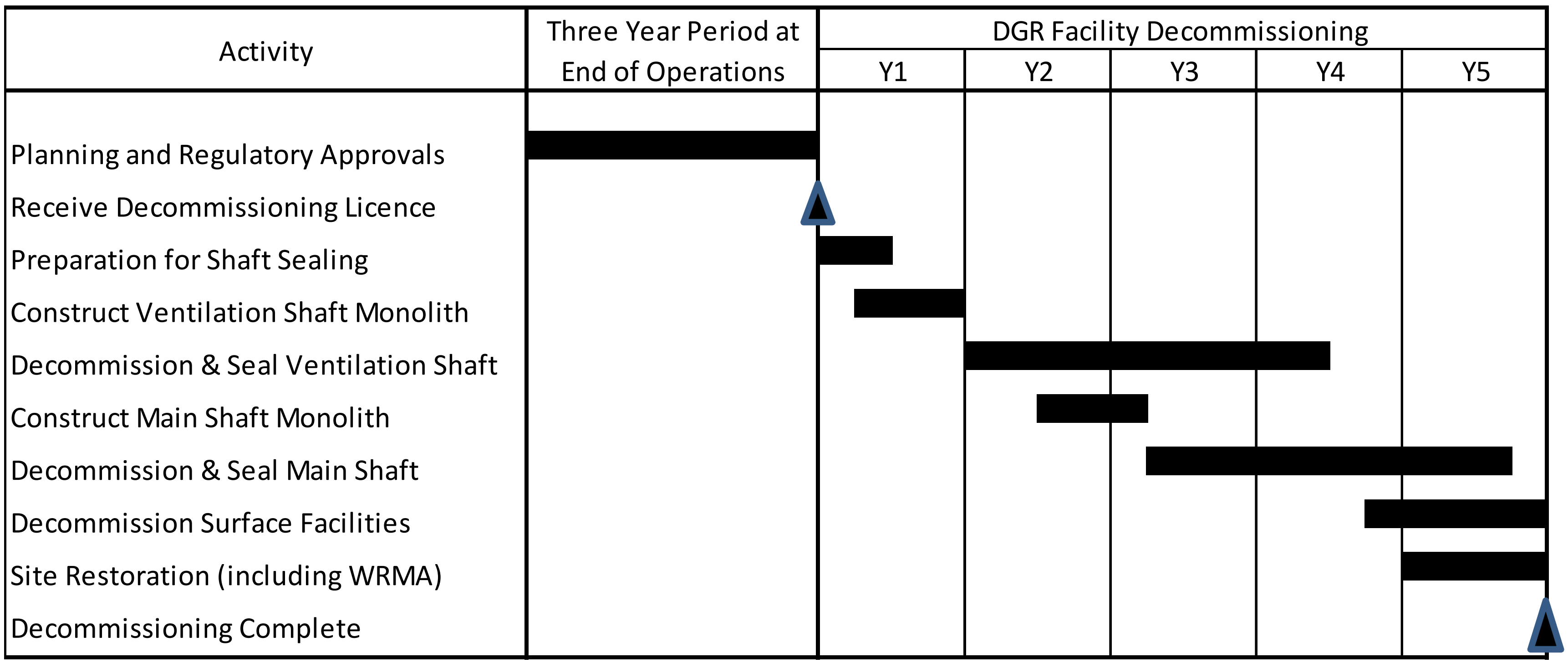


Figure 5.1: Schedule for Decommissioning

5.2 Preparation for Decommissioning

This phase of decommissioning will begin in anticipation of the cessation of waste emplacement operations at the DGR Facility. During this phase, OPG will prepare detailed plans for the decommissioning along with an application for a Licence to Decommission the DGR site. This phase will continue until the Licence to Decommission is received from the CNSC.

OPG will follow and comply with the requirements of the Nuclear Safety and Control Act (Government of Canada 1997) and associated Regulations, and any other applicable federal and provincial statutes and regulations to decommission the DGR Facility. Some of the actions that will be required include the following.

- Submitting a notification of the intent to decommission the DGR Facility and the general strategy for decommissioning to the CNSC.
- Conducting a public involvement program which will involve informing the public, key stakeholders and the host community of the decommissioning and obtain their input for the development of the DDP. The public involvement process will help to identify potential socio-economic impacts and other issues associated with the decommissioning activities and appropriate impact management strategies.
- Conducting an environmental assessment of the decommissioning under the Canadian Environmental Assessment Act (Government of Canada 1992) to assess the potential environmental effects for the decommissioning project.
- Completing the detailed design of the shaft seal system.
- Conducting a safety assessment of the decommissioning.
- Preparing and submitting a DDP and other supporting documents to the CNSC.
- Obtaining the provincial and municipal licences and permits required for the decommissioning work.
- Confirming that appropriate resources are in place to assume the responsibility for decommissioning.
- Providing sufficient staff with the required training.

It is anticipated that:

- The work described in this section will begin approximately 3 years prior to shutdown of the facility;
- The application for a Licence to Decommission the facility will be submitted approximately 2 years before the end of waste emplacement operations; and
- The Licence to Decommission will be granted following the end of operations.

5.2.1 Detailed Decommissioning Plan

A DDP will be prepared and submitted to the CNSC for approval prior to beginning decommissioning activities. Operational experience and surveys, as well as post-operational surveys, will be used to prepare the DDP. It will describe the actions that will be taken to permanently retire the facility from operation in a manner that ensures the health, safety and security of workers, the public and the environment. The DDP will establish the criteria that will be used to determine if material is suitable for uncontrolled release from the DGR site. It will also establish the levels that will be used to determine if the site itself is suitable to apply for a Licence to Abandon.

The DDP will describe the 'Decommissioning Planning Envelopes' which will include (OPG 2011a):

- Underground infrastructure:
  - Shaft and Services Area;
  - Ventilation Shaft;
  - Main Shaft;
- Surface infrastructure and buildings:
  - Heater Building;
  - Exhaust Fans;
  - Ventilation Shaft Headframe and Hoist House, hoisting system (including temporary winches installed for shaft stripping and sealing), and Collar House;
  - Main Shaft Headframe and temporary hoist system as well as associated buildings, including the WPRB; and
  - Waste Rock Management Area.

5.2.2 Regulatory Process

When OPG has made the decision to decommission the DGR Facility, it will notify the CNSC of the intention to decommission the DGR Facility.

OPG will also obtain all of the other required permits and licenses from federal, provincial and municipal agencies before any decommissioning work begins. A full list of the required permits and licenses will be included in the DDP.

5.2.2.1 Environmental Assessment

An environmental assessment will be initiated once OPG has notified the CNSC. The environmental assessment will be conducted in accordance with the Canadian Environmental Assessment Act (Government of Canada 1992).

5.2.2.2 Licence Application

OPG will prepare and submit an application for a Licence to Decommission that contains the information required by the Class I Nuclear Facilities Regulations (Government of Canada 2000) along with such other information as may be appropriate to the CNSC. The DDP will form part of the application for the Licence to Decommission. The Preparation for Decommissioning phase will not end until a Licence to Decommission has been granted by the CNSC.

5.2.3 Public Involvement Program

A public involvement program, as described in CNSC Regulatory Guide G-217 (CNSC 2004), will be developed and implemented in support of the decommissioning. The program will identify issues and concerns, ensure opportunities for involvement, ensure public feedback is incorporated into decommissioning planning activities and include the documentation of the process and results. The program will include both information and consultation opportunities. It will be designed to involve a broad cross-section of stakeholders employing a variety of methods that will meet the needs of the participants and the objectives of the business. The objectives of the communications approach used in the public involvement program are to ensure stakeholders are well informed of all aspects of decommissioning and to maintain a level of community support before proceeding.

5.2.4 Shutdown (End of Operations)

Facility shutdown begins when waste emplacement operations have ended, and there is no intention to handle or emplace more waste in the DGR.

During operation, closure walls will be constructed and erected in stages to fully isolate groups of rooms containing waste. Operational activities will be conducted in accordance with supporting programs and procedures. This will include conducting routine contamination surveys and recording events during facility operations. Operational experience and surveys will be used to prepare the DDP. It is assumed that at the time of shutdown all of the required closure walls will have already been erected. Operations will conclude with a period of environmental monitoring and surveys. The end of operations is assumed to be at the conclusion of the monitoring period.

The predicted nature and extent of contamination remaining in the DGR Facility at the end of operations is presented in Table 5.1.

Table 5.1: Contamination Prediction for the End of Operations

Location	Contamination Prediction	Reference Figure
Equipment in Underground Repository	Minimal (any contamination events are expected to have been dealt with at the time of the event)	Figure 3.5 and 3.6
Ventilation Shaft Infrastructure	Possible tritium contamination from the operation of the ventilation system	Figure 3.4
Main Shaft Infrastructure	Minimal (any contamination events are expected to have been dealt with at the time of the event)	Figure 3.3
WPRB	Minimal (any contamination events are expected to have been dealt with at the time of the event)	Figure 3.2

5.3 Site and Facility Preparation

Activities to prepare the site and the facility for decommissioning will include, but is not limited to the following.

- Any fuels, batteries and other hazardous materials will be removed to the surface.
- It is currently assumed that all DGR Facility equipment and materials used underground will be entombed in the sealed repository due to the potential for radiological contamination. It is possible, however, that some mobile equipment and materials that are free from contamination could be removed to the surface during this period.
- Any other actions required to transition from operations to decommissioning will be performed. Consideration of human factors impacts will be included in work planning.

5.4 Decommissioning of the DGR Facility

Decommissioning resources will be selected by OPG and assigned responsibility for the decommissioning work. Physical decommissioning work would begin after the detailed planning has been completed and the necessary licences, permits and approvals have been obtained. The activities listed below can be performed with currently available technology, but the required procedures to complete the tasks will depend on the technology available at the time of decommissioning.

The activities associated with each of the decommissioning packages that were presented at the beginning of this chapter are described below.

5.4.1 Preparing for Shaft Sealing

The WPRB will be inspected, tested for contamination and, if necessary, decontaminated for use during shaft sealing operations. The WPRB will act as a warehouse for the shaft sealing materials and as a maintenance workshop for the seal construction equipment (OPG 2011a).

At the ventilation shaft, a set of temporary stage winches will be installed from which a working platform (also called a “stage”) will be suspended on wire ropes. The platform will enable the placement of sealing materials within the shafts. The existing second egress hoist (i.e., hoist used during operations) within the ventilation shaft will be used as the primary means of travel between surface and the shaft bottom for workers, equipment and materials. However, once the steelwork has been stripped, the conveyances will use the stage ropes as guides, rather than the steel or timber guides. Shaft infrastructure, such as ventilation, will be removed on a phased basis in a manner that ensures the provision of required services to the shaft during shaft sealing.

Prior to the start of main shaft decommissioning, the main and auxiliary Koepe friction hoists (hoists used in main shaft during operations) will be removed and stage winches installed to suspend the working platform. In addition a temporary single drum hoist will be installed for worker, material and equipment access during shaft decommissioning and sealing work. Then decommissioning and sealing of main shaft will proceed in a manner similar to that described for the ventilation shaft.

5.4.2 Decommissioning of the Underground Services Area

The work performed during the decommissioning of the underground services area will include preparing this area for and constructing a concrete monolith (OPG 2011a). The monolith will be constructed in two stages.

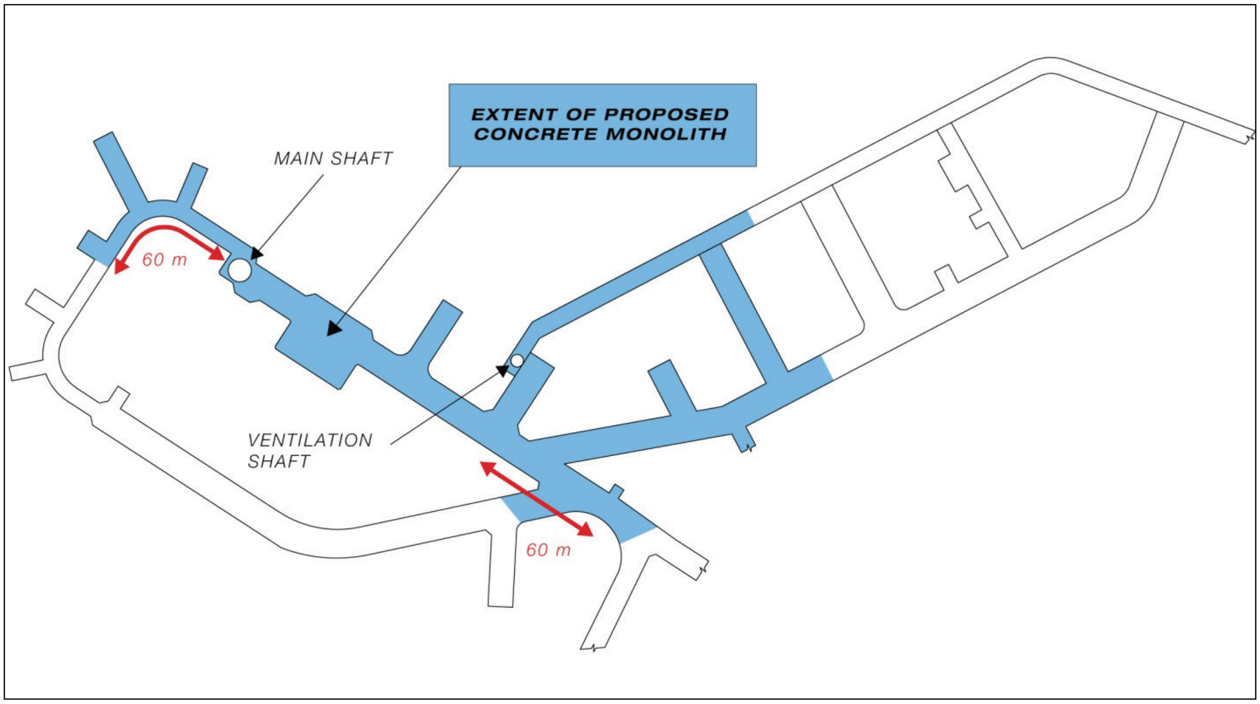
5.4.2.1 Concrete Monolith

A concrete monolith will be constructed at the base of the two shafts. The concrete monolith will provide a stable foundation for the overlying seal materials and a high degree of support to the shaft station rock openings. Low heat of hydration concrete will be used to minimize heat generation and shrinkage. The concrete will be placed to a distance of about 60 m beyond the circumference of the excavated shaft diameter (see Figure 5.2).

The large lateral extent of the monolith provides:

- Margin of safety against loads during glaciation events;

- Extended roof rock support around shaft to ensure that any roof collapse within the panel area does not propagate horizontally into rock around the shafts;
- Controls or limits the propagation of gas from waste-filled panels to the base of the shaft; and
- Greater certainty that bentonite/sand mixture in shafts will not be pushed or creep down from shaft into the repository void space.



Note: Figure is from OPG (2011a).

Figure 5.2: Shaft Services Area Showing the Extent of the Concrete Monolith

The monolith will be created in two stages, one for the ventilation shaft, followed by another for the main shaft. However, they will form one contiguous mass concrete structure and there will be no structural reinforcement within the concrete; i.e., monolith will be a mass concrete structure. All services and utilities will be stripped out of the excavations to be filled by the monolith so as to remove potential voids. Bulkheads will be constructed at the maximum limit of the monolith in the underground services area tunnels and other openings prior to placement of concrete. The concrete monolith will be created by filling the shaft sumps, ramps to the shaft bottom, shaft stations, and the tunnels or peripheral rooms with concrete.

Concrete will be mixed on the surface in a temporary batch plant and then delivered into either shaft through the use of a slickline and header. A slickline is essentially a steel pipe secured to the shaft wall to transport fluid concrete from the surface to the required depth. At the base of the slickline, a slightly larger steel pipe called a header diverts the downward flow of material 45 degrees, dissipating the impact energy of the falling material. A flexible hose is then connected to the header enabling exact placement of the concrete. For concrete that needs to be transferred to locations at a large distance from the base of either shaft, a pumping system will be used to transfer this concrete.

The installation of this monolith could potentially generate large amounts of heat during the concrete curing process. Mass concrete construction procedures will be developed and followed to control heat build-up.

5.4.3 Decommissioning and Sealing the Ventilation Shaft

Decommissioning of the ventilation shaft includes the removal of the shaft infrastructure and the shaft liner. At the same time, the shaft seal system will be installed.

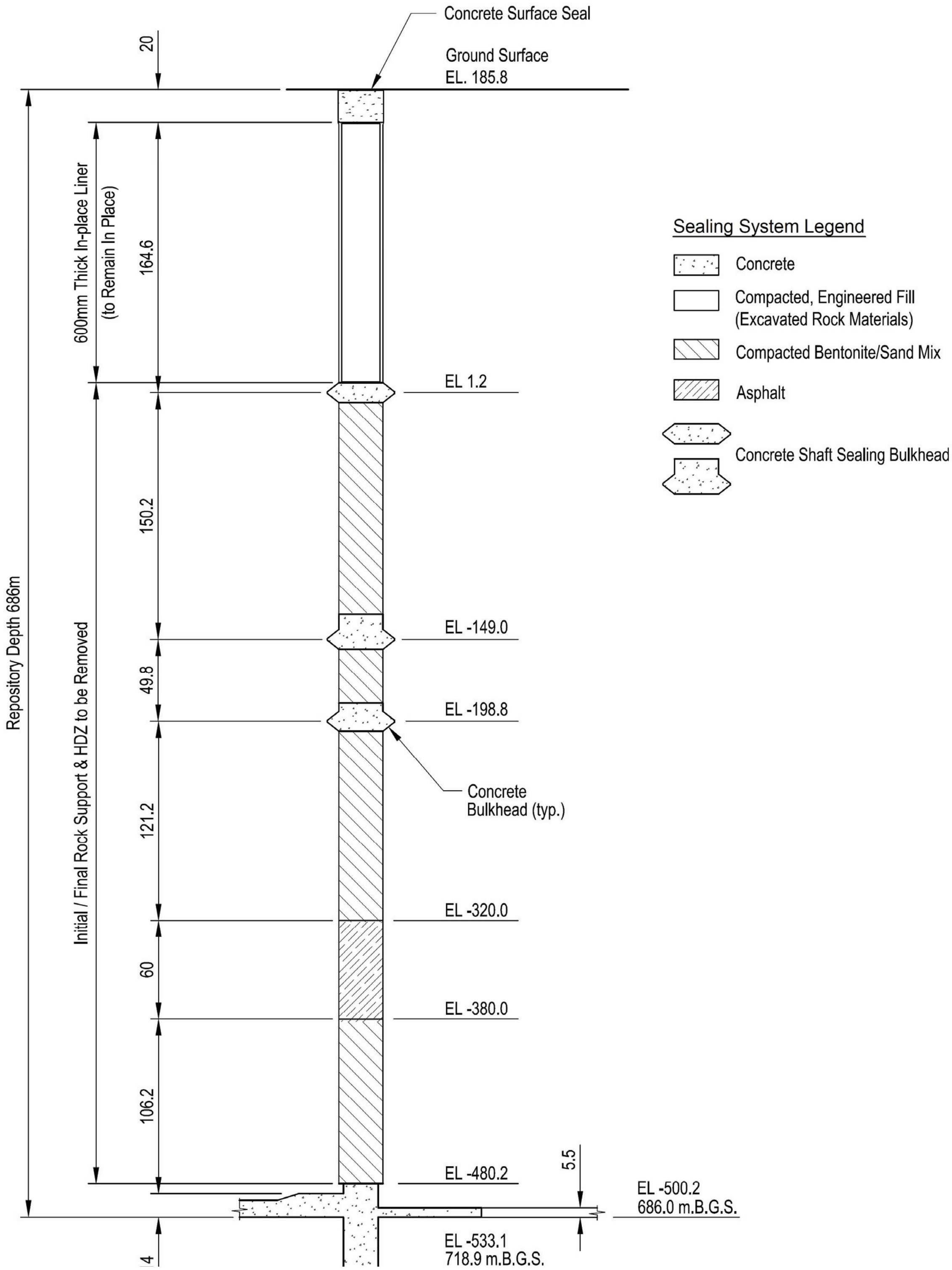
The design and construction of the shaft seal system (long-term passive engineered barrier) are described in Chapter 13 of the PSR (OPG 2011a). The approach for the shaft seal design and construction has focused on the use of simple, relatively well understood and durable materials, and use of proven methodologies for emplacement. The arrangement of the shaft sealing system, selected components and their relative location is shown in Figure 5.3.

The shaft seal system consists of a column of compacted bentonite/sand. Sand and bentonite are durable natural materials that are expected to last for the long term (OPG 2011a). An asphalt column is placed above the first bentonite/sand layer to provide a redundant low permeability sealing material against upward or downward fluid flow. A series of bentonite/sand columns are separated by concrete bulkheads to provide structural components to the column and provide additional sealing capability.

The work performed during decommissioning of the ventilation shaft will consist of sequential removal of shaft infrastructure and installation of the shaft seal materials. Removal of shaft infrastructure will take place on a phased basis to ensure the provision of the required services to the shaft during sealing. Stripping of the shaft concrete liner and the annulus of damaged rock will also take place sequentially with installation of seal materials.

Temporary stage winches will be installed, from which a working platform will be suspended on wire ropes, to provide a surface from which the shaft sealing process will be performed. The existing second egress hoist will be used as the primary means of travel between the surface and the shaft bottom for workers, equipment and materials.

The work associated with installing the shaft seal components (OPG 2011a) is described in the following sections. Provisions for worker safety are also described for the unique hazards that are associated with specific tasks.



Note: Figure is from OPG (2011a).

Figure 5.3: Arrangement of Shaft Seal Components

5.4.3.1 Removal of Shaft Infrastructure

Throughout all seal sections up to the top bulkhead in Figure 5.3, shaft support structures and concrete liners will be removed to ensure a complete seal of the shaft column to the surrounding low permeability host rock. Also, it is assumed that an additional 500 mm of host rock will be excavated beyond the initial shaft diameter to remove any damaged rock that may have formed during shaft sinking and the operational period of the DGR.

All shaft infrastructures will be mechanically cut from the shaft in a series of controlled lifts which are expected to be about 10 m to 20 m in length. Rock bolts will be installed, as required, to support the concrete liner and newly exposed rock where the liner has been removed to allow workers to safely place seal materials. Each section of removal will be closely followed by backfilling of the lift with shaft sealing materials.

5.4.3.2 Bentonite/Sand Mixture

The column of sealing materials is largely comprised of a compacted bentonite/sand mixture (Figure 5.3).

Bentonite will be mixed with sand to a 70:30 mix through the use of a temporary batch plant. The plant would have two hoppers, one holding the sand component and the other holding the bentonite, along with a tank that holds water. The sand and bentonite are fed onto a conveyor belt that feeds a screw-auger which mixes the materials as they approach the discharge spout. Water is applied to the mixture, as required, as it enters the screw-auger. The materials would then be transported directly into the shaft, or stored temporarily within plastic bags to retain moisture levels, and then transported into the shaft.

The bentonite/sand mixture will be placed loose via a slickline and header (similar to that used for placing the concrete), and then compacted in-situ to a dry density of approximately 1600 kg/m^3. Compaction of these materials can be performed using vibratory plate compactors, and sheepsfoot rollers. Seal materials will be placed in roughly 150 mm thick lifts to ensure compaction over full depth of each lift. Smaller compaction equipment will be used in proximity to the shaft walls in order to ensure adequate compaction in this area.

The use of sand will improve workability during placement, ease compaction and dust control.

5.4.3.3 Asphalt

Asphalt was selected because it has the ability to flow and make good contact with host rock. Immediately upon emplacement, the asphalt will create an effective barrier to water flow. The use of another low permeability sealing material provides an additional level of redundancy to the sealing system against upward or downward fluid flow. A 60 m thick asphalt column will be placed above the lowermost bentonite/sand column.

The reference asphalt mixture is based on a mix of asphalt compounds and aggregate, combined with a small porosity fraction to ensure low permeability. The asphalt mix will be prepared on the surface with the use of a temporary pug mill and heated to a temperature that would allow delivery by slickline. Following mixing, asphalt will be pumped to the shaft and placed through the use of a slickline and header. The slickline will require heating in order to maintain the asphalt's viscous state. Asphalt will be placed in controlled lifts. Following placement of an asphalt lift, placement operations will be ceased to allow for cooling of the asphalt and to ensure a safe environment for workers starting placement of the next layer of asphalt (or placement of bentonite/sand mixture at the top of the asphalt column).

In order to promote cooling and to remove any hazardous fumes, ventilation into the shaft will be maintained during this period. Air temperature and quality will be remotely monitored at a location 1-3 m above the asphalt column to establish when it would be safe to re-enter the shaft and resume shaft sealing operations.

5.4.3.4 Concrete Bulkheads

Leading up to the top bulkhead, there are two higher permeability units within the surrounding geosphere: the Guelph Formation and the upper 4 m of Salina A1 carbonate unit (see Figure 2.3). The Guelph Formation has a hydraulic conductivity which is 2 to 3 orders of magnitude greater than adjacent formations. Due to the expected lateral flow along this unit, a concrete cylinder will be placed along the full extent (approximately 6 m) of this unit. In order to ensure structural stability, the underlying concrete structure will be constructed to a height slightly larger than diameter of the excavated shaft. In order to maintain structural stability, the concrete bulkhead will be keyed into the surrounding host rock. The concrete mix will be similar to that selected for the concrete monolith. The concrete/rock interface will also be pressure-grouted to minimise groundwater flow along the interface.

A concrete bulkhead will be installed at the upper 4 m of the Salina A1 carbonate unit and the design will be the same as that proposed for the Guelph Formation.

Salina Unit F represents a lower (at least one order of magnitude) permeability zone within the dolostones (an aquitard) between a fresh water aquifer above and more saline water-bearing formations below. To prevent movement of the poor quality, saline groundwater from the lower Salina Formation upwards through the shaft cross-section into the upper fresh water aquifer, a concrete bulkhead will be constructed at this location.

As with the monolith, concrete for the bulkheads will be placed in mass and with no reinforcing steel, and using measures to control heat build-up. Contact/seal grouting will be applied around the bulkheads in order to minimize the potential impacts of shrinkage at the interface with the host rock formation. Concrete will be poured directly onto the bentonite/sand columns located below each bulkhead.

Because the three concrete bulkheads will be keyed into the adjacent rock, they will provide structural support for the overlying seal materials and confinement of the swelling seal materials between the bulkheads. The location and the need for additional bulkheads will be assessed in future design phases taking into consideration new information from field observations and geomechanical field testing. These confirmatory investigations will assist in the determination of final requirements for bulkheads to be installed during shaft seal construction.

5.4.3.5 Engineered Fill

The uppermost portion of the shaft will be filled with an engineered fill (e.g., ‘Granular A’ material), possibly created from crushed rock obtained during shaft excavation and/or concrete. The fill material will be engineered and compacted. It will not be necessary to remove the concrete liner throughout the section where fill is to be placed. Therefore, it will be left in place to avoid safety risks to workers and the cost associated with its removal; however, the state of the liner and the possibility of removal will be re-examined prior to seal construction to determine if liner removal has any significant benefits.

The rock materials will be crushed and screened prior to placement. This material will then be graded on the surface and hydrated in order to obtain optimal moisture content for compaction. Fill materials will then be transported into the shaft, via a slickline and header, in a manner similar to that proposed for concrete. Following placement, compaction of engineered fill will be completed in the same manner as for bentonite/sand; with the exception that compaction can be accomplished in larger lifts (i.e., 300 mm).

5.4.3.6 Concrete Cap

The engineered fill will be topped by a surficial concrete cap, representing the final element of the seal system. The cap will serve to:

- Further reduce the potential for subsidence, as concrete is stronger than compacted fill;
- Provide a marker for the shaft locations; and
- Reduce the potential for inadvertent human entry by providing a restrictive barrier at the surface.

The surficial cap will be constructed, at a minimum, of concrete to meet CSA A23.1. Air entrainment within the concrete is required to minimize adverse effects of freeze/thaw action on the concrete cap. The surficial cap will be constructed through staged pours, in approximately 3 m lifts. It is currently assumed that structural elements are not required within the concrete.

5.4.4 Constructing the Main Shaft Monolith

The main shaft monolith will be constructed as described in Section 5.4.2 to form one contiguous mass concrete structure with the ventilation shaft monolith.

5.4.5 Decommissioning and Sealing the Main Shaft

The main shaft will be decommissioning and the shaft sealing system will be installed as described in Section 5.4.3. The work performed during decommissioning of the main shaft mainly consists of:

- Removal of the operational main and auxiliary Koepe hoists in the main shaft and replacement with a stage hoist which will be used to suspend a working platform and a single drum hoist for worker, material and equipment access; and
- Sequential removal of shaft infrastructure and installation of the shaft seal materials. Shaft infrastructure will be removed on a phased basis to ensure the provision of the required services to the shaft during sealing. Stripping of the shaft concrete liner and the annulus of damaged rock will also take place sequentially with installation of seal materials.

The shaft sealing design is the same as that described in Section 5.4.3 above.

5.4.6 Decommissioning Surface Facilities

The majority of surface facility decommissioning will occur following completion of shaft sealing, because these facilities will be required to maintain service to the shafts during the installation of the shaft seals. The WPRB will act as a warehouse for the shaft sealing materials and as a maintenance workshop for the seal construction equipment. These facilities will be checked for contamination and decontaminated if required. Any unnecessary equipment and infrastructure will be removed.

The expected order of surface facility decommissioning is as follows:

- Heater building;
- Exhaust fans;
- Ventilation shaft headframe and hoist house, temporary hoisting system and temporary stage winches (installed for shaft stripping and sealing), and collar house;
- Main shaft headframe, temporary hoist system and temporary stage winches (installed for shaft stripping and sealing) as well as the associated buildings, including the WPRB; and
- Electrical substation and emergency generator.

5.4.7 Waste Rock Management Area

The waste rock remaining on the site will be covered by a soil cap and vegetation. The rock pile will be capped with a minimum of 150 mm of soil and topsoil that is suited to the requirements of the local flora. Prior to capping, the waste rock surface will be scarified or ripped in those areas where the rock has been compacted by vehicle traffic. Surface materials will be stabilized and the surface will be contoured as required to promote drainage and to minimize erosion. Wind breaks will be added, if required, for erosion control until such time that the vegetation has taken hold. Any additional rock added during decommissioning will also be capped and vegetated.

In addition, the waste rock pile will be inspected for physical stability during all stages of closure until the site is closed out. The pile would be inspected for tension cracks at the crest of any slopes, signs of new or ongoing failure, and rill or gully erosion both on the rock pile and on the soil cap. The soil cap vegetation will be inspected until it is fully established.

The stormwater pond and drainage ditches will be decommissioned during general site restoration work. They will not be maintained or monitored following decommissioning of the DGR Facility.

5.4.8 Operational Surveys

A series of surveys for radioactive and other hazardous materials will be performed throughout the course of the dismantling work based on available guidelines. Several different types of surveys are likely to be performed at different stages of the decommissioning.

Remediation control surveys will be performed throughout the decommissioning process in order to guide and monitor the decontamination work. They are used to control the exposure of decontamination workers to radiation and hazardous materials. Remediation control surveys are typically based on simple measurements such as contact radiation dose rates or direct contamination checks.

5.5 Site Restoration

Following the removal of all surface facilities this area will be graded and re-vegetated. Re-vegetation will be carried out so as to enhance natural vegetation growth and establish self-sustainable vegetation growth. The location of the shafts will be secured to ensure that the possibility of an accidental disturbance is minimized.

Prior to re-vegetating the site, the ground surface will be scarified or ripped in those areas where the surface has been compacted from vehicle traffic and construction activity. Surface materials will be stabilized and the surface will be contoured as required to blend into the surrounding areas, to promote natural drainage and to minimize erosion. Wind breaks will be added if required for erosion control until such time that the vegetation has taken hold.

A final environmental survey will be performed as part of site restoration work to confirm that there are no residual radioactive or hazardous materials remaining on the site. If necessary, appropriate actions will be taken to remove any radioactive or hazardous materials from the site and to transfer these materials to a licensed disposal facility.

By the end of the site restoration phase, the site areas will be free of industrial hazards. All radioactive contamination (if applicable) in excess of the clearance levels and all other hazardous materials will have been removed from each site area.

5.6 Final Surveys

The final surveys will be performed when the decontamination and decommissioning work is believed to be complete. Final surveys of residual radioactive and hazardous materials (if applicable) will be performed and documented to demonstrate that the final end state for remaining equipment, structures, and the site has been achieved in accordance with the established clearance levels specified in the DDP. These surveys will be performed in accordance with internationally recognized guidelines such as the International Atomic Energy Agency (IAEA) Monitoring Programmes for Unrestricted Release Related to Decommissioning Nuclear Facilities (IAEA 1992) and US survey-related manuals (US 2000, US 2009).

All of the surveys will be performed according to approved procedures that will be based on recognized standards and guidelines in use at the time. The procedures will describe:

- Sampling strategies and methods that will be employed during the survey;
- Instruments and laboratory methods that will be used;
- Statistical techniques that will be used to analyze and interpret the data;
- Documentation that will be prepared and retained; and
- The quality assurance and quality control programs that will be in place.

5.7 End State Report

Following the completion of decommissioning work, an end state report will be prepared. The report will describe the decommissioning work that has been performed, the outcome of that work, the results of the final surveys that were performed and the interpretation of those results. Other information required by the applicable regulations will also be included. The end state report will be filed with the CNSC to demonstrate that the intended end state has been achieved in accordance with the DDP and regulatory requirements.

5.8 Institutional Control

Following site restoration, the site will undergo a period of institutional control, currently assumed to last up to 300 years. Institutional controls will help prevent or reduce the likelihood of human actions inadvertently interfering with the waste or causing degradation of the safety features of the repository. More information on institutional controls can be found in CNSC G-219, Decommissioning Planning for Licensed Activities (CNSC 2000), CNSC Guide G-320, Assessing the Long Term Safety of Radioactive Waste Management (CNSC 2006) and IAEA Safety Standard WS-R-4, Geological Disposal of Radioactive Waste (IAEA 2006).

Given the type of facility and the nature of the hazards present, it is assumed that:

- A period of passive institutional control will be applied to the L&ILW DGR which may include local land use controls; local, national and international records; and the use of durable surface and/or subsurface markers;
- It is anticipated that the site will be available for other purposes that are consistent with any applicable land use restrictions; and
- The period of institutional controls is assumed to be up to 300 years.

This is consistent with national guidance and international practice.

Additional details of the nature of institutional controls will be included in the DDP.

5.9 Licence to Abandon and Abandonment

An application for a Licence to Abandon the facility will be submitted to the CNSC following decommissioning. The application will include:

- The results of the decommissioning; and
- The results of the environmental monitoring programs.

The results of the decommissioning will be described in the end state report.

The results of the environmental monitoring will include the information collected during the course of the decommissioning and during any other monitoring period.

A Licence to Abandon issued by the CNSC may include conditions that would apply throughout the period of institutional controls.

6. DECOMMISSIONING COST ESTIMATES AND FINANCIAL GUARANTEE

6.1 Decommissioning Cost Estimate

The estimated cost for decommissioning of the DGR Facility following operation of the facility for waste emplacement is approximately $322 million (2010 constant dollars). This estimate includes planning and approvals as well as the execution of decommissioning.

The costs are summarized in Table 6.1 and a description of the basis for the cost estimate is presented in this section.

Table 6.1: Decommissioning Cost Estimate

Cost Element	($k)
Site and Facility Preparation	1,594
Preparing for Decommissioning	18,415
Decommissioning of the DGR Facility	
Project/Program Management, Business Support and Technical Support Areas	72,675
Preparation of Winch Rooms	881
Hoisting and Platform Removal	4,613
Removal of Shaft Materials	55,010
Shaft Sealing	93,026
Site Restoration	1,800
Contingency	74,405
Grand Total Cost	**322,419**

6.1.1 Site and Facility Preparation

In preparation for decommissioning planning and execution, radiological surveys will be performed in the WPRB prior to commencing any decommissioning work. It is anticipated that the levels of radiological contamination will be relatively small and, if present, limited to the concrete floor. If contamination is found, it will be removed so that the WPRB can be safely used as a staging area for shaft sealing operations. Also, systems such as electrical systems and portions of the fire protection system, if not required for decommissioning work, will be de-energized. Utilities that are not required to support decommissioning work will be removed. These activities will be completed during the three years prior to facility decommissioning.

6.1.2 Preparing for Decommissioning

The technical support needed to prepare the decommissioning licence application and licensing submissions is expected to consist of support from geoscience, safety assessment, environmental assessment and regulatory affairs. It is anticipated that support throughout the approvals process will also be required and that the total effort would be needed during the three years prior to receiving a licence. The activities associated with this work include the preparation of:

- An environmental assessment;
- The detailed decommissioning plan;
- Safety assessment reports;
- An environmental monitoring program (US/DGR series wells);
- A regional seismic monitoring program;
- Borehole monitoring system maintenance/upgrade;
- Maintenance and archiving of the safety assessment codes, including reference datasets, under a suitable QA system;
- Maintenance and archiving of the reference site numerical model;
- Completion of underground experiments; and
- Community engagement program in support of decommissioning.

6.1.3 Decommissioning of the DGR Facility

In support of the decommissioning, the WPRB will be used as a sealing materials receipt and storage building. All work will be conducted in accordance with the Decommissioning Licence and reports will be submitted to the CNSC as specified in licence conditions. The facility decommissioning period including site restoration is planned to last 5 years and will follow the schedule presented in Figure 5.1.

Decommissioning labour costs have been included for project/program management, execution of field work (construction/demolition crews), and for providing technical support in the areas of safety assessment, geosciences, regulatory affairs, and community engagement throughout the decommissioning. In addition to the labour costs, material costs for specific activities are also included.

6.1.3.1 Decommissioning the Main and Ventilation Shafts

Preparation of Winch Rooms

New hoist houses (or winch rooms) will be constructed for the main shaft and ventilation shaft to house winches for lowering/raising stages. The demolition of these structures at the end of the decommissioning work is also included in the costs. Materials included in the cost estimate consist of such things as:

- Excavation neat;
- Backfill and compact neat;
- Concrete floor slabs, foundations, and footings;
- Steelwork; and
- Side cladding, including insulation and flashing.

Hoisting and Platform Removal

Four winches, four ropes and four sheaves will be required to lower/raise stages. It is anticipated that the same set of winches/ropes/sheaves will be used in ventilation shaft and main shaft. Two stages (one stage for each shaft) will be required to act as a working platform during placement of sealing materials. Also, a temporary hoist and ancillaries will be used to move workers and materials during shaft sealing work in the main shaft. The material costs for this work include stage winches, hoists, stage ropes, and stage sheaves.

Removal of Shaft Materials

Mechanical equipment (if any) to be sealed in the DGR will be secured. All existing utilities, which will be sealed in the DGR, will be dismantled. Ventilation shaft equipment (e.g., conveyances and ropes, excluding the hoist that was used during operations, will be removed during headframe demolition), steelwork and utilities could be disposed of underground in the DGR. Main shaft equipment, concrete lining, steelwork and utilities will be disposed of at a licenced facility. The concrete lining in the main and ventilation shafts will be removed by mechanically methods. It is assumed that the work will be executed as 1.5 m cut sections per shift to allow for the placement of sealing materials and that 486 m of concrete lining will be removed. A 500-mm annulus of damaged rock will also be removed at this same location.

Both headframes and all surface infrastructures will be demolished and removed to appropriate waste facilities outside of the Bruce nuclear site. The cost of demolition is based on labour and equipment requirements multiplied by estimated duration of demolition.

The most significant cost items consist of the removal and disposal of the concrete liner and the rock excavation.

Shaft Sealing

Asphalt, concrete, a bentonite/sand mixture, grout and engineered backfill materials will be required to seal the shafts. Costs for all sealing materials including delivery to the site, mixing, handling, and transfer down the shaft to the location of placement are captured in the cost estimate. It is assumed that the bentonite/sand mixture will be placed at 900 mm per day in 150 mm lifts. The total length of bentonite/sand mixture in two shafts is 766 m which translates into 852 days to place mixture in both shafts. Labour costs to place the materials as well as growth allowances were built into the unit rates. The exception is grout where the labour cost to place the material is included in the construction labour for concrete monolith and bulkheads. Installation costs are assumed at placement location for all materials. The bentonite/sand mixture and cement are the most significant cost contributors of the shaft sealing system.

Site Restoration

General restoration of the site will be completed once the shafts have been sealed and the surface infrastructure has been removed. Also, the waste rock pile will be capped with 150 mm of soil and vegetated. It is estimated that the waste rock pile area will be 10 ha and will require 15,000 m^3 of soil.

6.1.4 Contingency

A contingency of 30% has been included in this cost estimate due to the uncertainty associated with these preliminary cost estimates. Most of the uncertainty is associated with the shaft sealing work. The potential salvage value associated with structures, systems, components, and equipment has not been considered in the cost estimate. While reasonable assumptions have been made about the design of the shaft sealing system and its construction, the methods to be used cannot be fully defined until laboratory and field investigations are performed near the end of repository operations.

6.2 Present Value of the Decommissioning Cost

The total estimated cost of the decommissioning program when converted to 2013 present value dollars is $95 million. This assumes a decommissioning period from 2055 to 2062 in Figure 5.1.

6.3 Financial Guarantee

The financial guarantee arrangement to support a licence to site and construct the DGR Facility is discussed in Appendix B.

7. HUMAN FACTORS

OPG will ensure that human factors issues are considered throughout the planning and execution of the decommissioning project. The DGR Facility DDP will have a Human Factors Engineering (HFE) program that will address human factors considerations for DGR Facility decommissioning. The HFE program will be written in accordance with the available CNSC regulatory guidance at the time. The HFE program will describe the HFE input into the project (including integration into project processes and timelines) and provide a description of the methods of addressing HFE technical elements (CNSC 2003).

In order to ensure effective and timely application of Human Factors principles and guidance, the human factors activities covered in the HFE program will align with the activities of the DGR Facility decommissioning project in terms of schedule and resources. Human Factors considerations will be incorporated into the design of the tools, equipment, and tasks necessary to support the decommissioning staff in executing decommissioning tasks. Specifically, the DDP HFE program will ensure that relevant information about DGR Facility radioactive waste and SSCs is appropriately retained and transitioned as staff attrition throughout the DGR Facility decommissioning project life cycle. The mechanisms for the retention and transition of information, whether they are administrative or engineered, will take into consideration changes in technology and organizational restructuring to ensure that information retrieval is possible.

The HFE program will also take into consideration surveillance and monitoring of SSCs. A plan will be in place to guarantee that the systems that support this function are available to decommissioning staff up until these systems have to be decommissioned as well.

In addition to the installation of engineered barriers, a decommissioning project must also focus on issues surrounding administrative barriers in staffing, training, procedure development, and human performance monitoring. The roles and responsibilities of the workers as well as the lines of authority when it comes to decommissioning operations (i.e., normal, abnormal, and emergency operations) will be defined. In order to effectively manage training for both site staff and contractors a training program and plan which adheres to the systems approach to training will also be developed for DGR Facility decommissioning.

Finally, a program will be developed in conjunction with existing OPG practices on human performance monitoring to effectively measure human performance and record events during the DGR Facility decommissioning.

8. WASTE MANAGEMENT

8.1 Radioactive Waste

All waste packages will be checked for contamination, and decontaminated if necessary, before they are placed in the DGR Facility. Abnormal operating occurrences may result in some contamination events during the course of operations however, it is anticipated that any such contamination will be removed whenever it is discovered. It is expected that there will be minimal or no radioactive contamination on facility structures, systems and equipment. Consequently, the volume of radioactive waste generated during the decommissioning is expected to be generated from the surface facilities (mainly from the WPRB) and is roughly estimated to be 10 m^3 (OPG 2011a), in addition to the waste in Section 8.3. Operational experience and radiological surveys will be used to prepare a revised estimate for the DDP.

8.2 Hazardous Waste

Hazardous materials, other than radioactive materials, that are expected to be generated during the decommissioning of the DGR Facility are shown in Table 8.1. These wastes will mainly be generated as a result of decommissioning and sealing the ventilation and main shafts.

Table 8.1: Hazardous Materials Arising from the Decommissioning

Waste Material	Projected Range of Output
Oils and grease	15,000 – 18,000 L per year
Batteries	60 – 80 kg per year
Solvents	1,500 – 2,500 L per year
Domestic waste	25,000 – 35,000 kg per year
Sanitary waste	8,000 – 12,000 kg per year

Note: Projections from OPG (2011a).

OPG will register as a generator of hazardous wastes as appropriate. At the time of shutdown any surplus hazardous materials will be removed from the facility for disposal at a licensed hazardous waste management facility. Any hazardous materials that may be required during the course of the decommissioning will be removed from the facility prior to the completion of the decommissioning for disposal at a licensed hazardous waste management facility.

8.3 Demolition Waste

Wherever appropriate, equipment and materials from demolition of surface and underground facilities will be recycled or reused elsewhere to minimize requirements for disposal. Those materials that are not recycled will be disposed of in a licensed disposal facility. Any materials or equipment in surface facilities that would be considered radioactive waste will be removed near the start of decommissioning and placed in the underground repository prior to the start of shaft sealing.

It is currently assumed that underground mobile equipment, which has been tested and does not contain any residual radioactive contamination, will be removed to the surface. Once at surface, it is possible that some of the equipment and materials could be salvaged for reuse or for its scrap metal. Alternatively, if the equipment has no value and space is available and approval is received to do so, then the mobile equipment could remain underground. In these instances, all fluids (e.g., fuel, lubricants, hydraulic fluids, etc.) and any other hazardous materials (e.g., batteries) would be removed prior to leaving any equipment underground.

Waste materials resulting from the removal of ventilation shaft and main shaft infrastructure (such as shaft steelwork and concrete lining) will be brought to the surface and reused/recycled wherever possible. Similarly waste rock resulting from excavation of any damaged rock in two shafts will be reused on site wherever possible (e.g., as engineered fill in upper portion of shafts; see Figure 5.3) or could be placed in the WRMA, as noted in Section 5.4.7. Materials from decommissioning of ventilation shaft and main shaft that cannot be reused or recycled will be sent to a licensed disposal facility.

Table 8.2 presents the estimated quantity of waste materials that would arise from the decommissioning of the DGR Facility. As noted above, it is assumed that contamination that could occur during abnormal operational occurrences would have been decontaminated during the specific operational activity.

Since the demolition project involved in the decommissioning of the DGR Facility consists of a total floor area of at least 2000 m^2, a waste reduction plan will have to be prepared on the basis of a waste audit (Government of Ontario 1994).

Table 8.2: Waste Materials Arising from Decommissioning

Structure	Material Type	Quantity[a]
Ventilation shaft	Steel	490 tonnes
	Concrete	5,600 m^3 [b]
	Waste Rock (HDZ)	7,000 m^3
Ventilation shaft headframe	Steel	520 tonnes
	Concrete	260 m^3
Main shaft	Steel	780 tonnes
	Concrete	9,100 m^3
	Waste Rock (HDZ)	8,800 m^3
Main shaft headframe and WPRB	Steel	380 tonnes
	Concrete	8,700 m^3
Other items such as miscellaneous cabling, panels, and other equipment		

Notes:

Projections from OPG (2011a).

a. Volumes (in m^3) of material are bulked volumes.

b. It is assumed that less than 10% of the ventilation shaft concrete could be contaminated. However, it would be impractical to separate the contaminated concrete from the remainder of the concrete liner.

9. ENVIRONMENTAL IMPACTS

This chapter is intended to identify some of the areas in which major impacts on the natural and human environments are anticipated due to decommissioning activities at the DGR Facility. This list is not intended to be exhaustive, and a thorough assessment of the environmental and socio-economic impacts of the decommissioning project will be performed during the detailed planning process prior to facility shutdown.

9.1 Natural Environment

9.1.1 Air Quality

Heavy construction equipment and vehicles used to transport materials and waste during decommissioning activities may emit exhaust gasses into the atmosphere. The types and quantity of these emissions will depend upon the nature of the equipment available and in common use at the time. There may also be localized, temporary reductions in air quality due to dusts generated by cutting operations during dismantling and the traffic associated with decommissioning.

9.1.2 Land use

Land use will not change since it is anticipated that the land will continue to be owned and maintained by OPG following decommissioning and will continue to be used for industrial purposes in general. Decommissioning activities themselves are not expected to have any impact on the use of lands surrounding the DGR site.

9.1.3 Vegetation

The operating area of the DGR Facility will be highly developed, with most of the areas without buildings on them covered by asphalt. The most heavily vegetated areas surrounding the site are well removed from the facility and therefore, not likely to be impacted by decommissioning activities. Dust fall can affect any nearby vegetation, while silt and run-off can affect aquatic vegetation. In the final stages of decommissioning, following demolition of the surface facilities the site will be re-vegetated.

9.1.4 Wildlife

Wildlife activity within the DGR site boundary during facility operation is expected to be minimal due to a lack of habitat. However, wildlife is known to occupy areas of the Bruce nuclear site. During the phases of decommissioning when the level of activity on the site will increase there may be some resulting impact on wildlife populations. Potential effects may be caused by increased dust, noise and sediment runoffs due to dismantling work. Increased traffic volumes during some phases of decommissioning may also have an impact on wildlife due to traffic noise and collisions between vehicles and animals.

9.1.5 Water Quality and Aquatic Life

The DGR Facility is physically removed from the shore of Lake Huron and as a result decommissioning activities are not expected to have a direct impact on the lake. An extensive drainage system provides drainage for the Bruce nuclear site, including the DGR Facility area. Drainage generally flows from the vicinity of the DGR surface facilities and WRMA in a north-westerly direction, discharging into Lake Huron through drainage ditches on the Bruce nuclear site. The exception is the south-eastern portion of the WRMA, which drains into an abandoned railway ditch, eventually flowing into Lake Huron via a stream that was diverted to Baie du Doré during development of the Bruce nuclear site in the 1960s (OPG 2011a). Some increase in turbidity of the water along the railway ditch may result from dismantling and site restoration work. This may have a temporary impact on any aquatic life in that area.

Since there is no waterway leading from the DGR Facility to Little Sauble River, decommissioning of the DGR Facility is not expected to have any impact on Little Sauble River, the environmentally significant wetland area at Douglas Point Swamp and Baie du Doré.

9.1.6 Noise Levels

Dismantling work may involve the use of heavy construction equipment, which may produce localized elevated noise levels. These effects are likely to be limited to the Bruce nuclear site and affect site workers and wildlife.

9.2 Human and Socio-economic Environment

CNSC Regulatory Guide G-219 specifies that a PDP should include the "identification of any features of the surrounding social environment that could be significantly affected by the decommissioning process" (CNSC 2000). The impacts resulting from the decommissioning process will be assessed in a future environmental assessment and their significance determined at that time.

10. HEALTH AND SAFETY

All decommissioning work will be performed in compliance with the Ontario Occupational Health and Safety Act and Regulations (Government of Ontario 2009).

10.1 Hazard Assessment

Radiological, chemical and construction hazards are expected during decommissioning of the DGR Facility. These hazards are expected to be similar in nature to those anticipated during any dismantling or demolition work at a nuclear facility.

A thorough assessment of the hazards that may be encountered during decommissioning of the DGR Facility will be performed during the detailed planning process prior to facility shutdown. Some of the potential hazards are summarized below.

10.1.1 Radiological Hazards

The radiological hazards to which workers may be exposed during decommissioning include radiation dose rates from the L&ILW emplaced in the repository and low levels of contamination on the surfaces of equipment and structures. The L&ILW in the emplacement rooms will be isolated behind thick closure walls and they will not be handled during the course of the decommissioning work.

In any waste emplacement rooms that have not yet been isolated through installation of a closure wall, the dose rates are expected to be no greater than those present during normal waste emplacement operations. In areas outside of the emplacement rooms dose rates will be limited by room end walls to be put in place once an emplacement room is filled to capacity with waste packages. In accordance with OPG Radiation Protection Requirements, the dose rate outside an emplacement room will not exceed 25 μSv/hr. Therefore, in the emplacement room access ways, shafts and surface infrastructure, radiation fields will be low and the external radiation hazard will be minimal.

As discussed in Section 8.1, all waste packages will be checked for contamination, and decontaminated if necessary, before they are placed in the DGR. Abnormal operating occurrences may result in some portions becoming contaminated during the course of operations however, it is anticipated that any such contamination will be removed whenever it is discovered. Consequently, it is assumed that radioactive contamination on facility structures, systems and equipment will be negligible.

10.1.2 Chemical Hazards

The potential chemical hazards anticipated during decommissioning include cleaning agents used during decontamination work and concrete rock dust generated during dismantling work and fires. Exposure to dusts can be controlled through the use of local ventilation and respiratory protection.

10.1.3 Construction Hazards

Construction hazards that may be encountered during the decommissioning activities will be similar to those encountered in any other industrial demolition project. These may include:

- Operation of heavy construction equipment;

- Fires caused by cutting torches and grinders;
- Collapsing structures during demolition;
- Demolition techniques, such as blasting;
- Hazards routinely encountered during construction work, such as falls, heavy lifts, falling objects and the use of hand tools; and
- Rock fall events and fires. Additional care and design considerations must be employed in order to ensure that rock fall and fire safety are considered of paramount importance due to the confined nature of the underground repository; similar to that of a mine.

10.2 Radiological and Environmental Safety

All decommissioning activities will be performed in accordance with the As Low as Reasonably Achievable (ALARA) principle, with provisions for personnel dosimetry and in accordance withradiation and environmental protection procedures. As mentioned above, the primary radiological concern for areas outside of waste emplacement rooms is low-level contamination. OPG's radiological work planning process will be followed in the unlikely event that it becomes necessary to perform any radiation work during the course of the decommissioning.

Should radiological contamination be encountered in surface areas or infrastructure then personnel will be required to leave the area, thereby minimizing exposure. The contamination will be contained and cleaned by a trained crew of DGR Facility personnel in accordance with an approved procedure. A radiological contamination event in an underground facility is of greater significance due to the potential for contamination spread through the ventilation system and due to the enclosed nature of the areas. Should contamination be encountered in an underground facility then personnel will be required to evacuate the area and proceed to a refuge station. An evacuation plan would be developed to remove personnel safely to the surface. Once personnel are safely evacuated, a cleanup plan would be developed and implemented by a trained crew, directed by the Health Physicist. Changes may also be made to the ventilation system in order to prevent the spread of contamination once personnel are evacuated and it is safe to do so (OPG 2011a).

10.3 Chemical and Construction Safety

All decommissioning work will be performed in accordance with applicable provincial and federal occupational health and safety regulations. OPG will also ensure that work meets the requirements of the OPG occupational health and safety program, which meets the requirements of the Occupational Health and Safety Act of Ontario (Government of Ontario 2009). Any subcontractors involved in the decommissioning work will also be required to maintain occupational health and safety programs that are consistent with OPG's program. The OPG health and safety program identifies:

- The right of employees to know the hazards associated with their work;
- The right of employees to participate in decisions related to health and safety; and
- The right of employees to refuse to perform work that is unsafe.

10.4 Emergency Response Planning

A detailed assessment of the potential hazards to workers, the public and the environment will be carried out during development of the DDP. At all stages of the decommissioning work OPG will ensure that:

- Required emergency response plans and procedures will be in place;
- Response plans will be reviewed and practiced;
- There will be an adequate number of personnel available to respond to real or potential emergency situations; and
- Necessary emergency equipment will be available for use by emergency response personnel.

Specifically, emergency response procedures are anticipated for (but not limited to) the specific cases of rock fall events, fires, radiological contamination events, medical emergencies and injuries. As mentioned in Chapter 6 of the DGR Facility Preliminary Safety Report, a Mine Rescue Team will be available to respond to any potential fires, rock fall events or other non-radiological emergencies that might occur during the course of the decommissioning work.

11. SECURITY

During decommissioning, OPG will be responsible for the security of the DGR Facility throughout the course of decommissioning activities. Any contractors and subcontractors involved in the decommissioning work will be required to comply with OPG procedures regarding physical security.

12. QUALITY ASSURANCE

OPG will incorporate quality programs to ensure that all appropriate requirements, including protection of workers, the public and the environment, are met during decommissioning of the DGR Facility. OPG's Management System, which meets the requirements of CSA N286, Management System Requirements for Nuclear Power Plants will be in force during operation of the DGR Facility and will continue to be in force during decommissioning activities.

13. DOCUMENTATION (RECORDS)

Documentation and records related to the DGR Facility and its decommissioning will be maintained in accordance with the Nuclear Safety and Control Act (Government of Canada 1997). Records will be assembled and maintained in secure storage, in the storage medium in standard use at the time of the decommissioning, in duplicate. As required by the NSCA and its associated regulations, records will be retained for at least ten years after the expiry date of either the Licence to Abandon or an exemption from licensing. However, due to the long-term nature of the facility, regulatory expectations at the time of obtaining the Licence to Abandon will determine the future course of action on the length of extended retention period required and the type and material form of records to be preserved.

The documentation and records that will be maintained are listed below.

- The DDP.
- Public consultation and communication records.
- The environmental assessment report.
- Licences and permits required for the decommissioning work.
- The procedures used in decommissioning.
- Reports and other documents that describe:
  - The criteria used to define radioactive and hazardous materials and to distinguish contaminated from uncontaminated materials and the principles and models used to derive these criteria;
  - The criteria used to define the final decontaminated state of the facility and the principles and models use to derive these criteria;
  - The effectiveness of the decontamination processes or methods used;
  - The amounts of radioactive and hazardous materials removed and the disposition method;
  - The equipment and materials removed from the facility for recycling or use elsewhere, their treatment prior to removal from the site, and the disposition method;
  - The survey methods and types of instruments used; and
  - The equipment, materials, and structures remaining at the end of decommissioning.
- Reports, other documents, and photographs describing findings from inspections, modifications, and repairs to structures, systems, and equipment.
- Reports and other documents that describe unplanned or unusual occurrences, as well as any remedial actions taken.
- Results and interpretations of environmental monitoring programs.
- Occupational dose records.
- Deviations from plans and procedures.
- Quality assurance records.
- Facility inspection, maintenance, and equipment records.
- The final radiological and hazardous materials survey.
- The end-state report, including the radioactive waste inventory of the DGR.

14. PERIODIC REVIEW OF THE PDP

OPG will periodically review and update the PDP, as required. The next anticipated review and update to this PDP is prior to the next licensing milestone for the DGR Facility. This is expected to be upon application to the CNSC for a Licence to Operate the DGR Facility. The update will include, if appropriate, changes in site conditions, changes to the proposed decommissioning objectives or strategy, advances in technology, updated cost information, revised regulatory requirements, or revised records requirements.

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16. UNITS

Bq	becquerel
h	hour
ha	hectare
kg	kilogram
km	kilometre
kV	kilovolt
m	metre
m^2	square metre
m^3	cubic metre
mm	millimetre
mBGS	metres below ground surface
mSv	millisievert

17. ABBREVIATIONS AND ACRONYMS

AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable
ANDRA	Agence nationale pour la gestion des déchets radioactifs (French National Agency for Radioactive Waste Management)
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DDP	Detailed Decommissioning Plan
DGR	Deep Geologic Repository
HDZ	Highly Damaged Zone
HFE	Human Factors Engineering
IAEA	International Atomic Energy Agency
ILW	Intermediate-Level Waste
L&ILW	Low and Intermediate Level Waste
LLW	Low-Level Waste
OPG	Ontario Power Generation
PDP	Preliminary Decommissioning Plan
SON	Saugeen Ojibway Nation
SSCs	Structures, Systems and Components
URL	Underground Research Laboratory
US	United States
WIPP	Waste Isolation Pilot Plant
WPRB	Waste Package Receiving Building
WRMA	Waste Rock Management Area
WWMF	Western Waste Management Facility

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APPENDICES

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APPENDIX A: MAPPING BETWEEN CSA N294-09, CNSC G-219 AND THIS PLAN

N294-09 Annex A Section A.2 Item	CSA Standard N294-09 Descriptions	CNSC G-219 Related Clause	Chapter/ Section in this Plan
a	A description of the location of the facility, including	Section 6.1.2 #1	
	(i) a map of the facility and its specifications;		Figure 2.2
	(ii) geographic information;		2.1
	(iii) details regarding the surrounding environment;		2.2.1, 2.2.2, 2.2.4, 2.2.5
	(iv) land uses; and		2.2.3, 2.2.6, 2.2.7, 2.2.8
	(v) illustrations and maps of the facility in relation to the municipality;		Figure 2.1
b	Purpose and description of the facility, including	Section 6.1.2 # 1, 4	
	(i) primary components and systems;		3.1 &
	(ii) building type and construction, including location of any hazardous building materials (e.g., asbestos, PCBs);		3.2
	(iii) building services (e.g., power, heating, ventilation, sewer, water, fire protection);		3.1.1.4, 3.1.1.5, 3.1.2.3, 3.1.3
	(iv) laboratories and other hazardous handling areas;		3.1.1.2 & 3.2.3.1
	(v) type, quantity, and form of radioactive and hazardous materials stored, produced, or used during operation; and		3.2.3.5
	(vi) design features used to reduce the spread of contamination and facilitate decontamination and dismantling;		3.1.1.2, 3.1.1.6
c	Post-operational conditions, including	Section 6.1.2 # 2	
	(i) a summary of the shutdown process, including planned removal of stored inventories of hazardous materials;		5.2.4, 5.3
	(ii) the predicted nature and extent of contamination remaining in the primary systems and components (in list or table format with reference to applicable illustrations);		4.3.5, 5.2.4 Table 5.1

N294-09 Annex A Section A.2 Item	CSA Standard N294-09 Descriptions	CNSC G-219 Related Clause	Chapter/ Section in this Plan
	(iii) the predicted nature and extent of contamination on floors, walls, work surfaces, ventilation systems, etc.; and		4.3.5, 5.2.4
	(iv) the identification of any separate planning envelopes;		Ch. 5 Intro, 5.1
d	The decommissioning strategy, including	Section 6.1.2 # 5, 6	
	(i) the final end-state objective;		4.3
	(ii) rationale for		
	(1) the decommissioning strategy selected;		4.4, 4.4.1
	(2) interim end states;		
	(3) periods of storage with surveillance; and		
	(4) in-situ disposal concepts;		
	(iii) the requirements for long-term institutional controls; and		5.8
	(iv) the assessment of alternative strategies (or a rationale for why alternatives do not exist or do not warrant consideration);		4.4.1
e	A decommissioning work plan, including	Section 6.1.2 # 2, 3,4, 7, 8	
	(i) a summary of the main steps for decontamination/disassembly/removal of each of the components and systems (preferably grouped into work packages);		5.4 (5.4.1-5.4.8)
	(ii) for each work package, identification of those types of activities that could pose a significant hazard to workers, the public, or the environment;		5.4 (5.4.1-5.4.8), 10.1
	(iii) the role of existing operational standard procedures for radiation protection, hazardous materials handling, industrial safety, and environmental protection in managing hazards;		10.2, 10.3

N294-09 Annex A Section A.2 Item	CSA Standard N294-09 Descriptions	CNSC G-219 Related Clause	Chapter/ Section in this Plan
	(iv) specific activities for which additional protection/mitigation procedures will be required at the detailed planning stage;		5.4 (5.4.1-5.4.8)
	(v) a summary of the final dismantlement of the structures/components; and		5.4 (5.4.1-5.4.8)
	(vi) a conceptual schedule showing the approximate year of facility shutdown and the approximate sequencing and duration of the decommissioning work packages and, where relevant, storage periods;		Figure 5.1
f	Radiological monitoring and survey commitments, including	Section 6.1.2 # 7	
	(i) a program for conducting periodic contamination surveys and the recording of contamination events during facility operation;		5.2.4
	(ii) a commitment to conduct detailed post-operation surveys in support of DDP development;		5.2.1
	(iii) a commitment to develop plans and protocols acceptable to the regulatory authority at the detailed planning stage for monitoring		
	(1) work hazards during decommissioning;		10.1
	(2) personnel dosimetry;		10.2
	(3) environmental emissions and effluents; and		10.2
	(4) materials, sites, and structures to be cleared from regulatory control		5.6
g	A waste management strategy specifying	Section 6.1.2 #7	
	(i) the approximate quantities and characteristics of radioactive and chemically hazardous wastes expected to arise from the decommissioning (tied to specific work packages, if possible);		8.1, 8.2

N294-09 Annex A Section A.2 Item	CSA Standard N294-09 Descriptions	CNSC G-219 Related Clause	Chapter/ Section in this Plan
	(ii) the anticipated final disposition of radioactive and chemically hazardous materials; and (iii) a commitment to segregate as much material as possible for reuse and recycling;		8.1, 8.2 8.3
h	The cost and a financial guarantee, specifying (i) an estimate of the total present-value cost of the decommissioning; (ii) a reasonable basis for how cost estimates were derived; and (iii) a description of how the required funds will be provided;	Section 6.1.2 # 9, 10	6, Appendix B
i	A commitment to prepare a DDP or final decommissioning plan for regulatory approval prior to decommissioning and, if possible, one year prior to the scheduled shutdown of the facility;	Section 6.1.2 # 1	5.2.1
j	A commitment to periodically review and update the PDP until a DDP is prepared, in accordance with (i) changes in site conditions, including climate; (ii) changes to the decommissioning objectives or strategy; (iii) advances in decommissioning technology; (iv) modifications to the facility; (v) updated cost and funding information; (vi) revised regulatory requirements; and (vii) revised records requirements;	Section 6.1.2 # 11	14.
k	The physical state of the facility at (i) the end of operations; and (ii) the start of decommissioning;	Not a specific requirement by G-219	5.2.4 5.3

N294-09 Annex A Section A.2 Item	CSA Standard N294-09 Descriptions	CNSC G-219 Related Clause	Chapter/ Section in this Plan
l	The records required for decommissioning, including a description of the facility operational records that will be maintained to periodically update the PDP and prepare the DDP(s)	Section 6.1.2 # 11	13.
m	A public consultation plan, including a public information program and avenues for public participation.	Not required by G-219 Note: CNSC Guide G-217 (CNSC 2004) refers to Licensee Public Information Programs	5.2.3

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APPENDIX B: DECOMMISSIONING FOLLOWING CONSTRUCTION

To fulfill the financial guarantee requirement of the General Nuclear Safety and Control Regulations, clause 3(1)(*l*), this appendix describes the decommissioning of the DGR Facility for the activity to be licensed (site preparation and construction) in the event that it is decided to suspend construction prior to completion or prior to shut down of a fully constructed facility prior to the beginning of waste emplacement operations. In either case, it is assumed that waste emplacement operations have not begun, and that there is no intention to begin them prior to decommissioning. Decommissioning during or following construction will be similar to decommissioning following operation with one significant difference – the absence of any radioactive materials in the DGR emplacement rooms. Since, in this scenario, no radioactive waste will have been handled at the DGR Facility, decommissioning will not involve any radiological considerations. The following sections describe how the PDP for this case differs from decommissioning of the DGR Facility following waste emplacement.

B.1 Preliminary Decommissioning Plan

The scope of decommissioning following construction will remain the same and include all SSCs located within the security fence that will surround the DGR Facility. The objective to permanently retire the DGR Facility from service and restore the site to the desired end state will also remain the same. Decommissioning following construction will be complete when:

- The underground facilities and shaft infrastructure has been removed, as required;
- The surface facilities have been stripped and removed;
- The shafts have been capped; and
- The site has been restored.

After decommissioning, it is anticipated that OPG will retain ownership and maintenance of the property.

The desired end state dictates the decommissioning strategy. OPG's reference decommissioning strategy following construction is based on the fundamental assumption that no radioactive wastes will have been stored at the facility at the time of decommissioning. While still under the jurisdiction of the CNSC and subject to all of the associated licensing requirements, the decommissioning strategy will also be consistent with the Ontario Regulation 240, Mine Development and Closure (Government of Ontario 2007), as the absence of any radiological materials makes the project closely related to closure of a mine. As in the general case, the decommissioning strategy would be one of prompt decommissioning, whereby, the surface infrastructure and buildings, underground facilities and infrastructure, shaft infrastructure and the site drainage system will be immediately dismantled and removed. The ventilation and main shafts will be capped and the site will be restored.

Decommissioning of the DGR Facility following construction but prior to operation presents a situation similar to that of decommissioning AECL's URL near Pinawa, Manitoba. The URL was used to perform research regarding deep geologic repositories, and no spent fuel or high-level radioactive materials were ever placed there. The URL contained two underground radioisotope laboratories that had been closed and decontaminated prior to shutdown. This is considered similar to the situation that would exist if the DGR Facility has been constructed but no L&ILW has yet been emplaced there.

Since the two underground radioisotope laboratories in the URL had been closed and decontaminated prior to shutdown, the site was no longer licensed by the CNSC.

Consequently, it was determined that the URL decommissioning project was much more closely related to a mine shutdown than a nuclear decommissioning project and therefore it was subject to Provincial Mining Acts and Regulations (Government of Canada 2008). However, the DGR Facility will be a licensed nuclear facility during its construction and the relevant CNSC nuclear facility regulations will apply.

B.2 Description of Decommissioning Activities

In the event that decommissioning is required post-construction or prior to its completion, decommissioning begins when the decision is made not to proceed with waste emplacement operations. The decommissioning process will follow the general steps outlined in Chapter 5; however, the process will be much simpler and will exclude the construction of the concrete monolith and the shaft seal system. No radioactive surveys will be performed, as there will not be any radioactive material in the DGR Facility post-construction. After decommissioning is complete, the site will be abandoned in situ and available for other uses. Decommissioning of the DGR Facility post-construction will not involve a period of institutional controls. The schedule for decommissioning of a fully constructed facility is presented in Figure B.1.

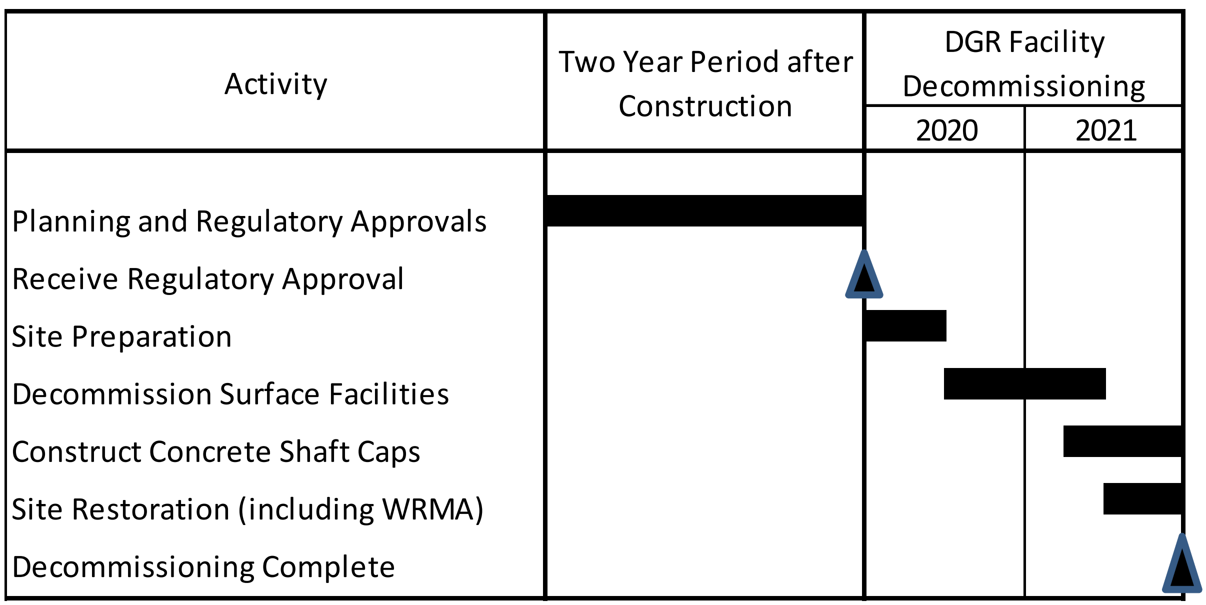

Figure B.1: End of Construction Decommissioning Schedule

B.3 Decommissioning Cost Estimates and Financial Guarantee

The cost of decommissioning a fully constructed DGR Facility, prior to waste emplacement, has been estimated to be $21.0 million (2010 constant dollars). The main cost elements are summarized in Table B.1.

The cost estimate developed for decommissioning following or during construction was developed by scaling down the cost estimate for decommissioning following operation based on reductions in the work scope described in Chapter 6. The estimate includes preparing for decommissioning as well as the execution of decommissioning. A public involvement program to be implemented both during the regulatory approvals process and during the execution of decommissioning work is also included.

Table B.1: Decommissioning Cost Estimate

Cost Element	($k)
Site and Facility Preparation	594
Preparing for Decommissioning	4,279
Decommissioning of the DGR Facility	
Program Management, Business Support and Technical Support Areas	3,607
Hoisting and Platform Removal	1,140
Removal of Shaft Materials	2,745
Shaft Sealing	1,967
Site Restoration	1,800
Contingency	4,840
Grand Total Cost	**20,972**

A contingency of 30% has been included in this cost estimate due to uncertainties associated with the scope of decommissioning. Most of the uncertainty is related to the fact that shaft capping requirements cannot be fully defined until discussions are held with the CNSC should the decision be made to decommission following construction. The potential salvage value associated with structures, systems, components, and equipment has not been considered in the cost estimate.

The total estimated cost of the decommissioning in 2013 present value dollars is $17.7 million. A financial guarantee for post construction decommissioning will be provided. This financial guarantee provides assurance that adequate funds are available to fund decommissioning obligations during the DGR Facility construction period. This financial guarantee is staged during the construction period to recognize liabilities as they build during construction. Details on the financial guarantee are submitted separately as part of the licence application.

B.4 Human Factors

Unlike decommissioning of a facility with radioactive L&ILW, the HFE program for decommissioning of a facility with no radioactive waste will focus more on minimizing conventional industrial health and safety consequences. The need for ensuring surveillance and monitoring as well as concern over the removal of engineered barriers will be minimal.

B.5 Waste Management

For decommissioning the DGR Facility prior to operation for L&ILW emplacement no radiological waste would be present since the DGR would not be housing any radioactive materials. Therefore, the only waste generated would be of a chemical and/or industrial nature and can be disposed of as discussed in Sections 8.2 and 8.3 respectively.

B.6 Environmental Impacts

The impact of decommissioning prior to operation of the facility on the natural, human and socio-economic environments will be no different from the impacts described in Chapter 9 for decommissioning following waste emplacement.

B.7 Health and Safety

Following construction of the facility, prior to facility operations for waste emplacement, no radiological hazards will be present as no radiological waste will have been present at the facility. Radiological hazards will therefore not pose any danger to personnel, the public or the environment.

For decommissioning following construction the only hazards that are considered are chemical and construction hazards. The chemical and construction hazards that may be encountered will be similar to those anticipated during any dismantling or demolition work. Included in the potential construction hazards are rock fall events and fires. Additional care and design considerations must be employed in order to ensure that rock fall and fire safety are taken into account due to the confined nature of the underground repository. During decommissioning work, potential chemical hazards may come from concrete dust generated during the dismantling work.