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In the Matter of the

À l'égard des

Canadian Nuclear Laboratories (CNL)

Laboratoires Nucléaires Canadiens (LNC)

Application from the CNL to amend its Chalk River Laboratories site licence to authorize the construction of a near surface disposal facility

Demande des LNC visant à modifier le permis du site des Laboratoires de Chalk River pour autoriser la construction d'une installation de gestion des déchets près de la surface

Commission Public Hearing
Part 2

Audience publique de la Commission
Partie 2

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Intervention With Respect to Canadian Nuclear Laboratories' Application to Amend Its Chalk River Laboratories Site Licence to Authorize the Construction of a Near Surface Radioactive Waste Disposal Facility

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Introduction

I would like to thank the Canadian Nuclear Safety Commission for this opportunity to present an intervention in the matter of the construction of a near surface radioactive waste facility at the Chalk River Laboratories.

The construction and operation of the Near Surface Disposal Facility (NDSF) at CNL represents a significant and commendable advance in the Canadian Nuclear Industry. However, as proposed in [1,2], it falls short of what has been successfully implemented internationally for the disposal of low-level radioactive wastes (LLW).

My comments below are based on a review of publicly available documents pertaining to the proposed NDSF and on my personal and professional experiences at the Chalk River Laboratories over a 30-year period.

Defense in Depth

The concept of Defense in Depth for nuclear facilities concerns the use of multiple layers of barriers to prevent or restrict the effects of ionizing radiation on the public and the environment. As this radiation is a physical phenomenon, it follows that the barriers themselves need to be mostly physical, with items such as administrative controls being of lesser effectiveness. For example, in a nuclear reactor, such as CANDU, the multiple barriers are:

- The composition of the fuel material in its ability to retain fission products,
- The integrity of the fuel sheath,
- The integrity of the Primary Heat Transfer System,

- The effectiveness of special safety systems, such as two diverse shutdown, emergency core cooling and containment,
- The size of the exclusion zone.

It is important to note that a nuclear reactor facility has a relatively short operating life, during which it is under constant instrumented and human surveillance with the potential for rapid intervention. However, a waste disposal facility will spend most of its much longer design life with minimal monitoring and potential for intervention. It follows then that such facilities need to be designed and built with barriers that are fundamentally passive and robust in nature. Thus, for waste disposal facilities, the analogous barriers are:

- For the short term (up to 300 years) containment during the operational (loading) and institutional control phase is by retentive properties of the waste itself, its packaging, and the surrounding engineered structures.
- For the long term, where institutional memory cannot be relied upon, containment is by geological properties of the site and the limitation of long-lived radionuclides.

At the heart of the safety case for both types of facilities, there is a fundamental safety principle that is shared – the control of the quantity of nuclear material in each:

- For a nuclear reactor, it is the control of available excess reactivity by core management.
- For a waste disposal facility, it is the control of the inventory - type and quantity of nuclear material.

In both cases, such control is maintained using physical measurements and procedural controls to ensure that predictions and estimations are aligned with reality.

The following Figure 1, taken from [1], shows the model of defense in depth proposed for NDSF.

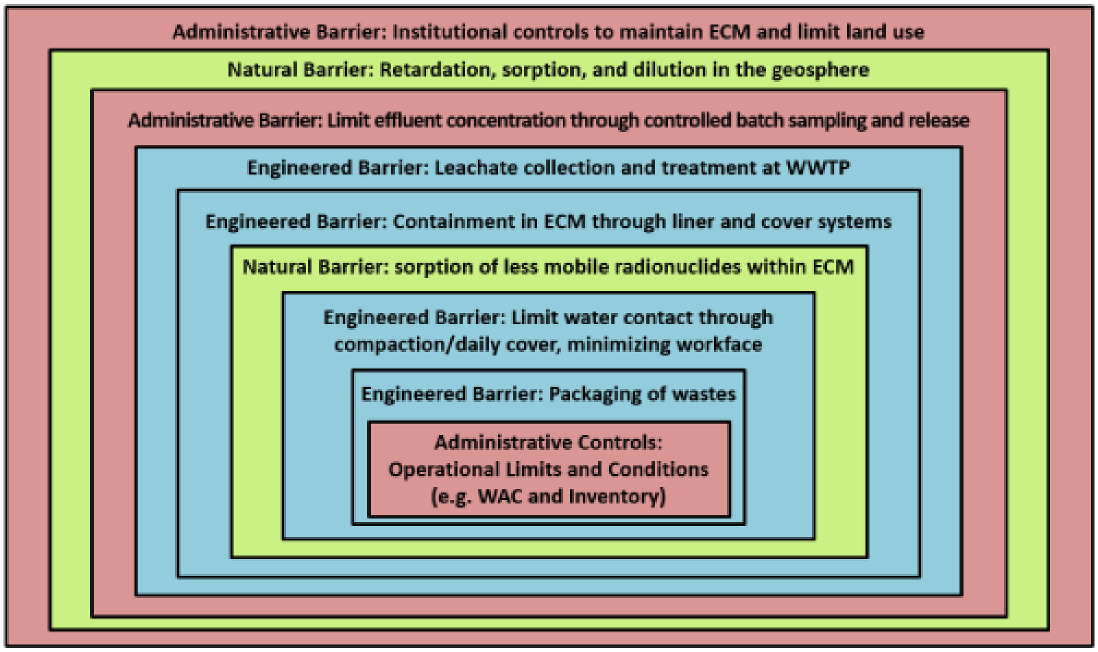

Figure 1 – Defence in Depth Model for NDSF

From this figure the "barriers" shown beyond "Containment in ECM through liner and cover systems" are not really barriers at all for the long-term condition. A leachate collection and treatment system is more of a process system that represents a potential leakage route out of containment The barriers then are:

- The control of the Inventory
- The packaging of the wastes
- The engineered structure.

The barrier missing here is the geological characteristics of the site itself to maintain long-term containment. The following Figure 2, from [2], shows the proposed location for the NDSF; its proximity to surface water does not give great confidence in its geological location as a barrier. To be fair, the Chalk River site itself is problematic for the establishment of any near surface radioactive waste disposal facility; there is simply too much ground and surface water. This need not be a disqualifier for the site. Figure 3 [2] shows the cross-section of the proposed NDSF. For comparison with international experience, Figure 4 shows a proposed Belgian LLW disposal facility at Dessel [3]. It is like facilities at El Cabril in Spain and the Centre de l'Aube in France. What Figure 4 does not show is the location of the water table, which is only 1 to 2 m below grade, but using an above-grade concrete cell structure, this problem is overcome. Also of note is that at closure, this too will be a mounded facility; in the case of failure of the earthworks, the concrete cells could continue to provide containment.

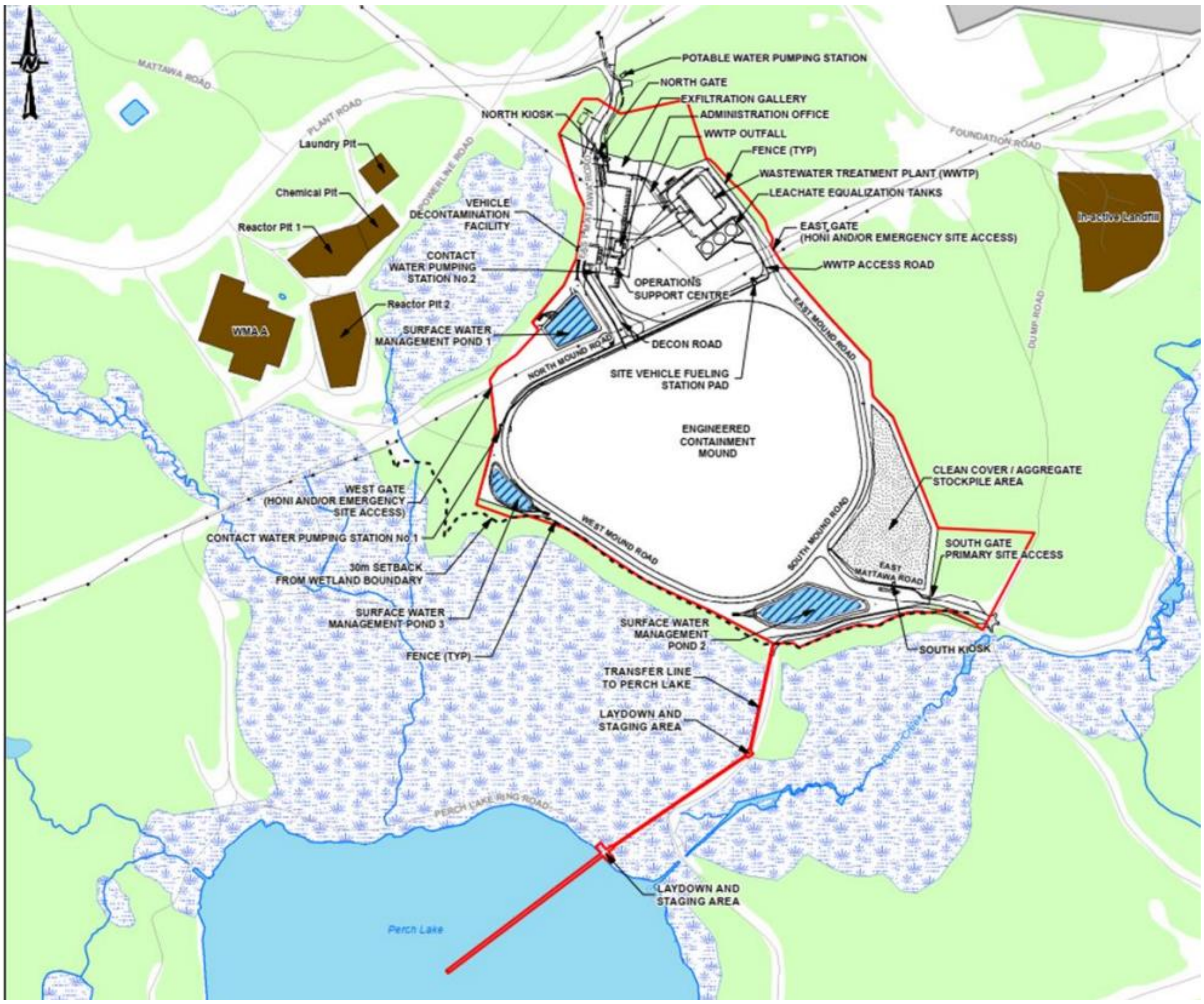

Figure 2 - Location of NDSF at CNL

Figure 5 illustrates the cross-section of a near surface facility at Morvilliers, France [4], intended for very low-level radioactive waste, a class considered to be of lesser hazard than LLW, and therefore requiring less rigour in its isolation from the environment. When compared to these European facilities, it can be seen that CNL's NDSF proposal is more in line with a VLLW, not LLW disposal facility.

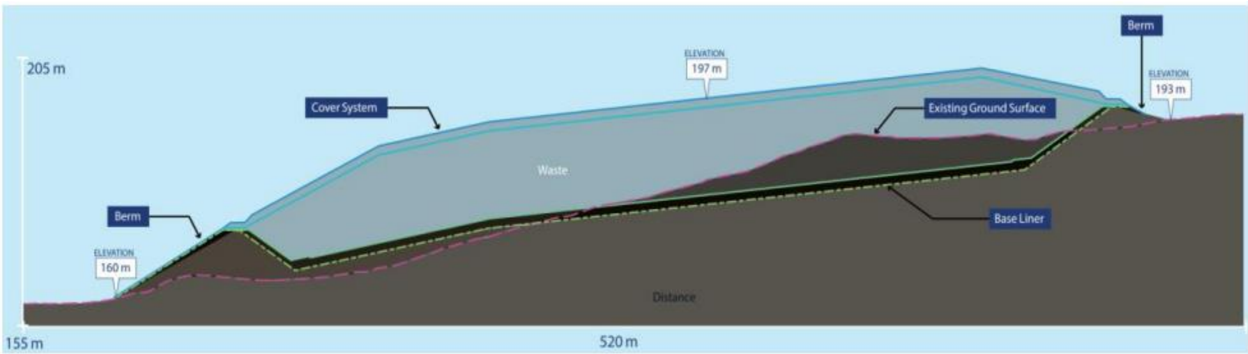

Figure 3 – Cross Section of the Proposed NDSF

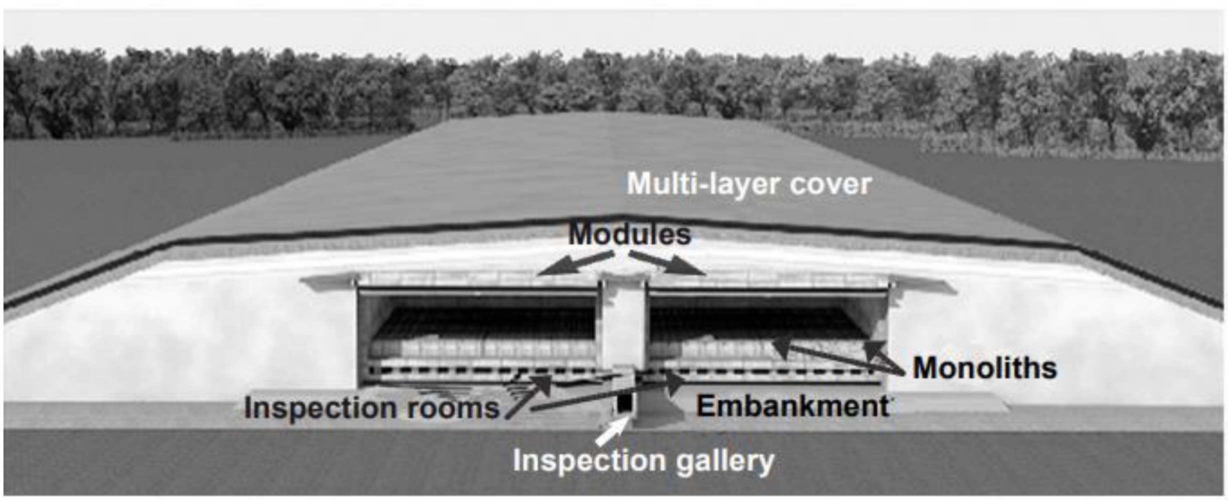

Figure 4 – Cross Section of Proposed LLW Facility at Dessel

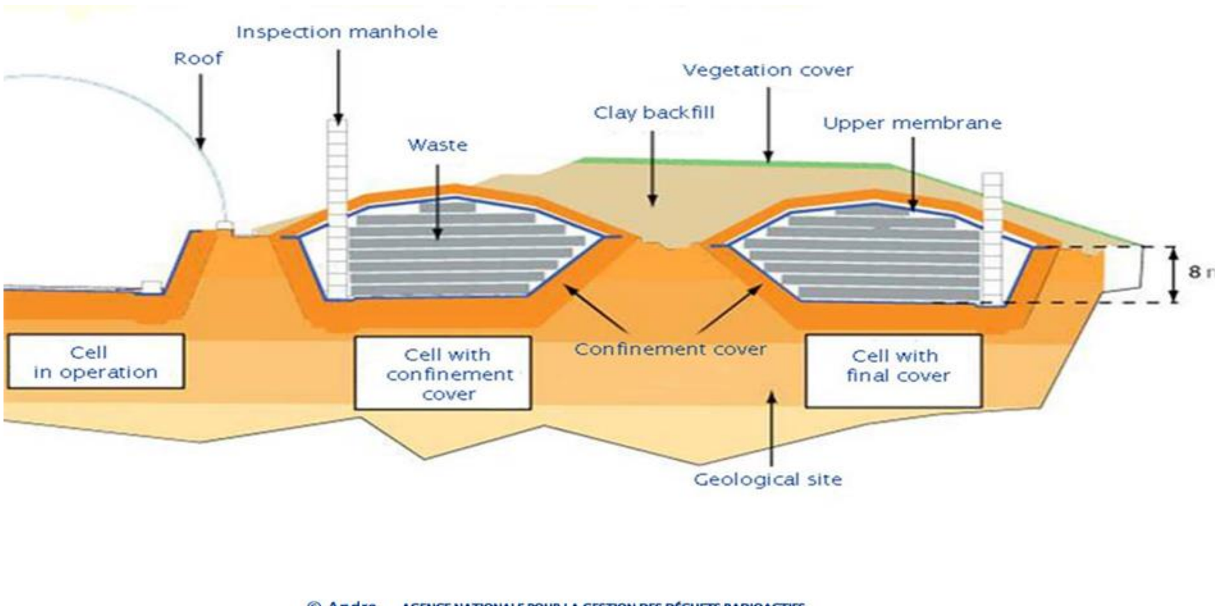

Figure 5 – Cross-Section of CIRES Facility at Morvilliers, France, For Very Low-Level Waste (VLLW) [4]

It can also be seen then that the limitations of proposed site of the NDSF need not disqualify it if the engineered barriers have been hardened beyond what has been proposed.

The Waste Inventory

Central to the safety case for any near surface radioactive waste disposal facility is the control of the radionuclide inventory. For near surface waste disposal facilities, this generally involves restricting the species of radionuclides to those with a $t_{1/2}$ of 30 years or less, and with quantities limited to that which would result in a decayed inventory, at 300 years, which would allow the land to be released from regulatory control. To meet this requirement, it is not only the radioactive materials that must be controlled, non-radioactive contaminants, organic and inorganic, which require isolation from the biosphere, such as Pb also need to be controlled. Small quantities of longer-lived radionuclides are permissible, all subject to the free release criteria of 300 years.
This basic safety requirement is achieved by using Waste Acceptance Criteria (WAC). Such criteria have been developed for NDSF [5] that establishes numerical limits for waste packages. and it is commendable that such WAC for LLW has been developed; historically, the terms Low Level Waste, Intermediate Level Waste,

and High-Level Waste were not used at the Chalk River Laboratories. Wastes were routed to storage facilities in the Waste Management Areas based on immediate radiological protection requirements, i.e., if the waste required shielded packaging or could be contact handled.

The problem of WAC is enforcement; characterization is required and verification. A process has been developed to characterize wastes [6], but it lacks detail on how this is to be done. Verification of wastes receipts seems to be based solely on document reviews. Again, historically, wastes sent to the Chalk River Waste Management Areas were not well categorized apart from very basic information; the information recorded as inventory can be considered actionable for routing to the appropriate storage facility, but not actionable for the purposes of classifying as LLW and thus be reliable for inclusion in NDSF.

Beginning in the 1990's, a Waste Identification Program was instituted to both to obtain waste characterization data, identify a future disposal route, devise a means of package identification that would assist in future retrieval, and maintain a database of this information. Waste characterization was done primarily by process knowledge and mass balance techniques, the result being an estimate of average per package quantities. For wastes originating from a relatively unchanging waste stream, e.g., isotope production, this approach is valid as an estimation, but only an estimation unless physical analytical verification activities are undertaken (example - gamma spectroscopy). In practice due to resourcing and infrastructure issues, this was not done on the scale envisioned.

The facilities identified for routing radioactive waste (but never built) that were intended for near surface disposal were:

a) STDF – a near surface sand trench facility, using secure landfill technology.
b) IRUS – a vaulted facility intended for longer-lived waste that would require isolation for a period longer than 300 years.

Recovering and routing stored STDF and IRUS wastes to NDSF is further complicated by the fact that, again due to resource and infrastructure reasons, it was not possible to maintain complete segregation of these wastes in the storge facilities and the problem of cross-contamination cannot be discounted. Thus prior to emplacement in NDSF, this waste will require some form of analytical verification.

Finally, while record keeping has been greatly improved over past practices, the information contained within about characterization is at best only a first approximation and care should be taken when using it in routing wastes or in safety analyses.

For practical purposes, when identifying candidate wastes for or accepting into NDSF:

- Wastes received from off-site should have the best characterization, as this is required to meet the transportation of dangerous goods requirements.

- On-site new arisings should also be adequately characterized, provided the proposed process is carried through with.

- Wastes recovered from existing waste management facilities that were covered by the Waste Identification Program, while better documented, will require some degree of physical verification

- Wastes recovered from older waste management facilities or from demolition and environmental restoration activities will require more rigour.

The NDSF proposal is lacking in detail on how this is to be accomplished.

Conclusions

As proposed, the NDSF is not a LLW disposal facility of the same calibre as has been implemented internationally; however, it should be adequate as a VLLW disposal facility for the large volume of CNL bulk material wastes that are expected to arise from demolition activities. The technology of secure landfills is well established, and these wastes are low-risk, provided that this low-risk can be demonstrated by:

a) The use of historical and process knowledge to identify candidate material.

b) Operational discipline to establish and maintain segregation of this material from more highly contamination wastes; and
c) Physical verification by sampling and analysis for radiological and non-radiological contaminants.

References

1. Canadian Nuclear Safety Commission, *A License Amendment, required Approvals for Construction of the Near Surface Disposal Facility (NDSF) to the Chalk River Laboratories (CNL) Licensing Basis*, CMD-22-H7, 2022 January 24

2. Canadian Nuclear Laboratories, Site License Amendment to Authorize the Construction of the Near Surface disposal Facility, 232-508760-REPT-002, CMD-H7.1, 2022 January 24.

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4. *VLLW Disposal and Management of Large Volume of Slightly Contaminated Materials, The French Experience,* Nicolas Solente, IAEA Technical Meeting on the Disposal of Large Volume of Radioactive Waste, 25-28 November 2013, Vienna.

5. Canadian nuclear Laboratories Waste Acceptance Criteria – Near Surface Disposal Facility Waste Acceptance Criteria 232-508600-WAC-003, Revision 2, 2020 September 23.

6. Canadian Nuclear Laboratories *Standard Waste Characterization*, 900-508600-SRD-003, 2019 December 10.