
CASE STUDY

A Transformer Repair Facility

**Soil and Groundwater Remediation,
Richmond, BC**

Liliana Jerade, M.Eng., P.Eng.



Introduction...a little bit of history...

What are PCBs?

- Polychlorinated biphenyls (PCBs) are synthetic chemical compounds consisting of chlorine, carbon and hydrogen.
- They are very stable, fire resistant, do not conduct electricity and have low volatility at normal temperatures.
- They were mainly used as a cooling and insulating fluid for industrial transformers and capacitors.

Introduction, cont.

....and what's all the fuss about them?

- Some of the same properties that made PCBs so widely used, also make them environmentally hazardous, especially their extreme resistance to chemical and biological breakdown by natural processes in the environment.
- Typical chemicals associated with the presence of PCB oils are chlorobenzene, lead, xylene, and petroleum hydrocarbons.

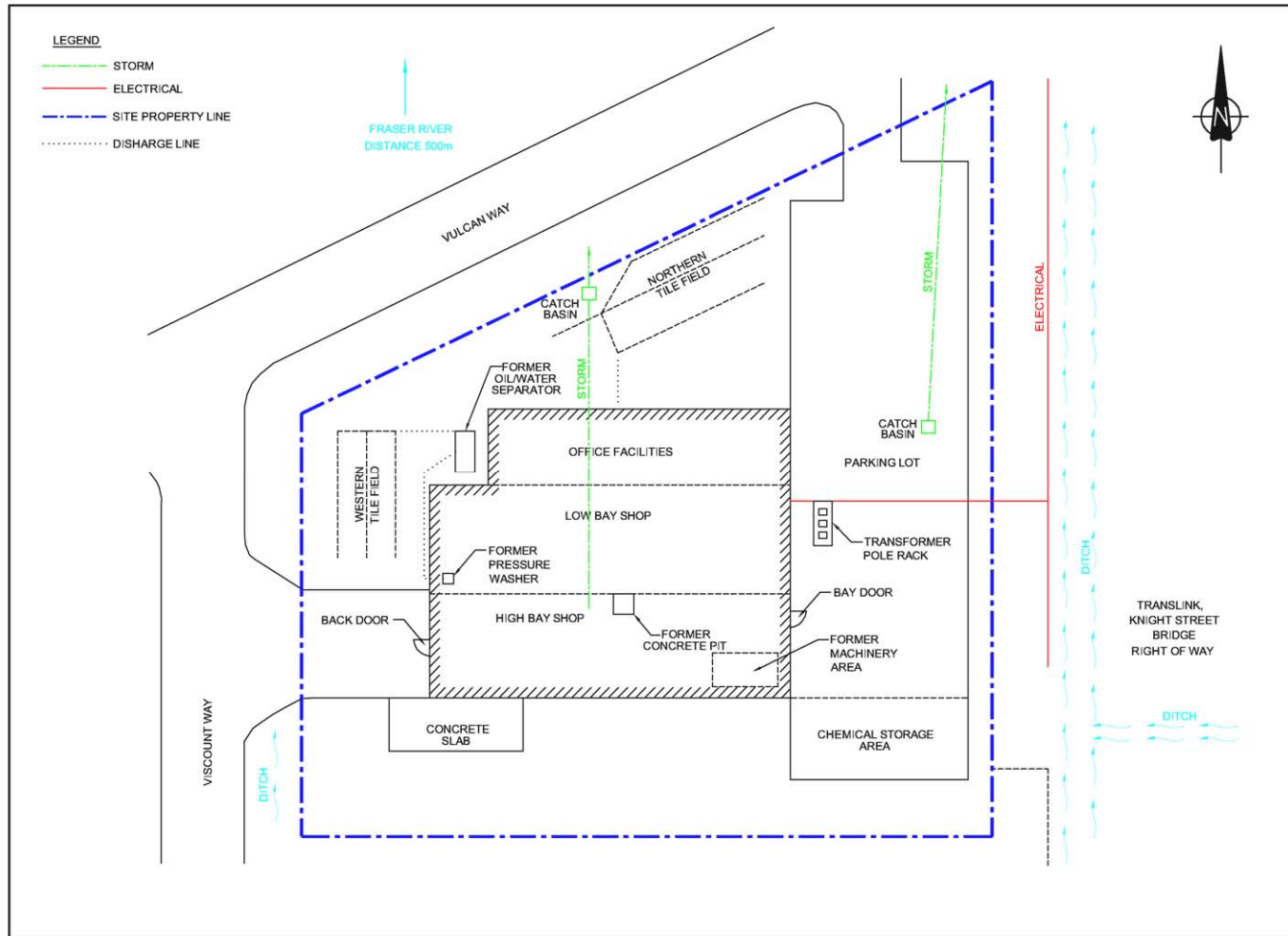


Background

- The Site operated as a repair facility of PCB-containing transformers from 1968 until 1998.
- The transformers were serviced, cleaned and stripped inside the building, repaired in a concrete pit and washed in a pressure washing area inside the shop.
- Drums of chemicals containing PCBs and solvents were stored outside the building in different locations.



Background, cont.



Background, cont.

- Siemens Canada Ltd. bought the property in 1998.
- The property was later sold in 2004 and, as part of the purchasing agreement, a Certificate of Compliance (CofC) from the BC MOE was required.
- As such, remediation work needed to be conducted.



Delineation Program

- The delineation program for the Site took approximately 3 ½ years to complete.
- Consisted of advancing 116 boreholes and 43 groundwater monitoring wells.



Zones of Contamination and Contaminants of Concern

- The delineation program identified PCBs, metals, petroleum hydrocarbons and chlorobenzene in three different mediums throughout the Site:
 - Soil
 - Groundwater
 - Concrete



Soil Impacts

- Six zones of contamination (ZOC) were identified including the Right of Way adjacent to the Site.
- The contaminants identified included:

Contaminant	Applicable standard (mg/kg)	Max. concentration detected (mg/kg)
PCBs	15 (HWR-50)	32,000
Arsenic	25	32.3
Cadmium	2	7.4
Chromium	60	256
Copper	250	1420
Lead	1000	1160
Zinc	300	364

Groundwater Impacts

- Contamination in groundwater was identified in two areas at the Site.
- The contaminants identified included:

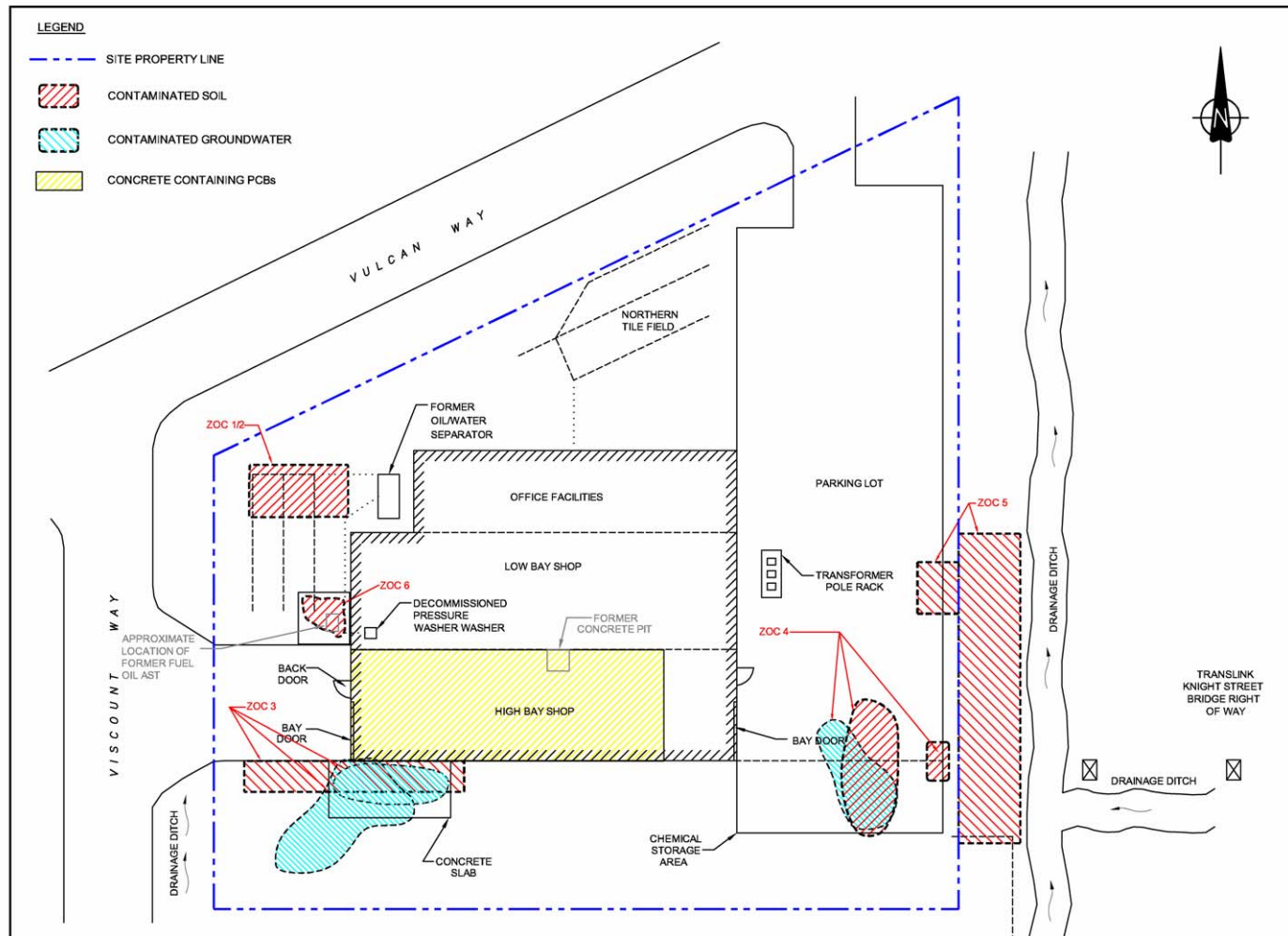
Contaminant	Applicable standard (mg/kg)	Max. concentration detected (mg/kg)
Chlorobenzene	120	490
EPHw ₍₁₀₋₁₉₎	5000	6400
LEPHw	500	6400

Concrete

- PCBs were identified within the concrete slab inside the building.
- There are no current standards applicable to concrete.

Contaminant	Max. concentration detected (mg/kg)
PCBs	480

Zones of Contamination



Remediation Options Evaluated

Soil

- Risk Assessment
- In-situ Treatment
- Soil Excavation and Off-site Disposal

Groundwater

- Removal and off-site treatment and disposal
- In-Situ Treatment

Soil...Risk Assessment Option

- Most cost effective remedial strategy
- PCBs do not qualify for risk assessment under MOE guidelines



Soil...In-Situ Treatment

In-situ treatment with hydrogen peroxide

- Elevated concentration of contaminants would have required large quantities of H_2O_2 – not economically feasible
- Permits required to inject chemical into the ground are costly and difficult to obtain
- Potential for introducing acidic groundwater into the adjacent Fraser River based on required pH for oxidation of PCBs to occur.

Selected Remedial Option

Soil Excavation and Off-Site Treatment

- **PCB impacts– Excavation and Off-Site Treatment (Incineration)**
 - Incineration has been shown to destroy PCBs at an efficiency of 99.9999
 - Short term disturbances to the Site

Selected Remedial Option, cont.

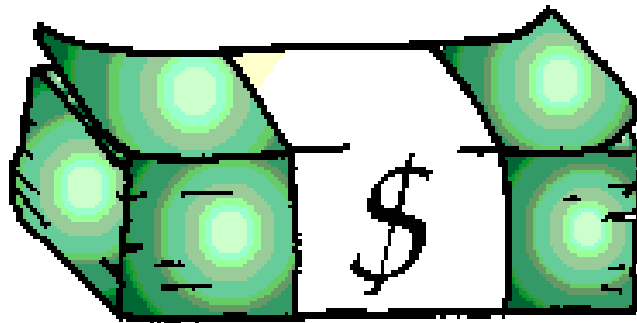
Soil Excavation and Off-Site Disposal

- **Metals – Excavation and Off-Site Disposal**
 - Most cost-effective
 - Fastest way to remove contamination from a Site
 - Short term disturbances to the Site



Soil Economic Analysis

- Soils exceeding HWR standards for PCBs are very expensive to remediate
- Different facilities were evaluated to minimize costs.



Soil Economic Analysis, cont.

- Transport of contaminated soil by rail to Saint-Ambroise, Quebec.
 - Unit rate for excavation, transport and disposal: **\$1080/tonne.**
- Transport of contaminated soil by truck to Alberta.
 - Unit rate for transport and disposal: **\$1200/tonne plus excavation costs.**

Implementation of Soil Remedial Program

- Due to the high cost related to the final disposal of the material, excavation of soils was performed in a staged approach.
- Excavations were kept to the minimum extent possible and were sampled to verify remediation



Implementation of Soil Remedial Program, cont.

- **Challenges:**
 - Turn around time for analysis of PCBs in BC is 7 working days
 - Dewatering of “in-progress” excavations was increasing costs
- **Solution:**
 - Pre-screen the samples on-Site with a field testing kit specific for PCBs

Remediation Options Evaluated

Soil

- Risk Assessment
- In-situ Treatment
- Soil Excavation
and Off-site
Disposal

Groundwater

- Removal and off-site
treatment and disposal
- In-Situ Treatment

Groundwater Remediation Options

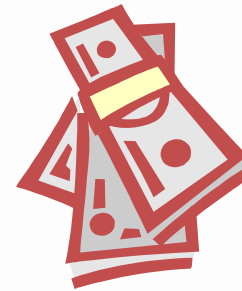
- An economic analysis was conducted to determine the best remediation option.
- Numbers provided by the selected contractor:
 - Off-site treatment and disposal of impacted water: \$250/m³
 - In-Situ equipment rental and operation (on a monthly basis): \$15,000



Groundwater Remediation Options, cont.

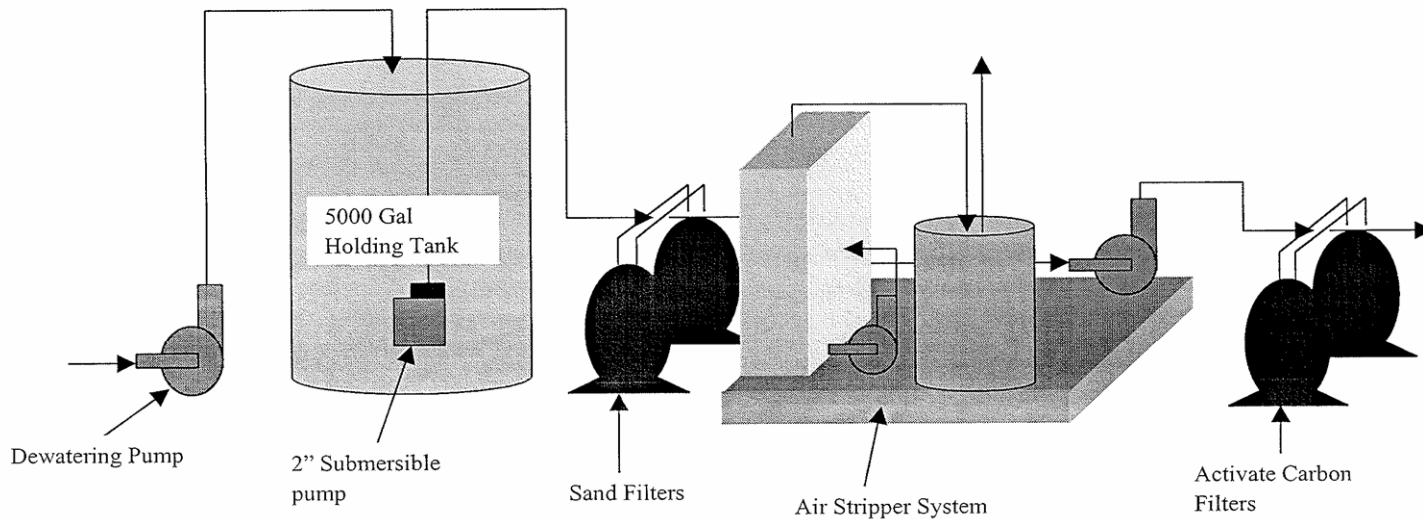
- Estimated impacted volume of groundwater:
535 m³
- Estimated timeframe to complete the remediation: 2 months

Savings from using the in-situ treatment versus off-site disposal were estimated to be over \$100,000.



Groundwater Remediation Options, cont.

- a Multi-Phase Extraction and Air Stripping system was selected to remediate the groundwater.

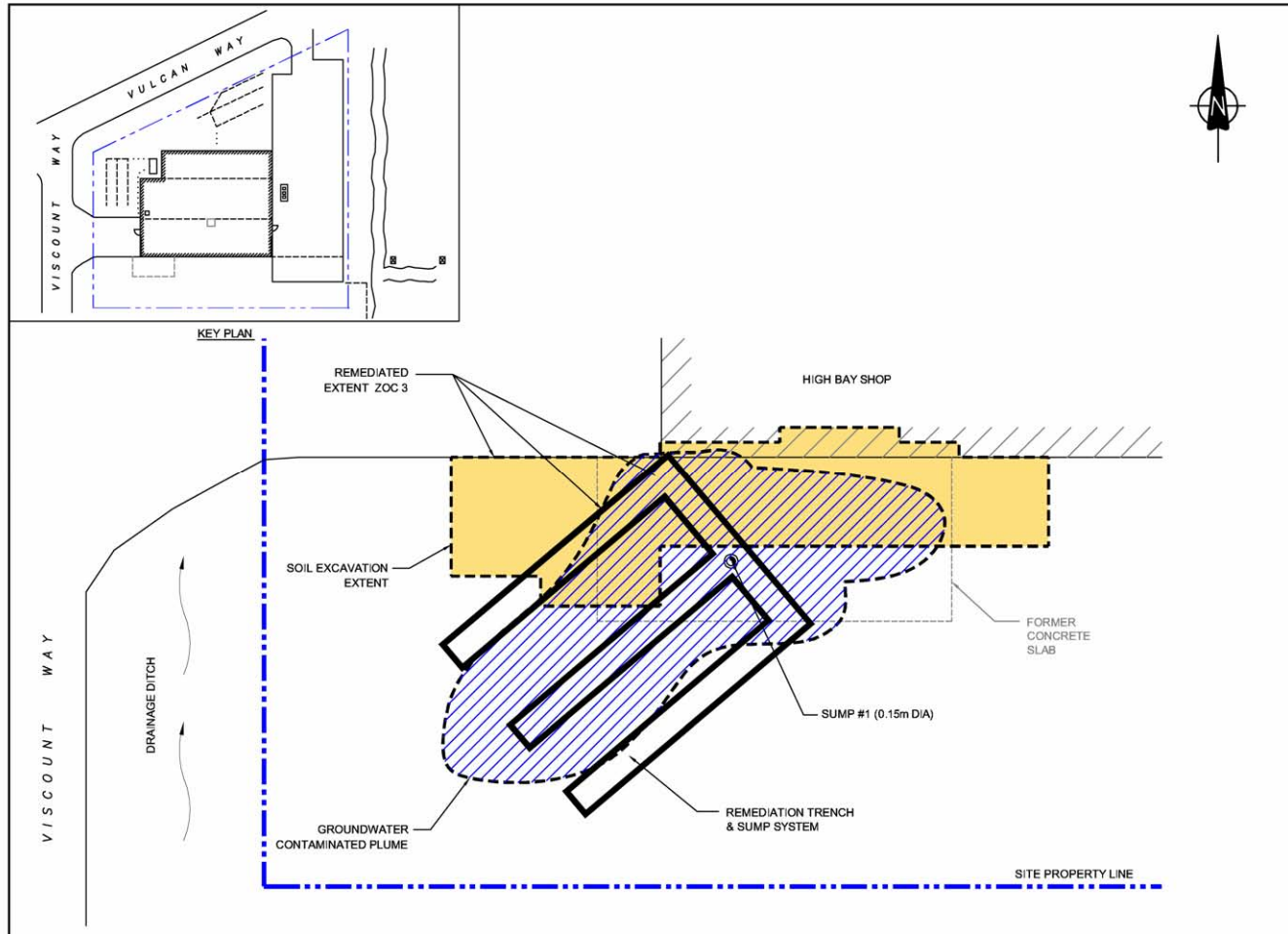


Water Treatment System
Capacity 45-60 GPM

Groundwater Remedial Program

- The design of the remediation system for the 2 impacted plumes consisted of:
 - a main trench approximately 8.5 m long by 1 m wide at a depth of 5 mbg.
 - three additional trenches, 7 m long oriented in the direction of the impacted plumes.
 - installing a sump as the extraction point at the centre of the main trench.
 - backfilling the trenches with gravel to facilitate extraction of groundwater

Groundwater Remediation Program



Groundwater System Operation

- The system was operated in a batch mode:
 - groundwater pumped from one of the sumps to a holding tank and from there to the treatment system.
 - When groundwater from one holding tank was being treated, groundwater from the second sump was pumped to a second holding tank.



Groundwater Remediation Progress

- Groundwater remediation from ZOC 3 was achieved after one month
- Remediation work for the contaminated plume in ZOC 4 took 10 months to complete



Challenges...

Things never go as smooth as planned...



"We've considered every potential risk except the risks of avoiding all risks."

Challenge...1

- After 8 months of treatment, chlorobenzene concentrations in ZOC 4 were not attenuating as anticipated
- Potential for soil contamination to still be present in ZOC 4
 - Groundwater being drawn to the sump getting impacted with the remaining contaminants

Challenge 1...cont.

- **PCBs do not migrate and contamination is usually localized**
 - Very difficult to locate
- **Solution**
 - Additional soil delineation in that area was conducted
 - 75 tonnes of impacted soil with PCBs exceeding HWR were excavated

Challenge...2

- Treated groundwater discharge into the sanitary service requires a permit from the GVRD
- The GVRD permit requires periodic sampling of different parameters
 - One of the parameters is Total Iron

Challenge...2, cont.

- GVRD's maximum discharge limit for total iron: 10 mg/L
- Background groundwater concentrations of iron in the City of Richmond: between 16 mg/L to over 130 mg/L



Solution

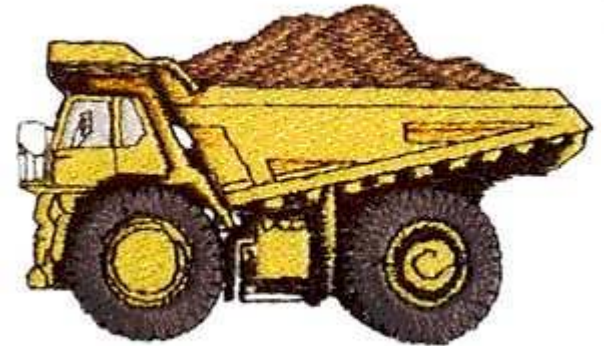
- Modifications to the system were implemented:
 - re-installing one holding tank before the treatment system to sediment TSS
 - connecting two 1 micron cloth filters in series after the holding tank



GVRD discharge limit was met!

Conclusions

- **Soil:**
 - Six areas at the Site were excavated. Total soil removed from the site:
 - 542 tonnes of soil with PCBs exceeding HWR
 - 345 tonnes of soil with PCBs and metals exceeding commercial standards



Conclusions

- **Groundwater**

- Remediation activities at the Site took 10 months to complete
- Total volume of groundwater treated and discharged: 1,180 m³



Conclusions

- **Based on the original remediation cost estimates:**

- A total of \$65,000 (+ excavation costs) were saved by transporting impacted soils with PCBs exceeding HWR to Saint-Ambroise, Quebec.
- Savings of \$145,000 were achieved by selecting the in-situ treatment option for groundwater.



Conclusions

- and....

A Certificate of Compliance was issued by the MOE on August 30, 2006



QUESTIONS

