AECL EACL

Basis of the Cost Estimate for the Chalk River Laboratories Decommissioning Liability

3611-01512-AB-001
Revision R0

2005 November

Novembre 2005

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GLOSSARY

Affected Lands. An area requiring remedial action because of real or suspected impacts from nuclear operations on AECL sites. The remedial actions may include decontamination, waste removal and environmental restoration of the site. Affected lands may also be referred to as Legacy Lands or Contaminated Lands.

Benchmark. A well established reference point with which to compare the data for your facility, operation or activity. The comparison is generally made for the purpose of establishing the quality of your operation or analysis.

Building Remediation Plan (BRP) – The term applied to the plan developed for the decommissioning of a building or facility that is not a licensed nuclear facility.

Bunker/Waste Storage Bunker. An engineered cement structure that is used for the storage of radioactive waste. The bunkers have varying geometries and may be placed above or below ground.

Cementation. The process of incorporation of waste into a cement matrix to produce a new waste form that has greater physical and chemical stability.

Chalk River Geological Disposal Facility. A facility planned for CRL that will be used to dispose of intermediate- and high-level waste.

Clearance. The process of analyzing waste to determine if it meets clearance levels where clearance levels are a set of values established by a country's nuclear regulatory body, expressed in terms of activity concentration and/or total activities, at or below which sources of radiation (e.g. waste) can be released from nuclear regulatory control.

Commissioning. The process during which a facilities components and systems , having been constructed, are made operational and verified to be in accordance with design specifications and have met the required performance criteria . Commissioning may include both non-radioactive (cold commissioning) and radiaoactive (hot commissioning) testing.

Conceptual Decommissioning Plan (CDP). A plan that describes conceptually the activities that will be conducted to decontaminate/remediate a redundant nuclear facilities to a condition that establishes a final end state and fulfills all pertinent regulatory and national policy requirements.

Concrete Canister. The primary closed or sealed concrete container used to store spent fuel or vitrified high-level waste

Contingency. The allowance that is made for additional costs that may occur in the delivery of a project due to uncertainty in the original cost estimates.

Controlled Areas 1 & 2. Distinct areas at CRL with specific rules for the movement and accumulation of radioactive substances.

Cost allowance. A cost provision assigned for an identified activity but without detailed scope available at the time of the estimate.

Cost model (WM, decommissioning /demolition). A model used to develop the cost for a decommissioning project or activity. For the cost estimating of AECL's decommissioning program both a decommissioning/demolition model and a waste model were developed and used.

Decommissioning. Actions taken at the end of the useful life of a nuclear facility in retiring it from service with adequate regard for the health and safety of workers and members of the public and protection of the environment.

Decommissioning Stage. Well defined and discrete part of the decommissioning process or work.

Deep Geologic Repository. A nuclear facility for waste disposal located underground (usually more than several hundred meters below the surface) in a stable geological formation to provide long term isolation of radionuclides from the biosphere. Such a repository is usually used for long lived or high level waste.

Detailed Decommissioning Plan (DDP). A plan to decontaminate/remediate redundant nuclear facilities to a condition that establishes a final end state and fulfills all pertinent regulatory and national policy requirements.

Disposal. The emplacement of waste in an approved, specified facility (e.g. near surface – IRUS or geological repository – SRC or National Waste Repository) without the intention of retrieval.

Distributed Services. The pipes and electrical lines that run between buildings and provide the services required to operate a facility.

Downblending. The process of diluting a constituent of a waste. For the purposes of AECL's decommissioning program downblending means specifically the dilution of the depleted uranium in stored liquid waste.

Enabling Facilities. New facilities required for the recovery, processing, packaging, storage or disposal of waste from the decommissioning of AECL's sites and facilities.

Environmental assessment. An evaluation of the physical, ecological, cultural and socioeconomic effects of a planned installation or a new technology.

Environmental Monitoring. The measurement of radiation or radionuclides in the environment of a nuclear facility for reasons related to the assessment or control of exposure and the interpretation of such measurements.

Expert opinion. A planning process whereby a decision is made based upon the concensus of opinion by a group of individuals (experts) with relevant knowledge and/or training and/or experience in the subject matter.

Facilities Information System (FIS). A database that is maintained by CRL Site Operations and contains vital statistics for buildings and structures (construction type, area etc.)

Federal Legacy Liability. The liability that accrues to the Canadian Federal government as a result of the need to decommission the existing buildings and facilities on AECL sites.

Fuel rod. The smallest structurally discrete part of a nuclear reactor fuel bundle or assembly which has the fuel as its principal constituent; usually a thin metallic tube containing a stack of uranium dioxide pellets

Fuel bundle. A number of fuel rods held together by plates and separated by spacers **attached** to the fuel cladding. Spent fuel may be stored or disposed in this configuration.

GANTT. A bar chart that depicts the activities required to deliver a project as blocks over time. The beginning and end of the block correspond to the beginning and end date of the activity.

Ground Water Monitoring Program (GWMP). A program to sample and analyze groundwater taken from sampling wells placed around the waste management areas at AECL's Chalk River Laboratories. This program is a subset of the larger Operational Control Monitoring program at CRL. The results of the program are reported regularly to the CNSC.

Guide G-206. A document issued by the Canadian Safety Regulatory Commission entitled, **"**Financial Guarantees for the Decommissioning of Licensed Activities"

High-Level Waste (HLW). A designation of radioactive waste that is considered long lived and that includes;

a) The radioactive liquid containing most of the fission products and actinides originally present in spent fuel and forming the residue from the first solvent extraction cycle in reprocessing and some of the associated streams
b) Solidified high-level waste from a) above and spent fuel.
c) Any other waste with an activity level comparable to a) or b).

Hotcells. Facilities that shield operators from direct radiation through a combination shielding , the use of remote handling equipment, filtered ventilation and safety systems.

Incineration. A waste treatment process of burning combustible waste to reduce its volume and yield an ash residue.

In-situ. A term referring to the management of radioactive material, waste or facility in its existing location.

Intermediate-Level Waste (ILW). Radioactive waste in which the concentration of or quantity of radionuclides is above clearance levels established by the regulatory body, but with a radionuclide content and thermal power below those of high level waste. ILW is long lived and is designated for disposed in geological repositories.

IRUS. AECL's Intrusion Resistant Underground Structure for the disposal of low-level waste.

Landfill. An area designated to receive solid wastes, such as municipal solid waste (household trash) where the waste contains radioactivity below clearance levels.

Liquid Dispersal Area (LDA). An area at the Chalk River Laboratory where slightly contaminated aqueous liquids have been discharged into pits or trenches excavated into the ground.

Listed Nuclear Facility. Those facilities that are explicitly listed by the Canadian Nuclear Safety Commission in the operating licenses for AECL sites.

Long Lived Waste. Radioactive waste containing long lived radionuclides having sufficient radiaotoxicity in quantities and/or concentrations that they requir long term isolation from the biosphere.

Low-Level Waste (LLW). Radioactive waste in which the concentration of or quantity of radionuclides is above clearance levels established by the regulatory body, but with a radionuclide content and thermal power below those of high level waste. LLW is short lived and may be disposed in near surface disposal facilities.

National Waste Repository. A nuclear facility that has been proposed by the Nuclear Waste Management Office, accepted by the Canadian government and approved by the nuclear regulator for the long term management of high level waste.

Operational Control Monitoring (OCM). A program to sample and analyze groundwater taken from sampling wells placed around the waste management areas at AECL's Chalk River Laboratories.

Planning Envelope (PE 1-4). Groupings of AECL buildings and facilities where each group contains elements with similar attributes and decommissioning strategies.

Plume. In the context of this document the term plume refers to a zone of groundwater contamination.

Project. A large or major undertaking that generally involves considerable money, personnel and equipment.

Radiological Safety Zone (RSZ). Refers to the zoning of a nuclear site into different areas or zones for the purposes of radiation protection.
Remediation. Corrective measures that are applied to reduce or eliminate an effect after an incident has occurred. For example, cleaning up contamination outside of a facility that has resulted from the operation of a facility is remediation.
Repository. A nuclear facility where waste is emplaced for disposal. Future retrieval of the waste from the repository is not intended.
Safe Shutdown. The state of a facility after actions have been taken to remove or contain any hazards that remain after the facility has ceased operation.
Safety Case. A documented body of evidence that provides a demonstrable and valid argument that a system is adequately safe for a given application and environment over its lifetime
Sand Trench. An excavation in sand where the bottom of the trench is above the groundwater table and into which wastes are emplaced and then covered.
Scabbling. The removal of the surface layers of a concrete or floor by physical techniques.
Scoping Survey. A survey that has the objective of scoping, not detailing, the nature and extent of contamination. Whereas a survey is a systematic investigation and measurement of radiation and/or contamination levels.
Shielded Facility. A facility that shields operators from direct radiation through the use of hot cells or warm cells for the handling of radioactive materials.
Short Lived Waste. Radioactive waste with half lives generally shorter than 30 years which will decay to a level which is considered to be insignificant from a radiological viewpoint in a time period during which institutional control (control by an authority designated by the laws of a country) can be expected to last.
Site Information Management System (SIMS). See FIS.
Storage with Surveillance (SWS). An intermediate phase in the decommissioning of a building or facility. During this phase monitoring and maintenance actions only are taken to ensure that a safe state is maintained.
Sludge. The solid slurry found in the bottom of tanks used to store liquid waste or in the bottom of other storage structures (e.g. tile holes).
SLW. Stored Liquid Waste. SLW are radioactively contaminated liquids that have been stored in tanks awaiting disposal either by direct discharge following radioactive decay or after processing to produce a waste form that is suitable for disposal.
Survey. A systematic investigation and measurement of radiation and/or contamination levels.
Tile Hole. A cylindrical concrete in-ground structure used to store waste that emits strong radiation fields (e.g. nuclear fuel rods, isotope production waste). The tile hole may be lined with steel.
Vitrification. The process of incorporating materials into a glass or glass-like form. Vitrification refers in this document to the solidification of liquid high-level waste.
Warm cells. A shielded facility like a hot cell but used for handling lower hazard radioactive materials and are designed to permit more rigorous destructive testing than would normally be carried out in a hot cell.
Waste Category. The designation of waste as Low-, Medium/Intermediate- or High-level Waste (LLW, M/ILW, HLW)

NWMO. Nuclear Waste Management Organization. An organization established by the nuclear waste owners to evaluate options for the long-term management of spent nuclear fuel and to recommend to the government the preferred option for implementation.

Work Breakdown Structure (WBS). A detailed breakdown or list of the activities required to deliver a project.

ACRONYMS

AECL. Atomic Energy of Canada Limited
BRP. Building Removal Plan
CA1. Controlled Area 1
CA2. Controlled Area 2
CDP. Conceptual Decommissioning Plan
CGDF. Chalk River Geological Disposal Facility
CNSC. Canadian Nuclear Safety Commission
CMWCF. Cemented Mo-99 Waste Conditioning Facility
CP. Chemical Pit
CRL. AECL's Chalk River Nuclear Laboratory.
CPDP. Conceptual Preliminary Decommissioning Plan
DDP. Detailed Decommissioning Plan
EA. Environmental Assessment
FIS. Facilities Information System
FA. Facility Authorization
FPF. Fuel Packaging Facility
GWMP. Ground Water Monitoring Program
HLW. High-Level Waste
ILW. Intermediate-Level Waste
IRUS. Intrusion Resistant Underground Structure
JWO. Joint Waste Owners
LDA. Liquid Dispersal Area
LLW. Low-Level Waste
M&S. Monitoring and Surveillance
MAGS. Modular Above Ground Storage
MARSSIM. Canadian Nuclear Safety Commission.
MCWCF. Mo-99 Cemented Waste Conditioning Facility
NNWPF. Non-Fuel, Non- Mo-99 Waste Processing Facility
NPV. Net Present Value
NWMO. Nuclear Waste Management Organization
OAG. Office of the Auditor General
OCM. Operational Control Monitoring
PDP. Preliminary Decommissioning Plan
PE. Planning Envelope
R&D. Research and Development
RSZ. Radiological Safety Zone
SF. Shielded Facility
SIMS. Site Information Management System
SLW. Stored Liquid Waste
SLWCF. Stored Liquid Waste Consolidation Facility
SLWPF. Stored Liquid Waste Processing Facility
SMAGS. Shielded Modular Above Ground Storage
SWCF. Solid Waste Cementation Facility

SWS. Storage With Surveillance
TH. Tile Hole
THIS. Tile Hole Investigation and Stabilization Project
THRPF #1 or #2. Tile Hole Remediation Processing Facility #1 or #2
TPDP. Tank Preparation Decommissioning Project
WAF. Waste Clearance Facility
WCF. Waste Characterization Facility
WI. Waste Incinerator
WMA. Waste Management Area
NWMO. Nuclear Waste Management Organization.
WBS. Work Breakdown Structure
WTC. Waste Treatment Centre

1. INTRODUCTION

This report presents the basis for the estimated cost to decommission the Chalk River Laboratories (CRL). The information assembled in this document presents the results of a process spanning several years to develop a decommissioning plan for the lands and structures currently present at CRL. In parallel with the development of the plan, projects were defined to implement the required decommissioning activities. These projects have provided the basis for estimating the cost of the liability and provide the information needed to characterize the overall liability. These project costs have been developed and refined progressively over time, and have been assembled in a variety of formats. Consequently, the introductory comments in the document that follow are intended to assist the reader in understanding and using the information.

Much of the cost information presented in this document was used to support an audit by the office of the Auditor General (OAG) of the liability estimates published in the AECL 2005 Annual Report. The basic work breakdown structure (WBS) and the proposed schedule of decommissioning activities that were used for the OAG audit have been retained in this document but with more detail presented here on the source of the estimates.

The cost estimate for decommissioning CRL has been derived through a comprehensive analysis that addresses three essential elements for the estimation process, namely:

1. Define the scope by identifying all activities that will be required to achieve the decommissioning objectives,
2. Define the time frame during which the activities will be conducted, and
3. Apply methodologies for estimating cost that will meet the accuracy requirements.

In this report the basis for the cost estimate is developed in reference to these three elements.

The scope of the decommissioning requirement is presented both in the body of the document and in the form of a schedule chart in Appendix A. Existing buildings, facilities, structures and associated services or land that require decommissioning are identified and the activities that will be conducted to achieve the decommissioning of each element are described along with the basis for the associated cost estimate. Although replacement or new facilities may be built in the future at CRL for AECL business requirements, the liability associated with their decommissioning is not addressed, but would be included at the time of their construction. The categorization of the individual decommissioning components differs reflecting their complexity and variety as well as the overall decommissioning strategy for each site. At CRL ongoing business operations will continue in parallel with decommissioning activities for the foreseeable future.

The decommissioning of the CRL Waste Management Areas (WMAs) is described individually for each facility within each WMA. The cost estimate for each WMA facility may include monitoring and characterization, waste retrieval, waste processing, interim waste storage, final disposition of the waste and decommissioning of the emptied structures. For a few WMA facilities, the decommissioning process will see the waste remain “in-situ” as the safe end state and the decommissioning cost estimate reflects only the surface engineering required to satisfy

the "in-situ" end state.

Included in the decommissioning activities and cost estimates for CRL are the design, construction, operation and decommissioning of new "enabling" facilities that will be needed to recover, process, store or dispose of the waste associated with the decommissioning. The cost to deliver each of these enabling facilities activities is developed in reference to the rationale (explanation or description) for the facilities along with the basis for scheduling. The costs are presented against individual buildings, facilities, services or enabling facilities.

The factors taken into consideration in establishing the schedule or time frame for the decommissioning activities include: the projected shutdown date for existing buildings; the projected lifetime of equipment or facilities; the need to sequence some activities; the timing and availability of waste disposal facilities (e.g., CRL Geological Disposal Facility (CGDF)) for the decommissioning waste; the time required to complete projects to put in place enabling facilities.

The cost estimating methodology presented in this report is consistent with the requirements in the Canadian Nuclear Safety Commission (CNSC) Guide G-206. The methodology applied to derive the cost estimate used information developed on the basis of:

1. ongoing operational costs (e.g., Storage with Surveillance (SWS), groundwater treatment systems)
2. ongoing monitoring (environmental monitoring)
3. current project estimates (for projects that are established and underway)
4. cost models for building decommissioning and WMA decommissioning
5. scaling from existing facilities and projects for future facilities
6. expert opinion

As a result of discussion with the OAG, the overall cost estimate carries a contingency of 20%. From G-206, Grade C are described as: "estimates are generally performed quickly using shortcut techniques, such as escalating and/or scale up from previous estimates, cost curves, and/or preliminary process design and equipment sizing, without plot plans or major equipment quotations". However, some activities estimated as part of the legacy liability are Grade-A or B estimates since they are based on costs already experienced within ongoing programs (e.g. monitoring or SWS costs), or are based on project estimates which have been through AECL's formal project review process and/or include cost estimates which have been prepared and/or detailed design has been completed to support a bidding process for delivery of the activity. Consistent with G-206, elements 1-3 in the list above are generally considered to provide Grade A estimates, element 4 generally provides Grade B estimates, and elements 5 and 6 provide Grade C estimates. Accordingly each of the cost items in this report is identified with the appropriate contingency, either Grade A, B or C.

The costs and schedules presented in this document are referenced to the decommissioning requirements identified in the September 2004 analysis, and all cost estimates are based on the assumption that the schedule for each activity commences as of the dates identified in September 2004. The cost table corresponding to the schedule chart in Appendix A is presented in Appendix B. The decommissioning schedule is dependent on AECL operations vacating

buildings and facilities on the currently planned schedule. The schedule and costs are "going forward" and do not include past accomplishments. The schedule and costs are based on a program start of April 1, 2005. The cost for decommissioning AECL's Chalk River Laboratories as presented in this document has a Net Present Value (NPV) 1.97 Billion $. This is part of the $2.75 Billion liability reported in the AECL 2005 Annual Report.

It is anticipated that this estimate will undergo future revisions where improvements will be made to the estimate as an increased experience base is developed. The schedule for future revisions will be set as required by AECL's financial management process. In addition, as public input to the plan is received (as one of the activities planned to be conducted in the first five years) changes may be made to address their input.

2. CRL DECOMMISSIONING

This section provides the cost basis for the decommissioning of CRL structures and facilities and is presented relative to the following categories; buildings (and other above ground structures), Services and Affected Lands, and Waste Management Areas. The Enabling Facilities category is discussed separately in Section 3.

Details on the decommissioning of the Chalk River Laboratories site can be found in the CRL Comprehensive Preliminary Decommissioning Plan (CPDP March 2005). Additional detail on the CRL site that is not presented here is also available in that document.

The CRL site covers 3700 hectares and contains many structures, and facilities some dating back to the beginning of the site in 1944. For the purposes of decommissioning, the structures and facilities are subdivided into several categories including; Structures/Buildings, Services and Affected lands, Waste Management Areas, and Enabling Facilities. CRL is expected to continue operating as a licensed nuclear site for many more decades and support a wide range of nuclear R&D, industrial and production activities. Several of the original buildings have been decommissioned already and the decommissioning of additional buildings and facilities will need to occur as structures age or as business needs change. Over the six decades since CRL was established new structures and facilities have been constructed to meet evolving business needs and further construction can be expected in the future. As a licensed nuclear site, CRL will continue to be subject to nuclear regulatory oversight and control.

Since the construction and decommissioning of buildings and facilities can be expected to continue throughout the long operational life of CRL, the decommissioning process for the CRL site will be a continuum of decommissioning projects rather than a single activity at the end of the site's operational life. The scheduling and funding for decommissioning projects is established through a prioritization process. The priority of individual decommissioning projects is set based on Health, Safety & Environment (HS&E) risks but also takes into consideration operational requirements and business priorities since the need to continue operations on the site will continue in parallel with the decommissioning process. The individual decommissioning projects are grouped into seven 'Planning Envelopes' where each Planning Envelope is a grouping of structures or facilities that has a significant degree of similarity that supports the application of common planning assumptions. The individual projects will take each respective structure or facility to a documented end-state while the site as a whole continues in operation. During the period of continued operation of the CRL site, selected parts of the site on which structures or facilities have been decommissioned may be turned over for industrial re-use in accordance with the then-current laws and regulations. In the long term, the combination of decommissioning for all structures and facilities plus radioactive decay and natural geophysical/geochemical processes will take the entire CRL site to a predictable, final end-state and site-wide qualification for industrial re-use.

2.1 CRL Buildings and Structures

2.1.1 Introduction

Since the majority of buildings at CRL are still operational, the preparation and maintenance of a detailed set of individual cost estimates for the decommissioning of the large number of buildings (more than 150) and other aboveground structures is impractical since the estimates would quickly become outdated due to unpredictable future changes in the buildings (different uses, modifications/additions, contamination etc.). A more practical and cost-effective approach for developing the decommissioning cost estimate has been applied for long-term strategic planning purposes. A decommissioning/demolition model has been developed that uses a unit cost approach for estimating the decommissioning cost, i.e. the model applies a cost per unit of area (or volume in the case of demolition) to accomplish each of the steps in the total decommissioning process, from initial planning to final site remediation. A variety of unit costs are applied to take into account the wide variety of attributes for the various buildings and individual rooms within the buildings. The attributes considered include; construction style, complexity, past use, radiation hazard, etc. An abbreviated description of the model is provided in the following sections of Chapter 2 and in Appendix C. Waste management and disposal costs for wastes arising from the decommissioning of building and structures are included with the appropriate enabling facility, see Section 3.

The buildings and structures cost estimate carry an overall Grade C contingency, but some components (SWS) are based on actual costs and therefore carry less contingency.

2.1.2 Stages in a Decommissioning Project

The model uses the following standardized stages that are applied to each building being decommissioned and subsequently demolished:

0. Declaration by the building's owner/operator that it is to be taken out of service and establishment of a Safe Shutdown State, through removal of inventories, chemicals, furniture etc. and disconnection of non-essential services. As a result of discussions with the OAG the costs for the decommissioning work at this stage is included as an allowance and therefore does not appear in Table 1,
1. Preparation of and securing of approval for the package of documentation in support of the decommissioning project,
2. Removal/stabilization of hazards in preparation for Storage with Surveillance,
3. A period of Storage with Surveillance, with periodic remediation and repair if the SWS is extended,
4. Preparation of the building for demolition (i.e. removal of hazards, beyond that performed in step 2, to the extent possible given the next step is demolition), then,
5. Removal of the structure and remediation/release of the site for industrial re-use.

For the purposes of the model, stages 0 to 4 are considered to be "decommissioning" and stage 5 "demolition".

Each stage is further broken down into distinct "elements of work" as follows:

Table 1 Decommissioning Stages and Elements of Work or Expense

Decommissioning Stage	Elements of Work or Expense in the Stage
1. Documentation and Planning	Prepare and secure approval of DDP/BRP Prepare and secure acceptance of Environmental Assessment (EA) (where required) Perform and document hazard characterization Prepare and secure approval of SWS plan
2. Prepare for storage with surveillance	Secure the building/facility Remove glove boxes (where required) Remove fume hoods (where required) Remove fixtures Remove miscellaneous equipment Modify HVAC services Modify Mechanical Services Modify Electrical Services Provide fire protection Isolate building
3. Storage with surveillance (annual)	Building utilities, taxes and common services Perform recurring inspections and reporting Conduct periodic structural assessments and repairs
4. Prepare for demolition	Conduct radiological Scoping Survey Remove active services Remove inactive services Isolate building and cap services @ 1 m from exterior face Perform Concrete scabbling Perform Surface washing and swabbing Perform Surface removal Conduct Waste segregation and packing
5 Demolition	Perform Basic Demolition Conduct contaminated materials Waste Management, reuse and recycling Perform Site Remediation (backfill, grading, seeding)

This stage/element structure in Table 1 provides a basic grouping for the generic decommissioning project. Implicitly included with stages 3-5 is the effort required to develop project and work plans.

2.1.3 Estimation Basis and Resources

2.1.3.1 Unit Rates

The standard approach to cost estimating of structural projects such as design, construction, providing/modifying/removing services, demolition etc. is the unit rate approach (dollars per unit of area or volume) using experience-based “benchmarks” or “yardsticks” with appropriate allowances for project requirements and local conditions. The unit rate approach is based on published guidelines for the general construction and the nuclear industry. The AECL decommissioning/demolition model draws on these resources where applicable. Additionally,

for elements of work that are specific to decommissioning on the CRL site, the model draws on the knowledge and experience of staff in the CRL Cost Engineering and Decommissioning Planning departments.

Details of the unit rates for the decommissioning model are documented in Appendix C.

2.1.3.2 Room Attributes

The efforts and costs to accomplish decommissioning stages up to and including stage 4 are impacted by attributes at the room level such as floor area, use (laboratory, office, workshop, mechanical; services room, etc.) and Radiological Safety Zone (RSZ) assignment. These attributes were collected for all spaces (rooms) on the CRL site in the Site Information Management System (SIMS) database maintained by AECL's Site Planning & Property Management.

At the room level, unit efforts and costs are influenced by the combination of the room's complexity (specific attributes) and the potential radiation hazard it poses (RSZ assignment) for the planned work.

For the purposes of the model, rooms have been grouped into three categories of complexity for eventual decommissioning as follows:

Category A (High complexity):	laboratories, process service areas
Category B (Medium complexity):	building service areas, workshops
Category C (Low complexity):	offices, meeting rooms, libraries

The RSZ classification assigned to the room is used together with the room's complexity to generate a combined hazard/complexity level that will determine the estimated decommissioning effort required. The matrix used to assign the hazard/complexity level is shown in Table 2.

Table 2 Room Hazard/Complexity Level Matrix

Radiological Safety Zone	Hazard/Complexity for Each Room Category		
	A	B	C
00 (not assigned)	High	Medium	Low
01 (very low or background)	High	Medium	Low
02 (low)	High	Medium	Low
03 (medium)	High	High	Medium
04 (high)	High	High	High
05 (very high)	High	High	High

The assignments indicated in Table 2 lead to a conservative cost estimate given the majority of rooms will be assigned to the highest effort level. The high, medium, low hazard/complexity category determine the level of effort and therefore cost (see Appendix C Table 4).

2.1.3.3 Structure Attributes

By the time the structure has been prepared for demolition the former room attributes are largely irrelevant and the attribute that determines the cost per unit of volume is construction type (wood frame, masonry, steel frame, etc.). The volume is based on external dimensions (footprint area

times height) for each distinct section of the structure, recognizing that any given structure may be made up of several sections built at different times and with different types of construction. Each floor is considered to be a distinct section. These attributes were collected by Ontario Lands Assessment (OLA) to assign current values to structures on the CRL site for purposes of determining the annual payments in lieu of municipal taxes. The estimated cost to demolish a given structure is determined by the sum of the estimates for each section that comprise the structure.

2.1.3.4 Planning Envelopes

For the purposes of the decommissioning model, buildings and structures on the CRL site have been grouped into Planning Envelopes, each containing elements with similar attributes and decommissioning strategies. The Planning Envelopes and their inclusions are summarized in Table 3.

Table 3 Planning Envelopes for Buildings/Structures on the CRL Site

Planning Envelope	Attributes
1. Listed Nuclear Facilities	Nuclear facilities listed in Appendix A (operational) or C (permanently shutdown) to the CRL site licence. These facilities have their own, facility-specific Preliminary Decommissioning Plans (PDP). Note that a listed nuclear facility may occupy only part of a structure, the balance of which will be Planning Envelope 2. These facilities include NRU, NRX, Hotcells etc.
2. Radiochemical Laboratories	Laboratories and other structures that have been or are being used primarily for work with radioactive materials and are known to contain contaminated components from planned activities and unplanned events.
3. Low Hazard Contaminated Structures	Laboratories and other structures that have been or are being used for activities that may involve small quantities of radioactive materials under controlled conditions. Local areas of low hazard contamination may be present as a result of spills or process upsets. Buildings in Controlled Area 2 other than those in Planning Envelopes 1 and 2 are assigned to this Planning Envelope.
4. Non-contaminated Structures	Buildings that have no record of being used for activities involving radioactive materials, but industrial hazards remain. These structures can be presumed – with a high level of confidence – to be free of contamination. Most buildings in Controlled Area 1 are assigned to this Planning Envelope.

The Planning Envelope (PE) has a significant impact on the unit efforts and costs to accomplish each decommissioning/demolition stage and its elements, with efforts and costs decreasing in the order PE 1>PE 2>PE 3>PE 4. It should be noted that in addition to the four building/structure planning envelopes there are three PEs for Distributed Services, Affected Lands and Waste Management Areas.

Further details on the application of the cost model to buildings and structures on the CRL, including a worked example, can be found in Appendix C.

2.2 Stacks and Tanks

2.2.1 Introduction

The Chalk River site has a number of tanks and stacks which were constructed to support various facilities and processes. The stacks include reactor and powerhouse stacks. Existing tanks provide containment for Low-Level Wastes (LLW), and High Level Wastes (HLW) wastes and also for tankage typical of an industrial operation. A specific project has been established for remediation of contents of the highest priority tanks see Section 3.5.2.2.

The schedule chart in Appendix A page 5 shows the details of the individual stacks and tanks scheduling while the Appendix B cost table shows accumulated costs for all stacks and tanks. Miscellaneous access ways for the tanks and stacks (also considered buildings) are included here.

Stacks and tanks enter into the decommissioning program only after they are declared redundant from CRL Operations.

2.2.2 Estimate

Third party cost estimates are the basis for the higher priority and more significant tanks. Other tank estimates were scaled from the third party cost estimates. Internal detailed estimates were prepared for tanks where scaling was not appropriate and for the tanks which are part of the Active Drain Line PDP. Service tanks are treated as a cost allowance. Based on the source or detail included with the individual estimates, they have either Grade B or C contingency assigned.

Stack decommissioning was based on scaling from the cost for removal of the NRX stack.

Prompt decommissioning is planned for tanks upon completion of removal of tank contents which takes place following turn over from operations to decommissioning.

Stacks are turned over from operations to decommissioning with their associated facilities. For scheduling, decommissioning of the stacks is planned along with the associated facility.

2.3 CRL Services and Affected Lands

2.4 Distributed Services

2.4.1 Introduction

Services distributed around the CRL site total approximately 80 km of civil services (process water, storm drains, sanitary sewers, steam, gases, etc.) and approximately 270 km of electrical cables (power, communications, data, etc.). The distribution is divided roughly equally between the Controlled Area 2 (CA-2) and the Controlled Area 1 (CA-1)/Supervised areas.
Approximately 95% of all services (civil plus electrical) are buried. The civil services consist of a variety of structural materials reflecting the vintage of construction.

The great majority of buried services are non-contaminated – although sections of them may lie within plumes, which will have to be taken into consideration during excavation and removal. The exceptions are the active liquid drain systems for which system-specific cost estimates have been developed in support of a facility specific PDPs.

Under conventional industrial circumstances, options for decommissio ning buried services include isolation and abandonment as low-cost alternative to excavation, removal and backfilling where hazardous materials or conditions are not involved. However, for the purposes of preparing liability estimates for the CRL site it has been conservatively assumed that all civil services will be removed with cost estimates derived from a unit cost model, developed in collaboration with CRL Cost Engineering .

Distributed services are assigned a Grade C contingency.

2.4.2 Inventory of Civil Services

The total inventory of civil services on the CRL site, taken from records maintained by the CRL Landlord (Facilities and Nuclear Operations), are summarized in Table 4 Inventory of Civil Services on the CRL. Services containing fluids are buried below the frost line, i.e. 2 metres or deeper.

Table 4 Inventory of Civil Services on the CRL

	Metres by Location			
Primary Services	**CA2**	**CA1**	**Total**	Comment
Service Water	4,353	4,398	8,751	Various materials up to 16" diameter
Process & Raw Water	3,470	571	4,041	Steel or cast iron up to 54" diameter
Sanitary Sewers	3,375	3,774	7,149	Various materials up to 12" diameter
Process Sewers	2,913	318	3,231	Various materials up to 48" diameter
Steam & Condensat e	7,963	5,976	13,939	Steel up to 12" diameter
Service & Process Air	4,153	3,542	7,695	Steel up to 6" diameter
Fire Water	3,892	6,211	10,103	Various materials up to 12" diameter
Storm Sewers	4,684	9,943	14,627	Various materials up to 72" diameter
Total Primary Services	**34,802**	**34,733**	**69,535**	
Miscellaneous Small Services			**-**	
Acid Waste	35	43	78	
Disposal Sewer	89	37	125	
Heating Water	1,721	249	1,970	
Helium Line	1,465	185	1,650	
Heating Drain	1,376	591	1,967	
Pneumatic Line	461	-	461	
Raw Water	184	208	392	
Refrigeration Line	66	44	109	
Total Miscellaneous Small Services	**5,396**	**1,356**	**6,752**	
Overall Totals:	**40,199**	**36,089**	**76,288**	

The significant figures shown in the table are not intended to reflect "in-field" accuracy.

2.4.3 Electrical Services

The total inventory of electrical services on the CRL site, taken from records maintained by the CRL Landlord (Facilities and Nuclear Operations), are summarized in Table 5.

Table 5 Electrical Services

GIS Level	Service	Length (m)		
		CA-2	CA-1	Total
18	2.4 kV Overhead Cable Run	740	2,345	3,085
19	2.4 kV Underground	15,940	18,217	34,157
22	Class 4 (Normal) 600V Cable Run	12,727	9,918	22,645
26	Class 3 (Emergency) 600V Cable Run	15,281	11,063	26,344
30	Plant Ground Run	30,530	24,152	54,682
34	Common Control Cable Run	22,416	20,081	42,497
38	Fire Signal Cable Run	11,365	12,611	23,976
42	Telephone Cable Run	15,284	21,622	36,906
46	Fibre Optic Cable Run	5,378	3,922	9,300
49	Ethernet Cable Run	1,990	594	2,584
54	Security Cable Run	7,708	7,519	15,227

2.4.4 Unit Cost Model

2.4.5 General

The model for decommissioning of distributed services consists of three standard stages (following drainage of the contents where appropriate):

Stage 1. Excavation of cover above the service
Stage 2. Removal of the service
Stage 3. Backfill and grading

The effort and costs for each stage will depend primarily on the diameter of the service involved. Additionally, the effort and cost for stage 2 will depend on the material which will dictate the method of removal.

Note that the unit cost model and the resulting estimates are presented in 2001 dollars. The estimates are then escalated when incorporated into the overall cost estimate.

Further details on the application of the unit cost model to distributed services on the CRL site, including a worked example, can be found in Appendix D.

2.4.6 Affected Lands

All lands within CA-1 and CA-2 are considered as having been affected by nuclear R&D/Industrial operations over the years. Some lands have been specifically documented as containing specific radiological and non-radiological substances and have been quantified and assigned identifying designations. The great majority of the lands in the Supervised Area are unaffected with the obvious exception of the Waste Management Areas (which are designated as CA-2). Past operations within the WMAs have resulted in groundwater plumes that extend beyond the defined boundaries of some of the WMAs. Additionally, some smaller areas have been identified as being affected – physically or radiologically – as a result of routine operations or accidental spills.

The affected lands are described in the CRL CPDP (March 2005) and include the items listed in Appendix A page 6(sub-heading sCRL CA1/CA2 Affected Lands and CRL WMA Affected Lands).

The items listed are scheduled to be remediated in the near future if they are no longer in service (1-5 years), or soon after they are taken out of service. The exceptions to this rule are Perch Lake sediment and the Ottawa River sediment where based on current knowledge no remediation is necessary. For these sediments monitoring will continue until a safety case is developed and accepted that supports the cessation of monitoring. The Glass Block sites (included in Section 2.5.15) may still have experimental value which was their intended purpose, and recovery is planned following availability of the CRL Geological Disposal Facility (CGDF). Remediaton of the 1953 pipeline route to WMA-A is also scheduled following availability of the CGDF.

Appendix D includes further information on costing for many of the Affected Lands items. All the Affected Lands items carry a Grade C contingency, with the exception of the groundwater treatment systems (discussed in the next section, 2.4.6.1), which have Grade A contingency based on operating experience.

2.4.6.1 Affected Lands Groundwater Treatment Systems

Waste storage operations at CRL have led to several instances of groundwater contamination due to leaching of the waste. Several treatment facilities are already in operation to treat the plumes of groundwater contamination.

The groundwater treatment systems include:

- The Chemical Pit treatment system (operational)
- The Spring B treatment system (operational)
- The Nitrate Plant treatment system -Wall and Curtain technology(operational)
- The South Swamp treatment system (not yet installed – installation covered under CRL enabling facilities (see Section 3.5.2.7)

For the treatment systems in operation, actual experienced operating costs were used and periodic replacement/upgrades were based on the original installation costs. For the South Swamp treatment system capital and operating costs were scaled from the Nitrate Plant facility, because it is assumed that the same technology (Wall and Curtain) will be implemented.

2.5 CRL Waste Management Areas

2.5.1 Introduction

The Waste Management Areas (WMAs) are nuclear facilities on the AECL Chalk River Laboratories (CRL) site. The facilities provide storage for wastes arising from the operation of research and development facilities at CRL, isotope processing operations, prototype CANDU reactors, hospitals, universities and industries across Canada. The WMAs employ different structures for the storage of LLW, ILW and HLW. The operation of the WMAs dates back over 60 years and the historical aspect of the operation of the Waste Management facilities is an important factor when planning for the decommissioning of these facilities.

The CRL WMAs were cost estimated based on the information available from engineered drawings for the facilities, operational records for the WMAs as well as from the waste generating facilities. The available information varied from facility to facility but included operations records (log books), transport records (waste slips), previous investigations etc. This information was summarized along with a description of the WMAs in the CRL Comprehensive Preliminary Decommissioning Plan (CPDP March 2005). In the case of WMA-A and WMA-B which have multiple storage structures summary spreadsheets were created to bring together all the information from the individual burials. These spreadsheets are included as Appendix E of this document. For WMAs which are single burials, no intermediate spreadsheet was required, and information was input directly into the Summary Spreadsheet. The WMAs overall summary spreadsheet is appended to this document and can be found in Appendix E. Costs for waste processing and disposal (e.g., incinerator and CGDF) are attributed to the specific enabling facility.

The basic methodology described below applies to all of the WMAs with exceptions as indicated. The specific considerations for individual WMAs follow in Sections 2.5.2 through 2.5.17. The cost estimates for the WMAs are assigned an overall Grade B contingency with exception of the plume updates and ongoing monitoring which were assigned a Grade A based on past cost experience.

The costs and/or waste volumes were collected in the following categories:

Waste Recovery
Waste recovery included consideration of many factors that enabled the contaminated volume of material (waste, facility structural material, and surrounding soil) to be calculated. . These factors included:

- Waste category (LLW, ILW, HLW)
- Processing (incinerable waste)
- Facility boundary
- Waste Volume, (comprising recovery fraction, facility volume (structure holding the

waste) and Soil Volume

Contaminated waste volume includes recovered waste, contaminated fraction of the facility holding the waste, and contaminated soil fraction.

Recovery Cost is based on the waste category, recovery cost is assigned in $ per cubic metre.
LLW = 5000 $/m^3 (based on previous concrete bunker waste recovery cost);
ILW = 7000 $/m^3 (based on LLW but 35-40% higher costs for increased (relative to previous experience) crew size in field, additional Radiation Surveyor support);
HLW = 10,000 $/m^3 (based on 25% of the cost from previous tileholes recoveries)
ILW and HLW are rarely use in the spreadsheet and therefore do not have a significant impact on the cost estimates.. HLW is only triggered for the steel lined fuel bearing tileholes for the steel liner volume. The fuel removal cost is captured under the Fuel recovery operation which is part of the Tile Hole Remediation effort and covered under the CRL enabling facilities in Section 3.5.3.2.

Clearance Volume

This is the fraction of the waste recovered that will be suitable for Clearance/release. Clearance or release refers to waste materials containing only small levels of radioactivity that do not cause any concern from a health or environmental perspective and therefore can be managed in the same manner as non-radiological wastes that is by recycle, reuse or landfill disposal. The cost associated with clearance is captured under the Waste Clearance Facility (WAF) enabling facility Section 3.2.1, and the WMAs spreadsheet indicates the volume of clearance wastes from the WMAs (clearance waste also arises from building/structure decommissioning activities).

Disposal Volume

This is the determination of the volume of waste requiring disposal. Processing can lead to volume reductions or in some cases small increases in volume as indicated in the spreadsheet. The total waste volume from the CRL WMAs is used as an input to the CRL Enabling Facility for disposal of LLW, ILW wastes, the Intrusion Resistant Underground Structure (IRUS) and CRL Geological Disposal Facility (CGDF) facilities, see sections 3.6.2 and 3.6.3. Disposal costs are therefore included with the specific enabling facility for which the wastes are destined.

Facility Characterization

Characterization costs are estimated based on a formula that was derived from previous AECL CRL expenditures for characterization. These are summarized in Appendix E. The activities include ongoing monitoring both pre and post waste recovery as well as facility specific characterization in support of recovery operations and for site closure (abandonment cases). Another aspect of facility characterization is the periodic updating of significant plumes emanating from several WMAs. Costs for future plume updates were estimated based on costs from previous updates and the schedule for future updates which is a regulatory requirement.

Facility Closure

Included in this category are costs for installing covers where appropriate and for the preparation of regulatory safety cases for abandonment.

Cap and cover costs are based on the facility area and scaled from a third party cost estimate prepared for multi-layer engineered cover for WMA-C.

Regulatory safety case costs are based on AECL's previous experience with the IRUS safety case and are adjusted for individual WMAs based on size and complexity.

2.5.2 WMA -A

Costs are collected for each of the items in the following list as indicated in Section 2.4 above and the notes are included for the scheduling rationale for waste recovery.

WMA -A Sand Trenches

These sand trenches are unlined and uncapped and therefore have been subject to infiltration over the last 50 years and represent a reasonably significant volume. Therefore recovery is scheduled after availability of the CGDF.

WMA -A Special Burials

The remaining burials in WMA-A are considered "Special Burials" because they are unique in that they were typically "one of a kind" burials either due to the nature of the waste form or in the case of wastes that were generated on an ongoing basis due to type of storage method employed. The items which comprise the special burials can be found in Appendix A page 6 (under heading WMA-A Special Burials).
Recovery of the special burials is planned to take place between now and the availability of the CGDF. The burials tend to involve small volumes and can be used to further develop recovery capabilities and techniques. Liquids and fuel fragments will be recovered first. The goal is to have WMA-A cleared of special burials so that when large volume recovery of the sand trenches begins (post 2020) this can proceed unhindered.

2.5.3 Liquid Dispersal Areas (LDA)

The LDAs contain a significant volume of contaminated soils which will require recovery. The liquid dispersal areas have also been subject to ongoing infiltration and leaching, and as a result of the liquid additions have been subject to infiltration leaching far greater than just that due to precipitation alone. All of these facilities will require some soil recovery, application of covers, safety cases for abandonment and ongoing monitoring. Recovery is planned for after the CGDF becomes available for each of the following facilities as listed in Appendix A, page 7 (under headings Reactor Pits, Chemical Pits, Laundry Pit, LDA Pipelines).

2.5.4 Nitrate Plant

The Ammonium Nitrate Decomposition plant operated between 1953 and 1954. It was partially decommissioned following discontinuation of operations but several contaminated areas remain.

These include: the Nitrate Plant Buildings (contaminated rubble which remains from Bldg 233). demolition); and the Nitrate Plant Pit (this limed pit received discharges of mixed fission products in salt solutions following a process accident, as well as decontaminating solutions). The remaining contamination has been subject to ongoing infiltration (no caps or liners) which has resulted in a strontium plume which is being treated using the Wall and Curtain technology see Section 2.4.6.1. Recovery and remediation activities are scheduled following the availability of the CGDF.

2.5.5 Thorium Pit

This pit received reprocessing wastes from operation of the ^{233}U extraction facility and the disposed waste inventory included a considerable quantity of irradiated natural Thorium and has resulted in a strontium plume.

The Thorium Pit has been subject to ongoing infiltration (no caps or liners) which has resulted in a strontium plume, but the strontium concentrations and travel times are such that no treatment is required for this plume (when it eventually emerges into Duke Swamp strontium concentrations will be below 5 Bq/l). Recovery and remediation activities are scheduled following the availability of the CGDF.

2.5.6 WMA -B

WMA -B was established in 1953 to succeed WMA -A as the site for solid waste management. The site is located on a sand covered upland approximately 750 m west of WMA -A.

WMA -B Sand Trenches –old and new

Early waste storage practices for LLW continued those used in WMA -A, namely emplacement in unlined sand trenches capped with sandy fill in what is now the northern portion of the site. The old sand trenches require recovery but because of their volume and since they have been subject to infiltration over the last 50 years they will be recovered starting in 2025. The newer sand trenches will be managed in situ with very targeted recovery of limited volumes of wastes. Use of sand trenches in WMA -B for LLW was discontinued in 1963 in favour of concrete bunkers and the diversion of some LLW to WMA -C.

WMA -B Asphalt Lined Trenches

Asphalt-lined and -capped trenches were used for solid ILW from 1955 to 1959 when they were superseded by concrete bunkers constructed below grade but above the water table in the site's sands. Recovery is sequenced to follow recovery of the old sand trenches, in order to provide access to the Asphalt trenches.

WMA -B Concrete Bunkers

Concrete bunkers are used to store solid waste packages that do not meet sand trench acceptance criteria but, as well, do not require a significant amount of shielding. Early concrete bunkers took the form ofrectangular concrete bunkers. These were superseded in 1977 by the currently-used cylindrical bunkers.

CD bunkers 16-56 will have their waste contents recovered for emplacement into enabling facility IRUS and therefore are scheduled for recovery beginning in 2012. The remaining cylindrical and rectangular bunkers would be decommissioned starting in 2035 after unlined, uncapped wastes are recovered.

The Resin Cartridge Bunkers and Solvent Bunkers will be recovered in the near-term before the CGDF is available (the solvent bunkers contain liquids). The Tile Filter Bunkers recovery is planned following the availability of the CGDF.

WMA-B Miscellaneous Wastes

The recovery of these miscellaneous wastes is scheduled to occur immediately following the availability of the CGDF and are listed Appendix A, page 8 (under heading WMA-B Miscellaneous Wastes).

WMA-B Special Burials

Similar to WMA-A, WMA-B also had a number of 'special' burials which are listed Appendix A, page 8 (under heading WMA-B Special Burials). The recovery of these special burials is scheduled to occur just before the availability of the CGDF, and in the years immediately following it's availability. The exception to this is Slightly Active Solvents, which are to be recovered earlier because of the presence of liquid wastes.

WMA-BTileholes

High-level wastes are also stored in WMA-B, in engineered facilities known as tile holes. Tile holes are used to store radioactive material that requires more shielding than can be provided in concrete bunkers. These tile holes are concrete drain pipes set vertically on a poured concrete base at the bottom of a trench, a minimum of 1.2 metres above the water table. The diameter and wall thickness of the holes vary depending on their use. Tile holes are constructed in large groups called arrays, and the excavation is backfilled with sand.

This section addresses the decommissioning of the tile hole structures following waste removal. The contents of the tileholes are addressed in Section 3. It should be noted that this approach (separating the wastes and structures) is in contrast to how the other waste facilities in the WMAs are planned to be decommissioned. Tile holes used for the storage of irradiated uranium and other fissionable material differ from the standard tile holes in that they consist of a standard tile hole into which a steel pipe, closed at the bottom is inserted and the annulus between the pipe and the tile hole is filled with poured concrete.

Decommissioning of the emptied tile hole structures are scheduled on an array basis as listed in Appendix A page 9 (under heading WMA-B Tile Holes).

2.5.7 WMA-C

WMA-C is planned for *in situ* disposal. It contains a large volume of lightly radioactively

contaminated waste from both AECL operations as well as from off-site waste producers. The potential impacts associated with recovery of all wastes from WMA-C are large with respect to cost and also with respect to sizing of the eventual disposal facility. For this reason work on the WMA-C in situ disposal approach (licensing and associated requirements) are positioned early in the schedule.

The costs for WMA-C are shown on the Summary Spreadsheet in Appendix E. Rationale for scheduling and regulatory safety case costs are provided below.

The cost of the case for regulatory approval for WMA-C is based on project experience gained through the IRUS performance assessment and licensing process. This included Environmental Assessment (EA) work as well as detailed assessment calculations predicting the potential impacts (radiological, non-radiological, human (worker, public, inadvertent intruder), non-human biota) of the facility over extended time periods. In the case of WMA-C the degree of complexity is seen to be similar to IRUS and both are near-surface facilities, therefore the same costs are included.

The WMA-C in situ disposal approach includes the provision of a multi-layer engineered cover to limit infiltration and access by non-human biota. The costs of the multi-layer engineered cover were estimated by a third party engineering consulting firm.

2.5.8 Tank Farm

The Waste Tank Farm was established in 1961 to store high- and intermediate-level liquid wastes resulting from operation of facilities at the CRL plant site. It consists of seven tanks, some of which are housed in stainless steel-lined concrete bunkers. The inventories are well characterized and contained and therefore no provision is included for these costs. Retrieval is planned as part of the Stored Liquid Waste (SLW) suite of activities – see CRL enabling Facilities Section 3.5.2. Decommissioning of the emptied tanks and structures was costed by a third party contractor and decommissioning is scheduled following recovery of contents in 2012.

2.5.9 WMA -D

WMA -D was established in 1976 to store obsolete or surplus equipment and components that are known or suspected to be contaminated but do not require enclosure (pipes, vessels, heat exchangers etc.) plus closed marine containers containing drums of contaminated oils and liquid scintillation cocktails (LSCs). The site consists of a fenced compound enclosing a gravel-surfaced area in which the components are placed.

All storage in WMA -D is above ground: no burials are authorized. Ongoing operational requirements will see WMA-D maintained by the CRL until 2040. Removal of contents from within the fenced compound will be achieved prior to WMA-D closure and no radioactive wastes are expected to result. A small allowance for contaminated soils is included in the cost for WMA-D, along with the requisite, characterization, monitoring and abandonment safety case.

2.5.10 WMA -E

WMA-E was a suspect soil lay-down area for bulk soils coming from the built-up area of the CRL laboratory site CA-1 and CA-2. Radiological Protection controls in place at the time routed

suspect soils to WMA-E, while if contamination was observed on bulk soils they were routed to WMA-C. Groundwater monitoring in the vicinity of WMA-E has not indicated the presence of radioactive contamination. The approach to WMA-E is similar to WMA-C. An *in situ* disposal case will be prepared early in the program, but staggered from WMA-C so that lessons learned from the WMA-C effort can be incorporated in the WMA-E safety case.

No provision for an earthen cover is included with WMA-E, given the absence of any contamination in the monitoring network, and the relatively innocuous inventory.

2.5.11 WMA -F

A new area was established in 1976 to accommodate contaminated soils and slags from Port Hope, Albion Hills and Ottawa. The stored materials contain low levels of ^{226}Ra, uranium and arsenic. Emplacement was completed in 1979 and the site is now considered closed, although subject to monitoring and surveillance to assess possible migration of radioactive and chemical contaminants.

WMA-F is a candidate for *in-situ* management. Therefore no waste recovery is planned, but an increased effort for characterization, monitoring and an in-situ management safety case are required. The potential impacts associated with recovery of all wastes from WMA-F are large with respect to cost and also with respect to sizing of the eventual disposal facility. For this reason work on the WMA-F *in situ* disposal approach (licensing and associated requirements) are positioned early in the schedule, but following WMA-C.

Cost for an earthen cover is included for WMA-F that is scaled from a third party contractor estimate.

2.5.12 WMA -G

WMA -G was established in 1988 to store the entire inventory of irradiated fuel from the NPD prototype CANDU power reactor in above-ground concrete canisters. Once fuel is removed and transported to the Nuclear Waste Management Organization (NWMO) facility for long-term management, the storage structures will be decommissioned in 2060. Based on monitoring results no contaminated materials are expected from the decommissioning of the storage structures.

2.5.13 WMA -H

WMA-H is the most recently constructed WMA at CRL. It consists of fenced compound in which two Modular Above Ground Storage (MAGS) buildings (currently) are located which store LLRW in containers. Costs for disposal of the stored wastes are captured with the enabling facilities IRUS and CGDF in Section 3.6. Demolition of the structures will follow waste recovery and is planned for 2050. A provision for some contaminated waste from the demolition of the structures is included, but this is assumed to be small because only containerized wastes are stored in these buildings. Furthermore the assumed storage facility lifetime of 50 years is within design basis criteria. A provision for a regulatory safety case for site abandonment is also included.

2.5.14 Bulk Storage Compound

The Bulk Storage Compound was used prior to 1973 for storage of large pieces of equipment from Controlled Area 2 which were believed to be free of contamination. The compound is in a 'U' shaped configuration with fencing and locked gates to control access. Decommissioning of this site is planned once special equipment (under enabling facilities Section 3.2.3) is available. All storage is above ground. Removal of contents from within the fenced compound is scheduled for 2010. A small allowance for contaminated soils is included in the cost, along with an abandonment safety case.

2.5.15 Glass Blocks Sites 1 and 2

Two sites were constructed with glass block wasteforms containing active wastes to study the release characteristics of the wasteform. The first set of 25 glass blocks were emplaced in 1958. The second set of 25 glass blocks were emplaced in 1960. Two glass blocks were retrieved for examination from this array in 1978.

Due to the robust nature of the vitrified wasteform which has been verified during detailed experimental analysis, the recovery of the glassblocks is scheduled in 2030. Costs for recovery are based on previous recovery efforts and are anticipated to be small.

2.5.16 Old In-active Landfill

The CRL non-active landfill is used for disposal of general refuse from operations. This landfill has been in use for more than 30 years and operations are planned to cease by 2014.

The closure costs assume the placement of a cover and the required regulatory approval process. The cover is scaled from a third party estimate for a WMA-C cover. Ongoing groundwater monitoring is also included for approximately 50 years following closure and costs are based on the existing monitoring program.

2.5.17 Waste Management Areas Plumes Updates

Waste storage operations at CRL have led to several instances of groundwater contamination due to leaching of the waste. Treatment of the contaminated groundwater is required in several cases to minimize environmental impacts and future liabilities. As part of the Groundwater Monitoring Program (GWMP) (which is a regulatory requirement) plumes associated with the WMAs are updated on pre-defined frequency. The plumes included are listed in Appendix A page 10 (see Heading CRL WMAs Plumes Updates).

The plume update effort includes sampling of existing wells, installation of new monitoring points, sampling, analysis and reporting. Costs for the plume updates are based on costs experienced for the plume updates that have been performed as part of the GWMP. Based on data from the ongoing monitoring no remedial activities beyond the groundwater treatment systems are planned for these plumes.

3. ENABLING FACILITIES

3.1 Introduction

Enabling Facilities are those facilities and equipment required to recover, process, package, store and/or dispose of the waste produced during the decommissioning of AECL's facilities and sites, i.e. the federal legacy liability. Over time the enabling facilities themselves will need to be decommissioned and the resulting waste is included as part of the legacy liability. Therefore, cost elements for enabling facilities will typically include: conceptual design, design, licensing, construction, commissioning, operation, refurbishment and decommissioning.

Wastes generated from building/facility decommissioning and WMA waste recoveries require processing/treatment, storage and eventual disposal. The enabling facilities are constructed to address these requirements and the costs for the enabling facilities therefore include fulfilling these requirements as is shown in Figure 1 Overview of the Enabling Facilities.

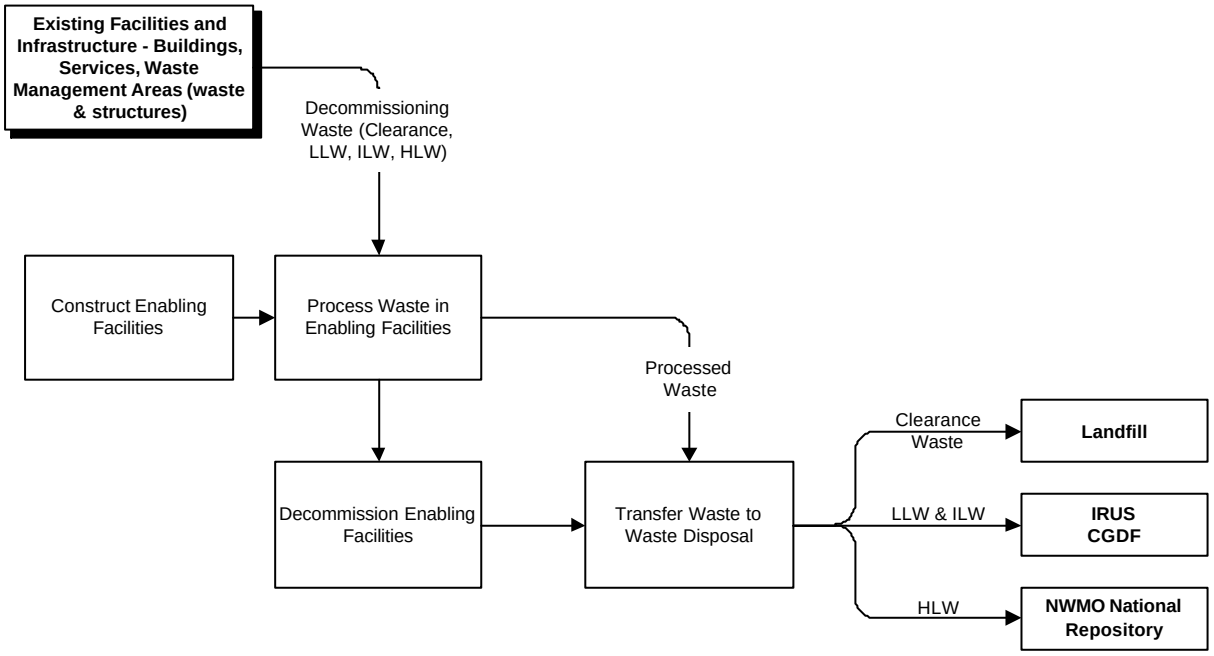

Figure 1 Overview of the Enabling Facilities

Due to the broad scope of the decommissioning requirements for the CRL site, a large number of enabling facilities will need to be built, operated and decommissioned. The individual facilities and the basis for their estimated cost is provided in the following sections.

3.2 CRL Waste Analysis Facilities

Large volumes of waste will be produced from the decommissioning of CRL. These wastes will need to be analysed and segregated to ensure that they are directed to the most technically appropriate and cost effective destination for long term management. In order to meet this need AECL will construct, equip and operate, as part of the decommissioning program, a Waste

Clearance Facility (WAF) and a Waste Characterization Facility (WCF) at CRL. In addition special equipment will be secured to support segregation, volume reduction and decontamination of various wastes. These requirements are discussed in more detail in the following 3 sections.

3.2.1 Waste Clearance Facility (WAF)

3.2.1.1 Introduction

The WAF is a non-nuclear facility that will be used for the purpose of monitoring large volumes of likely clean waste resulting from decommissioning and demolition activities. The facility will permit monitoring of the wastes in a low and stable background environment; this will provide AECL with a high level of confidence in which wastes are free of radioactive contamination and acceptable for "free release" (unrestricted scrap, recycle or disposal). Qualification as "free release" permits off site disposal of the waste in a landfill and removes any future nuclear liability. Without qualification as "free release" the wastes continue to represent a significant and avoidable financial liability since they must be treated as "suspect" or Low-Level Radioactive Waste (LLW).

The WAF is a one-year construction project commencing in 2005 to construct a permanent structure identified as Building 582. It will supersede the currently operating waste segregation facility as well as dedicated clearance efforts for decommissioning wastes. The facility is expected to operate until the conclusion of the decommissioning program in 2068.

3.2.1.2 Estimate

The cost estimate includes completion costs for design, siting as well as facility construction. The cost estimates were compiled by the project team, through preparation of a detailed work breakdown for delivery of the project and assessment of the resources required to deliver each element of the work. The project delivery details and cost analysis were compiled in a report that was reviewed through AECL's formal project review process.

The ongoing annual operation, maintenance, utilities and services costs were developed based on the expected lifetime of operation for the facility and the costs experienced during operations of similar facilities in Building 492 and dedicated clearance efforts for decommissioning wastes. The facility lifetime assumes continued operation until 2068 consistent with the anticipated turnover dates of currently operating facilities to Decommissioning and the anticipated timeframes for decommissioning of enabling facilities. A provision for facility refurbishment in 2046 has been included reflecting the extended period of operation. Prompt decommissioning follows facility shutdown with the cost based on the assumption of decommissioning cost equals a percentage (30%) of the cost to buy/build the facility.

The contingency for facility construction is assessed at a Grade B estimate level. The majority of costs for the facility are related to ongoing operation. The greater certainty with operation costs (as noted based on operational costs from existing facilities) results in an overall Grade A estimate being applied to the facility cost.

3.2.2 Waste Characterization Facility (WCF)

3.2.2.1 Introduction

Characterization of the radioactivity content of the waste from decommissioning operations is needed to ensure that the waste is appropriately routed for processing/treatment and disposal. Disposal of the radioactive waste requires further segregation into LLW, ILW and HLW based upon the quantity and type of radionuclides. The WCF is equipped with the scope of analytical instrumentation that is required to facilitate the segregation. The WCF will be required for the duration of the decommissioning program.

3.2.2.2 Estimate

Costs to construct the WCF facility were estimated and included delivery of the project and assessment of the resources required to deliver each element of the work. Detailed estimates for the analytical equipment were obtained and project costs were compiled in a note summarizing the status of the project during mid-2002.

Operating costs were developed based on a scale-up of the WAF reflecting a larger facility and more complex instrumentation. This revision effectively doubles the annual WAF operations and maintenance cost estimates for application to the WCF. The facility lifetime analysis assumes facility operation to 2068 consistent with the anticipated turnover dates to Decommissioning of currently operating facilities at CRL. Provision is made for one facility refurbishment in 2049 and two instrumentation upgrades in years 2028 and 2050 reflecting the long operating life of the facility and taking into consideration the likelihood of technological advancements in instrumentation and the evolution of new regulatory criteria.

Prompt decommissioning follows facility shutdown with the cost based on the assumption of decommissioning cost equals a percentage (30%) of the cost to buy/build of the facility.

The maintenance provision for the refurbished facility after 2049 has been decreased to half that of the original facility reflecting the shorter time-span of operation before dismantlement.

Contingency for a Grade B estimate is assumed for the construction and operation as only the instrumentation required for the facility has been fully scoped and priced. Operation costs have been scaled from the estimates for other similar facilities.

3.2.3 CRL Special Equipment

3.2.3.1 Introduction

Special Equipment will be required at the CRL site to allow volume reduction of both active and inactive waste streams. In addition, metals decontamination equipment will be required to support recycling and waste reduction initiatives. Soil segregation equipment is also required to reduce the volume of contaminated soil that will result primarily from remediation of the waste management areas.

3.2.3.2 Estimate

Estimates for purchasing specialized equipment were based on expert opinion in reference to previous experience with or knowledge of similar equipment.

Annual operating costs for the equipment were assigned in the same manner. Procurement of the equipment is targeted for 2008 and a replacement schedule for the equipment was assigned for years 2029 and 2050 based on the continued requirement for the equipment until the end of the program. No specific decommissioning cost is included for this equipment as previous experience has shown decontamination to be effective.

A Grade B contingency is used reflecting the absence of equipment specifications at the time of the estimate.

3.3 CRL Shielded Facilities

3.3.1 Introduction

The decommissioning program has a need for Shielded Facilities in which to examine existing HLW and fuel waste (decommissioning waste) and to use in the development of processing capabilities. Shielded facilities include both “hot cells” and “warm cells”. Hot cells are facilities that shield operators from direct radiation through the use of remote handling equipment and filtered ventilation and safety systems. Warm cells are used for lower radioactivity (radiation field) wastes. Specific decommissioning requirements include a “warm cell” for process development (see Section 3.5.3.5) and “hot cells” for examination and analysis of used reactor fuel to assess conditioning and long-term management requirements.

CRL has an existing hot cell facility that requires significant upgrading if it is to satisfy future requirements for both CRL site operations and decommissioning. The upgrading includes addition of a “warm cell”. The costs for upgrading the hot cells will be shared between decommissioning and CRL Site Operations since the hot cells are required for both activities.

3.3.2 Estimate

The cost estimate for the SF upgrade was developed by the project team through a detailed analysis of the initial project scope. The refurbished facility will service both decommissioning and site operations with the cost shared between both groups. No provision for operating costs is included in the estimate on the basis that the Decommissioning program will fund specific cell time through individual project activities as required. Facility operation is planned to continue through to 2029 at which time decommissioning of the shielded facilities is captured under the CRL site cost model for building decommissioning as part of Building 234 decommissioning costs. Commissioning is planned for the warm-cells in 2009 and for the hotcells by 2012.

A contingency allowance of Grade B is assigned in consideration of the uncertainty in the scope of refurbishment work at the time of the estimate as well as the uncertainty inherent in completing a project in an operating environment.

3.4 CRL Solid Waste Interim Storage Facilities (MAGS and SMAGS)

3.4.1 Introduction

Both the decommissioning program and CRL site operations have a continuing requirement to store low-level radioactive waste. The decommissioning program will replace the current storage technology, with Modular Above Ground Storage (MAGS) and Shielded Modular Above Ground Storage (SMAGS) buildings. MAGS and SMAGS technology will reduce both waste storage and future decommissioning costs and will support standardized waste packaging. These facilities will provide storage capacity for low-level solid decommissioning wastes from both demolition and maintenance and monitoring activities. Current MAGS units already on the CRL site are used for storage of low activity wastes, and an additional unit is planned. SMAGS, with it's increased shielding can store higher activity wastes.

The SMAGS facilities built by decommissioning will also service continued low-level operational solid wastes from the CRL site and other contractual waste storage obligations from external clients. The operational waste storage will be the subject of a pending cost sharing agreement.

3.4.2 Estimate

The SMAGS facilities built by decommissioning will also service continued low-level operational solid wastes from the CRL site and other external waste producers. The operational waste storage will be the subject of a pending cost sharing agreement. The cost estimate is based on the need for one additional MAGS unit and two SMAGS units to provide low-level waste storage capacity prior to the availability of a low and intermediate level waste CGDF facility at CRL.

The MAGS cost estimate is based on previous experience with construction of two of these units at CRL. Operation, maintenance and utilities costs were based on operating experience with current waste storage facilities. These are considered Grade A estimates.

The design, license, construct and commission costs for the first SMAGS unit were developed by the project team. The cost of the second unit has been adjusted downward to reflect anticipated savings in design and licensing, upfront project management and facility commissioning costs for a second identical unit. Operation, maintenance and utilities costs were developed by expert opinion based on operating experience with current waste storage facilities. These estimates are considered Grade B.

Decommissioning of MAGS and SMAGS is scheduled for 2051. The SMAGS decommissioning cost has been assigned based on the assumption of decommissioning cost equals 30% of the cost to buy/build the facility.

3.5 High Level Waste (HLW) Remediation Projects

3.5.1 General Introduction to the CRL HLW Wastes

High-level solid radioactive waste (HLW) is stored in engineered facilities known as tile holes (THs), and canisters. Liquid HLW is stored in tanks in various locations on the CRL site.

Figure 2 provides an overview roadmap for the decommissioning of the HLW. Liquid wastes are addressed in the section immediately following, while TH decommissioning is addressed in Section 3.5.3.2 and canisters in Section 3.5.3.7.

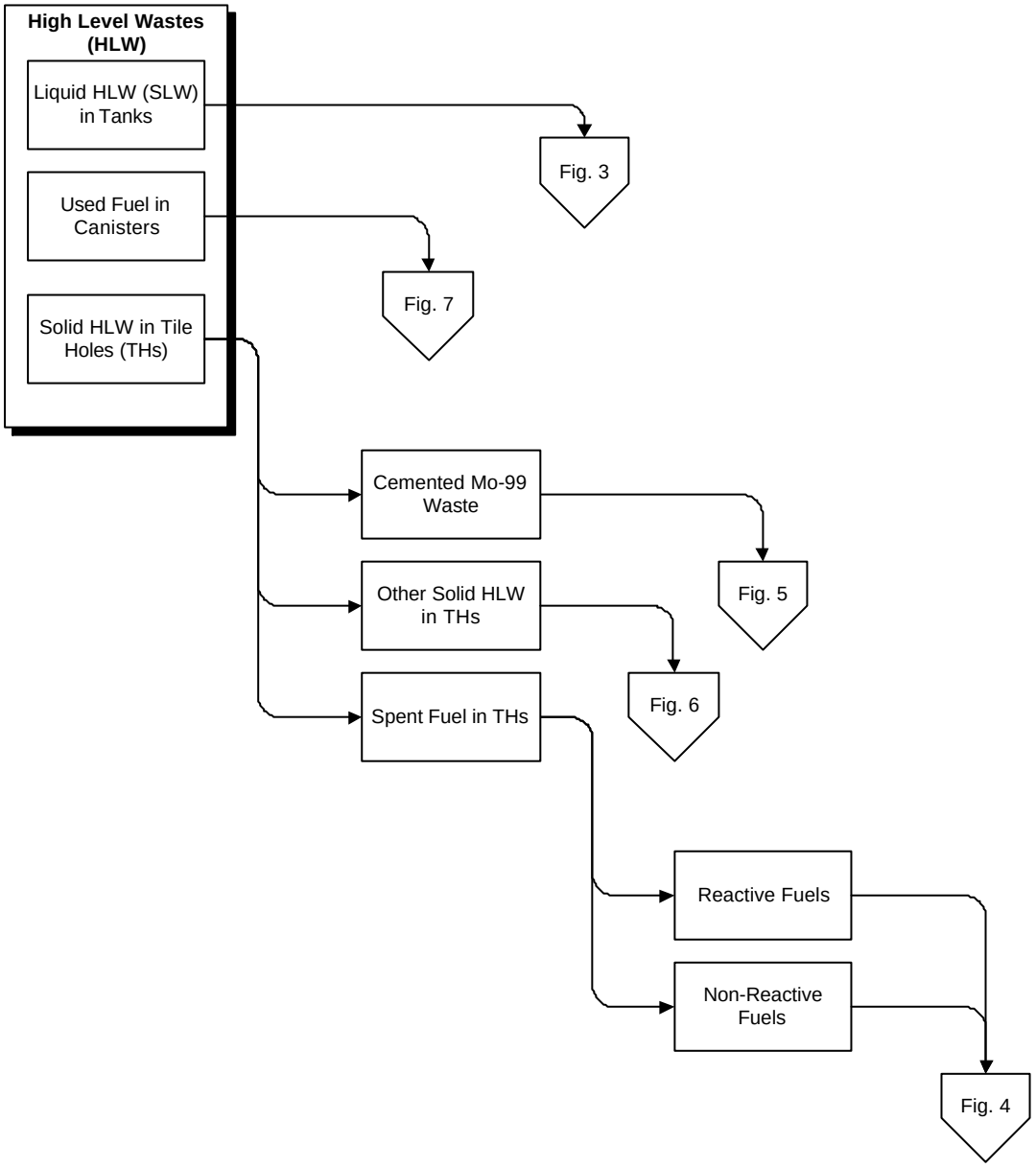

Figure 2 Overview of HLW

3.5.2 CRL Liquid Waste Processing Enabling Facilities

3.5.2.1 Introduction

AECL has liquid waste processing requirements for existing low-, and high-level liquid wastes in tanks, plumes and from operations. Stored Liquid Waste Consolidation and Processing Facilities

(SLWCF, SLWPF) will be constructed for HLW. WTC upgrades are required for operational liquid wastes and groundwater treatment facilities for plumes.

3.5.2.2 CRL Stored Liquid Waste

AECL has approximately 300 m3 of radioactive liquids and sludges stored in tanks that will require decommissioning. The tanks are located in structures in 2 locations, the tank farm in CRL's outer area and several buildings in the inner area. A simplified flow sheet of the activities that will be undertaken to decommission the stored liquid waste and associated structures is provided in Figure 3.

The decommissioning program objectives for the SLW are to design, construct and commission those facilities required to enable the decommissioning of the liquids, to deliver those activities required to process and/or store the waste until final disposition and to decommission all structures used to store or process the liquids.

For the purposes of organizing and delivering the requirements, activities have been aggregated into projects. The cost basis discussion provided in the next section refers to individual activities or where required to groups of activities that constitute a project in the decommissioning program.

3.5.2.3 Stored Liquid Waste Cost Basis

The majority of the cost is associated with 2 enabling facilities, a Stored Liquid Waste Retrieval and Consolidation Facility (SLWCF, Section 3.5.2.4) and a Stored Liquid Waste Processing Facility (SLWPF, Section 3.5.2.5) as is shown in Figure 3 Liquid HLW Tank Decommissioning . For the purposes of the decommissioning program and this cost basis document the activities associated with these enabling facilities are referenced to the full life cycle for the facility. The project for each facility includes design, licensing, construction and commissioning as well as the operation, maintenance and decommissioning costs from the time the facility commences operation until the facility and site is taken to the final end state of decommissioning. Where needed the cost estimate may also include waste storage costs for the processed waste until the waste is transferred to Fuel Waste Disposal Packaging (FPF) facility and the associated transfer costs.

The first activity for the SLW is to ensure the safety of the stored liquids through monitoring the integrity of the storage tanks until they are emptied. The costs for tank monitoring have been extrapolated from the historical costs for the ongoing monitoring.

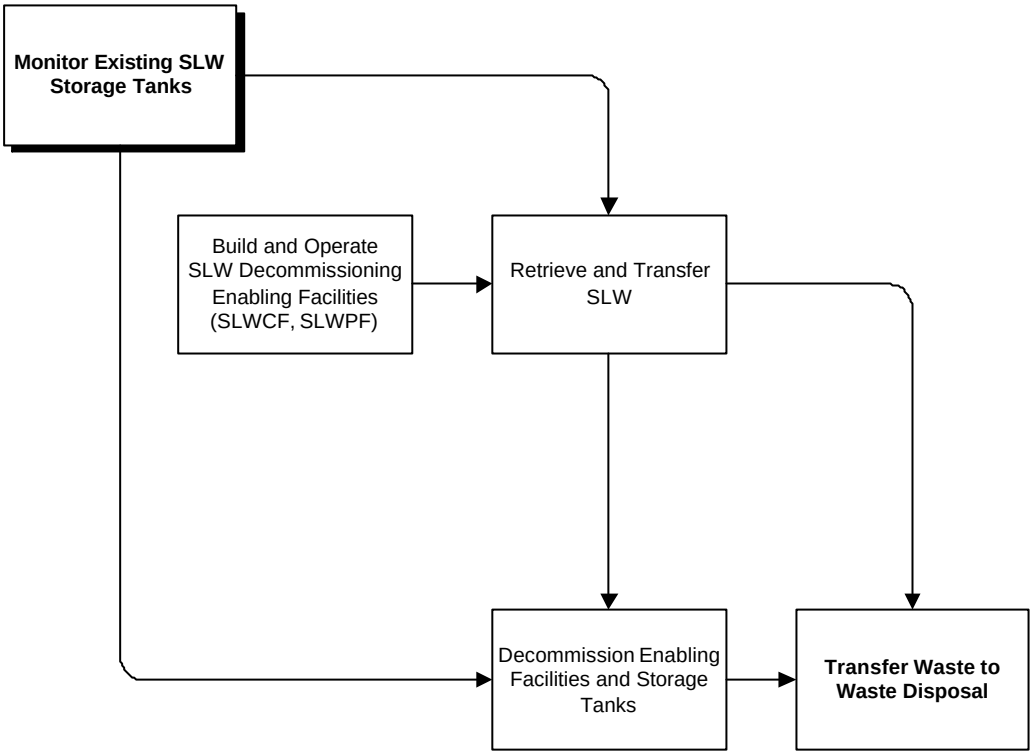

Figure 3 Liquid HLW Tank Decommissioning

3.5.2.4 CRL Stored Liquid Waste Consolidation Facility (SLWCF)

The SLWCF will provide the equipment required for liquid waste retrieval, processing and consolidation and storage of the waste. In order to address safety issues associated with one existing tank (FISST) the consolidation process will also include a down-blending component.

The SLWCF project team compiled the cost estimates for design, licensing, procurement, construc tion, commissioning and operation of the SLWCF. The cost estimates were developed through preparation of a detailed work breakdown for delivery of the project and assessment of the resources required to deliver each element of the work. The project delivery details and cost analysis were subject to AECL's formal project review process.

The SLWCF project team also developed the cost estimate for the ongoing requirement to maintain the facility and monitor the consolidated waste until they can be processed in the SLWPF. The maintenance and monitoring cost estimates were adjusted for the appropriate storage period and reviewed and compared with the experience based costs for operating existing tanks at CRL.

Several additional costs where identified subsequent to preparation of the project cost estimate, these included; the provision of utilities for the facility, the procurement of DU required for the down-blending of FISST waste and the shutdown operations required for the new tanks in the SLWCF. The cost estimates for these three cost elements where developed through analysis by a panel of experts.

The cost for decommissioning the SLWCF in 2059 was developed through a contract with an external consultant that has extensive experience in decommissioning cost estimation.

The overall estimate is assigned a Grade B.

3.5.2.4.1 Tank Preparation Decommissioning Project (TPDP)

Operation of the SLWCF facility described above, may include accessing the tanks, transferring the liquids to the SLWCF, consolidation and downblending operations. This work will be delivered through the Tank Preparation Decommissioning Project (TPDP). During the preparation of the estimate this was included as an allowance due to scope uncertainty. Therefore this is considered a Grade C estimate.

3.5.2.4.2 Storage Tank Decommissioning

The existing storage tanks will be decommissioned between 2014 – 2022, subsequent to the liquid wastes being transferred to the SLWCF. The cost estimates for decommissioning the tanks were developed by a third party contractor and are captured with Miscellaneous CRL Facilities – Stacks and Tanks Appendix A page 5.

This is considered a Grade C level estimate based on the complexity of the existing tanks and uncertainty with their end-state at turnover.

3.5.2.5 Stored Liquid Waste Processing Facility (SLWPF)

The SLWPF will be used to receive the consolidated waste from the SLWCF and to process that waste to a solid form suitable for interim dry storage and ultimately long-term management through the NWMO. Secondary waste will be processed in the upgraded WTC.

The SLWPF will also be used to process an additional waste, cemented Mo-99 waste that will be recovered from WMA-B and then conditioned in a separate facility, the cemented Mo-99 Waste Conditioning Facility (Section 3.5.3.5), prior to transfer to the SLWPF.

The schedule for the SLWPF project accommodates the recovery and processing of Mo-99 cemented waste since it requires similar processing capabilities. The facility constructed through the SLWPF project will be used to sequentially process the Mo-99 waste and the SLW and the cost estimates for operation/maintenance of the facility and monitoring of the consolidated liquid waste reflect the extended duration of operation. Vitrification (incorporation of the waste in a glass matrix) is the reference process for the SLWPF project to produce a stable long-term waste for disposal.

3.5.2.5.1 Cost Estimate

Costs estimates to design and construct the SLWPF were compiled by the SLWCF project team based on estimates received from a request for proposal to estimate the cost of a vitrification plant at CRL.

The lifecycle cost for a storage block for the newly processed vitrified waste form was derived from the storage block component of the Tile Hole Remediation Processing Facility 1 (THRPF1) project reflecting the waste volume.

Operating costs for the facility were assigned by expert opinion considering a processing timeframe of approximately 21 years for the recovery of Mo-99 wastes. The processing time is aligned with the Mo-99 tile hole recovery timetable for WMA -B. A further five years will be required to process the stored liquid wastes from the SLWCF followed by one additional year of operational costs for facility shutdown work.

Maintenance and utilities costs were assigned by expert opinion. Annual costs were included from the time the facility is commissioned for operation until the time of decommissioning.

Decommissioning of the SLWPF is targeted to commence in 2047, shortly after the shutdown work in 2044 to allow for time for planning and approvals. Decommissioning of the vitrified waste storage block is targeted to commence in 2056 following transfer of the vitrified waste to the Fuel Packaging Facility (FPF) (Section 3.5.3.7) for shipment to the NWMO National Repository for high activity waste, access to which is assumed available to CRL after 2055. The NWMO National Repository for high activity waste is not part of AECL's program but that of the NWMO. Decommissioning costs for the processing facility were provided by an external third-party consultant while decommissioning costs for the storage block were based on a percentage (30%) of the buy/build cost.

The final activity for the SLW decommissioning is to transfer the vitrified liquid waste to the fuel packaging facility (see Section 3.5.3.7).

The contingency added to the estimate for this facility is Grade C estimate based on the range of estimates received from proposals for a vitrification plant and the scale-up of other estimates.

3.5.2.6 WTC Upgrades

3.5.2.6.1 Introduction

Radioactive aqueous waste will be produced from various decommissioning activities as well as from the ongoing operational activities on the CRL site. The decommissioning program has as an objective to provide the capacity and capability to reliably process all ongoing aqueous wastes at CRL from both the decommissioning activities and continuing operational activities. Achievement of this objective will result in permanently ceasing discharge of contaminated water to seepage pits (discharges were stopped in 2000). Ceasing discharge will reduce the growth of future liability and permit decommissioning activities to remediate the area contaminated by the historic discharges.

The upgrades when completed will: improve capacity (completed); enhance reliability (underway); and provide a liquid waste cementation facility to immobilize low- and intermediate- level wastes for long-term management (to be initiated).

3.5.2.6.2 Cost Estimate

The cost estimates for the WTC upgrades were compiled by the project team and include work underway (equipment quotations) and third party estimates for future upgrades. The schedule for completion of the ongoing upgrades is scheduled for 2006 and overall completion by 2015. A portion of the facility upgrades underway is funded by AECL operating budgets.

A facility operations cost allowance was developed taking into account a planned cost-share arrangement, and were based on costs experienced in the currently operating facility including consideration of the impact of the upgrades.

One refurbishment of the facility evaporator is planned for 2026 based on the expected operational life of the facility. The refurbishment cost is based on expert opinion in reference to the cost of the current upgrades.

The decommissioning cost for the WTC is captured under the CRL Site building decommissioning cost model for Building 570 following shutdown in 2051 Appendix A page 1 CRL Planning Envelope 1 Bldgs. A separate cost estimate was compiled by the project for decommissioning the cementation facility since it is not captured in the current building decommissioning cost model. The decommissioning cost was based on 30% of the cost to buy/build the facility.

Contingency for the current project is at a Grade A level but a Grade B estimate is assigned to the overall project based on the unavailability of detailed requirements for completion of the balance of the project.

3.5.2.7 South Swamp Groundwater Treatment Facility

3.5.2.7.1 Introduction

Waste storage operations at CRL have led to several instances of groundwater contamination due to leaching of the waste. Treatment of the contaminated groundwater is required to minimize environmental impacts and future liabilities. Several treatment facilities are already in operation (see Section 2.4.6.1) and an additional facility is planned to intercept and remove radioactive contamination from groundwater that originates from WMA -A and discharges to the "South Swamp" wetland. The costs associated with this enabling facility include the construction of an engineered, "passive" interception system based on the system successfully implemented to treat the Nitrate Plant plume in 1999.

3.5.2.7.2 Cost Estimate

The cost estimate to install and operate the groundwater treatment facility was based on previous experience with a similar type of groundwater treatment system installed for the Nitrate Plant plume.

Operation of the treatment system is assumed for a 50 year period. There is no decommissioning cost applied due to the passive nature of the proposed facility. Operating costs (starting in 2008) are included under groundwater treatment systems (see Section 2.4.6.1).

Contingency applied to this project is Grade A based on previous experience with construction and operation with a similar type of treatment system.

3.5.3 CRL Solid Waste Processing Enabling Facilities

Large volumes of solid radioactive waste will be produced during decommissioning. Processing of much of this waste is needed in order to minimize costs and ensure that the wastes are in a form that is acceptable for long term management. The following enabling facilities are planned to achieve this requirement; a Waste Incinerator (WI), a Solid Waste Cementation Facility (SWCF), Tile Hole Remediation Processing facilities for the recovery, storage and processing of fuel in Tile Holes (THRPF1, THRPF2), a Mo-99 Cemented Waste Conditioning Facility

(MCWCF) a Non-Fuel Non-Mo-99 Waste Processing Facility (NNWPF), and a Fuel Packaging Facility for all HLW. Included in this section is the discussion of the decommissioning of the fuels stored in WMA-G canisters. All HLW will be routed to the NWMO long-term waste management facility. These facilities are described in more detail in the following sections of the document.

3.5.3.1 Waste Incinerator and Solid Waste Cementation Facility

3.5.3.1.1 Introduction

Incineration of combustible waste yields a product that is relatively homogeneous and greatly reduced in volume. These features reduce cost by making waste characterization easier and by ensuring that the waste volume is minimized as well as directed to the most cost effective facility for long term management.

One factor in providing confidence in the ability to manage radioactive waste over long time periods is the stability of the waste form, both in terms of mechanical stability and chemical stability. Through incorporation of ash into cement a waste form can be produced that has predictable qualities and much improved stability. The waste can also be subjected to tests and analysis that quantify its stability. A cementation facility will be constructed in conjunction with the incinerator facility.

3.5.3.1.2 Cost Estimate

The cost estimate for designing and building a WI was developed in two stages. An initial cost estimate and cost flow was provided based on a third party Thermal Waste Processing Options Study. Subsequently, during a review of the project the cost was scaled-up using expert opinion and prorated to the original cost flow for the activities.

The annual cost for incinerator operation, maintenance and utilities was derived using expert opinion and based on operational experience with similar nuclear facilities. Given the planned 31 year operating life of the incinerator facility and the life expectancy of the incinerator itself, a provision for incinerator refurbishment was included after 15 years of operation. The decommissioning cost was assigned based on a percentage (30%) of the cost to buy/build the facility.

The cost for a SWCF to immobilize waste is based on the same cost estimate and cost flow for a similar facility for liquid waste immobilization. The cost estimate is presented in Section 3.5.2.6 as part of the WTC facility upgrades. The annual cost for operation, maintenance and utilities was assigned using expert opinion. The decommissioning cost was assigned based on 30% of the cost to buy/build the facility.

A contingency of Grade C estimate is assigned considering the scale-up basis for the capital construction and equipment and the uncertainty in scope for the remainder of the estimate.

3.5.3.2 Tile Hole Decommissioning

The THs are located in CRL's Waste Management Area B (WMA-B). THs are subdivided into three sets that are used to store the following three types of waste;

- Reactor fuel
- Cemented waste from Mo-99 production
- Other non-fuel, non Mo-99 waste (typically hot cell waste including filters and irradiated reactor components)

The decommissioning program objectives for the HLW THs is to design, construct and commission those facilities required to enable the decommissioning of the solid HLW, to deliver those activities required to process and/or store the waste until final disposition and to decommission all existing and new structures used to store or process the liquids. Figures 4, 5 and 6 provide simplified flow sheets of the activities for each of the sets of THs and the HLW that they contain.

For the purposes of organizing and delivering the required facilities and achieving the various requirements, activities have been aggregated into projects. The cost basis discussion provided in the next section refers to individual activities or where required to groups of activities that constitute a project in the decommissioning program.

3.5.3.3 Tile Hole High Level Waste Cost Basis

The waste from each of the tile hole sets will require processing in one or more of the 6 enabling facilities specially constructed to address the differing requirements for the solid HLW from each of the sets of THs. Two enabling facilities, Phase 1 & 2 Tile Hole Remediation Processing Facilities (THRPF1 & THRPF2) are required to process the research reactor fuels (IFE 1-4, IMD 1-4). Two additional enabling facilities, the Cemented Mo-99 Waste Conditioning Facility (CMWCF) and the Stored Liquid Waste Processing Facility (SLWPF, see Section 3.5.2.2) are required to process the Mo-99 waste. A fifth enabling facility, the Non-fuel, Non-Mo-99 Waste Processing Facility (NNWPF) is required to process the waste from the third set of tile holes. Lastly, a Fuel Packaging Facility (FPF) is required to package the processed fuel, the vitrified Mo-99 waste as well as the vitrified stored liquid waste before transport to the NWMO National Repository. For the purposes of the decommissioning program and this cost basis document the activities associated with these enabling facilities are referenced to the full life cycle for the facility. The project for each facility includes design, licensing, construction and commissioning as well as the operation, maintenance and decommissioning costs from the time the facility commences operation until the facility and site is taken to the final end state of decommissioning. Where needed the cost estimate may also include waste storage costs for the processed waste until the waste is transferred to final disposal as well as the costs of transferring the waste.

The first activity for the HLW TH decommissioning is to carry out an investigation of the tile holes to assess the requirements for removal of the HLW. This work will be delivered through the Tile Hole Investigation and Stabilization (THIS) project. The THIS project has been underway for several years and estimates were provided by the THIS project based on the scope associated with IFE, IMD 1-4. The costs and schedule were then extended to include the remaining tileholes. The THIS project activities are included in the schedule chart Appendix A page 9 under heading WMA-B Tileholes.

For the cost basis discussion that follows in sections 3.5.3.4 and 3.5.3.5, the three sets of TH

facilities are treated separately.

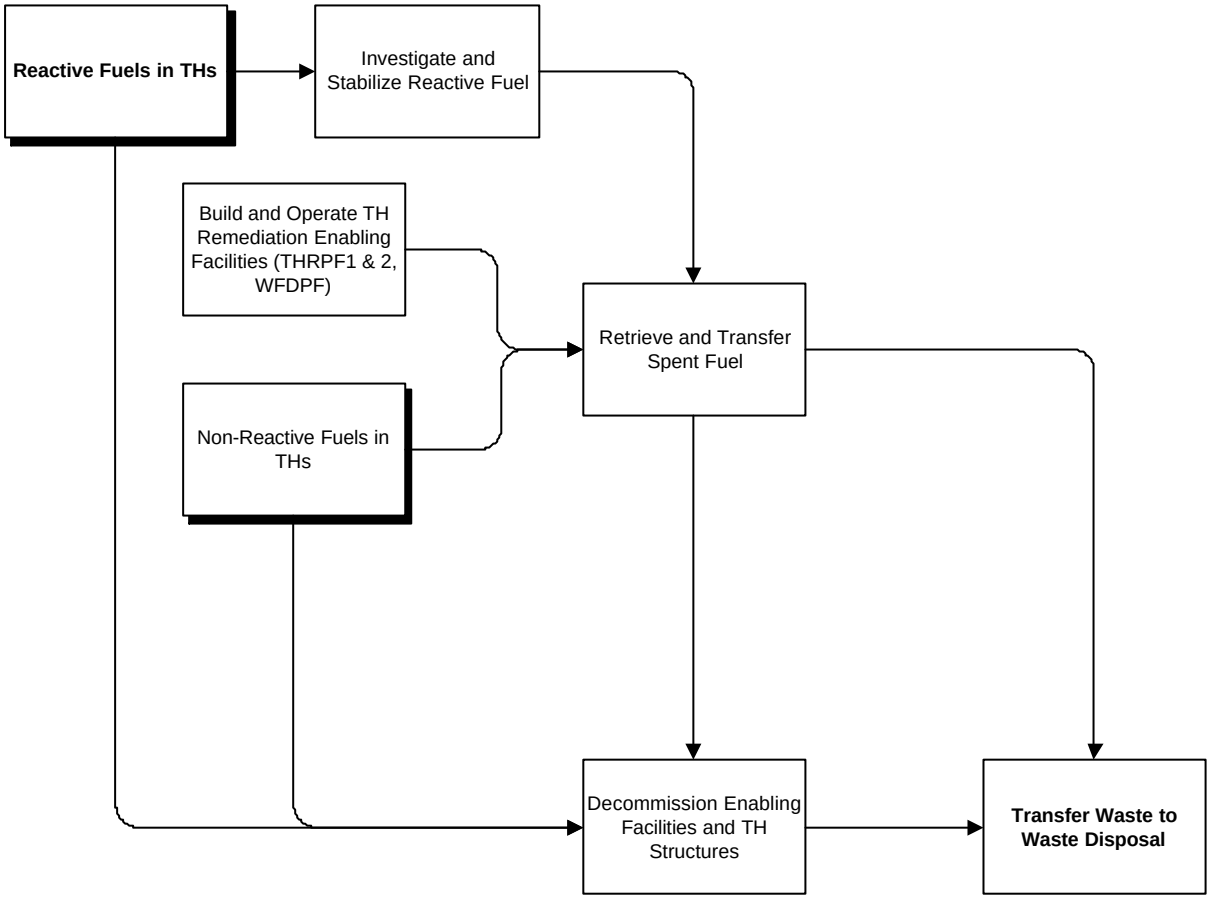

Figure 4 Used Fuel Tile Hole Decommissioning

3.5.3.4 Reactive Fuel Waste (THRPF1 and THRPF2) Cost Basis

As noted previously, two enabling facilities, THRPF1 and THRPF2 are required initially to process the reactor fuels. THRPF1 is required to process the oldest experimental fuels, long fuel rods, from the earliest generation of tile holes. The scope of THRPF1 includes the construction and "cold" commissioning (i.e.; not including radioactive materials) of a new storage block and the associated drying and repackaging facility by the end of 2011 to permit recovery and processing of the long rod fuels . Recovery of the fuel rods is scheduled to commence as part of "hot" commissioning and will permit the commencement of remedial activities for the tile holes and surrounding area. THRPF2 will be required to allow the processing of short bundle fuels. The project is scheduled to commence in 2035, with commissioning slated for 2041 and operation by 2044. THRPF1 and 2 are discussed in greater detail in the following sections.

3.5.3.4.1 Tile Hole Remediation Project Phase 1 (THRPF1)

Cost estimates and cost flow for the THRPF1 design, licensing, construction, commissioning and operation through the fuel recovery period were developed by the project team. The early generation tile holes, which contain the oldest experimental fuels, require recovery of the fuel

contents, drying of the fuel and new storage facilities for the dried fuel. The current project includes the construction and "cold" commissioning (i.e.; not including radioactive materials) of a new storage block and the associated drying and repackaging facility by 2011 for the long rod fuels. Recovery of the fuel rods, which is projected to commence as part of "hot" commissioning, will permit remedial activities for the tile holes and surrounding area The cost estimates were developed through preparation of a detailed work breakdown for delivery of the project and assessment of the resources required to deliver each element of the work. The project delivery details and cost analysis were compiled in a report that was reviewed and approved through AECL's formal project review process. Costs for maintenance, utilities and services throughout the facility lifespan were assigned by expert opinion, this included both the operating phase and the period of reduced costs associated with monitoring and surveillance of the dormant facility after active operation until planned decommissioning.

Decommissioning of the THRPF1 is scheduled for 2040. The cost was assigned based on the assumption of decommissioning cost equals a percentage (30%) of the cost to buy/build the facility.

Contingency is assigned at a Grade B through facility construction and active operation. The balance of costs for maintenance, monitoring/surveillance and final decommissioning assumed the same level of contingency.

3.5.3.4.2 Tile Hole Remediation Project Phase 2 (THRPF2)

Estimates and cost flow for the design, licensing, construction, and commissioning phases of the THRPF2 facility were compiled by the current THRPF1 project team. The project team utilized the knowledge gained in the THRPF1 project to assess the condition and challenges likely to be faced in delivering the THRPF2 project.

Operation and final decommissioning costs for the facility were scaled from the estimates fromTHRPF1 project but reflecting the additional complexity of THRPF2. Decommissioning of this facility is planned to commence in 2066.

Estimates for maintenance and utilities, shutdown, monitoring and surveillance during dormancy were assigned by expert opinion as with the THRPF1 project.

Contingency for the THRPF2 project is assigned as Grade C.

3.5.3.5 Cemented Mo-99 Waste Conditioning Facility (CMWCF)

3.5.3.5.1 Introduction

Mo-99 wastes from isotope production at CRL have been stored both as liquid in a tank and as a cemented solid in THs. The liquid waste has been cemented and stored in tile holes during periods when the FISST liquid waste storage tank was not available. A simplified flow sheet for decommissioning these tile holes and their content of cemented Mo-99 is shown in Figure 5 Mo-99 Tile Hole Decommissioning. A CMWCF is required to facilitate recovery of the cemented wastes from these tile holes and to process the wastes into a form with properties similar to the liquid waste stored in the FISST tank so that the same vitrification process may be applied to all of the Mo-99 waste. The CMWCF (shielded facility) will be required to house the conditioning

process for separating the Mo-99 and cement.

3.5.3.5.2 Cost Estimate

The cost estimate and cost flow for the design, licensing, construction and commissioning of the CMWCF facility was based on scaling from the THRPF1 reflecting the increased number of THs, complexity of retrieval and an early conceptualisation of processing requirements. A program to develop the Mo-99 processing technology was incorporated into the construction project and the cost estimate for that program was developed using expert opinion. Operational costs were based on operating experience with existing shielded facilities.

Decommissioning for this facility is planned for 2048. Decommissioning cost was assigned as a percentage (30%) of the cost to buy/build the facility. The contingency applied to the project is Grade C.

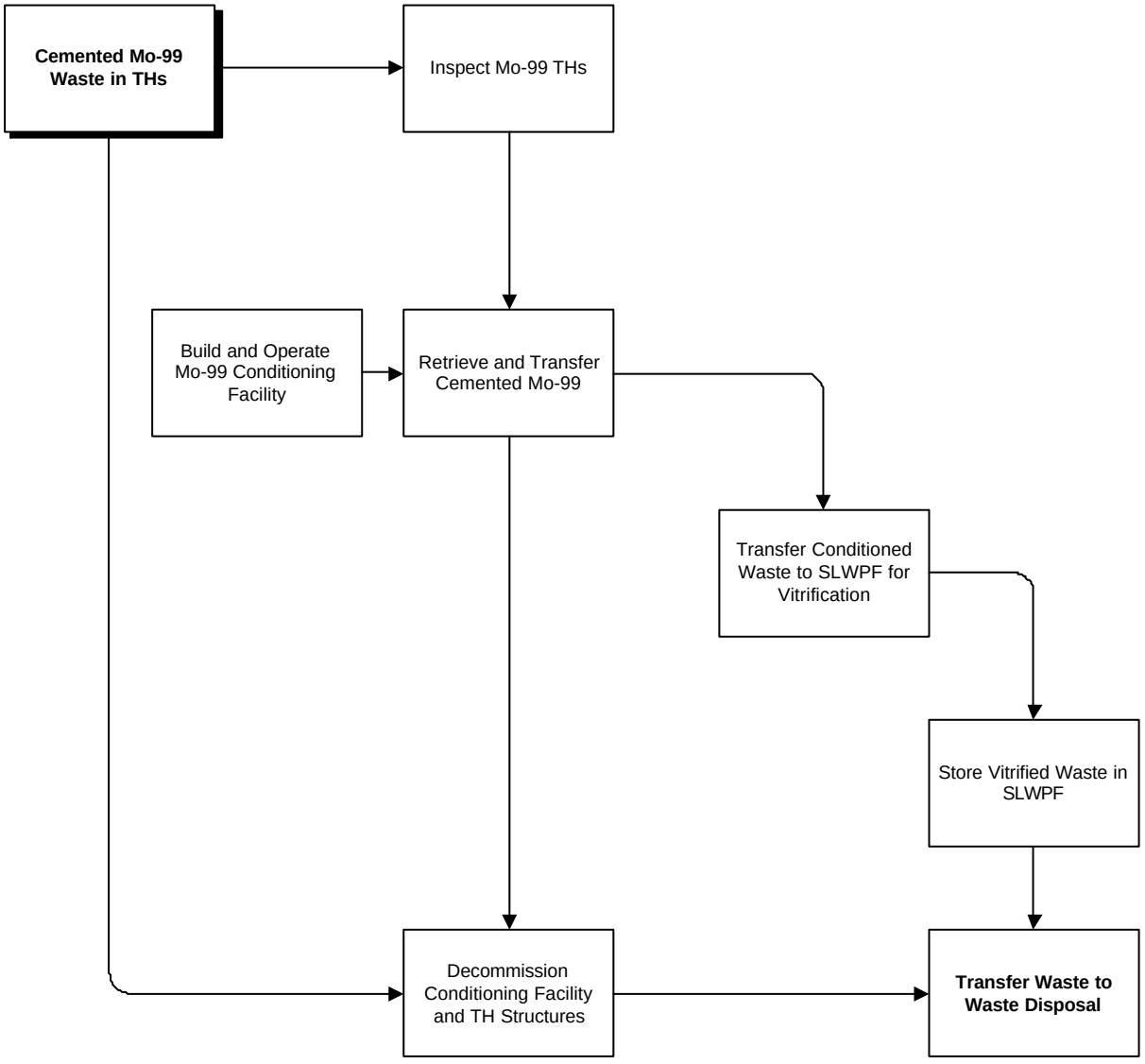

Figure 5 Mo-99 Tile Hole Decommissioning

3.5.3.6 Other Non-Fuel, Non-Mo-99 Waste Processing Facility

3.5.3.6.1 Introduction

A number of tile holes at CRL contain high-level solid waste that is neither used fuel nor cemented Mo-99 (e.g. miscellaneous high radiation field hotcell wastes). A simplified flow sheet for decommissioning these tile holes and the contained waste is shown in Figure 6. A Non-Fuel, Non-Mo-99 Waste Processing Facility (NNWPF) is required to process this waste since the waste cannot be properly processed by either the spent fuel or Mo-99 waste processing facilities.

3.5.3.6.2 Cost Estimate

The cost estimate to construct and operate the NNWPF was derived from expert opinion based on the number of tile holes to be addressed (i.e. efficiency of scale) and the complexity factor of the waste recovery operations, including consistency of waste form. This result was scaled on the basis of the experience gained from the current tile hole decommissioning project (THRPF1). Decommissioning of this facility is planned for 2046.

Decommissioning cost was assigned as a percentage (30%) of the cost to buy/build the facility.

The contingency applied to the cost estimate for the NNWPF is Grade C.

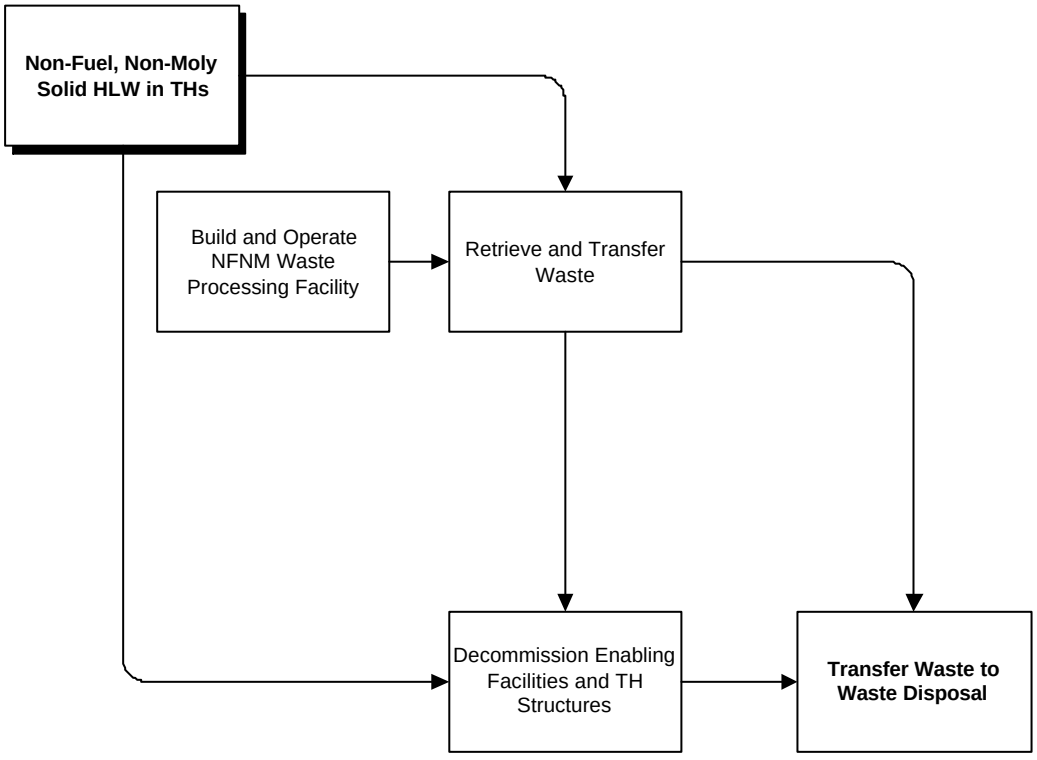

Figure 6 Non-Fuel Non -Moly 99 HLW Tile Hole Decommissioning

3.5.3.7 Fuel Disposal Packaging Facility

3.5.3.7.1 Introduction

As part of AECL's decommissioning strategy it is assumed that the NWMO National Repository for high-level waste will be ready to receive AECL's nuclear fuel waste starting in the year 2055. Prior to shipment to the NWMO facilities the fuel waste which includes the fuel remaining in tile holes and WMA-G canisters (Figure 7), the conditioned reactive fuel, the vitrified Mo-99 waste and the vitrified stored liquid waste will need to be packaged for transport.

A Fuel Disposal Packaging Facility (FPF) will be required to recover, condition and package the spent nuclear fuel & vitrified waste. The design and construction at CRL of the FPF will commence in the year 2042 to ensure that the AECL fuel wastes can be shipped progressively to the NWMO National Repository between the years 2055 and 2065.

3.5.3.7.2 Estimate

The cost estimate to construct and operate the FPF was derived from expert opinion based on the quantity of waste to be shipped to the NWMO. This result was scaled on the basis of the experience gained from the current tile hole decommissioning project (THRPF1) and on the complexity of the waste recovery operations. The facility will be decommissioned in 2066.

Decommissioning cost was assigned as a percentage (30%) of the cost to buy/build the facility.

The contingency applied to the cost estimate is Grade C.

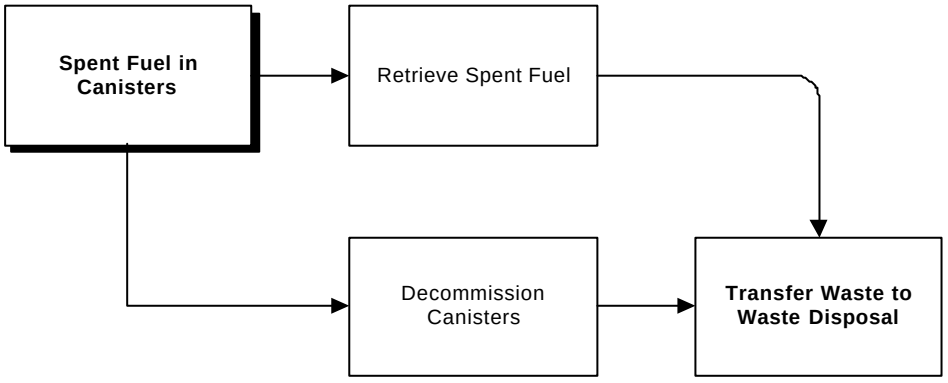

Figure 7 Used Fuel Canister Decommissioning

3.6 Long Term Waste Management Enabling Facilities

3.6.1 CRL New Inactive Landfill

3.6.1.1 Introduction

As discussed previously and shown in Figure 1, a large fraction of the decommissioning waste will not be radioactive. This non-radioactive waste will be disposed in an inactive landfill on the CRL site. The WAF described in Section 3.2.1 will provide the capability to analyse the waste and ensure that only wastes that meet the clearance criteria are sent to the landfill. Due to the

limited disposal capacity available in the existing CRL landfill, a new inactive landfill is planned.

3.6.1.2 Estimate

Cost estimate and cost-flow for design, licensing and construction was based on information from CRL Site Operations and their experience with the current landfill. Operating costs were assigned by expert opinion and based on the costs experienced in operating the current landfill. An operating lifetime of 57 years is assumed consistent with the current schedule for the operational shutdown and decommissioning of the CRL facilities.

The cost estimate for preparation of the final safety case for abandonment of the new landfill at the end of its operational period was based on expert opinion. With the long lifetime for this facility, ongoing operational costs are a very significant portion of the overall total cost. Therefore a Grade A contingency is assigned based on cost experience gained from the current landfill.

3.6.2 Intrusion Resistant Underground Structure (IRUS)

3.6.2.1 Introduction

As discussed previously and shown in Figure 1, a fraction of the waste generated from decommissioning will require disposal in a radioactive disposal facility. The decommissioning program plans to construct two Intrusion Resistant Underground Structures (IRUS) for disposal of low-level waste.. IRUS will demonstrate AECL's ability to achieve disposal for LLW at CRL and provide long-term disposal for wastes prior to the availability of the CGDF. . The IRUS project had advanced to a stage just short of receiving a construction license when AECL decided to put the project on hold in 1999. The IRUS licensing process has been reinitiated under the current decommissioning program with construction of the first unit expected to commence in 2009.

3.6.2.2 Estimate

The cost estimate for IRUS includes updating the previously submitted safety case based on a change in the regulatory environment and completion of an environmental screening/assessment that will be required to restart the project. The balance of the costs to design, license, build and commission the first IRUS vault and cap were based on detailed drawings for the facility. The cost estimate for the second IRUS unit uses the same costs for procurement and construction but includes reduced costs for design, licensing and commissioning of the unit.

Operating costs for IRUS were assigned by expert opinion and reflect operating experience with near-surface storage facilities. Each IRUS unit is expected to operate for a period of six-years.

A cost provision is included for the purchase and operation of bitumen over-coating equipment for the processing of selected waste, that will be recovered from bunkers, before emplacement in IRUS. The equipment is expected to operate for two years. This portion of the cost estimate was developed using expert opinion. No decommissioning costs are included or required since IRUS achieves the end point of disposal.

A Grade B contingency is assigned based on the relatively recent basis for the cost estimate, availability of detailed drawings and operational experience.

3.6.3 Chalk River Geological Disposal Facility (CGDF)

3.6.3.1 Introduction

For the longer term, AECL's decommissioning program plans to implement a solution for disposal that fully considers AECL requirements in terms of the large volumes of waste requiring disposal and the overall cost of disposal alternatives. The Chalk River Geological Disposal Facility (CGDF) (previously known as a Shallow Rock Cavity) is planned to meet these objectives and replace the use of further IRUS units. The CGDF will be situated at CRL since the majority of the AECL waste destined for the facility will originate at CRL.

3.6.3.2 Cost Estimate

The cost estimate and cost flow were scaled from an estimate prepared for a similar type of facility. The CGDF is sized for 132,000 cubic metres. The cost estimates for the CGDF development, facility siting, safety assessment, licensing, program management and facility shutdown/closure activities are treated as fixed costs (independent of facility size). The cost estimate for design, construction and operations costs are scaled based on the size of the disposal facility.

The contingency level assigned is Grade C based on the scaling of estimates and uncertainties in the waste volumes and the facility location.

4. DECOMMISSIONING PROGRAM AND SUPPORT COSTS

4.1 Introduction

This section addresses the costs associated with program oversight and various supporting functions that do not align with individual projects or activities. The following items are shown on the schedule chart Appendix A, page 11 & 12.

4.1.1 NWMO

Bill C-27 the Nuclear Fuel Waste Act which established the NWMO also stipulated payments from the fuel waste owners that are to be set aside in Trust Funds. The AECL contribution is proportional to the quantity of fuel (or equivalent in the case of other HLW) that AECL will eventually send to the NWMO long-term management facility.

AECL has used fuel stored at 3 locations in addition to CRL. Transport of used fuel to the NWMO facilities is a common requirement for all these sites. Fuel transport flasks (design, license, construct and decommission) are included with the CRL Support Costs. This is shown on the schedule chart Appendix A, page 11 (Fuel Transport Flasks). The basis for this cost was previous experience with similar transport flasks.

4.1.2 Decommissioning Program Overview

Long-term Planning, Priority Setting, Quality Assurance, Financial systems support and management oversight not associated with specific technical activities are all included here. These costs are based on existing costs for program administration that remain at their current levels. The information management costs are scaled based on an accelerated implementation of the CRL decommissioning program.

4.1.3 Public Consultation

It was recognized that the overall program planned for decommissioning CRL will require public consultation and therefore this was included as part of the plan. This public consultation is required over the early years of the implementation and further development of the strategy. Individual project public consultation as dictated by Canadian Environmental Assessment Act are included with the project cost estimates as necessary.

The cost estimate for public consultation and revision of the strategy and estimates was based on experience with AECL's Whiteshell Laboratories Environmental Assessment process.

4.1.4 Ongoing Operational Support Costs

This includes two distinct existing operational areas that are closely aligned with decommissioning program requirements and objectives. These operations are Stored Liquid Waste Tank Monitoring and Surveillance, and Waste Segregation Facility Operations.

Costs estimates are based on current experience with funding these activities. Stored Liquid Waste Tank Monitoring and Surveillance costs will continue until the required enabling facility becomes available, and the tanks are emptied. Waste Segregation Facility Operating costs are also based on past cost sharing experience (decommissioning and operations) and are planned to continue until the WAF enabling facility is available.

APPENDIX A

Schedule Chart for CRL Decommissioning

Activity ID	Activity Description	Orig Dur	FAC	Early Start	Early Finish
CRL Licensed Facilities - Plan Envelope 1 Bldgs					
1111000010	Decommission B100 Facility	7,901*	B100	01APR03	12JUL33
111100X010	Decommission B100X Facility	976*	B100X	01APR03	26DEC06
1111010010	Decommission B101 Facility	2,609*	B101	01APR03	29MAR13
111101X010	Decommission B101X Facility	2,609*	B101X	01APR03	29MAR13
1111030010	Decommission B103 Facility	1,893*	B103	01APR03	01JUL10
1111040010	Decommission B104 Facility	2,024*	B104	01APR03	31DEC10
1111100010	Decommission B110 Facility	1,600*	B110	01APR44	19MAY50
1111110010	Decommission B111 Facility	1,248*	B111	02APR47	11JAN52
1111260010	Decommission B126 Facility	1,236*	B126	01APR03	25DEC07
1111330010	Decommission B133 Facility	2,286*	B133	01APR03	03JAN12
1111440010	Decommission B144 Facility	2,548*	B144	01APR03	03JAN13
111145A010	Decommission PTR Facility	7,292*	B145A	01APR03	12MAR31
111145C010	Decommission ZED-2 Facility	1,834*	B145C	01APR30	09APR37
1111500010	Decommission B150 Facility	12,073*	B150	31DEC12	09APR59
1111620010	Decommission B162 Facility	2,358*	B162	05JAN16	16JAN25
1111630010	Decommission B163 Facility	2,358*	B163	05JAN16	16JAN25
1112040010	Decommission B204 Facility	5,553*	B204	01APR03	11JUL24
1112060010	Decommission B206 Facility	1,834*	B206	06APR11	16APR18
1112100010	Decommission B210 Facility for reuse	1,448*	B210	01APR03	16OCT08
111212A010	Decommission B212-A Facility for reuse	1,048*	B212A	01APR03	05APR07
1112150010	Decommission B215 Facility	4,192*	B215	01APR03	24APR19
1112200010	Decommission B220 Facility	5,553*	B220	01APR03	11JUL24
1112210010	Decommission B221 Facility	327*	B221	01APR03	30JUN04
1112230010	Decommission B223 Facility	6,339*	B223	01APR03	16JUL27
1112250010	Decommission B225 Facility	3,986*	B225	01APR08	11JUL23
1112280010	Decommission B228 Facility	2,503*	B228	01APR03	01NOV12
1112290010	Decommission B229 Facility	3,724*	B229	01APR08	08JUL22
1112600010	Decommission B260 Facility	3,668*	B260	02APR47	21APR61
111375A010	Decommission B375-RFFL Facility	2,874*	B375A	03APR34	06APR45
111375B010	Decommission B375-FM Hotcells Facility	3,144*	B375B	03APR34	19APR46
1114050010	Decommission B405 Facility	2,920*	B405	02APR47	10JUN58
1114290010	Decommission B429 Facility	2,358*	B429	02APR07	13APR16
1115480010	Decommission B548 Facility	1,834*	B548	09JAN19	19JAN26
1115700010	Decommission B570 Facility	2,882*	B570	03APR51	18APR62
CRL RadioChemical Labs - Plan Envelope 2 Bldgs					
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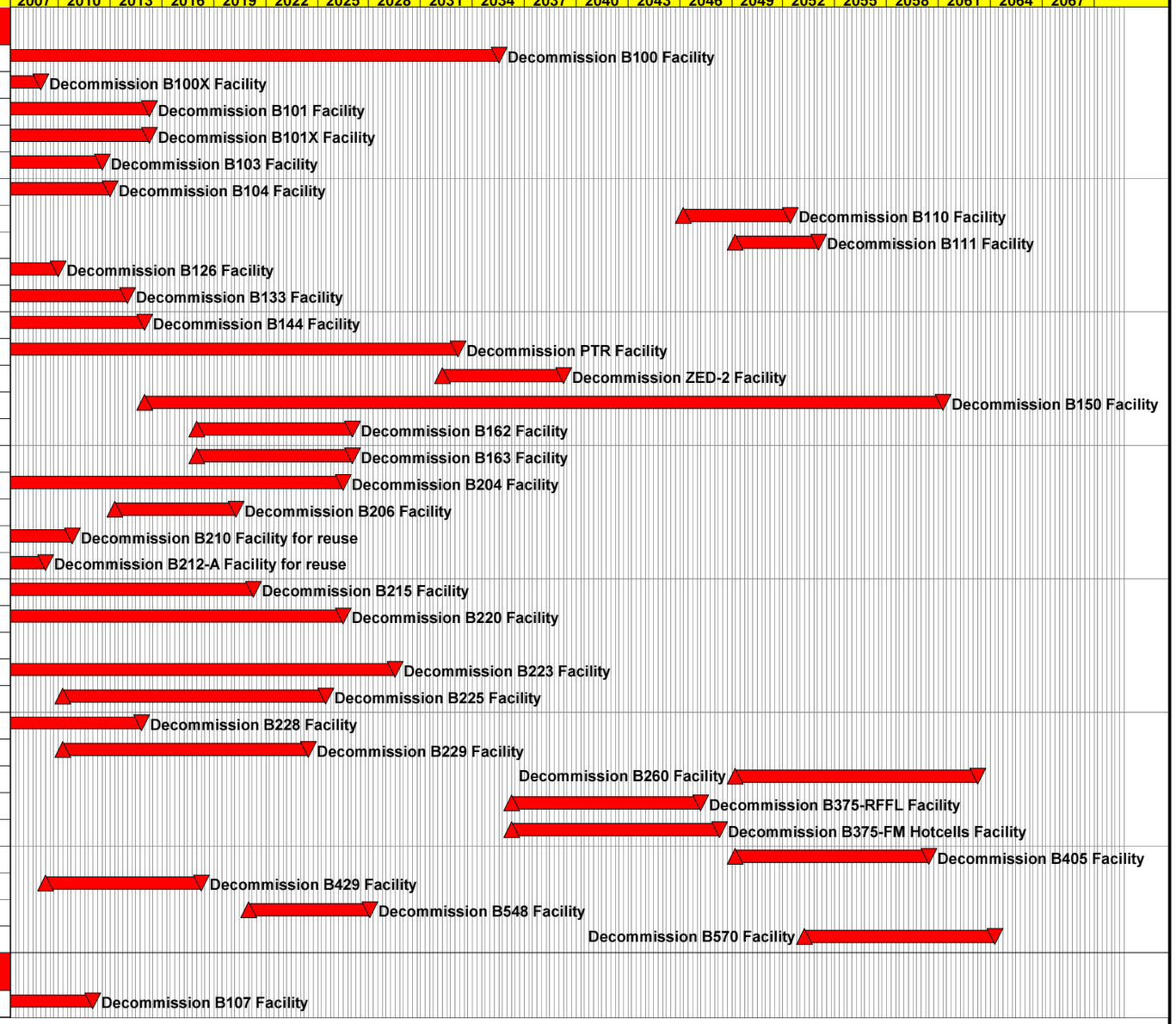

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Date	Revision	Checked	Approved

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1121600000	Decommission B160 Facility	1,834*	B160	07JAN48	15JAN55
1122020000	Decommission B202 Facility	1,834*	B202	03APR17	11APR24
1122050000	Decommission B205 Facility	1,048*	B205	01APR10	07APR14
1122070000	Decommission B207 Facility	1,572*	B207	10APR09	20APR15
1122220000	Decommission B222 Facility	1,053*	B222	13APR10	24APR14
1122240000	Decommission B224 Facility	1,834*	B224	01APR10	11APR17
1122260000	Decommission B226 Facility	1,834*	B226	01APR25	09APR32
1122400000	Decommission B240 Facility	2,083*	B240	01APR05	26MAR13
1122420000	Decommission B242 Facility	1,044*	B242	01APR10	01APR14
1122430000	Decommission B243 Facility	1,572*	B243	01APR10	08APR16
112250B000	Decommission B250 Building General	2,358*	B250B	01APR10	15APR19
1123000000	Decommission B300 Facility	2,622*	B300	02APR12	19APR22
1123200000	Decommission B320 Facility	1,834*	B320	01APR31	09APR38
1123300000	Decommission B330 Facility	1,834*	B330	03APR34	11APR41
112375C000	Decommission B375 Bldg General	2,620*	B375C	03APR34	15APR44
1124680000	Decommission B468 Facility	1,048*	B468	01APR09	05APR13
1124690000	Decommission B469 Facility	1,048*	B469	01APR25	05APR29
1125070000	Decommission B507 Facility	1,048*	B507	03APR17	07APR21
1125390000	Decommission B539 Facility	1,048*	B539	02APR47	06APR51
1125910000	Decommission B591 Facility	1,834*	B591	01APR43	11APR50
1125920000	Decommission B592 Facility	1,834*	B592	02APR35	10APR42
CRL Low Hazard Contam - Plan Envelope 3 Bldgs					
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1131350000	Decommission B135 Facility	916*	B135	02APR07	04OCT10
1131380000	Decommission B138 Facility	1,310*	B138	05JAN16	11JAN21
1131430000	Decommission B143 Facility	1,310*	B143	05JAN16	11JAN21
1131450000	Decommission B145 Facility	1,046*	B145B	01APR30	03APR34
1131680000	Decommission B168 Facility	1,310*	B168	05JAN16	11JAN21
1131710000	Decommission B171 Facility	1,045*	B171	05APR56	06APR60
1132000000	Decommission B200 Facility	5,292*	B200	01APR05	14JUL25
1132010000	Decommission B201 Facility	322*	B201	01APR03	23JUN04
1132120000	Decommission B212 Facility	1,310*	B212B	07JAN48	13JAN53
1132270000	Decommission B227 Facility	1,048*	B227	02APR12	06APR16
1133210000	Decommission B321 Facility	1,048*	B321	01APR32	07APR36
1133800000	Decommission B380 Facility	1,572*	B380	01APR30	08APR36
1134200000	Decommission B420 Facility	1,048*	B420	02APR40	06APR44
1134320000	Decommission B423 Facility	1,310*	B423	02APR40	07APR45

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1134420000	Decommission B442 Facility	1,048*	B442	02APR07	06APR11
1134440000	Decommission B444 Facility	1,048*	B444	02APR12	06APR16
1134510000	Decommission B451 Facility	1,048*	B451	01APR09	05APR13
1134560000	Decommission B456 Facility	1,310*	B456	01APR09	08APR14
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1134640000	Decommission B464 Facility	680*	B464	01APR04	08NOV06
1134660000	Decommission B466 Facility	1,310*	B466	01APR25	08APR30
1134670000	Decommission B467 Facility	1,310*	B467	01APR20	08APR25
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1135750000	Decommission B575 Facility	1,310*	B575	02APR48	09APR53
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CRL Non- Contaminated - Plan Envelope 4 Bldgs					
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1141140000	Decommission B114 Facility	1,048*	B114	03APR23	07APR27
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1142410000	Decommission B241 Facility	1,048*	B241	01APR05	07APR09
1144010000	Decommission B401 Facility	1,048*	B401	03APR06	07APR10
1144060000	Decommission B406 Facility	1,048*	B406	01APR09	05APR13
1144070000	Decommission B407 Facility	1,048*	B407	03APR06	07APR10
1144080000	Decommission B408 Facility	1,048*	B408	01APR09	05APR13
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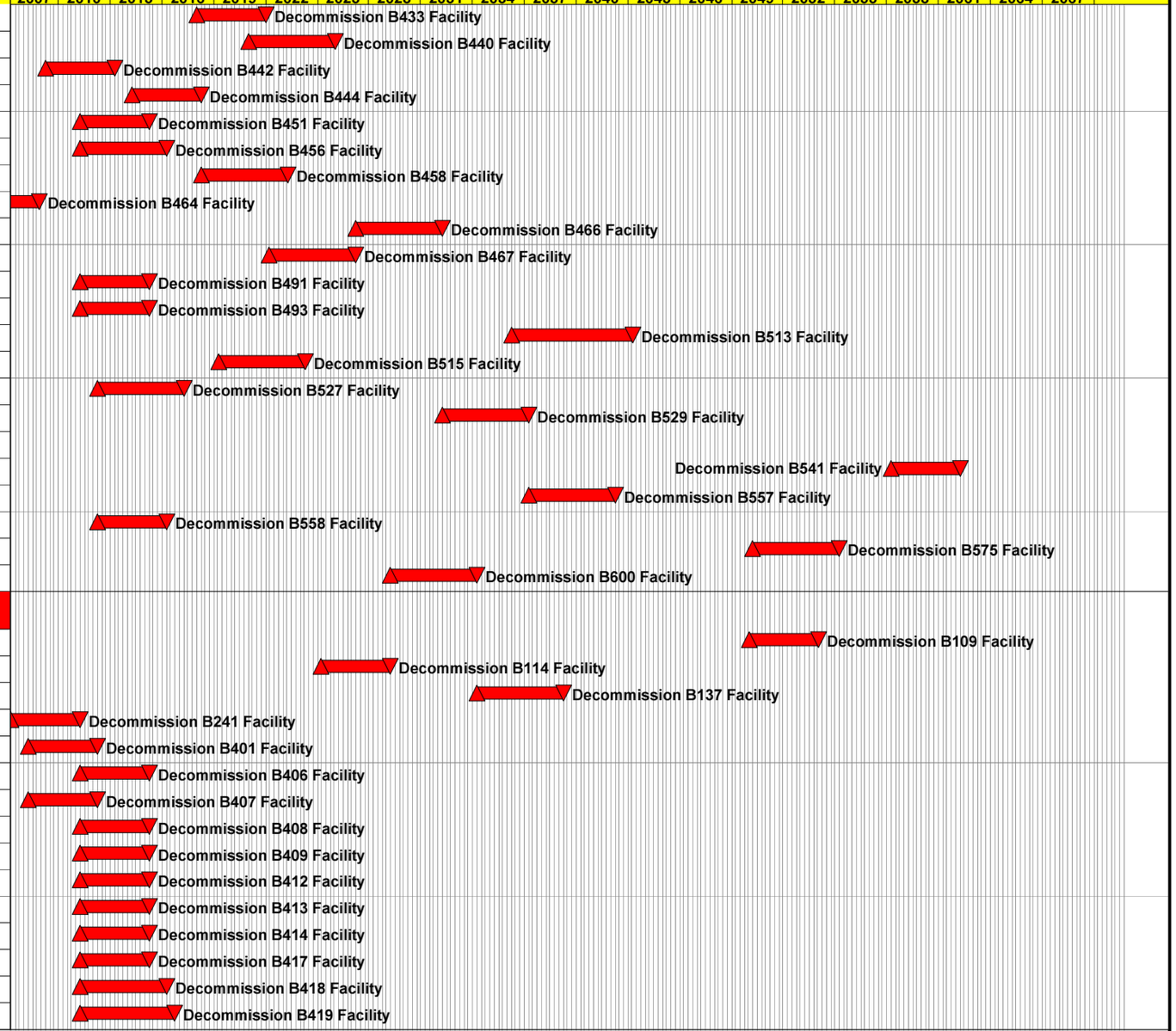

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1144470000	Decommission B447 Facility	1,048*	B447	01APR53	05APR57
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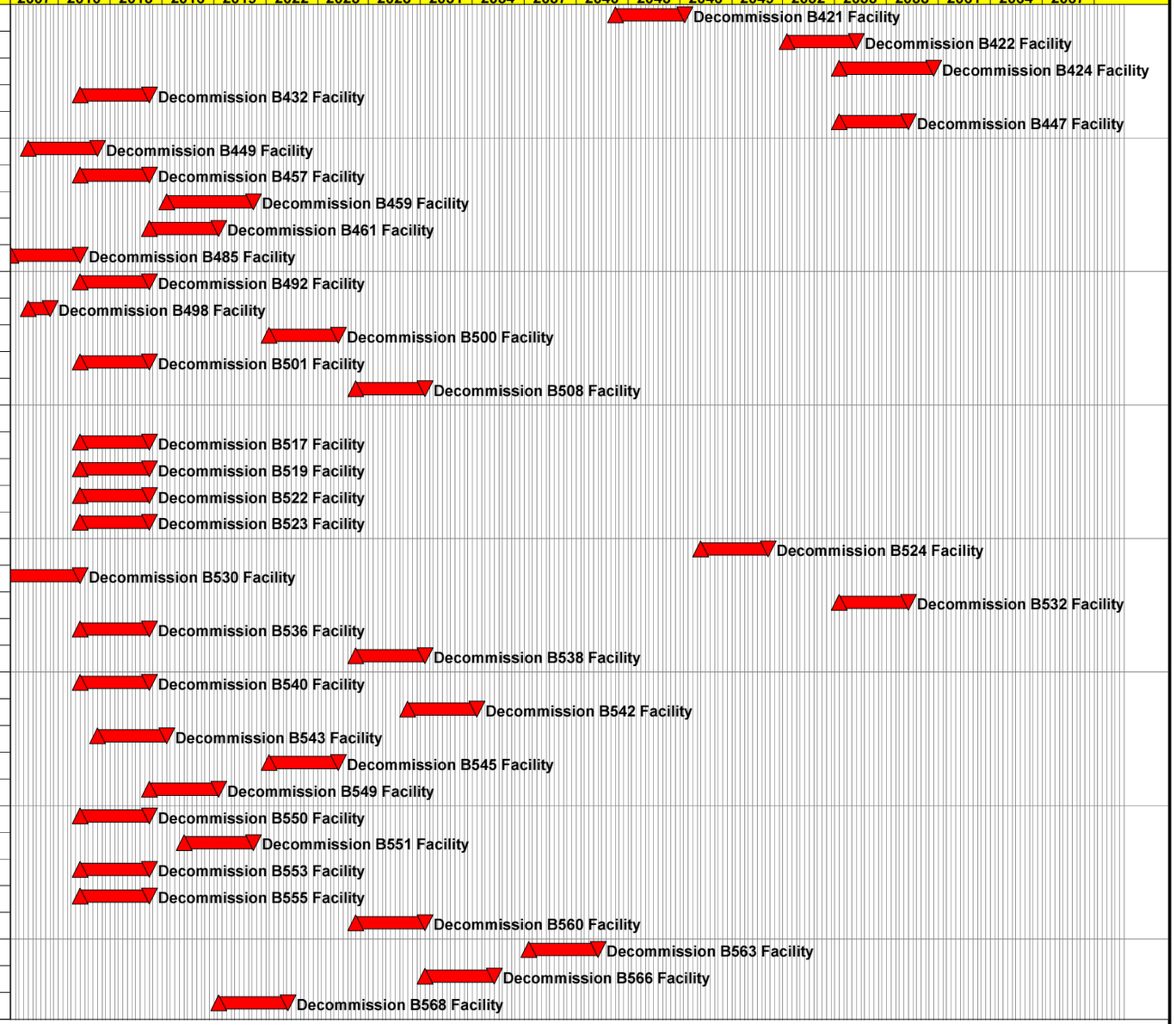

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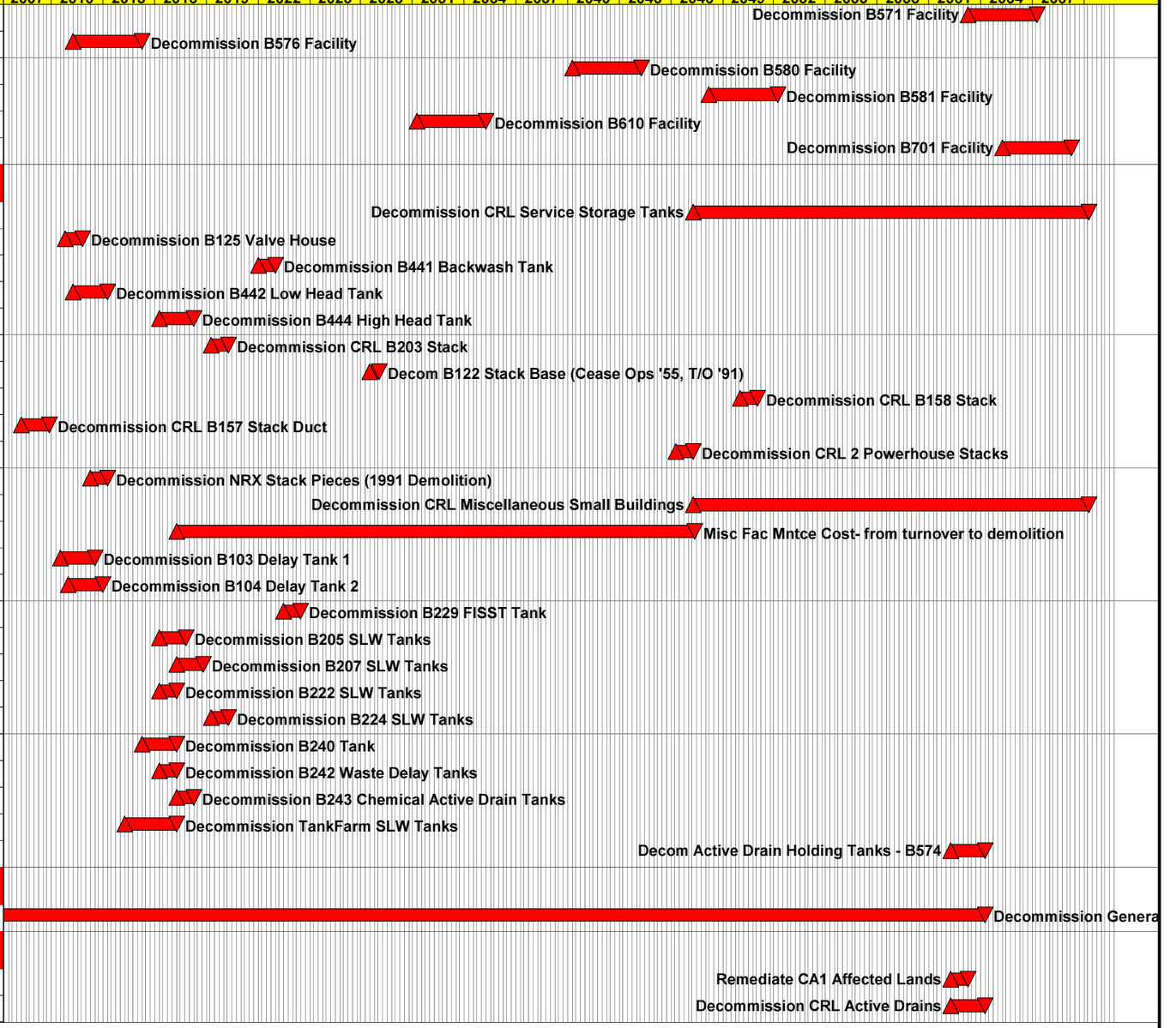
1145710000	Decommission B571 Facility	1,048*	B571	22APR61	28APR65
1145760000	Decommission B576 Facility	1,048*	B576	01APR09	05APR13
1145800000	Decommission B580 Facility	1,048*	B580	01APR38	07APR42
1145810000	Decommission B581 Facility	1,048*	B581	02APR46	06APR50
1146100000	Decommission B610 Facility	1,048*	B610	02APR29	06APR33
1147010000	Decommission B701 Facility	1,048*	B701	02APR63	06APR67
Other Misc CRL Facilities -Stacks & Tanks					
1150000010	Decommission CRL Service Storage Tanks	6,000	TANKSER	10APR45	06APR68
1150000110	Decommission B125 Valve House	262	B125	17OCT08	19OCT09
1150000120	Decommission B441 Backwash Tank	262	TANK441	10JAN20	11JAN21
1150000130	Decommission B442 Low Head Tank	524	TANK442	03APR09	06APR11
1150000140	Decommission B444 High Head Tank	524	TANK244	04APR14	06APR16
1150000150	Decommission CRL B203 Stack	262	STAK203	14APR17	16APR18
1150000155	Decom B122 Stack Base (Cease Ops '55, T/O '91)	131	STAK122	16JUL26	14JAN27
1150000160	Decommission CRL B158 Stack	262	STAK158	07JAN48	06JAN49
1150000165	Decommission CRL B157 Stack Duct	440	DUCT157	03APR06*	07DEC07
1150000170	Decommission CRL 2 Powerhouse Stacks	262	STAK420	07APR44	07APR45
1150000175	Decommission NRX Stack Pieces (1991 Demolition)	262	STAK100	05APR10	05APR11
1150000180	Decommission CRL Miscellaneous Small Buildings	6,000	MISCBLG	10APR45	06APR68
1150000190	Misc Fac Mntce Cost- from turnover to demolition	7,860	M&S	01APR15*	16MAY45
1150000214	Decommission B103 Delay Tank 1	524*	TANK103	30JUN08	01JUL10
1150000224	Decommission B104 Delay Tank 2	524*	TANK104	30DEC08	31DEC10
1150000230	Decommission B229 FISST Tank	262	TANK229	08JUL21	08JUL22
1150000240	Decommission B205 SLW Tanks	400	TANK205	08APR14*	19OCT15
1150000242	Decommission B207 SLW Tanks	400	TANK207	21APR15*	31OCT16
1150000250	Decommission B222 SLW Tanks	262	TANK222	25APR14	27APR15
1150000255	Decommission B224 SLW Tanks	262	TANK224	12APR17	12APR18
1150000264	Decommission B240 Tank	524*	TANK240	27MAR13	30MAR15
1150000270	Decommission B242 Waste Delay Tanks	262	TANK242	02APR14	02APR15
1150000272	Decommission B243 Chemical Active Drain Tanks	262	TANK243	03APR15	04APR16
1150000280	Decommission TankFarm SLW Tanks	786	TANKWME	16APR12	20APR15
1222000026	Decom Active Drain Holding Tanks - B574	524	TANK574	01APR60	04APR62
Distributed Services					
1214000000	Decommission General Site Distributed Services	15,396*	0	01APR03	04APR62
CRL CA1/CA2 Site Affected Lands					
1221000005	Remediate CA1 Affected Lands	262	CA1	01APR60	01APR61
1222000025	Decommission CRL Active Drains	524*	DRAINS	01APR60	04APR62



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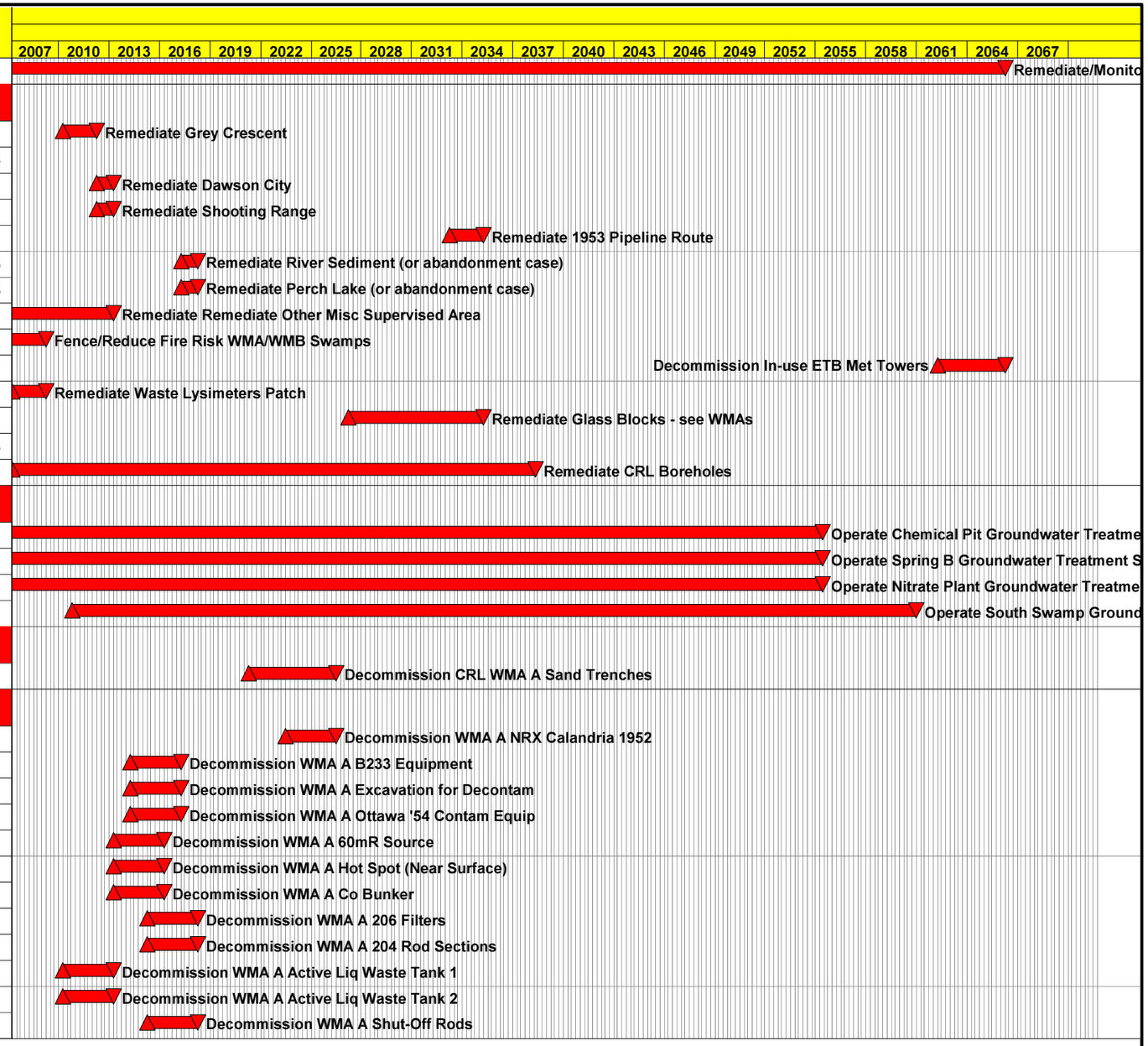
1222000060	Remediate/Monitor CA2 Affected Lands & Plumes	15,920*	CA2	01APR03	07APR64
CRL WMA Affected Lands					
1231000010	Remediate Grey Crescent	524	CRESCNT	01APR08*	02APR10
1231000020	Remediate Blimkie's Meadow	262	BLIMKIE	01APR03	31MAR04
1231000030	Remediate Dawson City	262	DAWSON	01APR10*	01APR11
1231000040	Remediate Shooting Range	262	SHOOTR	01APR10*	01APR11
1231000050	Remediate 1953 Pipeline Route	524	PIPELIN	09APR31	11APR33
1231000070	Remediate River Sediment (or abandonment case)	262	RIVER	01APR15*	31MAR16
1231000075	Remediate Perch Lake (or abandonment case)	262	PERCH L	01APR15*	31MAR16
1231000080	Remediate Remediate Other Misc Supervised Area	1,834	MISC	01APR04*	12APR11
1231000090	Fence/Reduce Fire Risk WMA/WMB Swamps	1,048	SWAMPS	01APR03	05APR07
1231000092	Decommission In-use ETB Met Towers	1,048	METTOWR	01APR60	07APR64
1232000020	Remediate Waste Lysimeters Patch	524	LYSIMET	01APR05*	04APR07
1232000030	Remediate Glass Blocks - see WMAs	2,096*	GLASSBL	01APR25	12APR33
1232000040	Remediate Perch Lake Canopy Tower/Met Study Area	262	PLTOWER	01APR03	31MAR04
1232000065	Remediate CRL Boreholes	8,122*	BOREHOL	01APR05	19MAY36
Affected Lands Groundwater Treatment Systems					
1400000010	Operate Chemical Pit Groundwater Treatment Sys	13,100	GWTCP	01APR03	16JUN53
1400000020	Operate Spring B Groundwater Treatment System	13,100	GWTSPGB	01APR03	16JUN53
1400000030	Operate Nitrate Plant Groundwater Treatment Sys	13,100	GWTW&C	01APR03	16JUN53
1400000040	Operate South Swamp Groundwater Treatment System	13,100	GWTSS	08OCT08	24DEC58
WMA A Sand Trenches					
1301100010	Decommission CRL WMA A Sand Trenches	1,371*	ASANDTR	11APR19	11JUL24
WMA A Special Burials					
1301200110	Decommission WMA A NRX Calandria 1952	786*	A-CAL	08JUL21	11JUL24
1301200210	Decommission WMA A B233 Equipment	786*	A-233	09APR12	13APR15
1301200310	Decommission WMA A Excavation for Decontam	786*	A-EXC	09APR12	13APR15
1301200410	Decommission WMA A Ottawa '54 Contam Equip	786*	A-OTT	09APR12	13APR15
1301200510	Decommission WMA A 60mR Source	786*	A-60MR	11APR11	14APR14
1301200610	Decommission WMA A Hot Spot (Near Surface)	786*	A-HS	11APR11	14APR14
1301200710	Decommission WMA A Co Bunker	786*	A-CO	11APR11	14APR14
1301200810	Decommission WMA A 206 Filters	786*	A-206F	09APR13	12APR16
1301200910	Decommission WMA A 204 Rod Sections	786*	A-204RS	09APR13	12APR16
1301201010	Decommission WMA A Active Liq Waste Tank 1	786*	A-ALWT1	08APR08	12APR11
1301201110	Decommission WMA A Active Liq Waste Tank 2	786*	A-ALWT2	08APR08	12APR11
1301201210	Decommission WMA A Shut-Off Rods	786*	A-SOR	09APR13	12APR16



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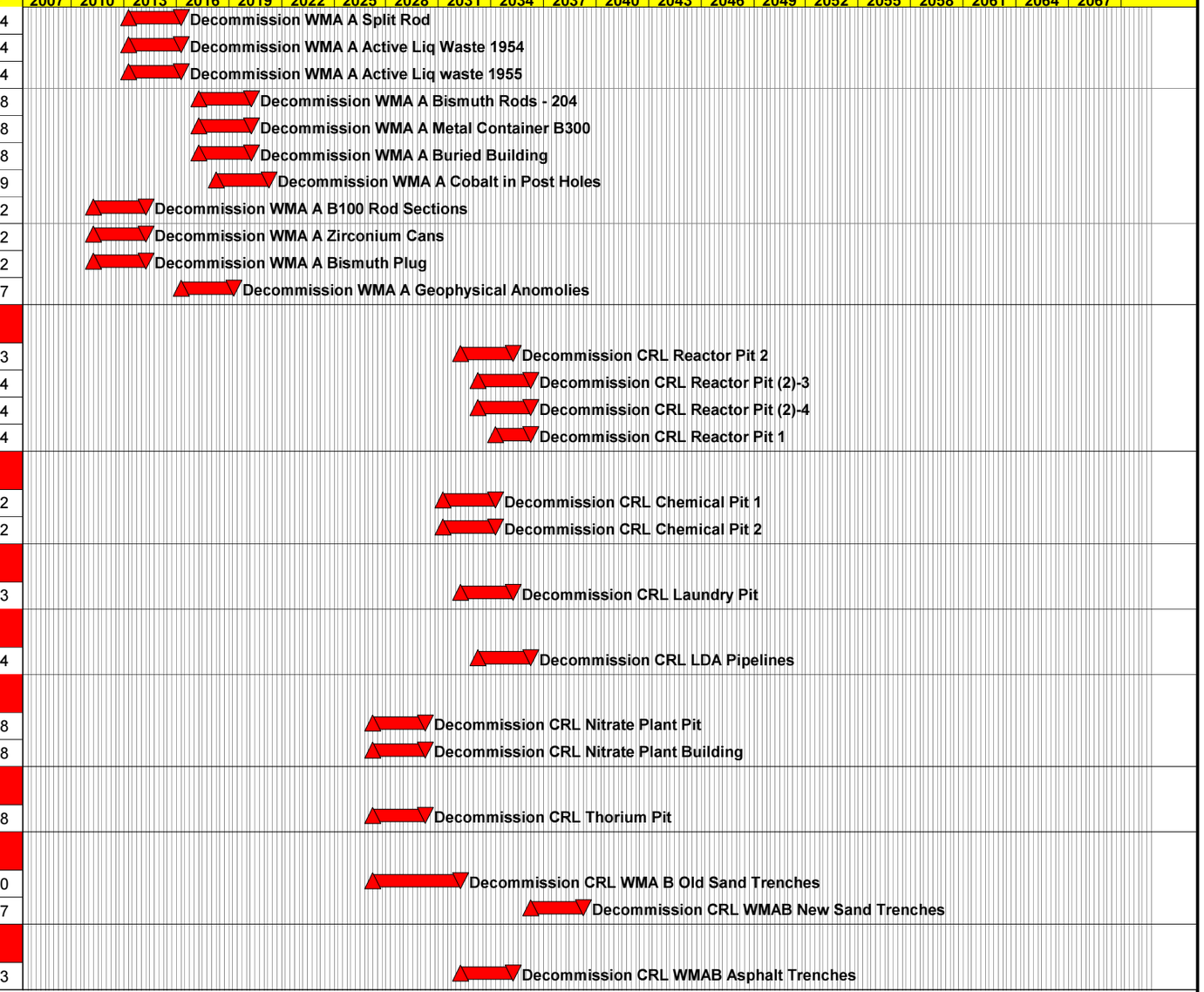
1301201301	Decommission WMA A Split Rod	786*	A-SR	11APR11	14APR14
1301201410	Decommission WMA A Active Liq Waste 1954	786*	A-ALW1	11APR11	14APR14
1301201510	Decommission WMA A Active Liq waste 1955	786*	A-ALW2	11APR11	14APR14
1301201610	Decommission WMA A Bismuth Rods - 204	786*	A-BR204	09APR15	12APR18
1301201710	Decommission WMA A Metal Container B300	786*	A-MC300	09APR15	12APR18
1301201810	Decommission WMA A Buried Building	786*	A-BLDG	09APR15	12APR18
1301201910	Decommission WMA A Cobalt in Post Holes	786*	A-COPH	08APR16	12APR19
1301202010	Decommission WMA A B100 Rod Sections	786*	AB100RS	09APR09	12APR12
1301202110	Decommission WMA A Zirconium Cans	786*	A-ZC	09APR09	12APR12
1301202210	Decommission WMA A Bismuth Plug	786*	A-BP	09APR09	12APR12
1301202301	Decommission WMA A Geophysical Anomolies	786*	A-GEOPH	09APR14	12APR17
Reactor Pits					
1302110010	Decommission CRL Reactor Pit 2	786*	RP2	09APR30	12APR33
1302120010	Decommission CRL Reactor Pit (2)-3	786*	RP23	09APR31	12APR34
1302130010	Decommission CRL Reactor Pit (2)-4	786*	RP24	09APR31	12APR34
1302140010	Decommission CRL Reactor Pit 1	525*	RP1	08APR32	12APR34
Chemical Pits					
1302210010	Decommission CRL Chemical Pit 1	786*	CP1	09APR29	12APR32
1302220010	Decommission CRL Chemical Pit 2	786*	CP2	09APR29	12APR32
Laundry Pit					
1302300010	Decommission CRL Laundry Pit	786*	LP	09APR30	12APR33
LDA Pipelines					
1302400010	Decommission CRL LDA Pipelines	786*	LDAPL	09APR31	12APR34
Nitrate Plant					
1303100010	Decommission CRL Nitrate Plant Pit	786*	NPPIT	09APR25	12APR28
1303200010	Decommission CRL Nitrate Plant Building	786*	NPBLDG	09APR25	12APR28
Thorium Pit					
1303400010	Decommission CRL Thorium Pit	786*	THORIUM	09APR25	12APR28
WMAB Sand Trenches					
1305110010	Decommission CRL WMA B Old Sand Trenches	1,310*	BSANDTO	09APR25	16APR30
1305120010	Decommission CRL WMAB New Sand Trenches	786*	BSANDTN	10APR34	13APR37
WMAB Asphalt Trenches					
1305200010	Decommission CRL WMAB Asphalt Trenches	786*	BASHPHL	09APR30	12APR33



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WMAB Concrete Bunkers					
1305320010	Decom WMAB Circular Concrete Bunkers 57-185	1,572*	BBUNKC2	09APR35	16APR41
1305320060	Recover Wastes Circular Concrete Bunkers CD16-56	1,489	BBUNKC1	12JUL12*	27MAR18
1305330010	Decommission WMA B Concrete Tile Filter Bunker	1,048*	BCTFILT	09APR40	13APR44
1305340010	Decomission WMAB Resin Cartidge Disposal Bunkers	786*	BRCDBKR	09APR13	12APR16
1305350010	Decommission WMAB Solvent Bunkers	786*	BSOLVEN	01APR04	05APR07
1305310010	Decom WMAB Rectangular Concrete Bunkers	1,572*	BBUNKRR	09APR38	18APR44
WMA B Miscellaneous Wastes					
1305410010	Decommission WMAB Barrels of Active Solution	786*	BBAS	08APR20	12APR23
1305420010	Decommission WMAB Bottle Cribs	786*	BBCRIB	11APR11	14APR14
1305430010	Decommission WMAB Control Units Waste	786*	BCU	08JUL21	11JUL24
1305440010	Decommission WMAB Caustic Cells	786*	BCC	08APR20	12APR23
1305450010	Decommission WMAB NRU-Rod Sections	786*	BNRURS	08JUL21	11JUL24
1305460010	Decommission WMAB Rat Pit 1	786*	BRATPIT	08APR24	12APR27
1305460315	Decommission WMAB Rat Pit 2	786*	BRATPIT	09APR18	12APR21
1305470010	Decommission WMAB SS Rod Bay Disposal container	786*	BSSRDDC	09APR19	12APR22
1305480010	Decommission WMAB SS Containers	786*	BSSCONT	09APR19	12APR22
1305490010	Decommission CRL WMB NRX Thermal Shield	786*	BNRXTHS	08JUL21	11JUL24
WMAB Cell Waste 1-5					
1305500010	Decommission WMAB Cell Waste	1,048*	BCWASTE	09APR19	13APR23
WMAB NRX /NRU Calandrias					
1305700010	Decommission WMAB NRX/NRU Calandrias	786*	BCALAND	08APR20	12APR23
WMAB Special Burials					
1305801105	Decommission WMAB Special Burials MG&A	786*	BSMG&A	08APR20	12APR23
1305801205	Decommission WMAB Special Burials EV228	786*	BSEV228	08APR20	12APR23
1305801305	Decom WMAB Spec Burials Cobalt 60 Capsules	786*	BSC60C	08APR20	12APR23
1305801501	Decom WMAB Slightly Active Solvents in Bottles	786*	BSSAS	11APR11	14APR14
1305801605	Decommission WMAB Spec Burials Concrete Flask	786*	BSCFL	10APR17	13APR20
1305801705	Decom WMAB Spec Burials Bismuth Rod Storage	786*	BSBR	10APR17	13APR20
1305801805	Decom WMAB Spec Burials Robson's Bismuth Plug	786*	BSRBP	10APR17	13APR20
1305801905	Decommission WMAB Spec Burials Morrison Castle	786*	BSMC	10APR17	13APR20
1305802005	Decom WMAB Special Burials Uranium Cans	786*	BSURC	10APR34	13APR37
1305802105	Decom WMAB Special Burials U238 Turnings	786*	BSU238T	11APR11	14APR14
WMA B Tile Holes					
1305910005	WMAB THs Waste Recovery & Safety Case	14,615*	BTHFUEL	01APR13	05APR69
1305920010	Decommission WMAB IFE 1-4, IMD 1-4 TH Structures	1,427*	BTIFE14	21APR54	08OCT59

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1305921050	Decommission rest of WMAB IFE/IMD TH Structures	2,620*	BTIFE56	18APR58	02MAY68
1305940005	Decommission WMAB IRP Mo99 TH Structures	5,916*	BTIRPMO	25OCT19	27JUN42
1305941040	Decommission WMAB IRP Non-Mo99 TH Structures	1,048*	BTIRPNM	12JUN43	18JUN47
1305942005	Decommission WMAB Galvanized Pipes Structures	1,048*	BTIRPPG	05MAY36	09MAY40
1305950010	Perform WMAB Fuel Tilehole Stabilization (THIS)	2,096*	BTHTHIS	01APR03	12APR11
WMA C					
1306000010	Decommission CRL Waste Management Area C	1,942*	WMAC	21OCT05	01APR13
Tank Farm					
1307000010	Decommission CRL TankFarm Structure	786*	TANKFRM	30MAY14	02JUN17
WMA D					
1308000010	Decommission CRL Waste Management Area D	786*	WMAD	09APR40	13APR43
WMA E					
1309000010	Decommission CRL Waste Management Area E	768*	WMAE	06APR10	14MAR13
WMA F					
1310000010	Decommission CRL Waste Management Area F	1,834*	WMAF	11MAR13	19MAR20
WMA G					
1311000010	Decommission CRL Waste Management Area G	786*	WMAG	21APR60	25APR63
WMA H					
1312000010	Decommission CRL Waste Management Area H	786*	WMAH	11APR50	14APR53
Bulk Storage Compound					
1313000010	Decommission CRL Bulk Storage Waste Area	786*	BULKSTR	09APR10	12APR13
Glass Blocks 1-2					
1315000010	Decommission CRL Glass Blocks Waste	786*	GLASSBL	09APR30	12APR33
Old In-active Landfill					
1316000010	Decommission CRL Current In-active Landfill	524*	LNDFILO	29JUN16	02JUL18
CRL Waste Management Areas Plumes Updates					
1410000000	Perform RP1 Plume updates	14,649*	PLUMRP1	02APR12	24MAY68
1420000000	Perform RP2 Plume updates	16,506*	PLUMRP2	10APR06	15JUL69
1430000000	Perform CP Plume updates	14,865*	PLUMCP	02APR12	22MAR69
1440000000	Perform WMA A Sand Trench Plume updates	16,244*	PLUMWMA	03APR06	05JUL68
1450000000	Perform WMA B Plume updates	16,244*	PLUMWMB	01APR04	06JUL66
1460000000	Perform WMA C Plume updates	15,982*	PLUMWMC	03APR06	05JUL67
1470000000	Perform WMA F Plume updates	17,292*	PLUMWMF	01APR03	10JUL69
1480000000	Perform NPPIT Plume updates	15,936*	PLUMNP	01APR03	29APR64

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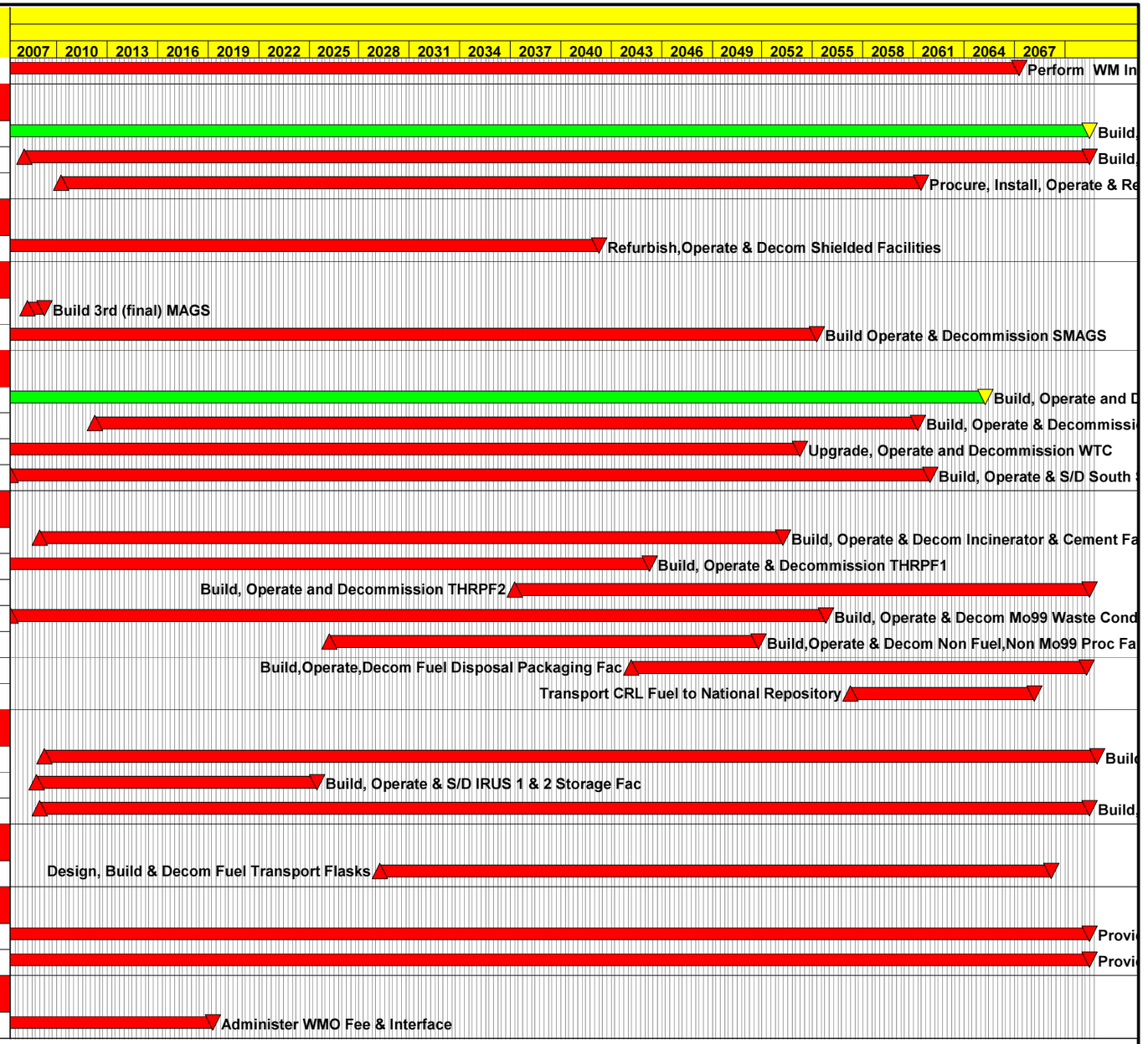
1490000000	Perform WM Inactive Landfill Plume updates	15,936*	PLUMLND	01APR04	30APR65
CRL Waste Analysis Facilities					
6111000005	Build,Operate & Decommission WAF Facility	17,290*	WAF	01APR03	08JUL69
6112000005	Build, Operate & Decommission WCF	16,558*	WCF	10JAN06	27JUN69
6111000205	Procure, Install, Operate & Refurb Special Equip	13,362*	EQUIPMT	01APR08	18JUN59
CRL Shielded Facilities - Hotcell Upgrades					
6120000005	Refurbish,Operate & Decom Shielded Facilities	9,414*	HOTCELL	01APR04	01MAY40
CRL Solid Waste Interim Storage Facilities					
6133000005	Build 3rd (final) MAGS	262	MAGS	03APR06*	03APR07
6133000015	Build Operate & Decommission SMAGS	12,924*	SMAGS	01OCT03	14APR53
CRL Liquid Waste Processing Enabling Facilities					
6141100005	Build, Operate and Decommission SLWCF	15,662*	SLWCF	01APR03	11APR63
6141200005	Build, Operate & Decommission SLWPF	12,783*	SLWPF	01APR10	31MAR59
6142100005	Upgrade, Operate and Decommission WTC	12,790*	WTC	01APR03	08APR52
6143100005	Build, Operate & S/D South Swamp G/W Treatment	14,280*	SSPUMPT	01APR05	25DEC59
CRL Solid Waste Processing Enabling Facilities					
6151000005	Build, Operate & Decom Incinerator & Cement Fac	11,544*	INCINER	03JAN07	03APR51
6152000005	Build, Operate & Decommission THRPF1	10,442*	THRPF1	01APR03	08APR43
6152000505	Build, Operate and Decommission THRPF2	8,927*	THRPF2	02APR35	18JUN69
6153000905	Build, Operate & Decom Mo99 Waste Condition Fac	12,666*	MO99CEM	01APR05	17OCT53
6154000050	Build,Operate & Decom Non Fuel,Non Mo99 Proc Fac	6,663*	NONFUEL	03APR24	15OCT49
6155000005	Build,Operate,Decom Fuel Disposal Packaging Fac	7,054*	FUELPAK	01APR42	12APR69
6155000100	Transport CRL Fuel to National Repository	2,863	FUELSHP	14APR55	02APR66
CRL Long Term WM Enabling Facilities					
6161000015	Build Operate & S/D Inactive Landfill Facility	16,365*	LANDFIL	02APR07	20DEC69
6162000005	Build, Operate & S/D IRUS 1 & 2 Storage Fac	4,346*	IRUS	25OCT06	21JUN23
6163000005	Build, Operate & S/D CR Geological Disposal Fac	16,310*	SRC	03JAN07	09JUL69
Fuel Transport Flasks					
6212000002	Design, Build & Decom Fuel Transport Flasks	10,436*	FUELTWO	05APR27	04APR67
Decom Program Overview					
7200000010	Provide AECL LM Overview Administration	17,294	PROGADM	01APR03	12JUL69
7200000015	Provide Decommissioning Information Management	17,286	DIMO	01APR03	02JUL69
NWMO					
7200000022	Administer WMO Fee & Interface	3,668*	WMOFEE	01APR03	20APR17



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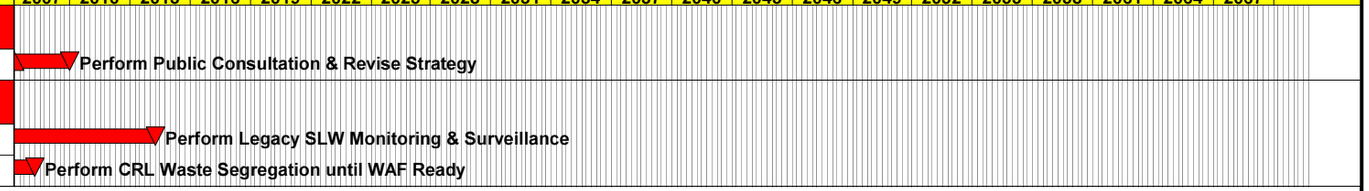
Public Consultation					
7300000006	Perform Public Consultation & Revise Strategy	718*	NONCEA	01APR05	01JAN08
Ongoing Operational Support Costs					
7200000033	Perform Legacy SLW Monitoring & Surveillance	2,358*	SLWM&S	01APR03	12APR12
7200000040	Perform CRL Waste Segregation until WAF Ready	786	NONWAF	01APR03	04APR06



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APPENDIX B

CRL Decommissioning Cost Estimates Summary
By Work Breakdown Structure

The cost estimates provided in this Appendix are presented in undiscounted, current dollars and without contingencies. These costs served as the basis for the Office of the Auditor General audit for the fiscal year ended 2005 March. These costs were then adjusted to include escalation and contingency and to reflect other relatively minor items to derive the $1.97B NPV liability for Chalk River.

CRL Site Basis of Estimate Summary Cost			
WBS	**Facility ID**	**Facility Description**	**TOTAL**
1.1.01.100 -	B100	NRX Reactor	50,513,948
1.1.01.100 -	B100X	D2O Salvage Building /Trench	55,936
1.1.01.101 -	B101	NRX Fan House	458,212
1.1.01.101 -	B101X	NRX Filter House	472,373
1.1.01.103 -	B103	NRX Delay Tank #1	94,731
1.1.01.104 -	B104	NRX Delay Tank #2	126,293
1.1.01.110 -	B110	Maple 1	
1.1.01.111 -	B111	Maple 2	
1.1.01.126 -	B126	Monitor & Water H.	93,003
1.1.01.133 -	B133	Rod Bay Washroom	152,835
1.1.01.144 -	B144	Gas Holder Building	195,473
1.1.01.145 -	B145A	Research Building - Pool Test	1,942,857
1.1.01.145 -	B145C	Research Building - ZED-2 Reactor	2,940,770
1.1.01.150 -	B150	NRU Reactor	219,702,320
1.1.01.162 -	B162	Filter house	508,757
1.1.01.163 -	B163	NRX/NRU Booster Fan House	1,220,013
1.1.01.204 -	B204	NRX Rod Bays	12,018,982
1.1.01.206 -	B206	Chemical Plant Filters & Fan House	1,265,512
1.1.01.210 -	B210	Heavy Water Upgrading Plant	10,703,980
1.1.01.212 -	B212A	D2O Storage	1,708,946
1.1.01.215 -	B215	Tritium Extraction - CECEUD	11,434,906
1.1.01.220 -	B220	Ops Lab - Pu Recovery	9,267,107
1.1.01.221 -	B221	Fan House for B220	
1.1.01.223 -	B223	Pu Tower	1,644,470
1.1.01.225 -	B225	Active Delay Columns - Mo99 Production	8,753,407
1.1.01.228 -	B228	Waste Solution Evaporator	2,841,281
1.1.01.229 -	B229	Fissile Solution Storage Tank	750,007
1.1.01.234 -	B234	Universal Cells	9,241,918
1.1.01.250 -	B250A	Chemical Engineering - Tritium Lab	2,730,237
1.1.01.260 -	B260	New Processing Faciity	
1.1.01.375 -	B375A	Metallurgy - RFFL	2,872,984
1.1.01.375 -	B375B	Metallurgy - FM Hot Cells	6,052,995
1.1.01.405 -	B405	RR Fabrication Facility	11,745,432
1.1.01.429 -	B429	RR Fuel Fabrication facility	5,197,924
1.1.01.548 -	B548	NRU Helium Storage	42,511
1.1.01.570 -	B570	Waste Treatment Center	13,092,998
1.1.02.107 -	B107	Physics & General Chemistry Lab	5,079,181
1.1.02.160 -	B160	LOCA Filter House	1,959,495
1.1.02.202 -	B202	Active Laundry Bldg	3,360,991
1.1.02.205 -	B205	Liquid Waste Storage	1,425,501
1.1.02.207 -	B207	Liquid Waste Storage	59,999
1.1.02.222 -	B222	Active Waste Storage	258,831
1.1.02.224 -	B224	Cool Waste Storage Area	730,000
1.1.02.226 -	B226	Active Area maintenance shop	1,421,989
1.1.02.240 -	B240	Surge Tank & Pump House	178,132
1.1.02.242 -	B242	Waste Delay Tanks	372,366
1.1.02.243 -	B243	Delay Tanks for Bldgs	937,494
1.1.02.250 -	B250B	Chemical Engineering - General Bldg	14,831,008
1.1.02.300 -	B300	Fuel Engineering Corrosion Lab & Offices	7,876,649
1.1.02.320 -	B320	Chemistry & Materials building	7,596,008

WBS	Facility ID	Facility Description	TOTAL
1.1.02.330 -	B330	Chemistry & Materials Building	8,149,507
1.1.02.375 -	B375C	Metallurgy - General Building	16,289,998
1.1.02.468 -	B468	R&IS Vehicle Decontam	1,081,997
1.1.02.469 -	B469	Fuel Engineering	4,453,502
1.1.02.507 -	B507	Decontamination Bldg	2,426,503
1.1.02.539 -	B539	Materials Bldg	466,501
1.1.02.591 -	B591	Waste Reception Centre	3,130,011
1.1.02.592 -	B592	Disposal Area 'D' Bldg	1,159,998
1.1.03.102 -	B102	Drum Cleaning Building	96,997
1.1.03.102 -	B102X	Drum Cleaning	89,505
1.1.03.135 -	B135	Generator Building	272,003
1.1.03.138 -	B138	Major Facilities Services & Storage	851,995
1.1.03.143 -	B143	Maintenance & Storage	666,001
1.1.03.145 -	B145B	Research Building - General Bldg	6,361,737
1.1.03.168 -	B168	Waste Disposal Sorting Building	54,995
1.1.03.171 -	B171	CHF Electrical Test Bldg	359,849
1.1.03.200 -	B200	Reactor & Processing Facilities Commissioning	2,593,001
1.1.03.201 -	B201	Filter Storage & Maintenance Shop	
1.1.03.212 -	B212B	Reactors Maintenance	193,998
1.1.03.227 -	B227	Nuclear Facilities Operations	549,498
1.1.03.321 -	B321	Gas Bottle Storage	7,003
1.1.03.380 -	B380	Materials Laboratories	3,522,494
1.1.03.420 -	B420	Power House & Related Facilities	10,021,500
1.1.03.423 -	B423	Sewage Pump House	13,005
1.1.03.433 -	B433	CA-2 Maintenance Shop	876,998
1.1.03.440 -	B440	Water Treatment & Filtration Plant	4,937,495
1.1.03.442 -	B442	Filtered Water Storage	36,498
1.1.03.444 -	B444	Filter Water Head	68,498
1.1.03.451 -	B451	Restricted Storage	680,497
1.1.03.456 -	B456	Engineering Tech OD&T Decommissioning	9,708,500
1.1.03.458 -	B458	Carpenter Shop CA-2	570,002
1.1.03.464 -	B464	Health Sciences & Dosimetry	976,480
1.1.03.466 -	B466	Thermalhydraulics & CA-2 Workshop	7,923,498
1.1.03.467 -	B467	Accelerator Development Lab	1,890,494
1.1.03.491 -	B491	Heavy Equipment Storage	707,003
1.1.03.493 -	B493	Quonset - Construction Storage	302,999
1.1.03.513 -	B513	Health Sciences & Environmental Research	7,299,502
1.1.03.515 -	B515	Emergency Equipment Storage	116,002
1.1.03.527 -	B527	Ammonia/Hydrogen/Amine Tower	503,503
1.1.03.529 -	B529	Burst Test Lab	129,999
1.1.03.535 -	B535	Oil & Paint storage	
1.1.03.541 -	B541	NRU Storage	377,502
1.1.03.557 -	B557	Active Equipment Storage	300,005
1.1.03.558 -	B558	Hydrogen/H2O Exchange Tower	277,999
1.1.03.575 -	B575	Uranium & Thorium	95,500
1.1.03.600 -	B600	Electronics Bldg	4,261,996
1.1.04.109 -	B109	Stack Monitoring Building	32,498
1.1.04.114 -	B114	Administration - FNO	1,063,503
1.1.04.137 -	B137	Former TASCC Facility	4,089,002
1.1.04.241 -	B241	Disposal Area Valve House	4,501
1.1.04.401 -	B401	Gate House	786,501

WBS	Facility ID	Facility Description	TOTAL
1.1.04.406 -	B406	Garage	2,307,501
1.1.04.407 -	B407	Fire Hall & Garage	283,502
1.1.04.408 -	B408	Lead Shop	63,502
1.1.04.409 -	B409	Balance of B409 Shop	918,498
1.1.04.412 -	B412	CA-1 Area Maintenance Shop	1,902,498
1.1.04.413 -	B413	Carpenter Shop & Storage	656,002
1.1.04.414 -	B414	Carpenter Shop Storage	82,002
1.1.04.417 -	B417	Aggregate Storage Bldg	122,498
1.1.04.418 -	B418	Lubricant & Scaffold storage	42,502
1.1.04.419 -	B419	Spare Parts Storage	73,502
1.1.04.421 -	B421	Water Intake	
1.1.04.422 -	B422	Substation	133,498
1.1.04.424 -	B424	Sewage Pump House	5,501
1.1.04.432 -	B432	Main Library	1,431,000
1.1.04.447 -	B447	Sewage Treatment Plant	101,998
1.1.04.449 -	B449	Guard House In Fence	2,501
1.1.04.457 -	B457	Purchasing Stores Photography	1,823,501
1.1.04.459 -	B459	Neutron & Solid State Physics	599,500
1.1.04.461 -	B461	Guard House	17,503
1.1.04.485 -	B485	Salt Storage	81,502
1.1.04.492 -	B492	Reactors Tooling Storage	277,002
1.1.04.498 -	B498	Aquatic Biology Bldg	2,617
1.1.04.500 -	B500	Cafeteria	1,250,000
1.1.04.501 -	B501	Pickling Bldg	77,999
1.1.04.508 -	B508	IT & Communication	1,846,498
1.1.04.514 -	B514	Emergency Storage Building	
1.1.04.517 -	B517	Sheet Metal shop	56,500
1.1.04.519 -	B519	Auxillary Auto Parts Storage	46,499
1.1.04.522 -	B522	Temporary PCB Storage Bldg	26,502
1.1.04.523 -	B523	Reactors Tool Storage	290,500
1.1.04.524 -	B524	Animal Facility	2,707,500
1.1.04.530 -	B530	Change Room & Storage	264,196
1.1.04.532 -	B532	Process Sewer Station	6,501
1.1.04.536 -	B536	Storage Building	229,501
1.1.04.538 -	B538	Products Bldg	19,503
1.1.04.540 -	B540	Misc Bulk Storage Bldg	329,501
1.1.04.542 -	B542	Environmental Research Structures	52,499
1.1.04.543 -	B543	Visitors Centre	667,500
1.1.04.545 -	B545	Liquid Nitrogen Storage	12,998
1.1.04.549 -	B549	Fuse & Document Shack	3,501
1.1.04.550 -	B550	Change House	66,500
1.1.04.551 -	B551	Firemen's Training Bldg	13,000
1.1.04.553 -	B553	Storage Bldg	84,999
1.1.04.555 -	B555	Vehicle Storage Bldg	154,503
1.1.04.560 -	B560	Low Background Laboratory	290,999
1.1.04.563 -	B563	Low Level Storage	267,002
1.1.04.566 -	B566	Fire & Impact Test Facility	87,502
1.1.04.568 -	B568	New Sewage Treatment Facility	117,003
1.1.04.571 -	B571	Service Building Disposal	38,000
1.1.04.576 -	B576	Mechanical Services	121,502
1.1.04.580 -	B580	Evacuation Monitoring Bldg	356,999

WBS	Facility ID	Facility Description	TOTAL
1.1.04.581 -	B581	Guard Entrance House	61,999
1.1.04.610 -	B610	Accelerator Development (former use)	1,597,002
1.1.04.701 -	B701	New Gatehouse	1,097,500
1.1.05 -		Total Tanks & Stacks	77,030,819
1.2.01 -	0	Distributed Services	12,189,745
1.2.02 -	CA1	Controlled Area 1 Affected Lands	330,000
1.2.02 -	CA2	Controlled Area 2 Affected Lands	5,300,195
1.2.02 -	DRAINS	Active Drains	16,000,000
1.2.03.1 -	BLIMKIE	Blimkie Meadow	
1.2.03.1 -	CRESCNT	Grey Crescent	100,000
1.2.03.1 -	DAWSON	Dawson City	37,880
1.2.03.1 -	LNDFILO	Current In-active Landfill	413,522
1.2.03.1 -	M&S	Affected Lands Monitoring & Surveillance	13,226,849
1.2.03.1 -	METTOWR	Meteorlogical Towers	200,000
1.2.03.1 -	MISC	Miscellaneous Remediations	171,538
1.2.03.1 -	PERCH L	Perch Lake	100,000
1.2.03.1 -	PIPELIN	Pipeline	50,000
1.2.03.1 -	RIVER	River Sediment	100,000
1.2.03.1 -	SHOOTR	Shooting range	5,000
1.2.03.1 -	SWAMPS	Swamps	100,191
1.2.03.2 -	BOREHOL	Boreholes	625,000
1.2.03.2 -	GLASSBL	Glass Blocks 1-2	
1.2.03.2 -	LYSIMET	Lysimeter Patch	148,100
1.2.03.2 -	PLTOWER	Perch Lake Tower Canopy	
1.2.03.3.1 -	GWTCP	G/W Treatment Chemical Pit	14,401,169
1.2.03.3.2 -	GWTSPGB	G/W Treatment Spring B	14,401,169
1.2.03.3.3 -	GWTW&C	G/W Treatment Nitrate Plant Wall & Curtain	4,800,390
1.2.03.3.4 -	GWTSS	G/W Treatment South Swamp	30,000,050
1.3.01.1 -	ASANDTR	WMA A Sand Trenches	81,545,496
1.3.01.2 -		WMA Special Burials	6,005,616
1.3.02.1 -	RP1	LDA - Reactor Pit #1	14,560,701
1.3.02.1 -	RP2	LDA _ Reactor Pit #2	22,006,706
1.3.02.1 -	RP23	LDA - Reactor Pit #2-3	5,015,369
1.3.02.1 -	RP24	LDA - Reactor Pit #2-4	4,143,869
1.3.02.2.1 -	CP1	LDA - Chemical Pit #1	7,236,564
1.3.02.2.2 -	CP2	LDA - Chemical Pit #2	7,921,191
1.3.02.3 -	LDAPL	LDA Pipelines	658,487
1.3.02.3 -	LP	LDA - Laundry Pit	569,141
1.3.03 -	NPBLDG	Nitrate Plant Buildings	17,308,446
1.3.03 -	NPPIT	Nitrate Plant Pit	3,017,476
1.3.04 -	THORIUM	Thorium Pit	2,092,711
1.3.05.1.		WMAB Sand Trenches	81,670,122
1.3.05.2 -	BASHPHL	WMAB Ashaplt Lined Trenches	14,795,525
1.3.05.3 -		WMA B Bunkers	99,118,245
1.3.05.4 -		WMA B Miscellaneous Wastes	6,503,569
1.3.05.8 -		WMA B Special Burials	6,374,010
1.3.05.9 -		WMAB TileHoles	88,679,623
1.3.06 -	WMAC	WMA C	7,417,174
1.3.07 -	TANKFRM	Tank Farm	900,705
1.3.08 -	WMAD	WMA D	537,492
1.3.09 -	WMAE	WMA E	801,233

WBS	Facility ID	Facility Description	TOTAL
1.3.10 -	WMAF	WMA F	9,252,286
1.3.11 -	WMAG	WMA G - CANDU Fuel Only	647,816
1.3.12 -	WMAH	WMA H	6,273,230
1.3.13 -	BULKSTR	Bulk Storage Compound	549,823
1.3.15 -	GLASSBL	Glass Blocks 1-2	376,716
1.3.16 -	LNDFILO	Current In-active Landfill	2,431,251
1.4		Plume Updates	5,375,286
6.1.01.1 -	WAF	CRL Waste Clearance Facility	51,422,780
6.1.01.2 -	WCF	CRL Waste Characterization Facility	108,864,968
6.1.01.3 -	EQUIPMT	Special Equipment	26,100,024
6.1.02 -	HOTCELL	CRL Shielded Facilities	29,891,000
6.1.03 -	MAGS	MAGS- Modular Above Ground Storage	450,000
6.1.03.3 -	SMAGS	SMAGS - Shielded MAGS	9,678,536
6.1.04.1.1 -	SLWCF	SLW Retrieval & Consolidation	63,875,676
6.1.04.1.2 -	SLWPF	SLW Processing Facility	260,109,104
6.1.04.2 -	WTC	Waste Treatment Center	90,523,088
6.1.04.3 -	SSPUMPT	WMA A South Swamp Pump & Treat	1,870,000
6.1.05.1 -	INCINER	Waste Incinerator & Solid Waste Cementation	89,379,432
6.1.05.2 -	THRPF1	Tile Hole Remediation Processing Fac Phase 1	72,467,056
6.1.05.2 -	THRPF2	Tile Hole Remediation Processing Fac Phase 2	182,043,520
6.1.05.3 -	MO99CEM	Cemented Mo99 Waste Conditioning Facility	320,247,936
6.1.05.4 -	NONFUEL	Non Fuel Non Mo99 TH Waste Processing Facility	218,598,096
6.1.05.5 -	FUELPAK	Waste Fuel Disposal Packaging	441,646,944
6.1.05.5 -	FUELSHP	CRL Fuel Shipments to National Repository	101,000,000
6.1.06.1 -	LANDFIL	CRL New Inactive Landfill	8,758,406
6.1.06.2 -	IRUS	IRUS - Intrusion Resistant Underground Structure	30,911,416
6.1.06.3 -	SRC	CGDF - Chalk River Geological Disposal Facility	401,407,264
6.4 -	FUELTWO	Fuel Transport Flasks	17,800,000
7.1		Decommissioning Program Overview	147,189,600
7.2 -	WMOFEE	NWMO	34,007,628
7.3 -	NONCEA	Public Consultation	2,800,000
7.5		Ongoing Operational Support Costs	6,454,769
		Total CRL Decommissioning Program	**3,980,944,412**

APPENDIX C

CRL Decommissioning/Demolition Cost Model
Abbreviated Description

Decommissioning Cost Model

The decommissioning/demolition model uses a unit cost approach for estimating decommissioning costs, i.e. the model applies a cost per unit of area or volume for each step in the decommissioning process. A description of the modelling steps is provided below.

Unit Rate Matrix

The unit rate matrix used to estimate decommissioning and demolition costs for structures on the CRL site is presented in Table 1. The matrix takes into account the decommissioning stage and the hazard/complexity level as discussed in the main body of this document). For decommissioning stages 1 to 4 the unit rates are expressed as a range ($/m^2) covering three room hazard/complexity levels (High, Medium, Low). For Stage 5, demolition , the unit rates are expressed as a range ($/m^3) covering the identified construction types.

Table 1 Unit Rate Matrix for Decommissioning/Demolition of Structures on the CRL Site

Decommissioning Stage	Elements of Work or Expense in the Stage	Unit Rate by Planning Envelope			
		PE1	PE2	PE3	PE4
1. Documentation and Planning $/m^2	Prepare and secure approval of DDP/BRP	22-108	5-54	5	3
	Prepare and secure acceptance of Environmental Assessment (where required)	54	0	0	0
	Perform and document hazard characterization	11-113	11-57	11-26	11
	Prepare and secure approval of SWS plan	11-27	5-22	5	5
	Totals for Stage 1:	**97-301**	**22-132**	**22-37**	**19**
2. Prepare for storage with surveillance $/m^2	Remove glove boxes (where required)	0-2,021	0-476	0	0
	Remove fume hoods (where required)	0-1,606	0-1,440	0-891	0-198
	Remove fixtures	0-628	0-257	0-98	0-25
	Remove miscellaneous equipment	0-1,618	0-628	0-258	0-83
	Modify HVAC services	92-368	69-276	24-92	13-46
	Modify Mechanical Services	39-156	30-121	0	0
	Modify Electrical Services	31-125	30-121	22-88	14-56
	Provide fire protection	24-98	18-73	12-49	12-49
	Isolate building	29-49	39-37	29-32	24
	Totals for Stage 2:	**216-5,069**	**177-2,797**	**87-1,248**	**62-398**
3. Storage with surveillance (annual)	Building utilities, taxes and common services	148	148	148	148

Decommissioning Stage $/m^2	Elements of Work or Expense in the Stage	Unit Rate by Planning Envelope			
		PE1	PE2	PE3	PE4
	Recurring inspections and reporting	6-52	6-19	5-8	3
	Periodic structural assessments and repairs	25	25	25	21
	Totals for Stage 3:	**180-225**	**180-192**	**178-181**	**171**
4. Prepare for demolition $/m^2	Radiological Scoping Survey	10-27	7-20	7	7
	Remove active services	0-1,320	0-1,080	0-597	0-298
	Remove inactive components	7-12	6-9	6-7	5
	Isolate building and cap services @ 1 m from exterior face	14-19	13-16	13-14	12
	Concrete scabbling	0-78	0-35	0-6	0
	Surface washing and swabbing	0-88	0-49	0-12	0
	Surface removal	0-702	0-312	0-47	0
	Waste segregation and packing	0-263	0-132	0-22	0
	Totals for Stage 4:	**31-2,570**	**25-1,692**	**25-720**	**23-321**
5. Demolition $/m^3	Basic Demolition	37-47	37-46	35-45	30-38
	Contaminated Waste Management	250-316	114-144	27-36	0
	Site Remediation (backfill, grading, seeding)	5-6	4-5	3-4	2-3
	Totals for Stage 5:	**292-369**	**154-194**	**67-85**	**32-41**

Waste Arisings

The decommissioning/demolition model also generates estimates for the volume of wastes arising from decommissioning and demolition of a structure on the CRL site. The largest volumes arise from stage 5 (demolition) with smaller volumes arising from stage 2 (prepare for SWS) and stage 4 (prepare for demolition). The unit values have been derived from detailed estimates that were prepared by CRL's Cost Engineering department for approximately 20 buildings of various sizes and construction types. The unit values cover several attributes of the waste arisings including type of waste (construction materials, masonry, metals etc.) and the fraction that is expected to be classified as Low-Level radioactive Waste (LLW). The total volume generated during the overall decommissioning/demolition project is approximately 25% of the building's volume (based on external dimensions) regardless of Planning Envelope assigned to the building. However, for the two preparation stages that focus on hazard removal greater volumes are projected to be generated as the potential for contamination hazards increases (PE4 to PE1).

Table 2 summarizes the projections for each of the three stages during which wastes are generated. Note the units used to express the projections: for stages 2 and 4 the units are volume per unit of floor area; for stage 5 the units are volume per unit of building volume. The ranges (or "up to") cover the three room hazard/complexity levels.

Table 2 Waste Generation during Decommissioning and Demolition

Stage	Units	Waste Volume and percent LLW by Planning Envelope			
		PE1	PE2	PE3	PE4
2: Prepare for SWS	m^3/sq. m	Up to 0.17 (up to 100% LLW)	Up to 0.12 (up to 100% LLW)	Up to 0.08 (up to 5% LLW)	Up to 0.02 (0% LLW)
4: Prepare for Demolition	m^3/sq. m	0.07 - 0.26 (up to 50% LLW)	0.07 - 0.26 (up to 20% LLW)	0.03 - 0.13 (up to 2% LLW)	0.02 - 0.07 (0% LLW)
5: Demolition	m^3/cu. m	0.21 (~10% LLW)	0.21 (~10% LLW)	0.23 (~5% LLW)	0.24 (0% LLW)

The wastes generated during the two preparation stages can be varied but are categorized as "miscellaneous". The mix of demolition waste types depends on the type of construction but the range is approximately as follows:

Masonry (concrete, brick, stone etc.):	75-85%
Construction (lumber, finishes, roofing materials etc.):	10-20%
Metals (structural steel, ducting, piping etc.):	2.5-7.5%
Miscellaneous (glass, wiring etc.):	2.5%

Worked Example

The decommissioning/demolition model is built into a Microsoft Access database that performs all the necessary calculations to combine all the room/structure attributes with the stored unit values for cost and waste arising and output the projections in a series of reports. Although the model will provide detail for each building, generally, these reports contain rolled-up projections to support strategic planning rather than detailed data for a single building. However, the following worked example for Building 107 demonstrates the details of the model.

B107 is a radiochemical laboratory (PE2) in CRL's Controlled Area 2, now in a safe shutdown state (Stage 0 complete). Its key room attributes are summarized in Table 3.

Table 3 Key Attributes of Rooms in B107

Radiation Safety Zone	Number of Rooms and Floor Area (m^2) in each Category		
	A	B	C
00 (Not Assigned)			3 34.3
01 (very low or background)	5 146.4	13 820.7	61 1,025.5
02 (low)	15 656.5	1 2.1	9 190.1
03 (medium)	3 89.2		1 7.0

Note: The cell shading indicates the Hazard/Complexity level, High, Medium, Low. See (Table 2 in the main body of the document)

The resulting cost calculations for each decommissioning stage and element of work are presented in Table 4. Note that the decimals in the cost projections are included solely to permit cross-checking of the calculations: no claim is made that the projections carry this level of precision.

Table 4 Cost Estimate Calculations to Decommission and Demolish B107 on the CRL Site

Room Hazard/Complexity Level		High	Medium	Low	Total for B107
	No. of Rooms:	23	15	73	111
	Area, sq. m.:	892	830	1,250	2,972
Stage 1: Planning and Documentation					
1.1 Prepare and secure approval of DDP/BRP	*Rate, $/$m^2$:*	*$53.82*	*$26.91*	*$5.38*	
	Cost of Work Element, $k:	$48.0	$22.3	$6.7	$77.1
1.2 Prepare and secure acceptance of Environmental Assessment (where required)	*Rate, $/$m^2$:*	*$0.00*	*$0.00*	*$0.00*	
	Cost of Work Element, $k:	$0.0	$0.0	$0.0	$0.0
1.3 Perform and document hazard characterization	*Rate, $/$m^2$:*	*$56.51*	*$26.37*	*$11.30*	
	Cost of Work Element, $k:	$50.4	$21.9	$14.1	$86.4
1.4 Prepare and secure approval of SWS plan	*Rate, $/$m^2$:*	*$21.53*	*$10.76*	*$5.38*	
	Cost of Work Element, $k:	$19.2	$8.9	$6.7	$34.9
	Totals for Stage 1, $k:	**$117.6**	**$53.1**	**$27.6**	**$198.4**
Stage 2: Prepare for SWS					
2.1 Remove glove boxes (where required)	*Rate, $/$m^2$:*	*$476.00*	*$0.00*	*$0.00*	
	Cost of Work Element, $k:	$424.6	$0.0	$0.0	$424.6

Room Hazard/Complexity Level		High	Medium	Low	Total for B107
2.2 Remove fume hoods (where required)	*Rate, $/m²:*	*$1,440.00*	*$0.00*	*$0.00*	
	Cost of Work Element, $k:	$1,284.6	$0.0	$0.0	$1,284.6
2.3 Remove fixtures	*Rate, $/m²:*	*$257.00*	*$0.00*	*$0.00*	
	Cost of Work Element, $k:	$229.3	$0.0	$0.0	$229.3
2.4 Remove miscellaneous equipment	*Rate, $/m²:*	*$0.00*	*$628.00*	*$0.00*	
	Cost of Work Element, $k:	$0.0	$521.1	$0.0	$521.1
2.5 Modify HVAC services	*Rate, $/m²:*	*$276.24*	*$137.54*	*$69.35*	
	Cost of Work Element, $k:	$246.4	$114.1	$86.7	$447.2
2.6 Modify Mechanical Services	*Rate, $/m²:*	*$120.75*	*$60.23*	*$30.26*	
	Cost of Work Element, $k:	$107.7	$50.0	$37.8	$195.5
2.7 Modify Electrical Services	*Rate, $/m²:*	*$120.75*	*$60.23*	*$30.26*	
	Cost of Work Element, $k:	$107.7	$50.0	$37.8	$195.5
2.8 Provide fire protection	*Rate, $/m²:*	*$73.46*	*$36.73*	*$18.37*	
	Cost of Work Element, $k:	$65.5	$30.5	$23.0	$119.0
2.9 Isolate building	*Rate, $/m²:*	*$36.73*	*$31.83*	*$29.39*	
	Cost of Work Element, $k:	$32.8	$26.4	$36.7	$95.9
	Totals for Stage 2, $k:	**$2,498.6**	**$792.1**	**$222.0**	**$3,512.8**
Stage 3: SWS (annual costs)					
3.1 Building utilities, taxes and common services	*Rate, $/m²:*	*$148.06*	*$148.06*	*$148.06*	
	Cost of Work Element, $k:	$132.1	$122.9	$185.1	$440.0
3.2 Recurring inspections and reporting	*Rate, $/m²:*	*$19.38*	*$7.53*	*$6.46*	
	Cost of Work Element, $k:	$17.3	$6.2	$8.1	$31.6
3.3 Periodic structural assessments and repairs	*Rate, $/m²:*	*$25.30*	*$25.30*	*$25.30*	
	Cost of Work Element, $k:	$22.6	$21.0	$31.6	$75.2
	Totals for Stage 3, $k:	**$171.9**	**$150.1**	**$224.8**	**$546.8**
Stage 4: Prepare for Demolition					
4.1 Radiological Scoping Survey	*Rate, $/m²:*	*$20.05*	*$11.70*	*$6.68*	
	Cost of Work Element, $k:	$17.9	$9.7	$8.4	$36.0
4.2 Remove active services	*Rate, $/m²:*	*$1,080.44*	*$468.82*	*$0.00*	
	Cost of Work Element, $k:	$963.8	$389.1	$0.0	$1,352.9
4.3 Remove inactive components	*Rate, $/m²:*	*$9.36*	*$7.02*	*$5.85*	
	Cost of Work Element, $k:	$8.3	$5.8	$7.3	$21.5
4.4 Isolate building and cap services @ 1 m from exterior face	*Rate, $/m²:*	*$16.38*	*$14.04*	*$12.87*	
	Cost of Work Element, $k:	$14.6	$11.6	$16.1	$42.3
4.5 Concrete scabbling	*Rate, $/m²:*	*$35.09*	*$17.55*	*$0.00*	
	Cost of Work Element, $k:	$31.3	$14.6	$0.0	$45.9
4.6 Surface washing and swabbing	*Rate, $/m²:*	*$48.74*	*$24.37*	*$0.00*	
	Cost of Work Element, $k:	$43.5	$20.2	$0.0	$63.7
4.7 Surface removal	*Rate, $/m²:*	*$311.94*	*$155.97*	*$0.00*	
	Cost of Work Element, $k:	$278.3	$129.4	$0.0	$407.7
4.8 Waste segregation and packing	*Rate, $/m²:*	*$131.60*	*$65.80*	*$0.00*	
	Cost of Work Element, $k:	$117.4	$54.6	$0.0	$172.0

Room Hazard/Complexity Level		High	Medium	Low	Total for B107
Totals for Stage 4, $k:		**$1,475.1**	**$635.1**	**$31.7**	**$2,141.9**
Stage 5: Demolition					
Construction Type:		**Wood Frame**	**Concrete Block**	**Reinforced Concrete**	**Total for B107**
No. of Sections:		6	4	1	11
Volume, m^3:		8,486	776	1,110	10,382
5.1 Basic Demolition	*Rate, $/$m^3$:*	*$38.21*	*$40.12*	*$45.85*	
	Cost of Work Element, $k:	$324.2	$31.1	$50.9	$406.3
5.2 Contaminated Waste Management	*Rate, $/$m^3$:*	*$119.71*	*$125.69*	*$143.65*	
	Cost of Work Element, $k:	$1,015.8	$97.6	$159.5	$1,272.9
5.3 Site Remediation (backfill, grading, seeding)	*Rate, $/$m^3$:*	*$3.95*	*$4.15*	*$4.74*	
	Cost of Work Element, $k:	$33.5	$3.2	$5.3	$42.0
Totals for Stage 5, $k:		**$1,373.6**	**$131.9**	**$215.7**	**$1,721.1**

Projections for the volume of waste (total plus low-level radioactive) generated during decommissioning and demolition are presented in Table 5.

Table 5 Estimates for Waste Arisings during Decommissioning and Demolition of B107 on the CRL Site

Stage	Room Hazard/Complexity Level	High	Medium	Low	Total for B107
2	*Waste Rate, m^3/m^2:*	*0.12*	*0.02*	*0*	
	Total Waste, m^3:	107	17	0	124
	LLW Fraction:	*100%*	*25%*	*0%*	
	LLW, m^3:	107	4	0	111
4	*Waste Rate, m^3/m^2:*	*0.26*	*0.13*	*0.07*	
	Total Waste, m^3:	232	109	89	429
	LLW Fraction:	*20%*	*10%*	*5%*	
	LLW, m^3:	46	11	4	62
	Construction Type:	**Wood Frame**	**Concrete Block**	**Reinforced Concrete**	**Total for B107**
5	*Waste Rate, m^3/m^3:*	*0.21*	*0.20*	*0.19*	
	Total Waste, m^3:	1,783	163	233	2,179
	LLW Fraction:	*10%*	*10%*	*10%*	
	LLW, m^3:	178	16	23	218

In summary, the model's cost and waste projections for B107 are as follows:

Direct cost: $8.1M
Total waste: 2,700 m^3
LLW: 391 m^3

APPENDIX D

Decommissioning Cost Model For Distributed Services and Affected Lands

Distributed Services

The CRL site has hundreds of kilometres of distributed services for its many facilities. For cost estimating purposes it has been conservatively assumed that all distributed services will be removed. The unit cost model developed to estimate distributed service removal costs is presented below

Stage 1

Cost estimates have been developed in reference to Industry standards for excavation in various types of soil. These are usually expressed as $/cu. ft. or $/cu. m. For Type 1 soil (sand – all services are located in sand) on the CRL site, the crew costs and productivity used are as described in the following sentence. The Crew costs $298/hr including overhead and can excavate 155 m^3/hr in Type 1 soil for a volumetric unit cost of $\$1.92/m^3$.

The model assumes that the dimensions of the required trench are dependent on the diameter of the service (above a certain minimum), thereby giving a volume excavated per unit of length and hence a unit cost, $/m. The resulting unit costs range from approximately $4/m to $25/m.

Stage 2 – Service Removal

Unit costs to remove services from the excavated trench were estimated by an analysis of the crew (personnel plus equipment) required to remove the service using three methods, together with the estimated rate of progress (metres per hour). The crew will be relatively independent of service size except that, at a certain diameter (~36") it will be necessary to emplo y a larger crane.

Table 1 Unit Cost Ranges for Removal of Civil Services

Removal Method	Crew	Crew Cost incl. O/H	*Productivity Range*	*Unit Cost Range*
Bolted	Foreman with pickup Labour (3) 14T crane*	$413/hr	12": 24 m/hr 72": 6 m/hr	12": $17/m 72": $76/m
Torch/Saw	Foreman with lift truck Labour (1) Pipefitter/welder	$213/hr	2": 30 m/hr 54": 1.1 m/hr	2": $7/m 54": $233/m
Bag/Saw	Foreman with lift truck Labour (3) Pipefitter/welder	$240/hr	4": 7.6 m/hr 36": 1.3 m/hr	4": $31/m 36": $232/m

* Crane increased to 25T for 36" diameter and greater

Stage 3 - Backfilling

The cost estimate references industry standards for backfilling The required crew consists of a foreman with pickup, a front end loader/bulldozer, a pan type compactor and 2 labourers

This crew costs $298/hr including overhead and can emplace and compact 45 m^3/hr in trenches for a volumetric unit cost of $6.62/$m^3$.

The model assumes that the excavated fill will be replaced during backfilling but imported fill will be required to replace the volume formerly occupied by the removed service. This volume will be directly proportional to the cross-sectional area of the service but will only be significant for the larger diameters. A cost of $3/$m^3$ is used in the model.

The resulting linear unit rates for backfilling and grading the trenches following removal of services of various diameters range from $13/m for a 2" diameter former service to $110/m for a 54" former service.

Allowances

Allowances to the unit rates are added for productivity factors (e.g. monitoring and security requirements, documentation and project management). Based on standard benchmarks and CRL's Costs Engineering experience these allowances are dependent on the area of the site and are as follows:

Allowance	CA-1	CA-2	Site Avg.
Site access/security	5%	20%	13%
Survey/monitoring	5%	15%	10%
Documentation	5%	5%	5%
PM & support	35%	35%	35%

Worked Example

Table 2 presents an example to illustrate how the model develops decommissioning costs for a typical service, in this case steam and condensate.
The inventory of steam and condensate lines on the CRL site and the respective unit and total costs for the 3 stages of decommissioning are summarized in Table 2.

Table 2 Inventories, Unit Rates and Costs for Decommissioning of Steam and Condensate Lines on the CRL Site

Material and Removal Method	Service Diameter									Totals
	Up to 2"	2½"	3"	4"	5"	6"	8"	10"	12"	
Lengths, metres										
Cast Iron (Jointed):				98						**98**
Steel (Torch):	3,024	621	2,623	2,689	34	1,205	461	650	88	**11,393**
Unit Rates, $/m										
Excavation:	$3.69	$3.79	$3.89	$4.09	$4.30	$4.51	$4.93	$5.38	$5.82	
Removal (Jointed):				$16.93						
Removal (Torch):	$6.99	$10.66	$14.33	$21.66	$23.58	$25.50	$29.34	$34.58	$39.82	
Backfill:	$12.78	$13.15	$13.52	$14.26	$15.02	$15.78	$17.34	$19.04	$20.73	
Direct Costs, $k										
Excavation:	$11.1	$2.4	$10.2	$11.4	$0.1	$5.4	$2.3	$3.5	$0.5	**$47**
Removal:	$21.1	$6.6	$37.6	$59.9	$0.8	$30.7	$13.5	$22.5	$3.5	**$196**
Backfill:	$38.6	$8.2	$35.5	$39.7	$0.5	$19.0	$8.0	$12.4	$1.8	**$164**
Totals:	**$71**	**$17**	**$83**	**$111**	**$1**	**$55**	**$24**	**$38**	**$6**	**$407**
Allowances, $k										
Access/Security:	$9.2	$2.2	$10.8	$14.4	$0.2	$7.2	$3.1	$5.0	$0.8	**$53**
Survey/Monitoring:	$7.1	$1.7	$8.3	$11.1	$0.1	$5.5	$2.4	$3.8	$0.6	**$41**
Documentation:	$4.4	$1.1	$5.1	$6.8	$0.1	$3.4	$1.5	$2.4	$0.4	**$25**
PM & Support:	$32.1	$7.7	$37.6	$50.2	$0.7	$24.9	$10.7	$17.3	$2.7	**$184**
Overall Total:	**$124**	**$30**	**$145**	**$194**	**$3**	**$96**	**$41**	**$67**	**$10**	**$709**

Thus the total cost to decommission all steam and condensate lines on the CRL site is estimated at approximately $0.7M. When the model is applied to all civil services the overall total is somewhat less than $10M.

Affected Lands

All lands within CA1 and CA 2 on the CRL site are considered as having been affected by CRL operations and cost estimates have been developed for the identified areas of affected land. Table 3 provides a summary of the requirements, costs and waste volumes, where relevant, for the Affected Lands.

Table 3 Affected Lands – Requirements, Costs and Waste Volumes

Facility/Item Description	Planning Assumption Requirement	Cost & Waste Estimates (As Applicable) 2001$
Inner Area Plumes	Ongoing Monitoring No retrieval required, source removed with facility/structure	5 to 10 boreholes + twice per year sampling $50k/annum ongoing for 50 years
Grey Crescent General Area Used for Landfill/Backfill Activities	Ongoing Monitoring and assessment Small selective retrieval may be required (monitoring to confirm)	10 to 15 boreholes + twice per year sampling $100k/annum ongoing for 50 years
Road Salt & Oiled CRL Roads	Continued use expected - No Action Required	NA
River Sediment	No Action Required	NA
Snow Dumps (2)	Continued use expected	Re-vegetating
Meteorological Towers	Continued use expected, no contamination, thereby allowing conventional removal	NA
Landfill Attenuation Zones	Continued use - No Action Required	NA
Blimkie's Meadow	Removal of surplus equipment, equipment needs to be surveyed before release	$20k
Dawson City	No Action Required – construction debris used for landfill – confirmatory monitoring	Sampling requirements included in Grey Crescent
Shooting Range	Recovery of lead fragments & re-vegetating	$10k (waste) + reclamation $5k = $15k
1953 NRX Pipeline Route	Confirmatory Survey of No Action Required – potential for residual contaminations exists, but short in-use period was in early 1950's	$25k
On-site Sanitary Landfill	No recovery of materials assumed to be required – to be confirmed by continued monitoring	5 acres @ $10k = $50k $50k closure document $5k ongoing annual monitoring

Table 3 (continued) Affected Lands – Requirements, Costs and Waste Volumes

Facility/Item Description	Planning Assumption Requirement	Cost & Waste Estimates (As Applicable) 2001$
Perch Lake Hydro-Meteorological Study Area	Recovery of redundant equipment, no residual contamination	$15k
Waste Lysimeters	Recovery of waste materials (minor contamination) and extraction of facility structure	$75k + 5 m^3 LLRW
O-Nest	Shallow boreholes –covered with shallow boreholes below	NA
Twin Lake Tracer	Shallow boreholes – covered with shallow boreholes below	NA
Glass Blocks	Recovery of Blocks and soils in immediate vicinity	$50k + 1.5 m^3 ILRW
Perch Lake Canopy Tower	Removal of Scaffolding Tower and miscellaneous equipment	$15k
Deep Boreholes	Grouting of boreholes and removal of protruding casings – no contamination anticipated	50 boreholes @ $5k $250k
Shallow Boreholes	Extraction of (mostly PVC) casings to 1 metre below grade – no contamination anticipated	2,500 boreholes @ $0.15k $375k

APPENDIX E

Summary Spreadsheet for CRL Waste Management Areas

Notes to Summary Spreadsheet

The summary spreadsheet provides information on each of the WMAs. Costs and waste volumes are collected against the categories as noted.

Facility

These columns contain facility and waste descriptors

HLW, ILW, LLW - Waste Type – The waste type assigns the appropriate cost factor for recovery and processing of waste materials: LLW=2, ILW=1, HLW = 0. This is used in the formula for calculating waste recovery.

WMA – Area - Identifies a specific WMA, e.g. WMA-A
WMA – Specific Facility – Identifies specific facilities within individual WMA's, e.g. WMA-A Sand Trenches

Waste Recovery

Volume Recovered –The volume recovered is that fraction of the total estimated volume for a WMA facility that is expected to be recovered. The total estimated volume takes into account both the facility structure, if present, and the waste plus surrounding backfill or soil, if present. The volume of waste that was emplaced is taken from records or determined on the basis of a calculation. The volume recovered is based on a Recovery fraction that is assigned based on expert judgement and current knowledge of the waste and soil contamination

Recovery Cost–
The recovery cost is based on the waste category, recovery cost is assigned in $ per cubic metre as follows;

LLW = 5000 $/$m^3$ (based on previous concrete bunker waste recovery cost);
ILW = 7000 $/$m^3$ (based on LLW but 35-40% higher costs for increased (relative to previous experience) crew size in field and additional Radiation Surveyor support);
HLW = 10,000 $/$m^3$ (based on the cost from previous tileholes recoveries)

ILW and HLW are rarely use in the spreadsheet and therefore do not have a significant impact on the cost estimates. HLW is only triggered for the steel lined fuel bearing tileholes for the steel liner volume. The fuel removal cost is captured under the Fuel recovery operation which is part of the Tile Hole Remediation effort and covered under the CRL enabling facilities

Clearance volume – The clearance volume is the fraction of the total volume of waste recovered that can be cleared for release. Waste are cleared for release on the basis that analysis has shown that they contain only small levels of radioactivity that do not cause

any concern from a health or environmental perspective and therefore can be managed in the same manner as non-radiological wastes – recycle, reuse or landfill disposal. Clearance cost is captured as part of the waste costs for the wastes processed through the Waste Clearance Facility enabling facility , see the Waste Clearance Facility in the main body of the report.

Disposal volume

The disposal volume is the total volume of waste materials recovered less the clearance volume. Cost for disposal is captured as part of the cost estimate for two enabling facilities – IRUS and CGDF.

Facility Characterization and Monitoring

Characterization

Characterization costs are estimated based on a formula that has been derived on the basis of our previous expenditures for characterization. The minimum cost for collecting soil samples, drilling a single borehole, performing and documenting the analysis and, preparing the necessary documentation to secure approvals is 50 k$. The formula therefore has a minimum cost ; we can't characterize any item for less than 50 k$. The maximum cost for characterization of an individual facility, based on expert judgement for some of the larger facilities, is estimated to be approximately 3M$. This judgement was partially based on the effort to characterize IRUS wastes and the IRUS site, and therefore is based on previous experience. This upper-end also aligns with recent experience on the effort required for a significant plume update which for the larger facilities at CRL (WMA-C, WMA-A) may have several plumes to be characterized, and the magnitude of the Operational Control Monitoring (OCM) Program required for a specific facility. Along with the groundwater monitoring requirements, wastes from the facility would need to be sampled and characterized, at a cost that would be approximately the same as that for the OCM. This maximum cost estimate may be overly conservative in cases where there is greater waste homogeneity in the facility or where the amount of radioactivity is low. In such cases, e.g. WMA-E that contains very low-level solid waste or suspect soils, the formula has been overridden . Also adding to the conservatism is the fact that previous characterization work has not been taken into consideration.

Monitoring

The extent of monitoring for the pre-waste recovery period is based on the current OCM program. The input is the # of monitoring holes required based on the current OCM program for that specific facility or site.

Pre-recovery Monitoring Cost

Based on the currently experienced OCM costs which are 5k$ per borehole per year. The total monitoring cost is arrived at by multiplying the unit borehole cost by the duration and by the number of boreholes.

Post recovery boreholes
This is based on judgement and is consistent with the trend that fewer boreholes are required after waste recovery.

Post-recovery Monitoring Cost
This cost is the same as the pre-recovery borehole monitoring cost and is based on the currently experienced OCM costs of 5k$ per borehole per year. The total monitoring cost is arrived by multiplying the unit borehole cost by the duration and by the number of boreholes.

Plume Updates –
This is the cost of providing the CNSC with updates of significant plumes in the outer area. This is an activity already being performed and part of a regulatory requirement. This will continue on a prescribed basis as reflected in the schedule.

Cost/update –
A formula is used to calculate the cost based on the number of updates during both the pre waste recovery period (every 10 years) and the post waste recovery period of waste (every 20 years) multiplied by the update cost. This corresponds to about 4 updates over the next 80 years for each significant plume.

Initial frequency –
The planned frequency for plume updates is every 10 years during the pre recovery period (or early years of the program?)

Closure

Remedial Requirements - Cap cover cost
A unit cost of 65$ per square metre of landfill type cover (based on a third party estimate for an engineered cover for WMA-C) is used. Only those facilities with waste remaining in the ground require covers.

Final safety case for abandonment – The safety case cost is based on a formula that applies similar logic to the characterization cost calculation. The minimum cost is estimated at 50k$ since we can't provide any kind of regulatory document for less than 50K$. The maximum cost is estimated at 4M$ on the basis that an effort similar to that required for IRUS will be required. The formula uses the volume in the waste volume column.

Facility			Waste Recovery		Clearance Volume	Disposal Volume	Facility Characterization and Monitoring							Closure	
HLW=0 ILW=1 LLW=2	WMA	WMA	Volume recovered	Recovery Cost	Clearance Volume (soil and facility Structure - not contaminated)	Disposal Volume	Characterization	Monitoring				Plume Updates		Remedial requirements	Final Safety case for abondonment
Waste Type	Area	Specific Faciliity						pre-recovery # of Boreholes	cost	pre-recovery # of Boreholes	cost	cost/update	Ininitial frequency years	cap/cover cost	
			109,040	$332,572,813	46,231	64,593	$35,576,860		$8,210,000		$10,990,000			$12,929,680	$42,576,860
	LDAs														
2		RP2	3433	$17,162,500	0	3433	$1,716,250	5	$575,000	3	$1,095,000	$150,000	10	$455,000	$1,716,250
2		RP(2)-3	671	$3,355,000	0	671	$671,000	2	$230,000	1	$365,000			$0	$671,000
2		RP(2)-4	547	$2,732,500	0	547	$546,500	1	$115,000	1	$365,000			$0	$546,500
2		RP1	2220	$11,100,000	0	2220	$1,110,000	2	$230,000	1	$365,000			$260,000	$1,110,000
2		CP-1	945	$4,725,000	0	945	$945,000	3	$345,000	1	$365,000	$150,000	10	$188,500	$945,000
2		CP-2	1227	$6,135,000	0	1227	$736,200	3	$345,000	1	$365,000			$0	$736,200
2		LP	0	$0	0	0	$50,000	2	$230,000	1	$365,000			$156,000	$50,000
2		LDA Pipelines	205	$525,000	100	105	$50,000	2	$230,000	1	$365,000			$0	$50,000
2		Nitrate Plant Pit	320	$1,600,000	0	320	$400,000	2	$230,000	2	$730,000	$125,000	10	$0	$400,000
2		Nitrate Plant Buildings	4500	$15,000,000		3000	$900,000	1	$115,000	1	$365,000			$195,000	$900,000
1		Thorium Pit	150	$1,050,000	0	150	$150,000	3	$345,000	2	$730,000			$26,000	$150,000
2		WMA-C	0	$0	0	0	$3,000,000	14	$420,000	2	$900,000	$150,000	10	$2,600,000	$4,000,000
2		WMA-F	0	$0	0	0	$3,000,000	2	$110,000	2	$850,000	$150,000	10	$1,625,000	$4,000,000
1		WMA-E	0	$0	0	0	$3,000,000	5	$275,000	2	$850,000	$20,000	10	$1,300,000	$4,000,000
2		WMA-D		$125,000	475	25	$50,000	1	$55,000	1	$425,000		10	$0	$50,000
2		WMA-H		$4,225,000	855	845	$800,000	2	$110,000		$0		10	$0	$800,000
1		WMA-G		$0	353	0	$50,000	2	$110,000		$0		10	$0	$50,000
2		Bulk Storage	310	$125,000	285	25	$200,000	1	$55,000		$0		10	$0	$200,000
1		Tank Farm		$175,000	25	25	$50,000	8	$440,000	1	$425,000		10	$0	$50,000
1		Glass Block 1-2	7	$28,000	3	4	$50,000	2	$110,000		$0		10	$0	$50,000
		Inactive Landfill	0	$0	0	0	$50,000	2	$110,000		$0		10	$1,625,000	$50,000
	WMA-B														
2		Sand Trenches - old	19518	$61,155,310	7287	12231	$3,000,000	3	$345,000	1	$365,000	$150,000	10		$4,000,000
2		Sand Trenches-new		$3,402,269	0	680	$3,000,000	2	$110,000	2	$850,000		10	$1,769,180	$4,000,000
1		Asphalt Trenches	2922	$12,536,200	1131	1791	$692,177	2	$110,000	2	$850,000		10		$692,177
2		CD 1-15	12330	$34,839,547	5362	6968	$1,648,040	1	$55,000	0	$0		10		$1,648,040
2		CD 16 -185	15300	$53,550,000	4590	10710	$3,000,000	1	$55,000	0	$0		10		$4,000,000
2		BAS 1-3	426	$1,784,818	69	357	$339,662	1	$55,000	0	$0		10		$339,662
2		Bottle Crib 1-3	357	$1,187,524	119	238	$189,610	1	$55,000	0	$0		10		$189,610
2		RCD 1-3	28	$57,694	16	12	$50,000	1	$55,000	0	$0		10		$50,000
2		Solvent Bunkers 1-3	2	$0	2	0	$50,000	1	$55,000	0	$0		10		$50,000
2		CU 1-2	22	$15,828	18	3	$50,000	1	$55,000	0	$0		10		$50,000
2		CS 1-5	117	$285,316	60	57	$50,000	1	$55,000	0	$0		10		$50,000

Facility			Waste Recovery		Clearance Volume	Disposal Volume	Facility Characterization and Monitoring							Closure	
HLW=0 ILW=1 LLW=2	WMA	WMA	Volume recovered	Recovery Cost	Clearance Volume (soil and facility Structure - not contaminated)	Disposal Volume	Characterization	Monitoring				Plume Updates		Remedial requirements	Final Safety case for abondonment
Waste Type	Area	Specific Faciliity						pre-recovery # of Boreholes	cost	pre-recovery # of Boreholes	cost	cost/update	Ininitial frequency years	cap/cover cost	
1		NRU-RS	328	$343,505	279	49	$50,000	1	$55,000	0	$0		10		$50,000
2		RP 1-2	273	$397,309	193	79	$50,000	1	$55,000	0	$0		10		$50,000
2		CW 1-5	590	$471,289	496	94	$52,603	1	$55,000	0	$0		10		$52,603
1		SSRB 1-2	10	$10,728	8	2	$50,000	1	$55,000	0	$0		10		$50,000
1		SS56 1-4	10	$15,708	7	2	$50,000	1	$55,000	0	$0		10		$50,000
1		Thermal S 1-3	39	$78,374	28	11	$50,000	1	$55,000	0	$0		10		$50,000
1		Calandria 1-2	88	$389,970	32	56	$54,024	1	$55,000	0	$0		10		$54,024
		MG&A	0	$0	0	0	$50,000	1	$55,000	0	$0		10		$50,000
1		EV228	20	$66,697	11	10	$50,000	1	$55,000	0	$0		10		$50,000
2		C60C	23	$54,258	12	11	$50,000	1	$55,000	0	$0		10		$50,000
1		GP	292	$1,320,250	104	189	$50,000	1	$55,000	0	$0		10		$50,000
1		SAS	38	$137,603	18	20	$50,000	1	$55,000	0	$0		10		$50,000
1		CFL	9	$29,289	5	4	$50,000	1	$55,000	0	$0		10		$50,000
2		BR	95	$301,532	35	60	$50,000	1	$55,000	0	$0		10		$50,000
2		RBP	11	$22,172	7	4	$50,000	1	$55,000	0	$0		10		$50,000
2		MC	11	$22,172	7	4	$50,000	1	$55,000	0	$0		10		$50,000
2		URC	5	$27,184	0	5	$50,000	1	$55,000	0	$0		10		$50,000
1		U238T	4	$6,323	3	1	$50,000	1	$55,000	0	$0		10		$50,000
	tileholes (not contents)														
1		IFE/IMD 767TH(Concrete)	4799	$1,487,094	4586	212	$50,000	1	$55,000	0	$0		10		$50,000
0		IFE/IMD (Steel)	16	$161,647	0	16	$50,000	1	$55,000	0	$0		10		$50,000
1		IRP 2577 TH	12084	$15,513,207	9868	2216	$725,799	1	$55,000	0	$0		10		$725,799
	WMA-A														
2		Sand Trenches	23729	$71,187,026	9492	14237	$3,000,000	1	$55,000	0	$0		10	$2,730,000	$4,000,000
1		CAL	32	$159,509	9	23	$50,000	1	$55,000	0	$0		10		$50,000
2		233	149	$559,323	37	112	$96,012	1	$55,000	0	$0		10		$96,012
2		EXC	149	$559,323	37	112	$96,012	1	$55,000	0	$0		10		$96,012
2		OTT	14	$41,605	6	8	$50,000	1	$55,000	0	$0		10		$50,000
2		60mR	2	$3,511	1	1	$50,000	1	$55,000	0	$0		10		$50,000
2		HS	2	$3,511	1	1	$50,000	1	$55,000	0	$0		10		$50,000
2		Co	47	$134,901	20	27	$50,000	1	$55,000	0	$0		10		$50,000
2		206F	17	$49,753	7	10	$50,000	1	$55,000	0	$0		10		$50,000
2		204RS	9	$21,917	5	4	$50,000	1	$55,000	0	$0		10		$50,000
2		ALWT	102	$342,237	33	68	$50,000	1	$55,000	0	$0		10		$50,000
2		ALWT	86	$280,896	30	56	$50,000	1	$55,000	0	$0		10		$50,000
2		SOR	73	$258,759	22	52	$50,000	1	$55,000	0	$0		10		$50,000
2		SR	4	$8,891	2	2	$50,000	1	$55,000	0	$0		10		$50,000
2		ALW	95	$370,285	21	74	$65,050	1	$55,000	0	$0		10		$65,050
2		ALW	95	$370,285	21	74	$65,050	1	$55,000	0	$0		10		$65,050
2		BR204	5	$12,120	3	2	$50,000	1	$55,000	0	$0		10		$50,000
2		MC300	5	$12,120	3	2	$50,000	1	$55,000	0	$0		10		$50,000
2		BLDG	120	$452,985	30	91	$77,871	1	$55,000	0	$0		10		$77,871
2		CoPH	1	$2,534	1	1	$50,000	1	$55,000	0	$0		10		$50,000
2		B100RS	1	$1,984	1	0	$50,000	1	$55,000	0	$0		10		$50,000
2		ZC	1	$2,435	1	0	$50,000	1	$55,000	0	$0		10		$50,000
2		BP	1	$3,084	1	1	$50,000	1	$55,000	0	$0		10		$50,000