Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Environmental Remediation and Site Revitalization Planning at A Complex Nuclear Site Using a Multi-Attribute Prioritization Tool

November 16, 2023
Luc Robitaille
Canadian Nuclear Laboratories

Restore and protect Canada's environment

Subjective risk-ranking is not the most effective way to manage remedial actions
at a complex site

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CHALK RIVER LABORATORIES

Built in 1944

Most important Nuclear Research Facility in Canada

Covers 40 Km^2

200 Km upstream from Ottawa

Unceded Indigenous land

Undergoing major revitalization

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

60+ AREAS OF POTENTIAL ENVIRONMENTAL CONCERN
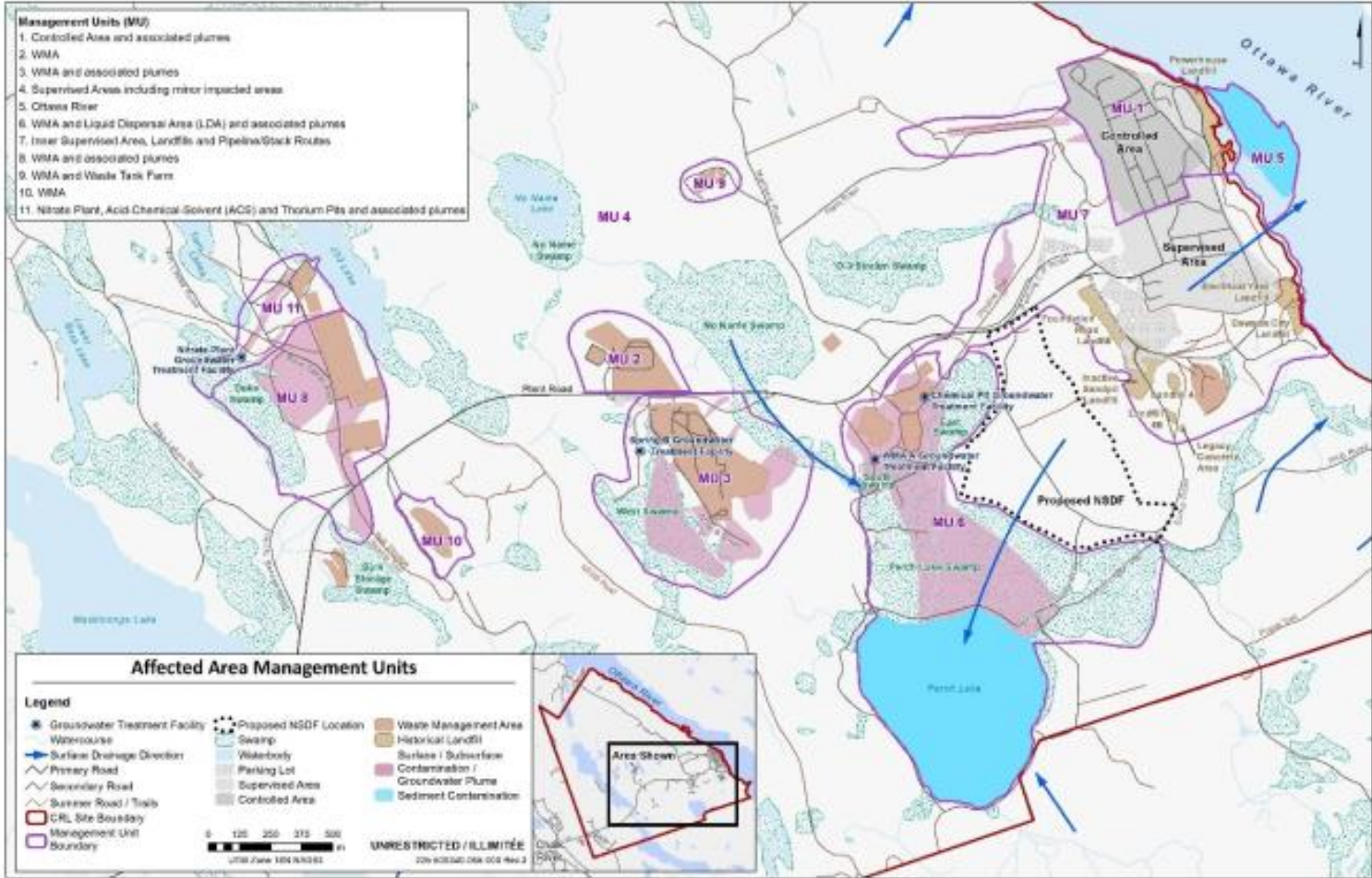
Challenge: manage the cleanup of a complex site while a new modern research campus is being developed!

PRIORITIZATION TOOL DEVELOPMENT AT CRL

- Risk-ranking has been carried out at CRL over the past 15 years

- Did not provide enough differentiation

- Has not been integrated into planning

MODEL INPUTS RESULTED IN POOR DIFFERENTIATION

Radiological Contamination	Non-Radiological Contamination	Proximity to Public	Proximity to Surface Water	Condition	Technical F...
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Available &
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Low	Low	Longer Distance	Moderate (>30 m)	Adequate	Immediately .
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Good	Available &
Moderate	Low	Shorter Distance	Moderate (>30 m)	Adequate	Available &
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Available &
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Available &
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Available &
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Good	Available &
Moderate	Low	Longer Distance	Low / Minimal	Adequate	Immediately .
Moderate	Low	Longer Distance	Moderate (>30 m)	Adequate	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Good	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Good	Available &
Moderate	Low	Longer Distance	Low / Minimal	Fair	Available &
Moderate	Low	Longer Distance	Moderate (>30 m)	Fair	Available &
Moderate	High	Longer Distance	Moderate (>30 m)	Fair	Available &
Very high	Low	Longer Distance	Low / Minimal	Fair	Available &
Moderate	Low	Longer Distance	Low / Minimal	Good	Available &

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

SITE-RANKING VS PRIORITY-SETTING

Site-ranking tools:

- Places sites in an order of risk

- Often limited control on inputs

Priority-setting tools:

- Helps identify trade-offs across sites (risk vs cost vs redevelopment)

- Determine which actions should take place and when (acting now vs later)

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

GUIDING PRINCIPLES FOR PRIORITIZATION TOOL

Based upon the review of 24 existing tools:

- The simpler the tool, the more likely it will be trusted and applied

- A sophisticated system is not required to achieve sound results

- It should support all types of environmental decisions and goals (such as future land use)

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

# WHY PRIORITIZE?…START WITH YOUR GOALS IN MIND !

- Identify areas with greater health and ecological risks reduction potential

- Restore affected areas to their highest beneficial use
    (ie. cleanup with a purpose)

- Align site-wide decommissioning, remediation strategy with operational and redevelopment needs
    (i.e. what does CRL need and where should it go)

- Stakeholder engagement

CHALKBoard PRIORITIZATION TOOL DESIGN FEATURES

- Does not weigh parameters - clear links to original data & eliminate bias

- Eliminates judgement or default values where actual data is available

- Demonstrates the value/benefit of proposed action (before and after cleanup scores)
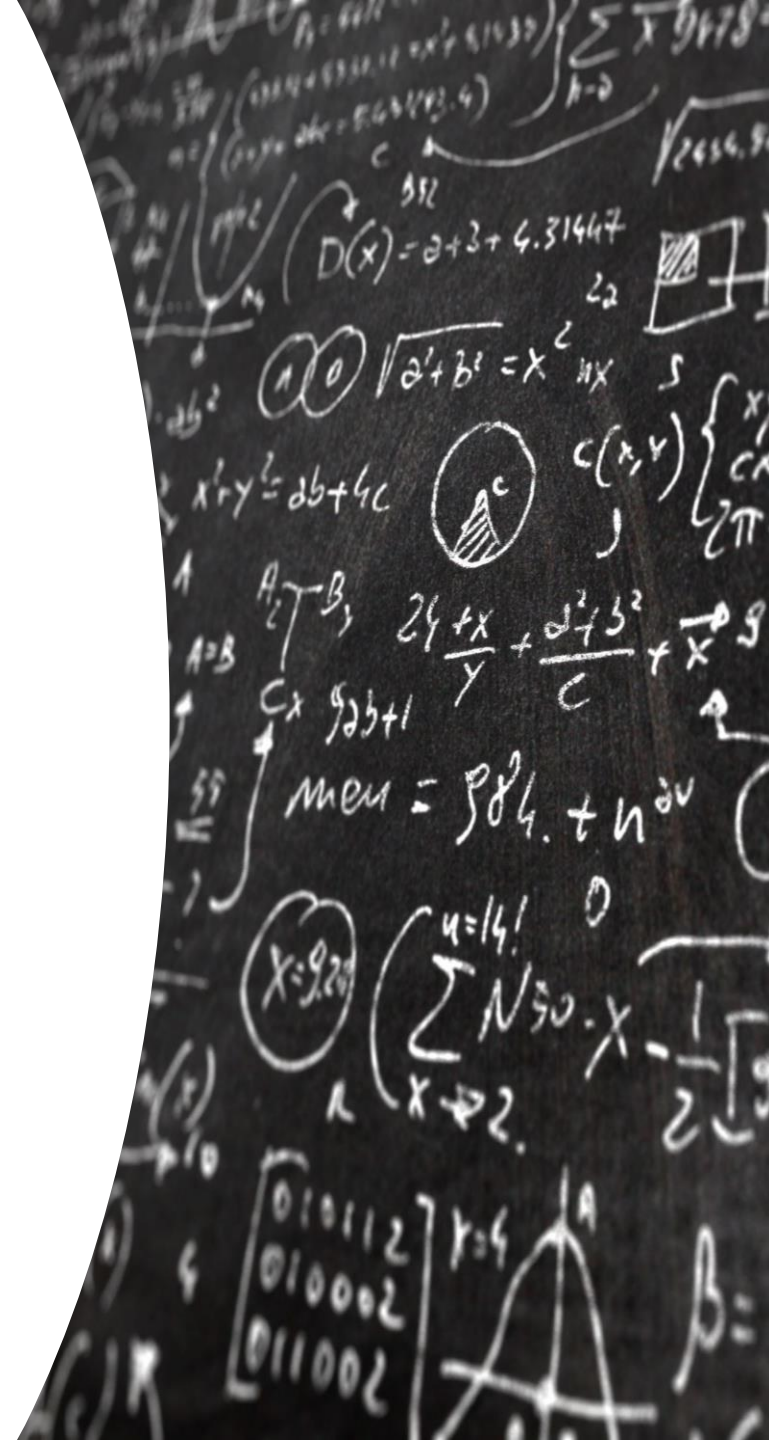
IT USES A MULTI-CRITERIA, NON-AGGREGATING APPROACH

Parameters

Contamination – Radiological
Contamination – Non-Radiological
Impact to Surface Water

Impact – Human Health and Safety
Migration
Complexity
Technical Feasibility
Redevelopment Potential
Stakeholder/Social
Uncertainty – Regulatory Compliance
Cost (capital & long-term)

Scoring parameters individually is more effective, flexible and transparent

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

STEP 2: EVALUATE PARAMETER SCORE

	SCORE	MAX EQ
	0	below detection or background
	1	EQ < 10% of applicable standard or criteria
	2	EQ between 10% and 99% of applicable standard or criteria
	3	max EQ between 1 X and 10 X of applicable criteria
	4	max EQ between 10 X and 25 X of applicable criteria
	5	max EQ between 25 X and 50 X of applicable criteria
	6	max EQ between 50 X and 100 X of applicable criteria
107	7	max EQ between 100X and 250 X of applicable criteria
	8	max EQ between 250 X and 1000 X of applicable criteria
	9	max EQ between 1000 X and 5000 X of applicable criteria
	10	max EQ > 5,000 X of applicable criteria
	7	
SECTION 4	MODIFIER	Note: FOR EACH Yes answer add +1 point
y	+1	If Long-lived radionuclides (>400 yrs half-life) has EQ > 2
Y	+1	if soil/waste volume is > 1,000 m3
N	0	if soil/waste volume is > 10,000 m3
N	0	ILW suspected / present
Y	+1	HLW suspected / present
	3	
TOTAL	10	

PRIORITIZATION IS ABOUT ASKING THE RIGHT QUESTIONS

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

PRIORITIZATION TOOL PARAMETER - MIGRATION

Score parameters such as public health, complexity, technical feasibility, regulatory compliance, uncertainty using clear objective attributes

- Extent of contamination (beyond fence line)
- Barrier to groundwater migration
- Upgradient contaminant source impacting facility
- Evidence of erosion exposing wastes
- Waste containment failing (rusting drums)

Monitoring well design is critical in determining contaminant migration

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
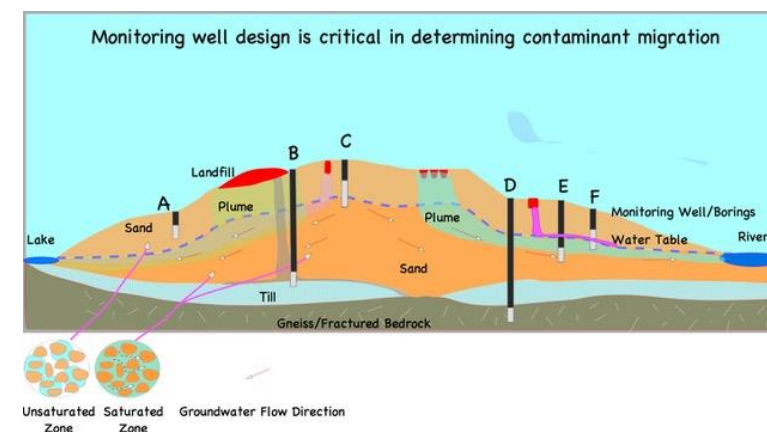
REDEVELOPMENT POTENTIAL PARAMETER

- Present consideration for redevelopment
- Brownfield site
- Proximity to infrastructure/site services
- Compatibility with surrounding land uses
- No geological/geotechnical limitations

STAKEHOLDER CONCERNS PARAMETER

- Positive Economic, Social, Scientific impact
- Supportive of Indigenous culture/practices/values
- Absence of nuisance impacts (traffic, noise, dust…)
- Biodiversity impacts
- Validated by stakeholders

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CHALKboard PRIORITIZATION TOOL – SCORING SUMMARY

Issue	Scoring Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CONTAMINATION	RADIOLOGICAL															
CONTAMINATION	NON-RADIOLOGICAL															
IMPACT	GROUNDWATER															
IMPACT	PUBLIC HEALTH															
CONDITION	MIGRATION															
CONDITION	COMPLEXITY															
REVITALIZATION	TECHNICAL FEASIBILITY															
REVITALIZATION	REDEVELOPMENT POTENTIAL															
UNCERTAINTY	STAKEHOLDER															
UNCERTAINTY	REG. CONFORMANCE/UNCERTAINTY															
COST	TOTAL COSTS															
COST	LONG-TERM STEWARDSHIP COSTS															

White arrows reflect the scenario associated with excavating contamination source, post-remediation

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

HOW CAN PRIORITIZATION SERVE IN SITE PLANNING ?

Focusing on Brownfield sites, for example, identify:

- Site with high redevelopment potential & no groundwater impact or geological constraints

- Site with large risk reduction potential & small contaminated soil volume

- Site with low uncertainty can be cleaned up faster and with less risk

- Evaluate remediation scenarios

Issue	Scoring Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CONTAMINATION	RADIOLOGICAL															
CONTAMINATION	NON-RADIOLOGICAL															
IMPACT	GROUNDWATER															
IMPACT	PUBLIC HEALTH															
CONDITION	MIGRATION															
CONDITION	COMPLEXITY															
REVITALIZATION	TECHNICAL FEASIBILITY															
REVITALIZATION	REDEVELOPMENT POTENTIAL															
UNCERTAINTY	STAKEHOLDER															
UNCERTAINTY	REG. CONFORMANCE/UNCERTAINTY															
COST	TOTAL COSTS															
COST	LONG-TERM STEWARDSHIP COSTS															

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

HOW ROBUST HAVE RESULTS BEEN?

- More representative dispersion / differentiation

- Repeatable – independently verified

- Aligned with environmental characterization planning & reporting

- Scoring parameters and approach validated by Community Advisory Panel

In summary...

Start with your goals in mind..!

Prioritization can be an effective tool if it is tailor-made to meet your needs

Ask the right questions...!