
Case Study

Gasoline Spill Remediation

Sears Gas Bar



Soil Vapour Extraction System, Prince George, BC
Liliana Jerade, M.Eng., P.Eng.



Introduction

- **This presentation is focused on a case study outlining the remediation of a Sears former Service Station in Prince George, BC.**
- **Hydrocarbon contamination as a result of historic gasoline spills has had significant delays on the lease termination and redevelopment of the Site.**



Background

- **Two gasoline spills occurred at the Site 20 years ago.**
- **The total loss of fuel was reported to be 36,800 L**
- **Based on the assessments to date, soil impacted with petroleum hydrocarbons remains at the site at a depth of 10 meters below grade.**



Background, cont.

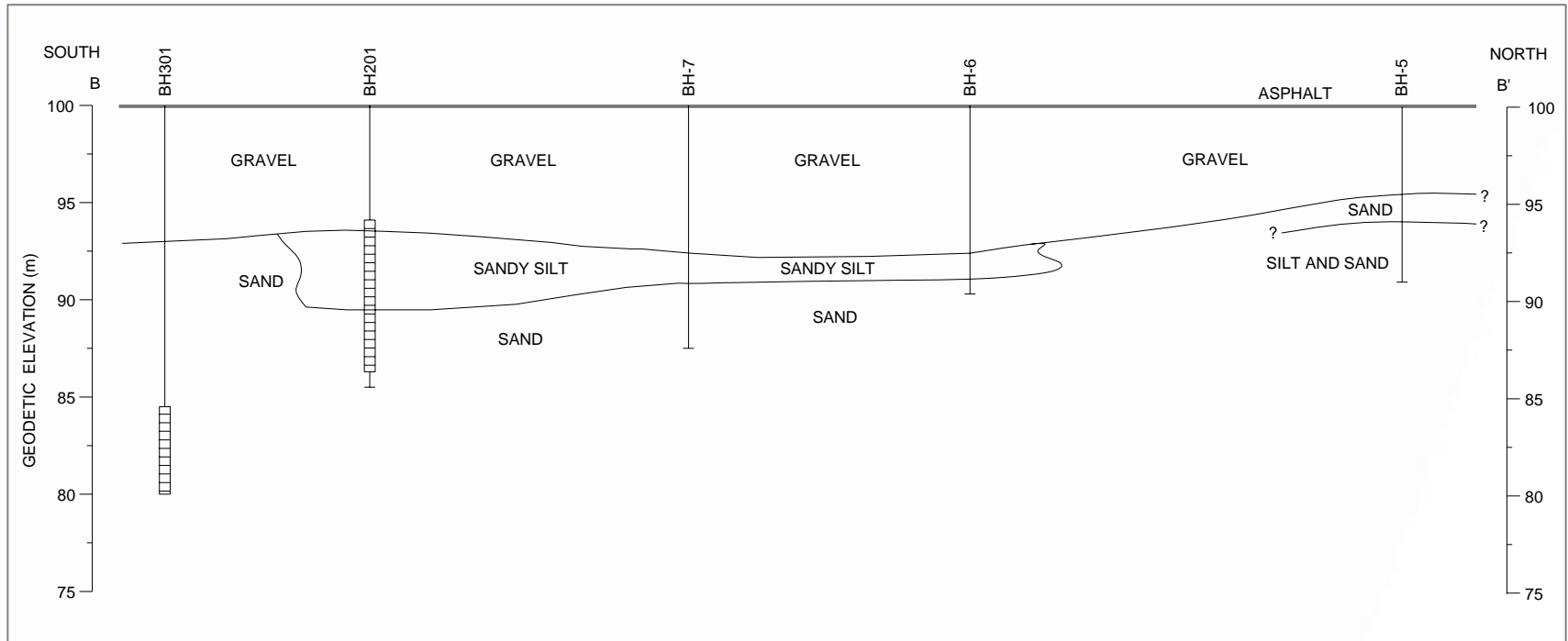
- **The Site is located within the boundaries of a shopping centre and Sears has been leasing it for 30 years.**
- **The shopping centre was sold and the new owner wants to redevelop the entire property.**
- **In order to obtain the required permits, the existing contamination needed to be remediated.**



Site Description - Stratigraphy

- **The stratigraphy at the Site consists of:**
 - sand and gravel to 7 mbg
 - sandy silt from approximately 0.6 to 3.0 m in thickness
 - grey fine sand to the maximum depth investigated.
- **The sandy silt layer acted as a confining layer absorbing the gasoline from the spills.**

Stratigraphy, cont.



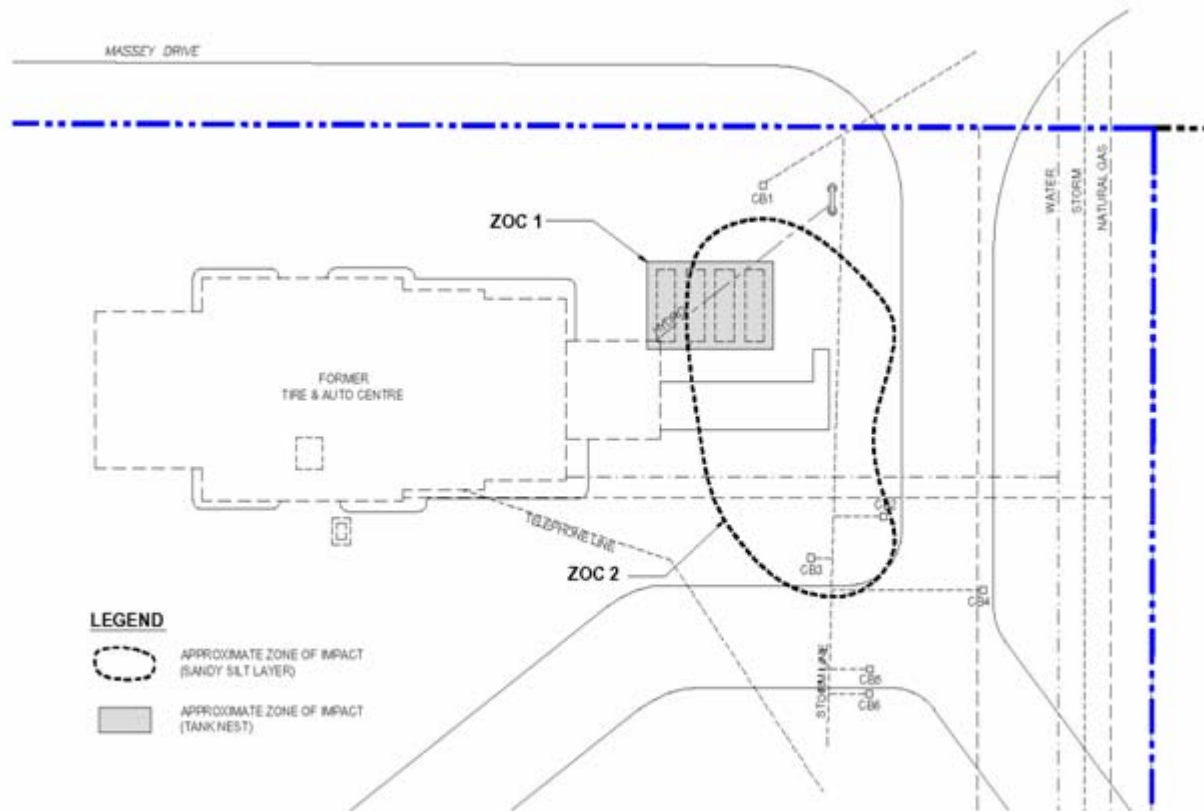
Extent of Impacts

- **Two zones of contamination (ZOC) were identified:**
 - ZOC 1: Approximately 750 m³ soil impacted with petroleum hydrocarbon above the Hazardous Waste Regulation was identified in the former Tank nest, with an approximate areal extent of 150 m²
 - ZOC 2: Approximately 3000 m³ of soil impacted above Commercial Land Use standards with an approximate areal extent of 1000 m²

Extent of Impacts, cont.

- **ZOC 2 was identified within the sandy silt layer present at a depth of 7 mbg with an average thickness of 3 m.**
- **Approximately 7000 m³ of clean sand and gravel overlie the impacted area.**

Extent of Impacts, cont.



Remediation Options Evaluated

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

Risk Assessment Option

- **Most cost effective remedial strategy**
- **Not completed due to contractual agreements between Sears and the owner of the shopping centre.**

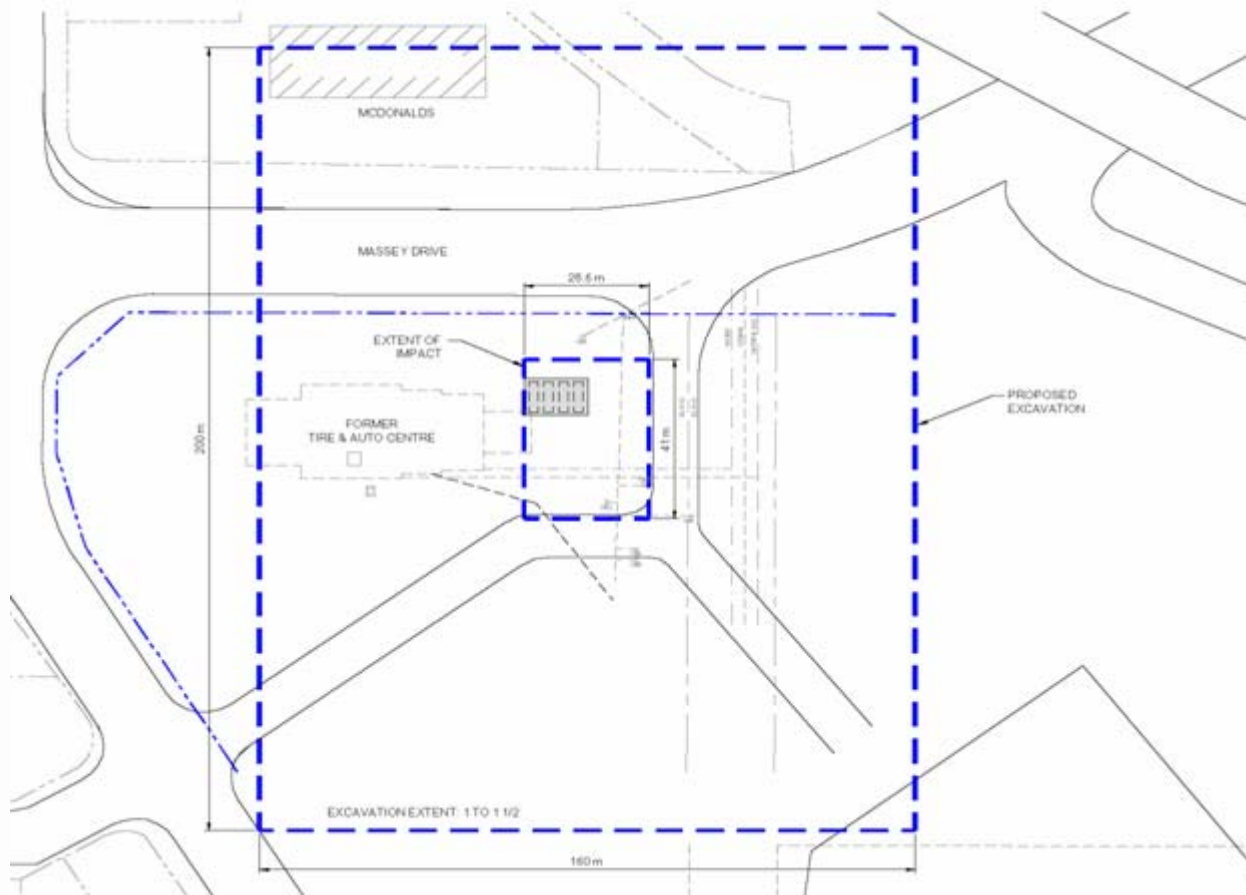
Soil Excavation and Off-Site Disposal – ZOC 1

- **Selected remedial option for the UST nest contamination:**
 - Required to meet the BC Ministry of Environment (BC MOE) contaminant mass reduction program
 - Required to conduct the remedial option selected for ZOC 2

Soil Excavation and Off-Site Disposal - ZOC 2

- Fastest way to remove contamination from the Site
- Based on the extent and depth of contamination, this option was not viable.

Soil Excavation and Off-Site Disposal – ZOC 2



In-Situ Treatment

- **Soil Vapour Extraction System (SVE)**
 - Applying vacuum to the unsaturated zone
 - Removing petroleum hydrocarbons from the subsurface area
 - Treating extracted vapours at the surface

Vertical SVE Pilot Test

- A pilot test was conducted using a vertical well network to evaluate effectiveness of this remediation option.
- Vertical wells were installed 2 m apart in the sandy silt zone

Vertical SVE Pilot Test - Results

- Vacuum radius of influence was minimal to none.
- Approximate number of vertical wells that would be required: 440
- Option determined to be non cost-effective

Horizontal Well Network

- Expected to provide a better radius of influence than vertical wells
- Increase contact area between well screen and impacted area
- Minimize number of wells required

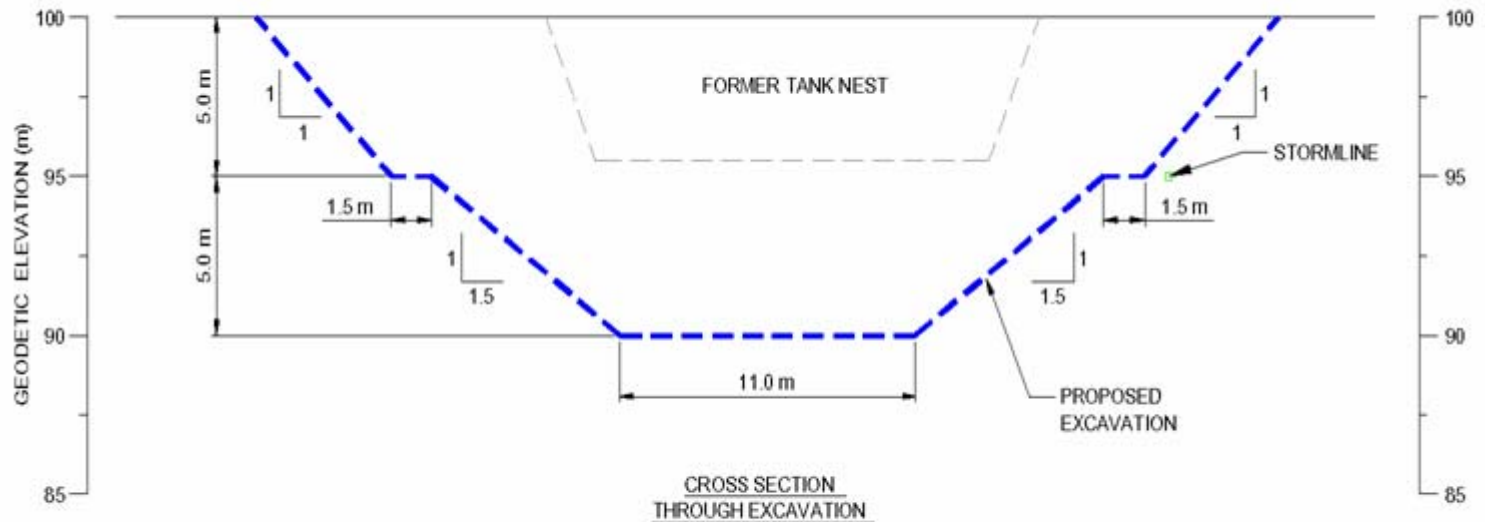


Implementation of Remedial Program

- ZOC 1 - Excavated to 5 mbg and soils transported off-site
- Excavation expanded to 10 mbg to conduct horizontal drilling program to remediate ZOC 2



Excavation Dimensions



Excavation Dimensions



Horizontal Drilling and Well Installation– ZOC 2

- Twenty four horizontal wells were installed at a depth ranging from 7 to 10 mbg
- Wells were drilled radially outward to intersect the sandy silt layer
- **Challenge:** Identify change in stratigraphy to prevent drilling through the sandy silt layer

Horizontal Well Network Completion

- Each well brought up to grade individually and was completed in 4 separate headers of 6 wells each



Horizontal Well Network Pilot Test

- **A series of pilot tests were conducted in order to:**
 - determine the radius of influence
 - the size of equipment that would be required to run the SVE system



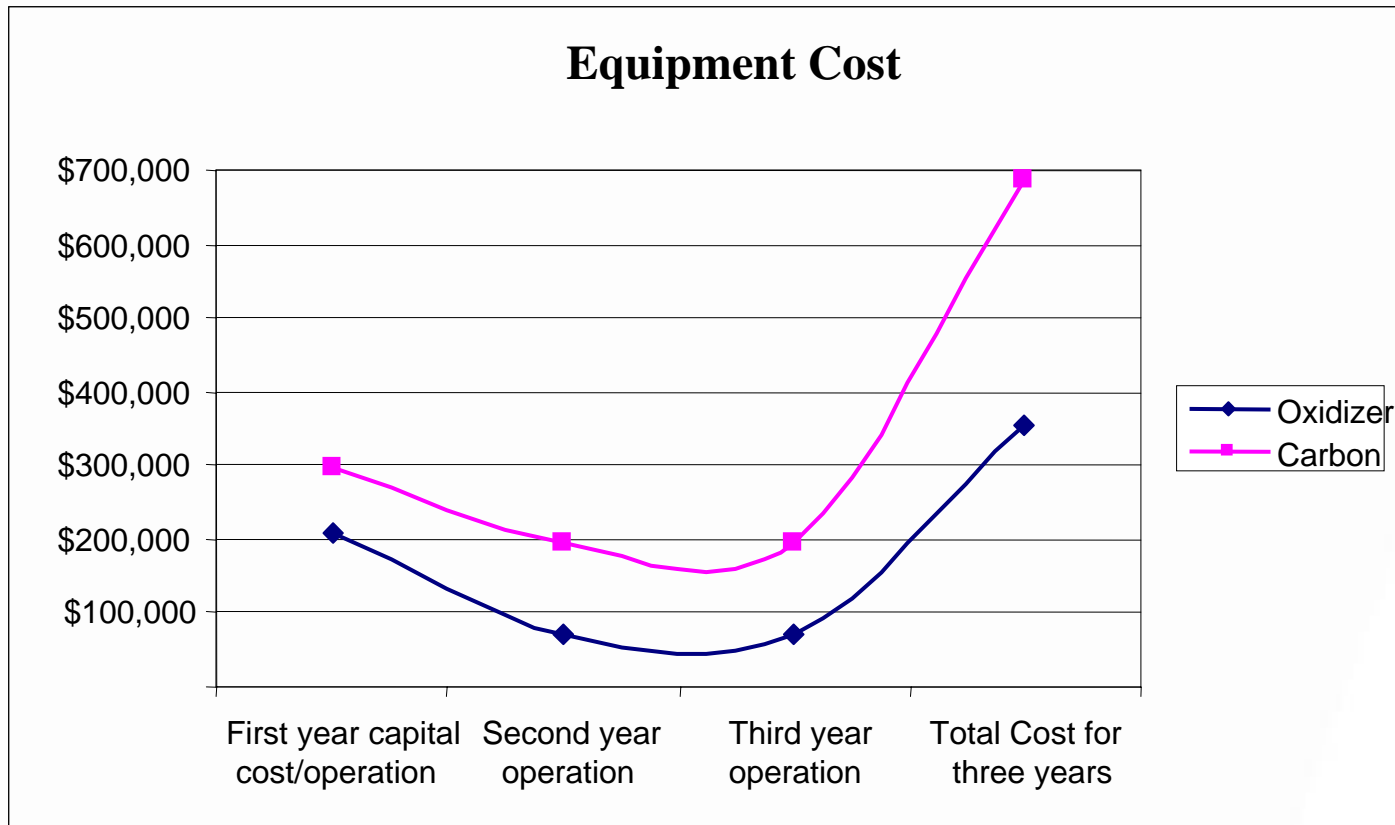
Equipment Requirements

- **Based on the results from the pilot test the equipment required was:**
 - Two 350 to 500 scfm blowers to provide 10 to 15 inHg of vacuum,
 - Two 300 scfm catalytic oxidizers or two 2000 lb activated carbon vessels to treat the extracted vapours

Carbon Vessels or Catalytic Oxidizers?

- Catalytic oxidizers
 - require less maintenance and are more reliable than activated carbon
 - no risk of breakthrough
 - high initial capital cost
- Activated Carbon
 - low initial capital cost
 - Initial savings offset by high cost in operation and disposal of used carbon

Cost Analysis



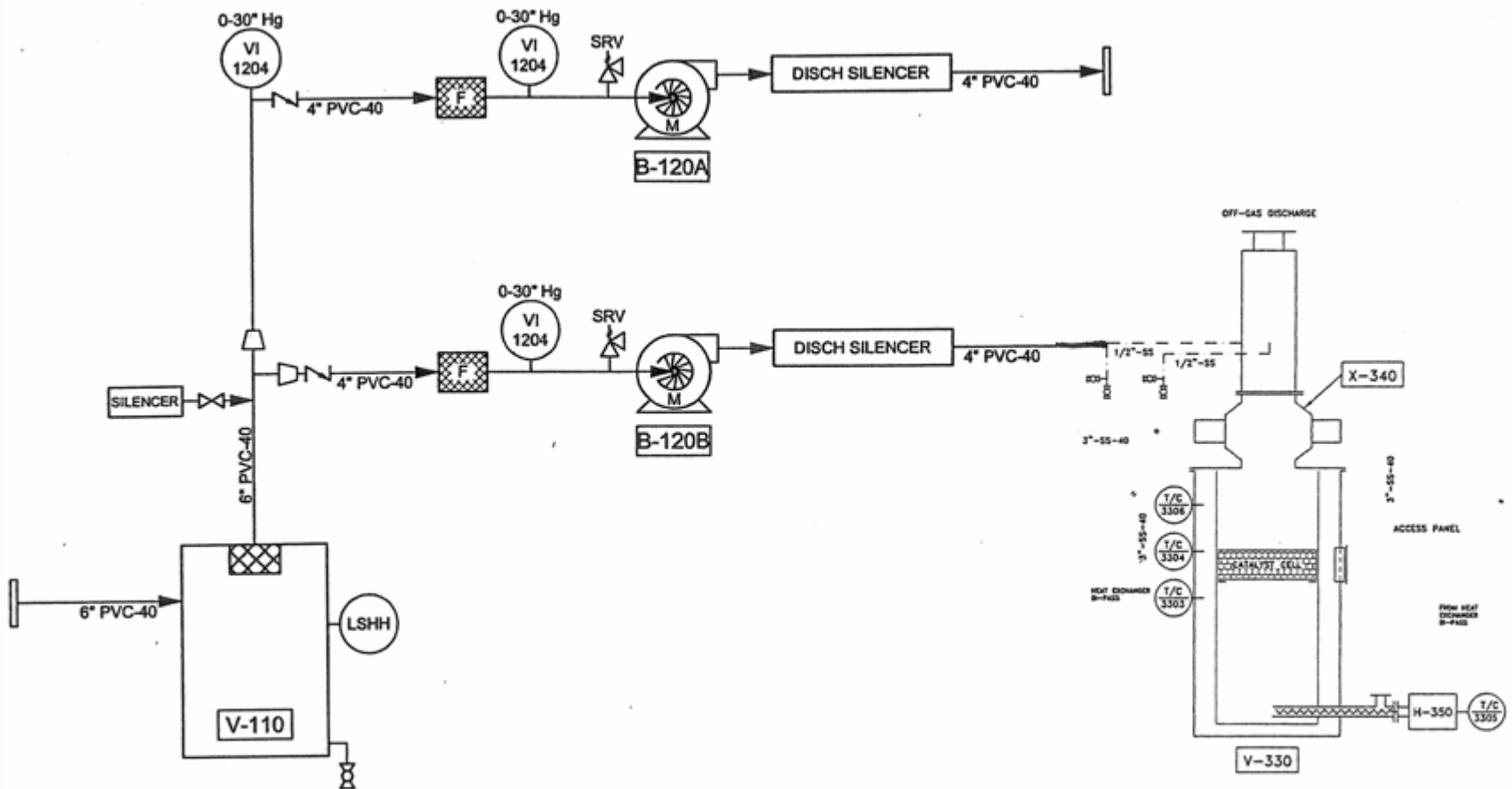
Note: Carbon consumption was estimated assuming extraction levels would decrease to 100 ppm after the first year of operations

System Installation

- The final system consisted of:
 - One knock-out drum
 - Two 40 HP, 350 scfm vacuum blowers
 - Two silencers
 - Two 45 amp, 460 V, 300 scfm catalytic oxidizers



System Schematic Diagram



SVE System



System Operation Requirements

- Start up of the system requirements:
 - Open one well at a time to prevent overloading the oxidizers- maximum capacity 25%LEL
 - Maintain minimum catalyst temperature of 500°F
 - Maintain maximum vacuum at the blowers of 16 inHg



System Start Up - Challenges

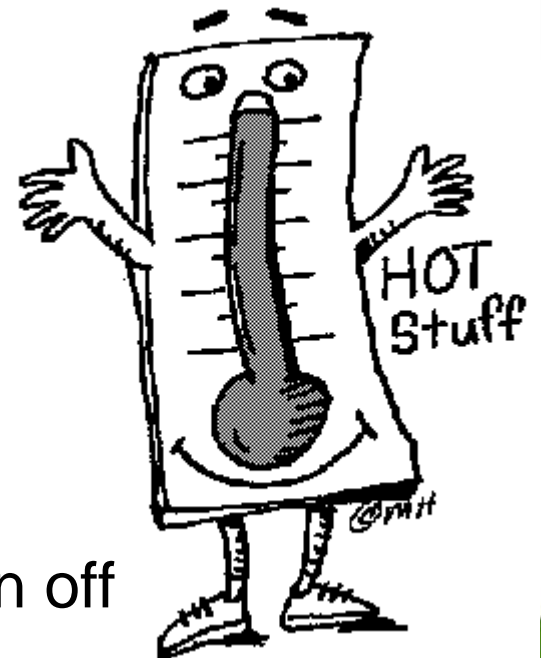
MURPHY'S LAW

If something can go wrong...it will



Challenges....1

- After the start up of the system, several challenges were encountered:
 - Maintaining vacuum from the blowers between 10 and 15 inHg,
 - Keeping minimum temperature required at the oxidizers.
 - Cycling of the vacuum blowers causing them to overheat and turn off



Solution

- A butterfly valve was installed to control the vacuum in the system
 - The new valve would control the mixture of dilution air and vapours from the soils, maximizing the extraction levels but maintaining the minimum vacuum required

Challenges...2

- One month after start up of the system, one of the vacuum blowers (Side A) had to be completely replaced due to a failure with the bearings.
- A month later, the other blower (Side B) had to be replaced due to a broken shaft



Challenges...3

- **A month after the blower from side B was completely replaced, the bearings had to be replaced...again**



Solution

- **It was determined that the metal platform that supported the system was not even, creating vibrations on the blowers and making them go off alignment
...the system has been running constantly since....**



Status of the System to Date

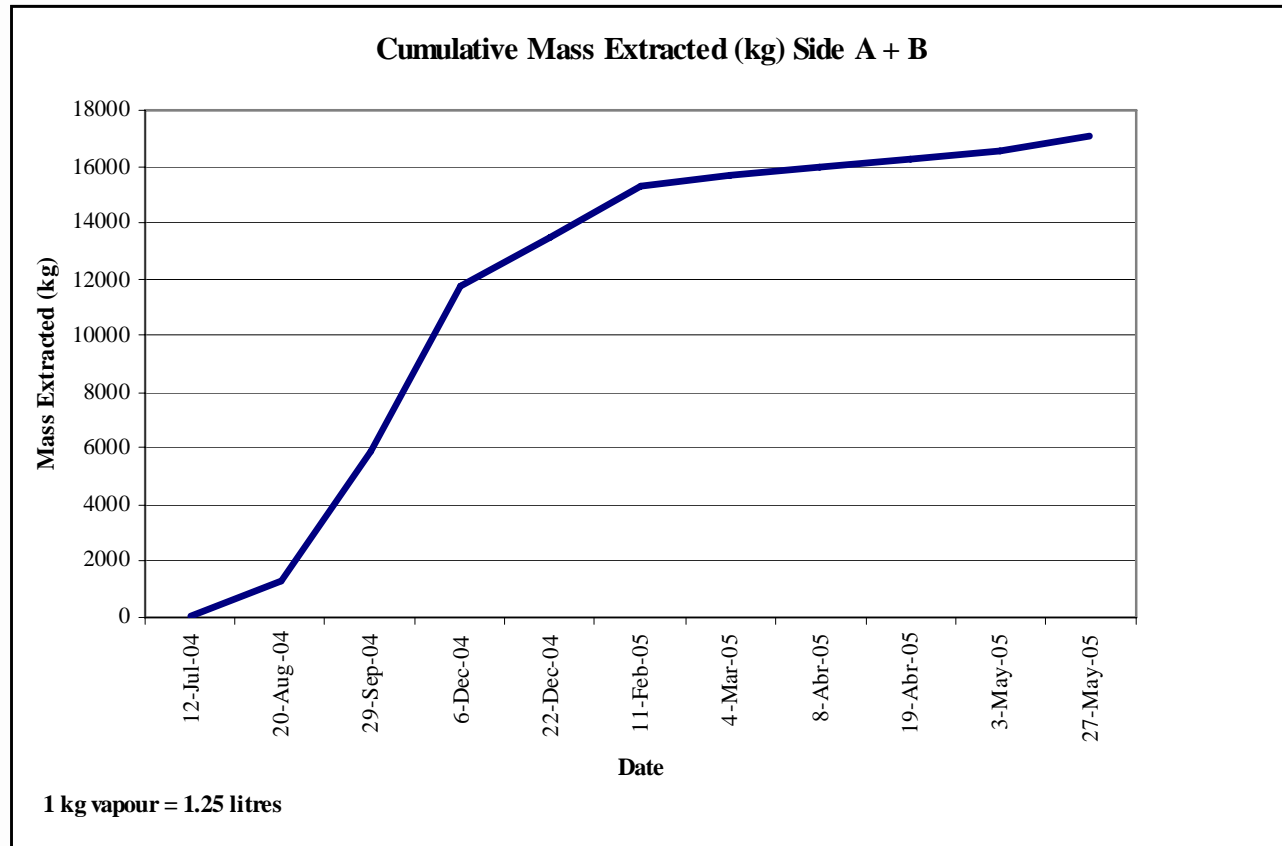
- The system is operating at a constant catalytic temperature,
- The vacuum in both blowers remains at 12 inHg
- All the horizontal wells are open
- The dilution valve is fully closed

Mass Extracted to Date

- An estimate of 22,250 L of product have been remediated with the SVE System
- Approximately 60% of the released gasoline has been removed after 14 months of operation



Mass Extracted to Date



Efficiency

- The system is operating at about a 50% higher efficiency than originally anticipated
- Currently, the system is operating at 1%LEL, which represents a removal of approximately 10 L of gasoline per day

Next Steps

- Potential for rebound effects
 - Turn system off for a period of 4 weeks to evaluate the potential of gasoline accumulation in the well network
 - Collect air samples and vapour readings to assess the amount of contamination remaining in the soil

Next Steps, cont.

- Bioventing
 - Reverse the blowers to inject air into the subsurface to provide a constant supply of fresh air and promote biodegradation of the remaining petroleum hydrocarbon impacts

QUESTIONS

