The use of a Performance Based Approach for the Environmental Remediation of the Former Moisie Royal Canadian Air Force Radar Station RemTech 2017

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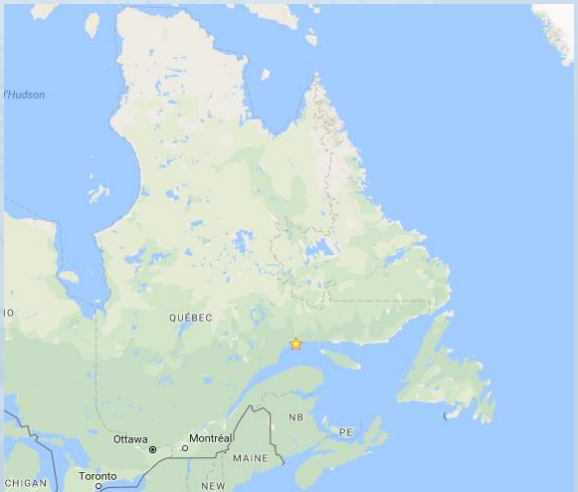
OUTLINE

1. Historical background
2. Initial soil and groundwater contamination
3. Procurement process :
   Performance based approach
4. Selection of the Remediation Option
5. Preliminary Assumptions vs Actual Results
6. Conclusion

Historical background

- CFS Moisie was a former radar station of the Royal Canadian Air Forces (PineTree Line)
- Located near Sept-Iles on the North Shore of the St-Lawrence Seaway, in the Quebec province
- In operation between 1953 and 1988
- Privately owned since 1989 with partial dismantling and remediation works



Initial soil and groundwater contamination

The soil contamination originated from the leakage of two former above ground storage tanks which used to supply diesel fuel to the station's heating plant

Estimation of 10 600 m^3 of contaminated soil above the applicable criteria found between 4 and 10 m below ground surface

Groundwater contaminated by the presence of contaminated soils but no contaminated groundwater reached the Moisie River and the St-Lawrence Seaway

Performance based approach

Reasons why and positive aspects of the approach

- Opens the contract to a wider industry
- Industry takes the risk of their technology
- Industry is responsible for all phases of the project : design, construction and operation
- Prevents arguments on responsibility between the different phases of the project
- Contract management is less time consuming

Performance based approach

Good Option Since

- Good knowledge of the site:
  - Contamination, hydrogeology – numerous environmental site assessments, treatability studies
  - Former rehabilitation work:
    - Surface soils already treated
    - Free phase recovered using multi-phase extraction
- Many technologies applicable
  - Previous request for remediation plans: Industry proposed 3 different technologies at comparable costs
- Clear objectives
  - Reach of the applicable criteria, within a specific time frame

Performance based approach - challenges

- Added complexity to contractual documents
  - Different confirmation sampling program to fit different possible technologies
  - Different terms of payments to fit different possible technologies
- Needed buy-in by the different owners and the environmental authorities
  - More planning upfront of the contract
- Contract security and Bonds
  - May reduce the number of proposals
  - May influence the proposed technology depending of the risk tolerance of the industry
- Environmental permits and authorization
  - Risk transferred to the industry
  - Depends on the selected technology

Performance based approach – outcome

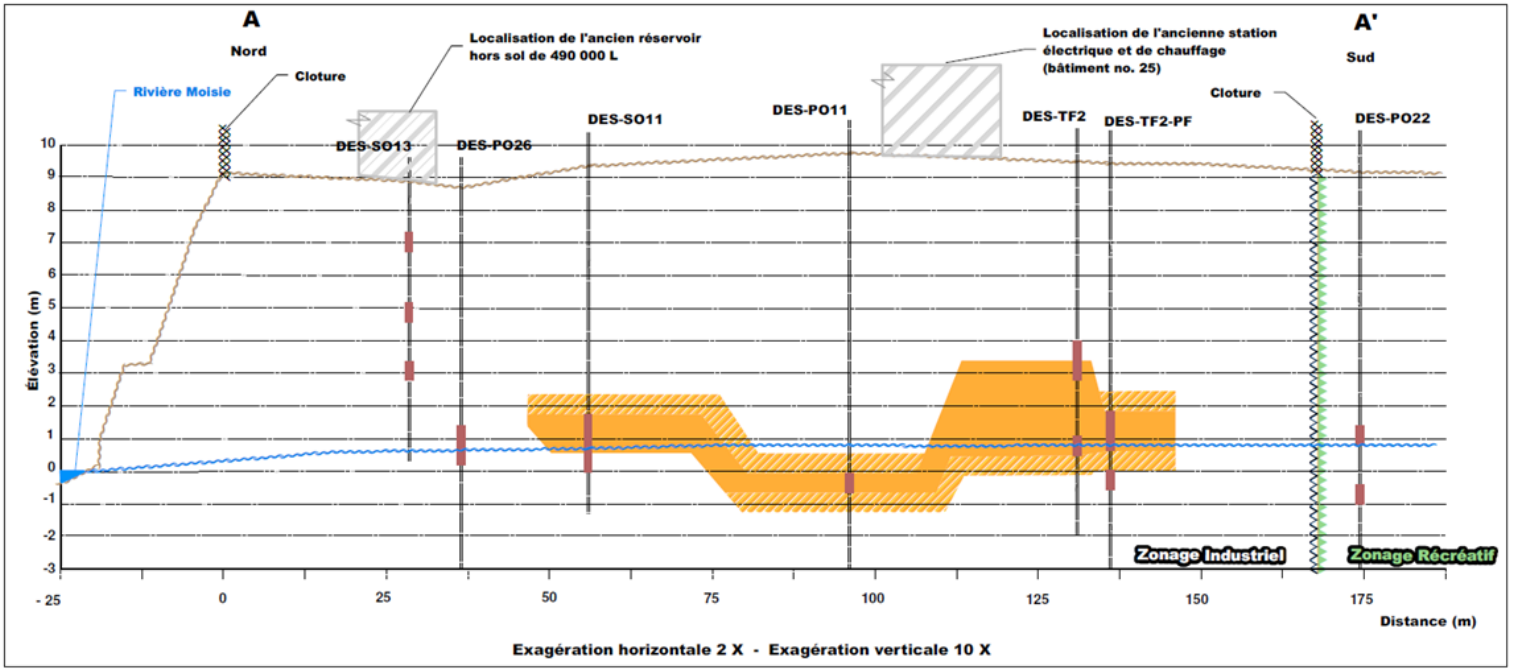
- Good answer from industry:

  Nine proposals
- Different proposed remediation options:

  In-Situ, Ex-Situ and a mix of both
- Contract awarded to:

  SNC-Lavalin

Selection of the Remediation Option



Selection of the Remediation Option – In-Situ

Site conditions were suitable for an In-Situ Approach:

- The contamination was deep (8-12 meters below ground level)
- The contamination spread under existing buildings
- Soil permeability was high (sandy material)
- Some contamination was below groundwater level
- Contamination was organic (petroleum hydrocarbons)

Although other factors rendered the option less favorable:

- The size of the contaminated area
- The level of contamination
- Difficulty to garantee the results

Selection of the Remediation Option – Ex-Situ

Challenges with the Ex-Situ Remediation Option:

- Maintaining slope stability
- Presence of a building in the excavation zone
- Mass excavation of non-contaminated soil
- Lowering of groundwater level near a river
- Pumping & treatment of a large quantity of water in a short period of time
- Discharge of treated water in a sensitive environment
- Favorable bioremediation conditions?
- Neighbors close to site (disturbances)

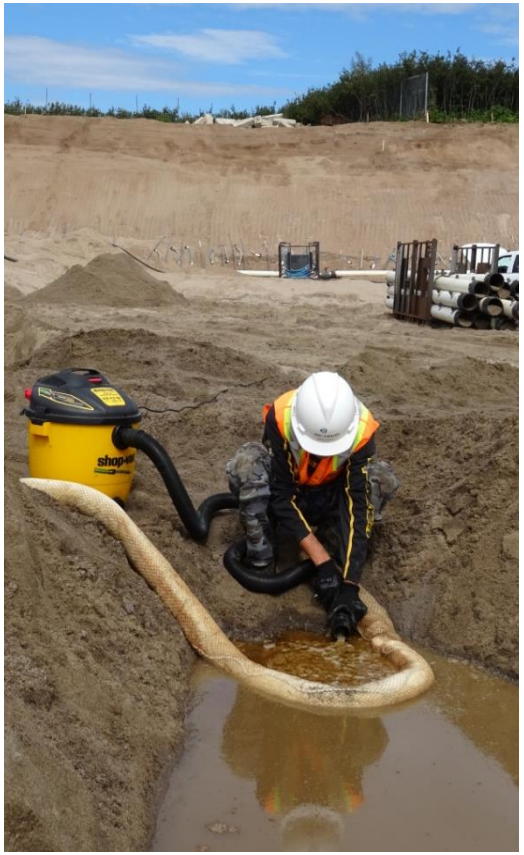
Overview (Drone)

Preliminary assumptions vs Actual results

Assumption 1: Dewatering of the excavation using Well Points

Preliminary assumptions vs Actual results

Assumption 2: Recovery of Liquid petroleulm Hydrocarbons (LNAPL)



Preliminary assumptions vs Actual results

Assumption 3: Filling retention reservoir

Preliminary assumptions vs Actual results

Assumption 4: Transfering water from one reservoir to another

Preliminary assumptions vs Actual results

Assumption 5: Using reservoir for water treatment

Preliminary assumptions vs Actual results

Groundwater pumped in Northern excavation (August 2016):

- 160 well points were installed
- Expected quantities: Flow of **90 m^3/h** for **36 h** for a total of **3240 m^3**
- Actual quantities: Flow of **88 m^3/h** for **58 h** for a total of **5104 m^3**

Groundwater pumped in Southern excavation (September 2016):

- 230 well points were installed
- Expected quantities: Flow of **85 m^3/h** for **36 h** for a total of **3060 m^3**
- Actual quantities: Flow of **235 m^3/h** for **16 h** for a total of **3760 m^3**

Preliminary assumptions vs Actual results

Quantity:

Instead of the estimated **6300 m³**, a total of **8864 m³** of groundwater had to be pumped and treated

Quality:

Estimated time of treatment: 6 days

Actual treatment time: 2 days

Preliminary assumptions vs Actual results

Estimated Quantity (m^3)

Non-Contaminated Soil: 108,000

Contaminated Soil: 10,600

Actual Quantity (m^3)

Non-Contaminated Soil: 87,440

Contaminated Soil: 14,280

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Loading of the Biopile

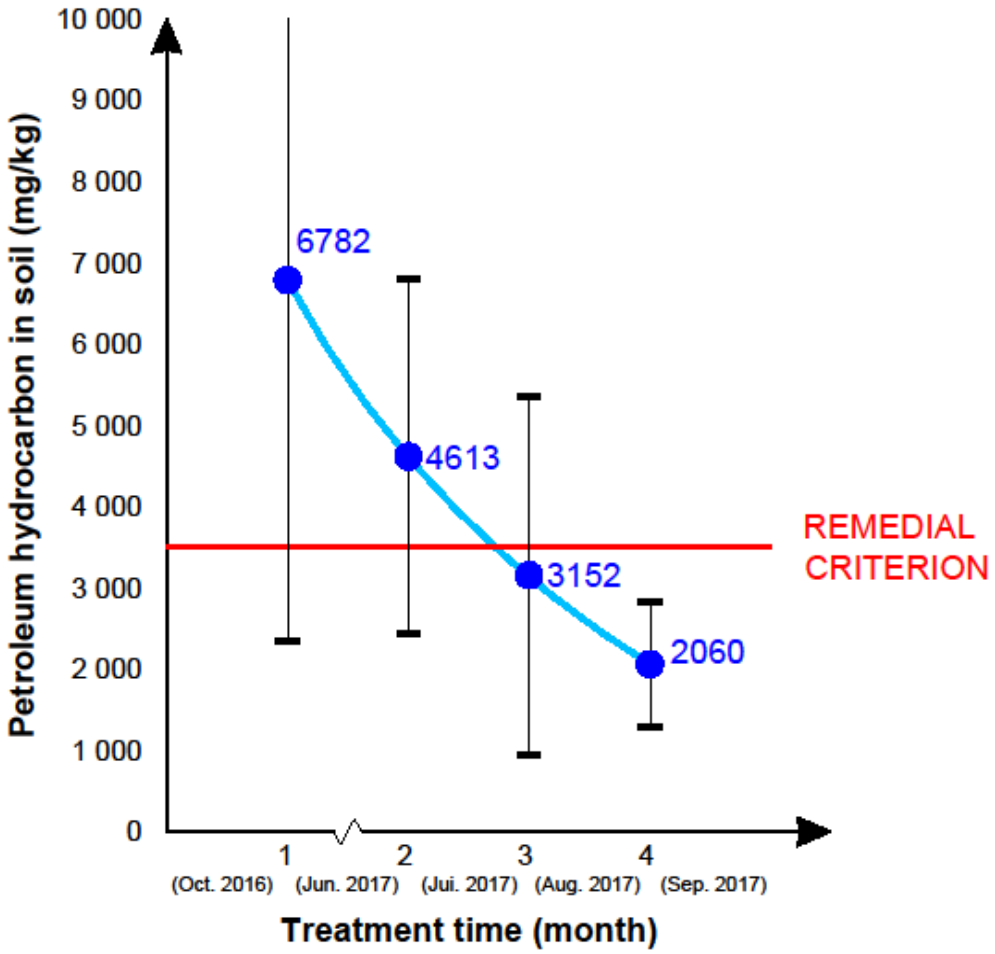
Preliminary assumptions vs Actual results

Biopile height was in average 4,8 m

Preliminary assumptions vs Actual results

Preliminary assumptions vs Actual results

Petroleum Hydrocarbon Reduction



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Conclusion

Expected Challenges	Actual Challenges
Presence of a building in the excavation zone	No
Slopes Stability	No
Large Quantity of water to manage	Yes
Bioremediation Conditions	No
Disturbance of the neighbourhood (noise, dust, etc)	Yes

Conclusion

Unexpected Challenges

- Schedule changes due to unforseen work
- Winter Conditions
- Relations with the community

4- Conclusion

Project summary:

- Ex-Situ (treatment on-site) was a cost-efficient approach for this site and all objectives were met
- Initial assumptions turned out to be appropriate, but contingencies were necessary
- With a Performance-Based Contract, responsibility is transferred to the contractor

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QUESTIONS ?