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Surfactant Flushing and Enhanced Remediation at a Remote Site in Northern BC



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Site Location

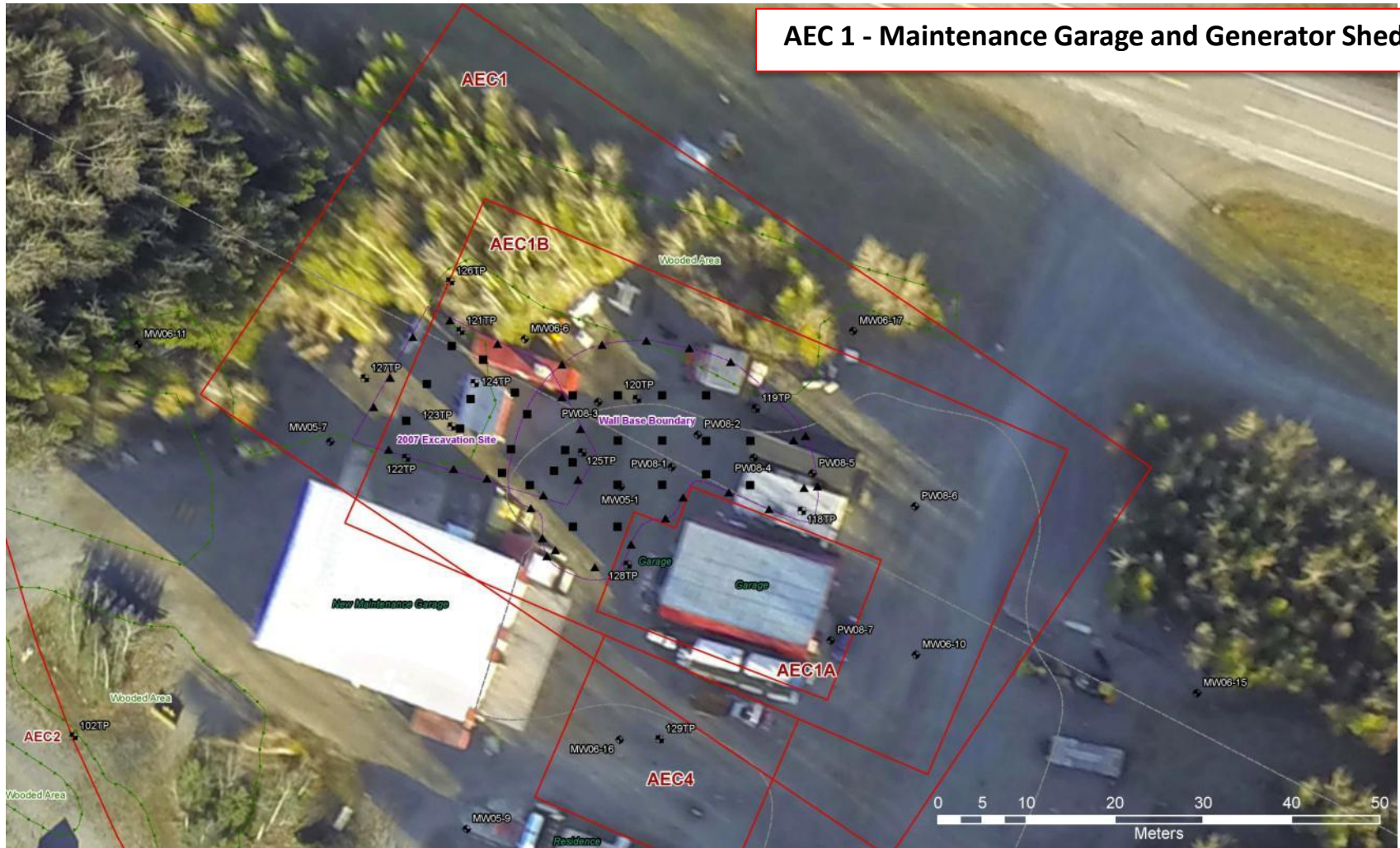


Site Plan



Site Plan – AEC 1

AEC 1 - Maintenance Garage and Generator Shed



Site History


Alaska Highway Construction Camp 1942

- One of the main camps in the construction effort
- Support camp for the Liard River Bridge construction work

Highway Maintenance Camp

- Site has been used as a Construction and Maintenance area since the Alaska Highway was built in 1942.

Previous Investigations

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- 2001: *Phase I ESA, PWGSC*
 - 2002: *Phase II ESA, PWGSC*
 - 2003: *Phase III ESA, PWGSC*
 - 2005: *Environmental Audit , PGL*
 - 2005/6: *Stage II PSI and DSI, Franz*
 - 2007/8: *Remedial Excavation, Franz*
 - 2008: *Groundwater Modeling and In-situ Treatment System Design, Franz*
 - 2008: *Site Specific Risk Assessment for AEC 1 and AEC 4, Franz*
 - 2009+: Remedial System installation and operation, groundwater sampling

Site Stratigraphy / Groundwater Flow

- Stratigraphy:
 - Surface to 22m - unconsolidated sand and gravel, with layers of cobbles and traces of silt. Silt and sand lenses.
 - No wells have encountered bedrock.
- Groundwater Flow:
 - Groundwater levels:
 - Spring ~ 16.5 mbgs (meters below ground surface)
 - Winter ~ 18.5 mbgs
 - Inferred flow direction: Varies from north to north-east, towards the Liard River

Background #5 – Site Stratigraphy / Groundwater Flow



Remedial Excavation

- 2007 / 2008: Excavation of 4,600 m³ hydrocarbon contaminated soil from areas adjacent to the new and old maintenance garages (AEC* 1) and at discrete areas (AEC 2 and 4)
- On-site treatment in an LTF
- Approximately 50 m³ hazardous waste soil and 25 m³ of soil contaminated with Molybdenum and Zinc was transported offsite



* Area of Environmental Concern

Conditions Prior to Start of Remedial System Activation

- Shallow impacted soil remained under the old maintenance shed
- Deep impacted soil - 18-21 mbgs
- Free phase hydrocarbon at 7 of 8 locations inside the Target Zone.
 - Observed in 6 of the 7 remediation pumping wells
 - 14cm, sheen, 0.5cm, 16cm, 7cm, 10cm
 - Observed in the one MW located in the Target Zone (10cm)

Eliminate Risk

caused by hydrocarbon contaminated soils

- **Onsite Receptors**
- **Down Gradient Receptors**

Challenges in Remediating the Site

- Very Deep – 18 to 21 mbgs.
- Partly under a building, including a significant shallow impacted zone.
- Power – not available.
- Active maintenance yard.
- Large target area – 50m x 30m.
- Extremely cold in the winter (lowest reported temp approx -50C, 2007 by the Onsite Operator).
- Logistic and Personnel Support.

Challenges in Remediating the Site



Challenges in Remediating the Site



Challenges in Remediating the Site

Bison, Bison and More Bison



Remedial Strategy

- Capture free phase
- Immobilize the dissolved phase plume
- Mobilize the soil contamination
- Capture the mobilized hydrocarbons
- Degrade the mobilized hydrocarbons thru enhanced biodegradation

System Design – 7 Components

- Mechanical System (Pump and Treat)
- Outside Water Holding Tanks (4 x 16,000L)
- 7 Remediation Pumping Wells
- Shallow Infiltration Bed (under old Main Shed)
- Deep Infiltration Bed (over the remainder of site)
- Side Gradient Treated Water Discharge Gallery

System Design – Mechanical System

System Components inside of 2 shipping containers

- Manufactured by Ground Effects Environmental (Regina)
- Water Treatment Unit (Pump and Treat)
 - Oil Water Separator
 - MCM Vessels (modified clay media)
 - Primary GAC Vessels (granular activated carbon)
 - Secondary GAC Vessels
 - Pump Manifold
- Power and Control Unit
 - Control Room (Main Power Panel, Control, Communications, Datalogging, Telemetry)
 - Generator Room (30 KVA, Diesel Primary Power Generator)
 - Fuel Tank Room (10,000L)

System Design – Infrastructure

Infiltration Beds

- Purpose – trickle surfactant and water through the subsurface in order to mobilize the hydrocarbon contamination.
- Design:
 - 1 inch Perforated Polyethylene lines spaced 2m apart
 - Shallow lines under the old maintenance shed
 - Deep Lines across the remainder of the site.

System Design – Infrastructure

Tanks

- Purpose:
 - Capture Emulsion if Present, Sediment, Floc and Precipitate.
 - Maximize dispersion of infiltrated water to the target zone.
- Design:
 - 4 x 16,000L Polyethylene Stock Tanks.
 - Tank 1 – Capture Tank
 - Tanks 2 to 4:
 - Surfactant Addition and Flushing
 - Connected in Parallel

System Description and Features



System Description and Features



System Description and Features



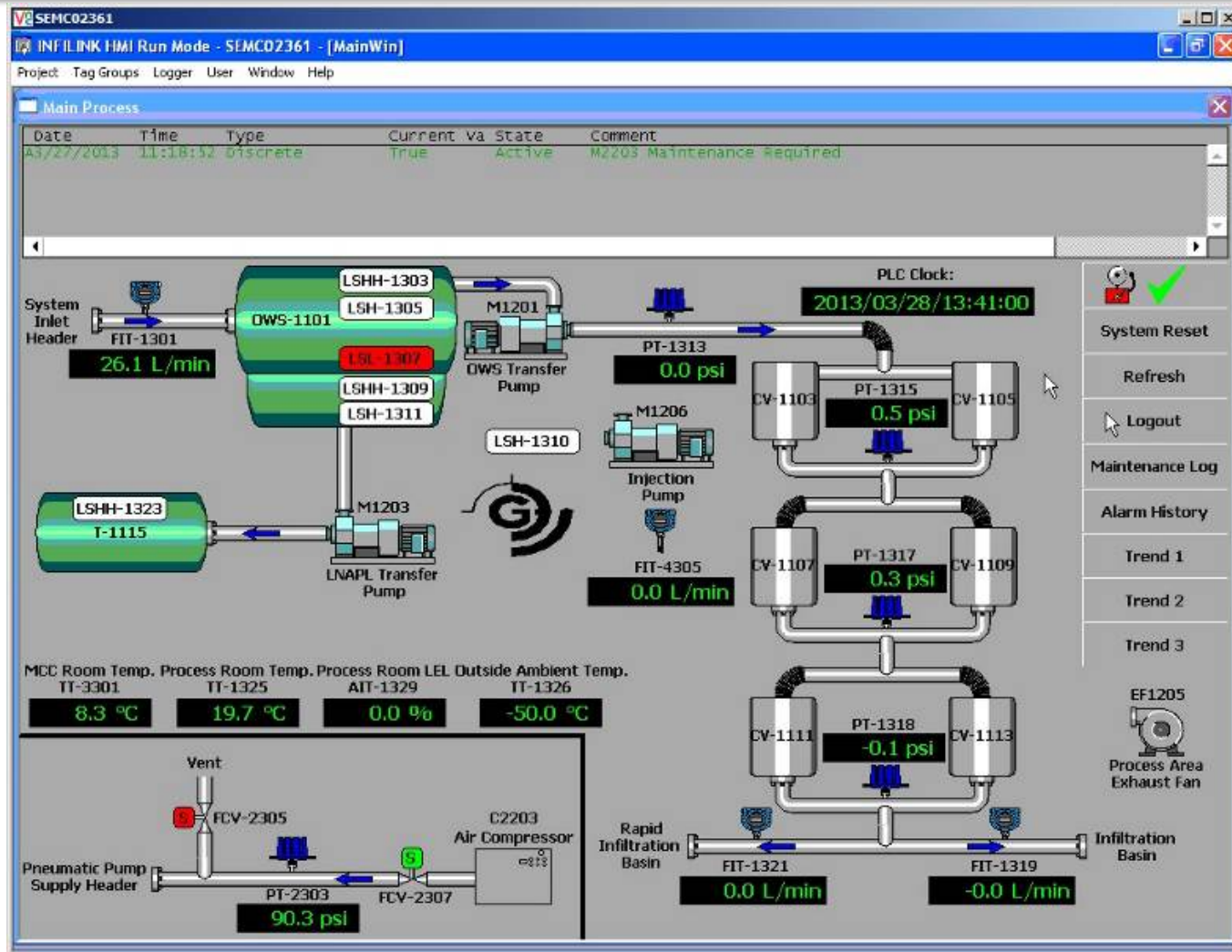
System Description and Features



System Description and Features



System Description and Features



Operations and Lessons learned

- Soil Washing Using IveySol
 - Batch injections at 4.3% and 2.5%
 - Continuous addition at 0.07%
- Pneumatic Pumps
 - QED Hammerhead Pro, Top and Bottom Loaders
 - DGSI SRX Top Loading Pump
 - Problems with icing were overcome using 3-way solenoid valves

Operations and Lessons learned

- Effectively Flooding the Subsurface
 - Flood the entire bed with 48,000L of water and surfactant using a high capacity pump.
 - Connect Tanks in Parallel to achieve a sufficient volume
- Water Level Data Loggers
 - Solinst Levelogger
 - Provides information to support the GW Model and demonstrate capture

Trends in Free Phase

- Start – Observed in 7 of 8 wells located in the target zone.
 - Max 16cm
- Fall 2013 – Observed in 2 of 8 wells located in the target zone.
 - Max 1.5 and 3.4cm (centre of the zone).

Trends in Contaminant Loading

- Significant Free Phase Reductions (only 2 wells now).
- Contaminant Loading in Pumping wells has reduced in the pumping wells by approximately 70% in 3 operating seasons.
- Concentration have almost reached non-detect levels in all but the immediate area of the old maintenance shed.
- Concentrations in down gradient sentinel wells (all non-detect) indicate that the system is capturing the dissolved phase plume.

Trends in Bio-Remediation

- Initially no evidence of significant biological activity was observed. Clear water no bacterial build-up.
- Once IveySol injections were initiated (year 2), significant biological activity became evident (at the beginning of year 3) with significant iron reducing bacterial growth on all wetted components.
- Water is injected with approximately 5 ppm Oxygen and is being extracted at approximately 0.5 ppm.

Next Stages in the Remedial Plan

- Add smaller targeted injection galleries and injection points to focus on the remaining hot zones.
- Enhance the biological remediation mechanisms through nutrient addition.

Questions

Questions and Comments