



Understanding Complex Hydrogeological Conditions to Protect a River from a Gasoline Release

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→ RemTech 2025

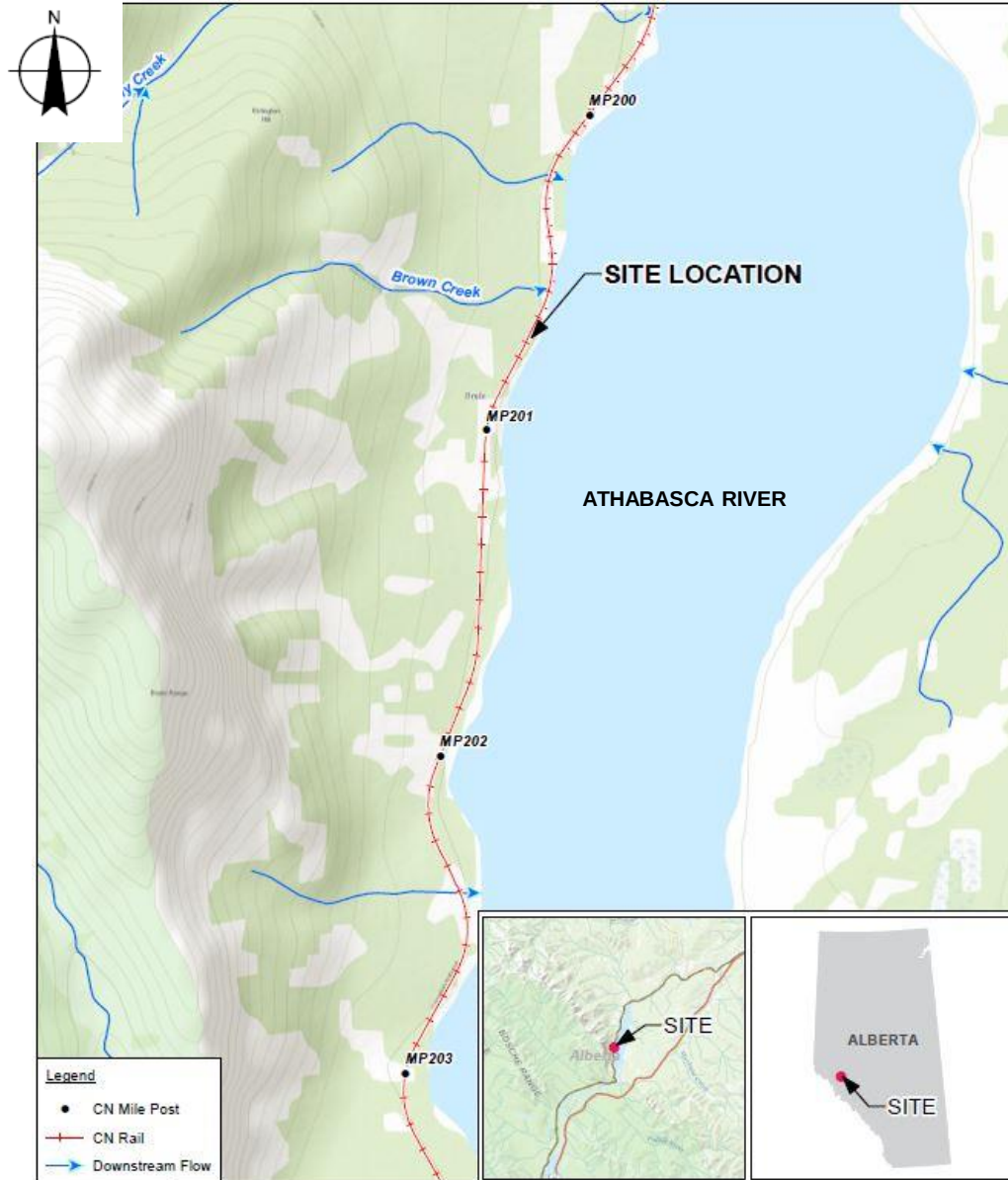


Agenda

- Site background
- Challenges and objectives
- Project strategy
 - Rapid design, installation, and enhancements of in situ remediation systems
 - Development of LNAPL CSM
 - Risk management
- Path forward
- Acknowledgements
- Q&A



Site Background



February 2022



June 2023



Site Hydrology/Hydrogeology

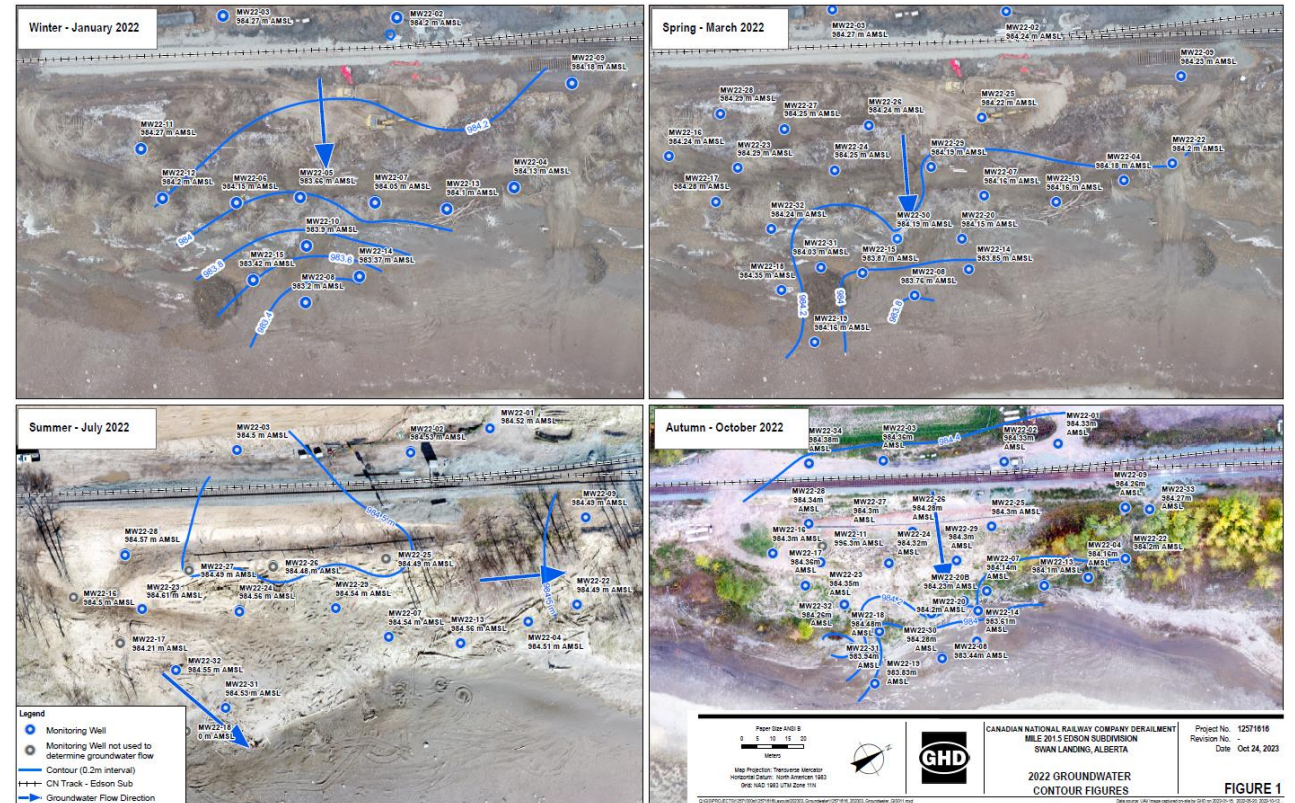
May 2022 – Pre-Freshet



July 2022 – Peak Freshet

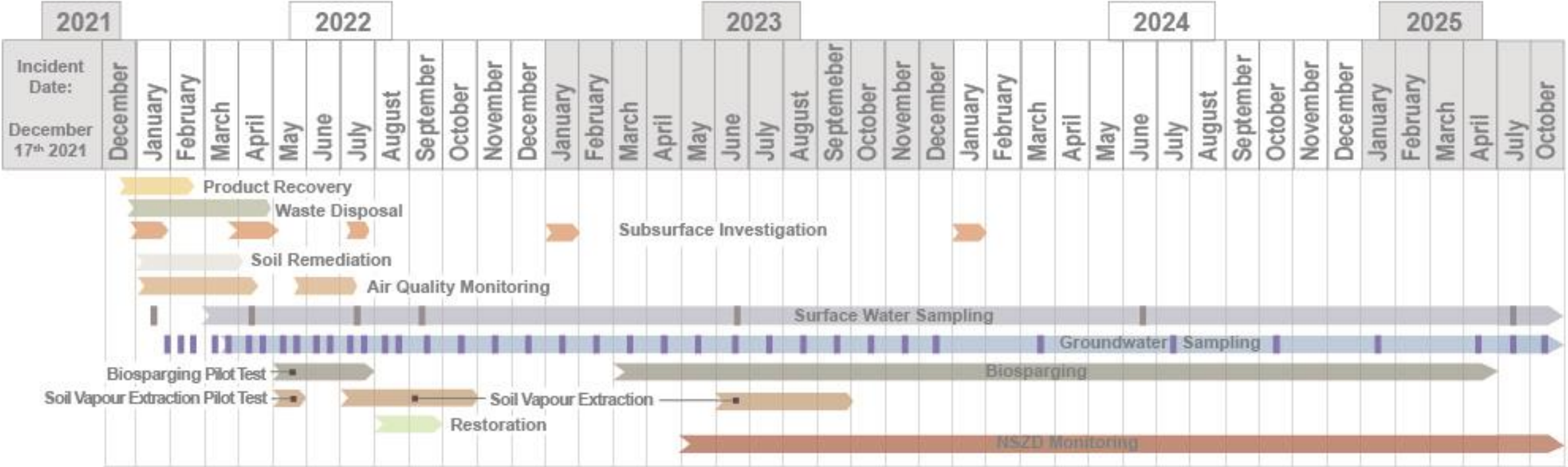


2022 Groundwater Contours



Work Completed 2021-2025

Timeline of Site Activities 2021-2025



Challenges and Objectives

Site Challenges

- Extreme weather
- Topography
- Proximity to track and river
- Complex hydrogeological conditions

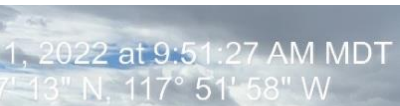
Site Objectives

- Demonstrate no impact to river.
- Demonstrate that the remaining LNAPL is stable in extent, has been recovered to the extent practical, is degrading via NSZD processes.
- Demonstrate that dissolved phase groundwater plume is stable or decreasing without migration controls (i.e., biosparge system).
- Confirm that residual concentrations of gasoline-related COCs in soil and groundwater do not pose unacceptable risk to human health and the environment.



Project Strategy

In Situ Migration Control and Source Recovery



SVE System Performance

Estimated Recovery

(Total Volume and Rate of Recovery)

Date	Time Period	Run Time (hours)	Total Estimated Recovery (L)
2022 Pilot Test	April 27 to May 3, 2022	46	100
2022 Operation	July 20 to October 12, 2023	1750	13300
2023 Operation	June 8 to September 15, 2023	1850	2300
Total		3646	15700

Notes:

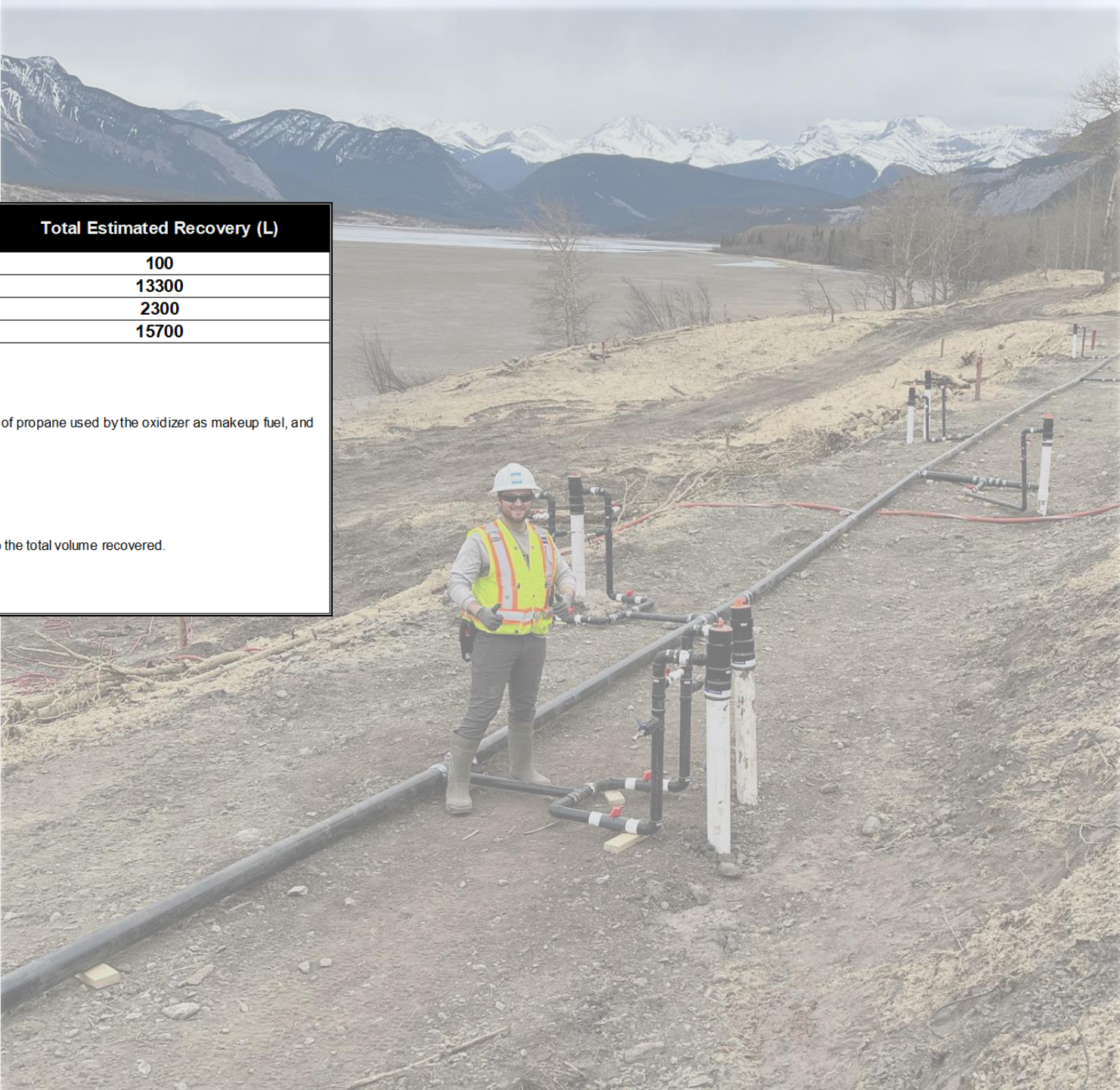
- Data from pilot test was collected from individual wells during testing.
- Data in 2022 was collected on a weekly basis
- Data in 2023 was collected on a bi-weekly basis.
- Calculations were based on data collection of the process temperature of the oxidizer, flowrate of vapour through the system, volume of propane used by the oxidizer as makeup fuel, and hours of operation.
- Calculations were based on the following assumptions:
 - 100% combustion efficiency.
 - Ignores heat loss through the oxidizer.
 - Air temperature entering the oxidizer is an average of 10 degrees Celsius.
 - Process temperature is an average of the last two weekly readings.
- Adjustments were being made to the system weekly in 2022 and bi-weekly in 2023 to optimize recovery and may result in changes to the total volume recovered.

Definitions:

L - Litres

Estimated Recovery Rates

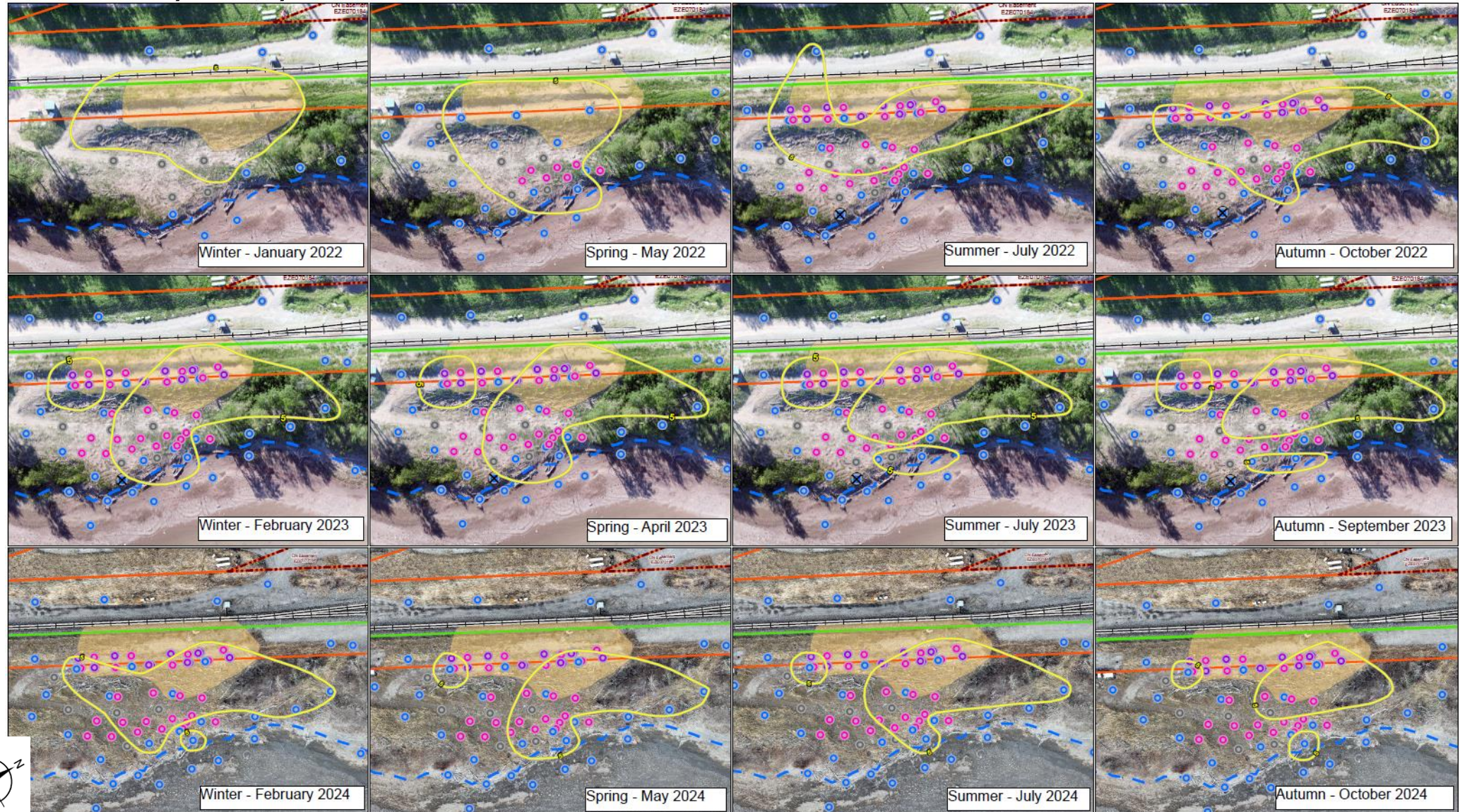
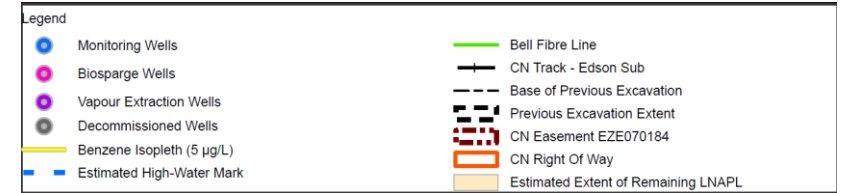
- SVE recovery rates in 2022 estimated at 7.6 L/hr
- SVE recovery rates in 2023 estimated at 0.9 L/hr
- SVE performance quantifies stripping only (enhanced NSZD not quantified)
- Average Natural Source Zone Depletion (NSZD) rates in July 2022 (between pilot and full-scale SVE) estimated at:
 - 4-6.5 L/m²/yr
 - 4,000-7,000 US gal/acre/yr
 - 0.23 – 0.74 L/hr



Biosparge System Performance

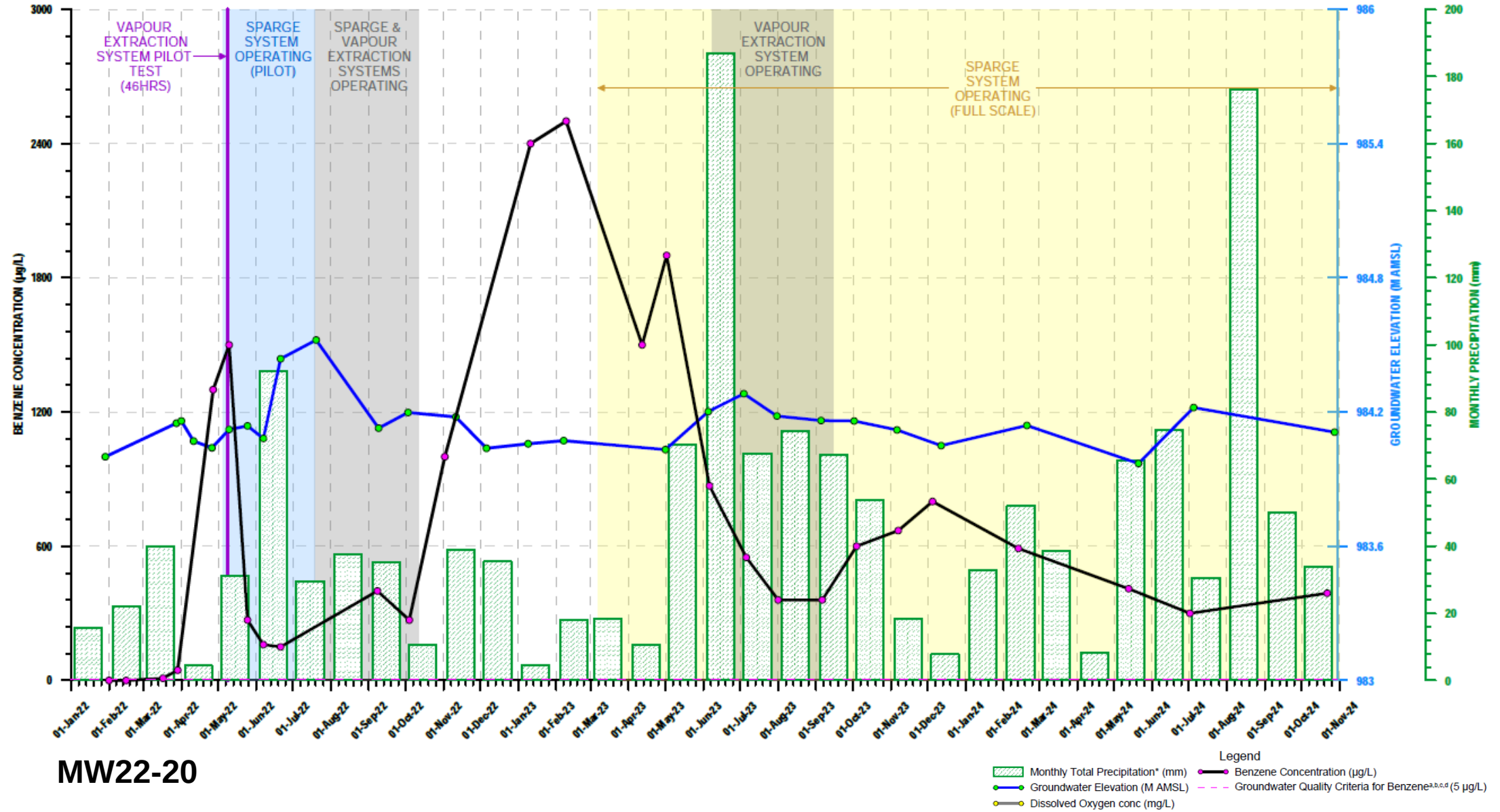
Dissolved Phase Groundwater Impacts

Benzene – 2022, 2023, 2024



Dissolved Phase Groundwater Plots - Benzene

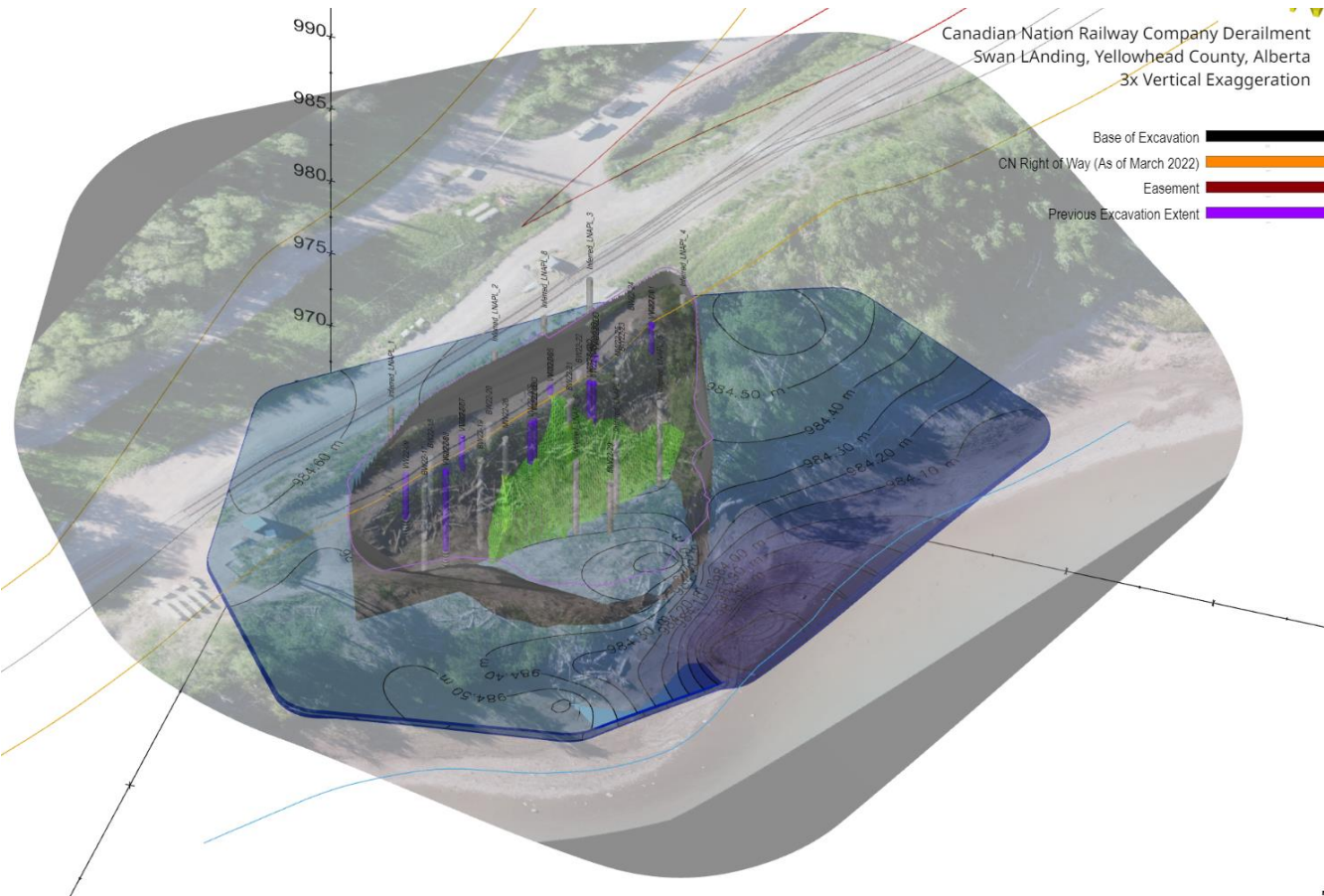
River Shoreline (East)



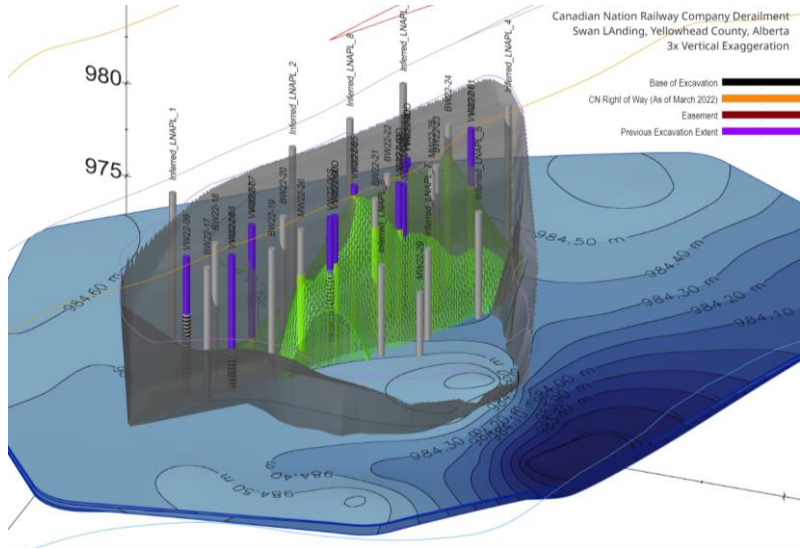
LNAPL Conceptual Site Model



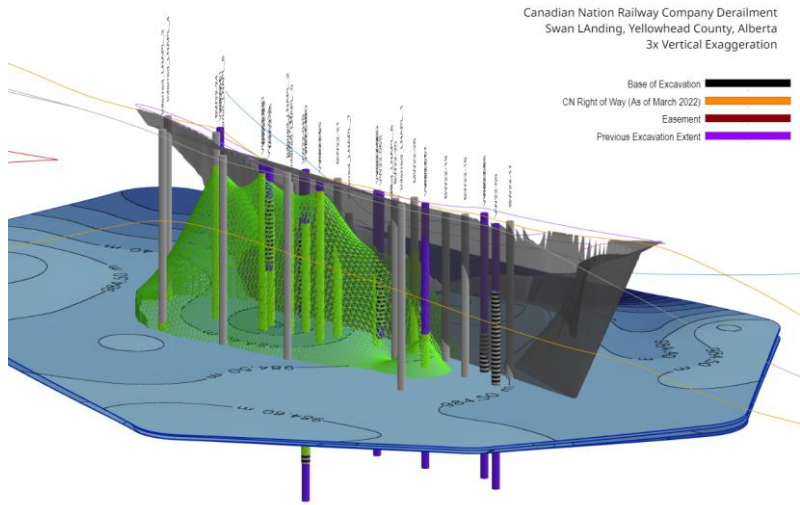
LNAPL Conceptual Site Model



3DV Looking Northwest – With Aerial



3DV Looking Northwest



3DV Looking Northeast

Site Conditions – 2025

LNAPL

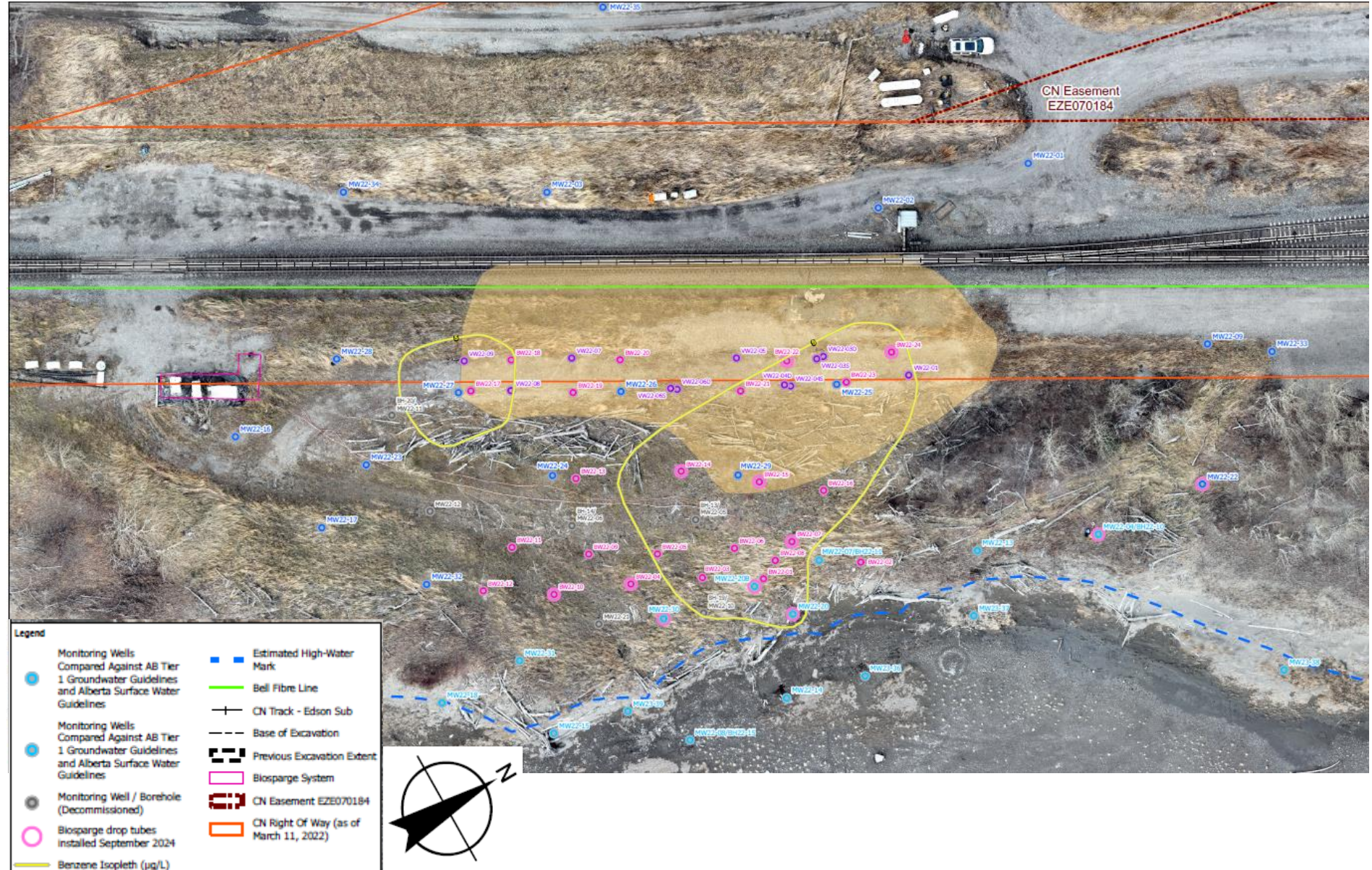
- Remains below and adjacent to tracks, where excavation was not practical

Groundwater

- Dissolved phase groundwater plume remains
- Biosparge system operating to reduce concentrations and mitigate migration

Surface Water

- No sheen, odour, or product observed in river to date
- No gasoline related constituents detected in surface water samples to date



Risk Management

Phased site-specific risk assessment completed to assess risks associated with remaining impacts and control measures required until Site management objectives achieved.

1) Initial Screening

- Comparison of maximum concentrations to generic remediation objectives (GROs), which are the most stringent of available criteria.
- COCs with exceedances of GROs were carried forward to the next tier

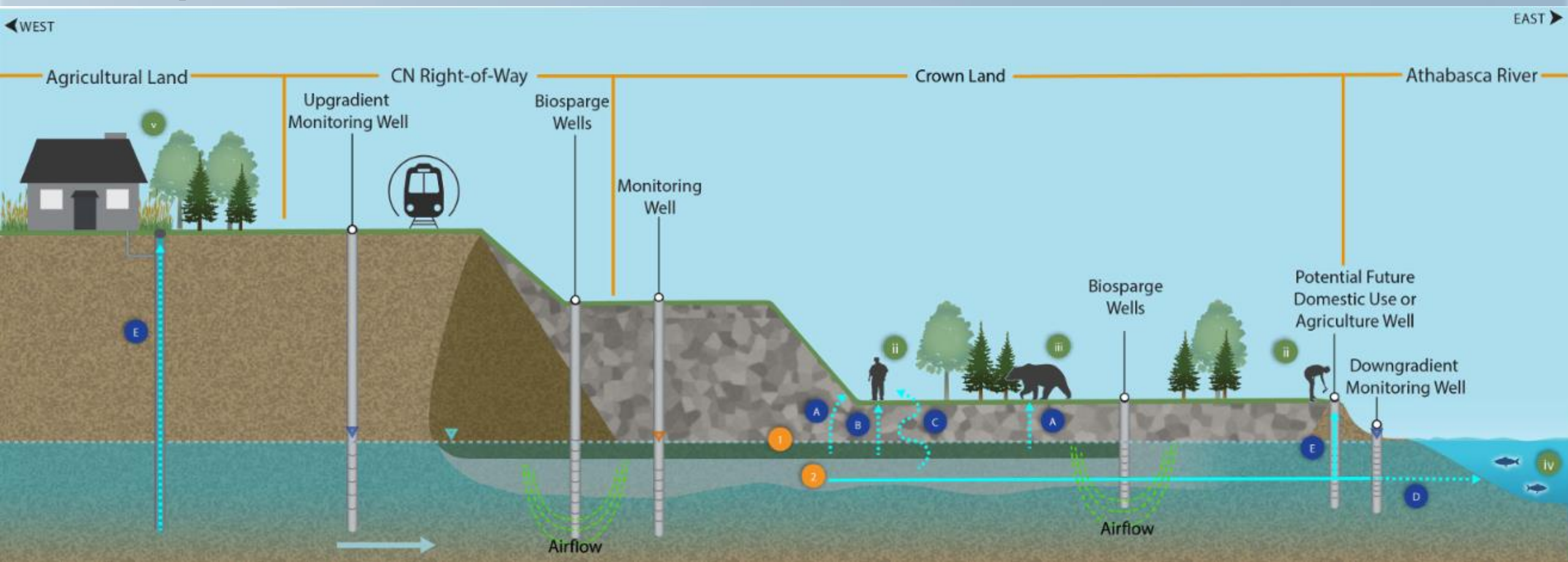
2) Secondary Screening

- An exposure pathway analysis and development of Site-specific remediation objectives (SSROs)
- Subsequent comparison of maximum concentrations to the SSROs

3) Risk Characterization and Management

Exposure pathway summary	
Pathway	Maximum Concentration Exceeds Site Specific Remedial Objective (SSRO)?
Human direct contact with soil	No
Protection of potable groundwater	Yes, control measures in place
Ecological direct contact with soil	No
Protection of surface water	Yes, control measures in place

Conceptual Site Model



LEGEND

- Potentially complete exposure pathway (risk management measures implemented)
- Incomplete exposure pathway
- Ground Water impacted
- Ground Water not impacted
- Ground Water table
- Ground Water flow direction
- Backfill

RECEPTOR

- Human health outside CN ROW
- Terrestrial biota
- Freshwater aquatic life
- Agriculture (Livestock and Crops)

SOURCE

- Residual impacted soil
- Dissolved phase impacts in Ground Water

PATHWAY

- Direct Contact
- Soil Vapour Exposure (outdoor)
- Groundwater Vapour Exposure (outdoor)
- Groundwater Flow to Surface Water Body
- Groundwater Extraction for Drinking Water or Agriculture

Path Forward

Site Management Objectives

- ✓ Demonstrate no impact to river - **Complete**
- ✓ Demonstrate LNAPL is stable and degrading - **Complete**
- ✓ Demonstrate negligible risk to human health and ecological receptors – **Complete, with control measures in place**
 - Engineering control of biosparge system, until groundwater plume is demonstrated to be stable/decreasing
 - Administrative control of groundwater sampling while biosparge system is operating
- ✓ Demonstrate dissolved phase plume is stable and decreasing without migration control – **In progress**



Acknowledgements

Thank you to:



CN

Sequoia Environmental Remediation Inc.

Secure Energy



Q&A
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