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Remediation of a Fuel Release in Steeply-Sloping Terrain Adjacent to a River

Prince George, BC

INTRODUCTION

- On August 5, 2007, two trains collided at Mile 464.3 of the Chetwynd subdivision at CN's Prince George Terminal
- Approximately 171,500 L of gasoline, 1,600 L of diesel and a small volume of lubricating oil were lost
- A fire that resulted from the collision burned off an unknown volume of fuel at the time of the incident


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SITE CONDITIONS

- Located adjacent to the Fraser River immediately east of Prince George
- Spill area approximately 0.2 ha in size
- The topography slopes steeply down to the Fraser River, located about 12 m below the tracks
- Access along the slope is very difficult

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INITIAL RESPONSE TO SPILL

- Two remedial excavations were completed covering the area of the fuel release down the slope to the Fraser River foreshore
- Approximately 2,000 m^3 of soil was removed
- Shortly after release, LNAPL globules began to appear in the Fraser River on the foreshore
- Booms and absorbents were placed in the foreshore area to control hydrocarbons

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SLOPE STABILIZATION / DRILL RIG ACCESS

- Lock blocks installed to stabilize slope
- Middle and lower benches constructed to allow for drill rig access
- Ramp constructed to provide access down the slope

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Upper Bench
Middle Bench
Lower Bench
OCTOBER 2007 EXCAVATION


Link-Belt
JULY 2008 EXCAVATION

ENVIRONMENTAL INVESTIGATIONS

- Investigate soil and groundwater conditions in the area of the fuel release
- Delineate soil and groundwater contamination in the spill area
- Installation of 16 groundwater monitoring wells, 7 soil vapour wells, and 2 contingency air sparge wells

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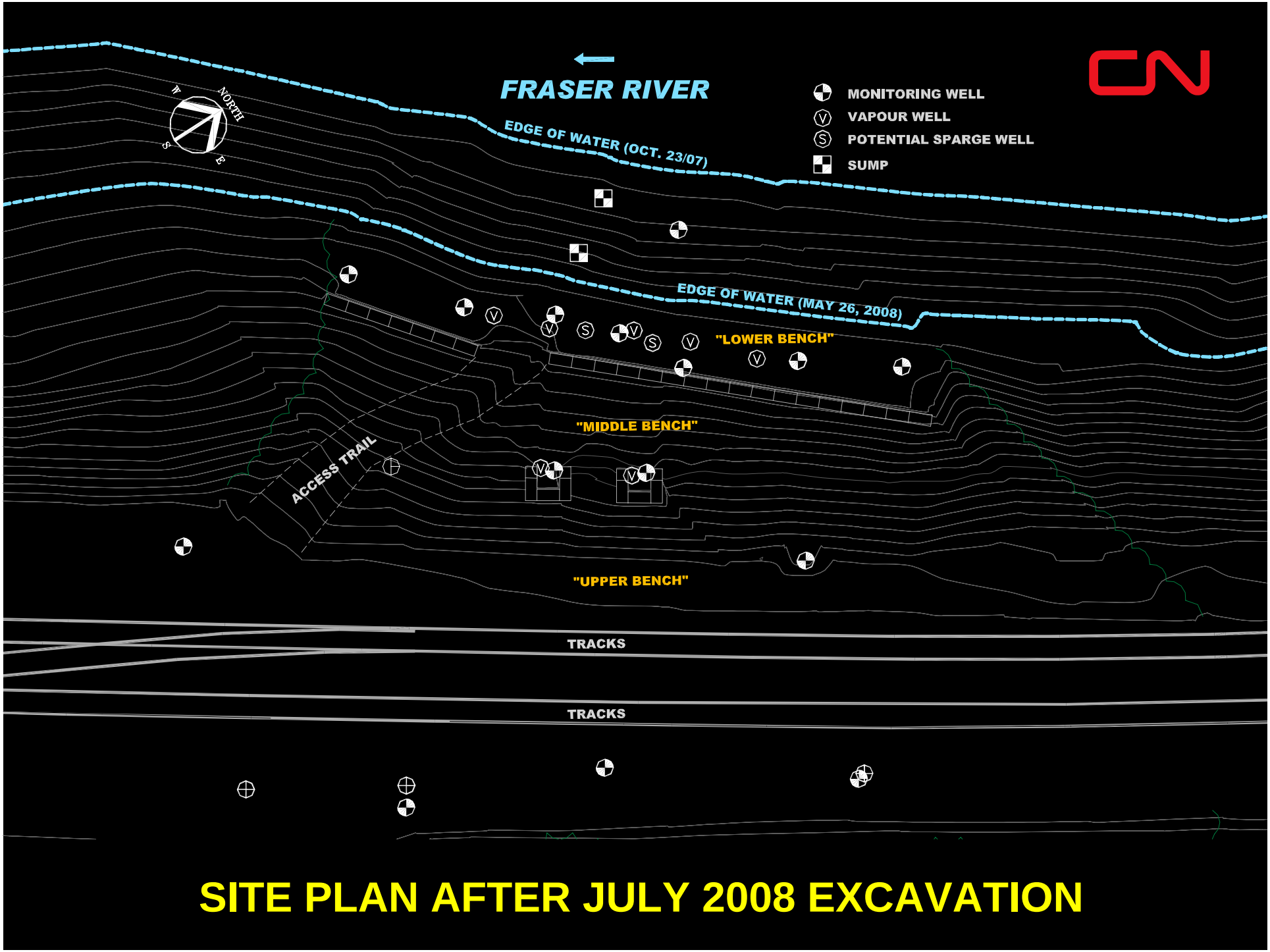
DECEMBER 2007 DRILLING


JULY 2008 DRILLING



SITE PLAN AFTER JULY 2008 EXCAVATION

HYDROGEOLOGY

- Soil consists of sand and gravel with some silt
- Groundwater 11 m to 13 m below from the top of slope
- There is generally less than 1 m of elevation difference in the water table across the site
- Groundwater levels fluctuate by 4 m
- Groundwater flow is generally directed towards the Fraser River however, during freshet (May-June) groundwater is directed inland

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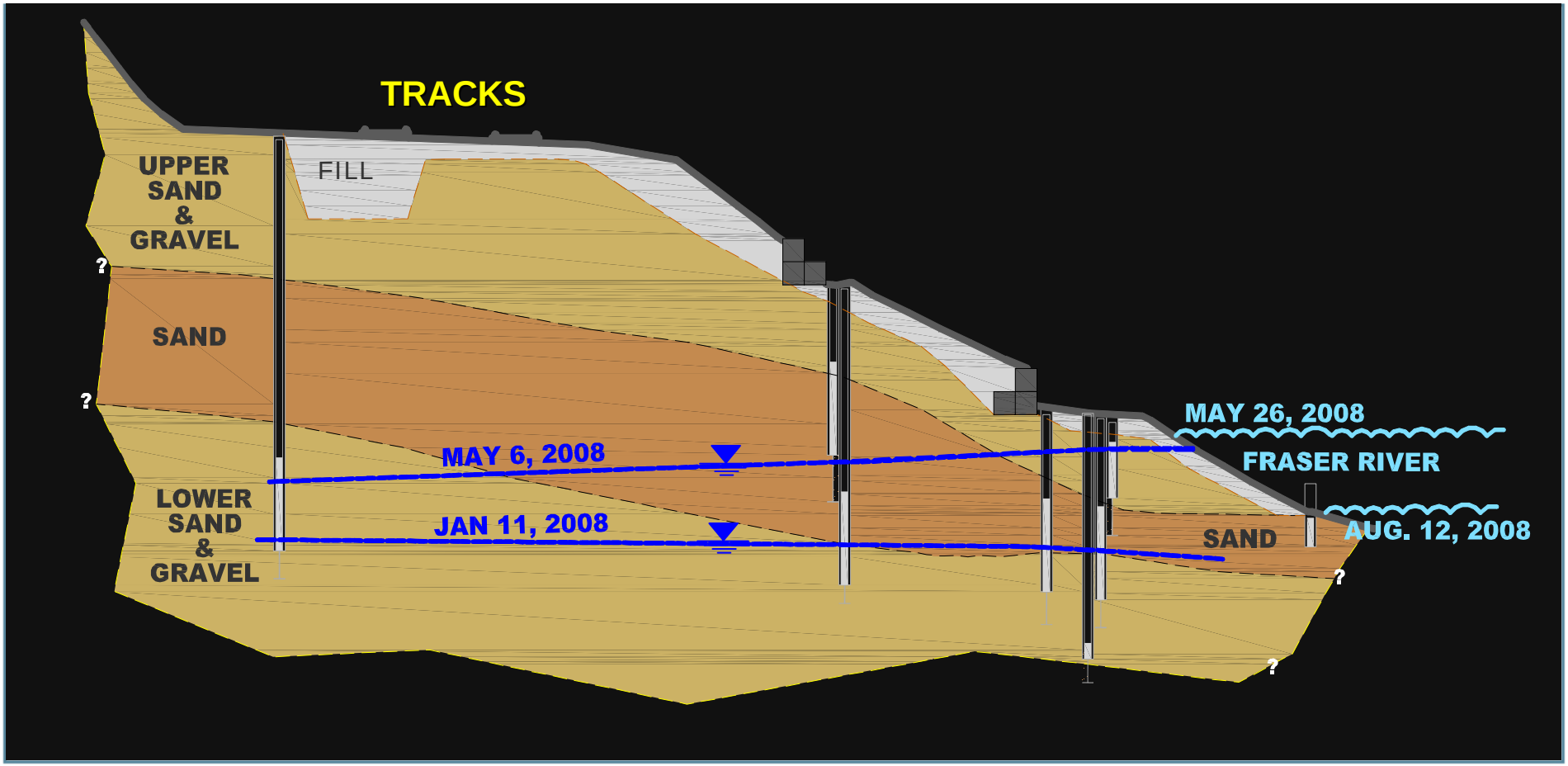
HYDROSTRATIGRAPHY



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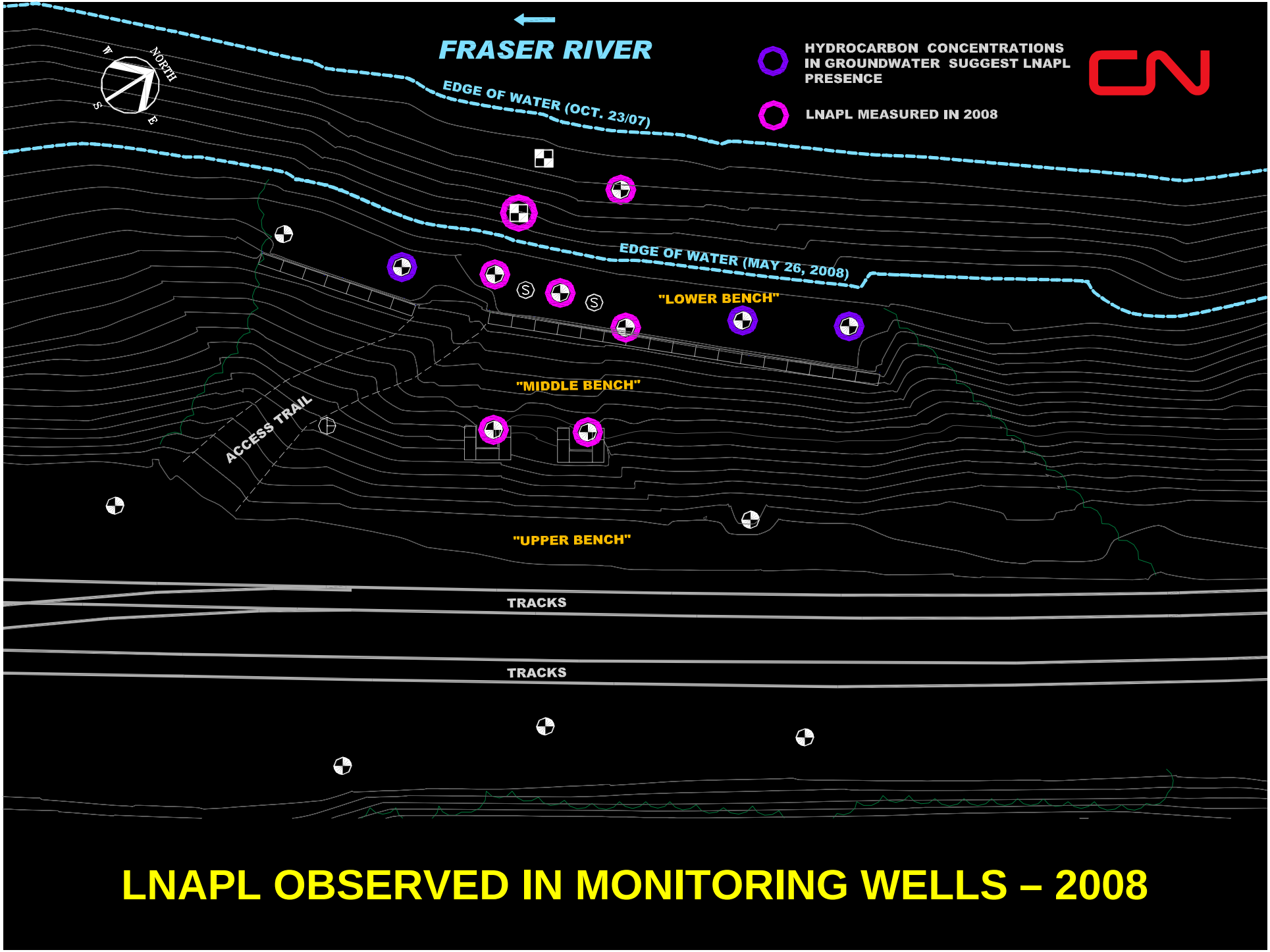
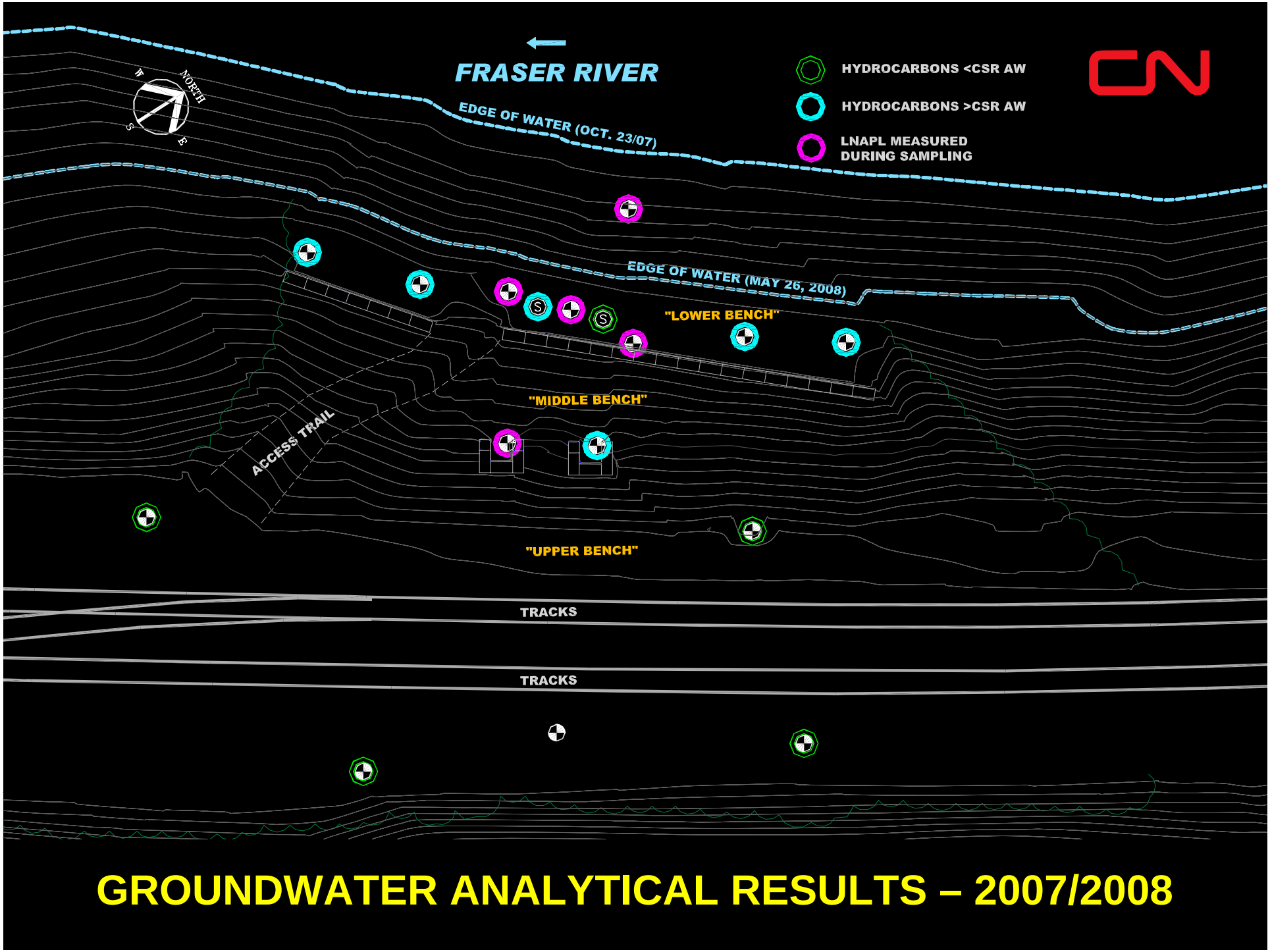
ENVIRONMENTAL CONDITIONS

- Soil impacts were generally identified from near ground surface to the water table
- LNAPL present in the central portion of the site, extending from the Middle Bench to the Lower Bench. Apparent LNAPL thicknesses up to 0.5 m initially observed
- Dissolved phase hydrocarbons present from the “Middle Bench” to the edge of the Fraser River. Initial concentrations suggested the presence of LNAPL at some monitoring wells



LNAPL OBSERVED IN MONITORING WELLS – 2008



GROUNDWATER ANALYTICAL RESULTS – 2007/2008

REMEDIAL OBJECTIVES

- Reduce potential for LNAPL migration to the Fraser River
- Reduce LNAPL accumulations within the spill area
- Reduce soil concentrations to relevant standards or to risk-based criteria

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REMEDIAL OPTION LIMITATIONS

- Proximity to river requires that the remediation option selected does not impact the river
- The preferred option can not adversely affect adjacent railway operations
- The site is on a steep bank, which provides limited access for equipment placement and stability issues
- No nearby utilities

PREFERRED REMEDIAL OPTION

- Soil Vapour Extraction / Air Sparging
- Both options are ideal for remediating volatile hydrocarbons such as gasoline
- Both options require minimal maintenance
- Little to no groundwater is produced, so groundwater treatment and disposal should not be an issue
- Sands and gravels were expected to provide good air flow for both soil vapour extraction and air sparging

SITE REMEDIATION & RESTORATION

- Air sparge/soil vapour extraction pilot test completed in Spring 2009
- Evaluated extracted vapour concentrations, flowrates, and radius of influence from existing monitoring wells
- Evaluated air injection flowrate, injection pressure and radius of influence for air sparging

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PILOT TEST – SPRING 2009

SITE REMEDIATION & RESTORATION

- Installation of a dedicated electrical service was identified as the most suitable method for powering AS/SVE equipment and electric oxidizer
- 1.8 km 25 kV 3 ph. direct buried cables were installed in August 2010
- Installed along CN's maintenance road

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ELECTRICAL SERVICE INSTALLATION – 2010

SITE REMEDIATION & RESTORATION

- Installation and commissioning of AS/SVE system, electric oxidizer, and associated aboveground infrastructure completed in September 2010
- Extracted vapours from individual wells were monitored regularly. Vapour extraction was focused on the most heavily impacted wells to optimize remediation.
- Extracted vapour concentrations from the SVE well network remained at or near the maximum vapour processing capacity of the catalytic electric oxidizer through March 2011


AS AND SVE SYSTEM

SITE REMEDIATION & RESTORATION

- Air sparging was started in May 2011 to enhance soil vapour extraction and reduce dissolved phase hydrocarbon impacts
- System uptime near 100% since commissioning
- An estimated 9,500 kg of hydrocarbons removed through SVE to date

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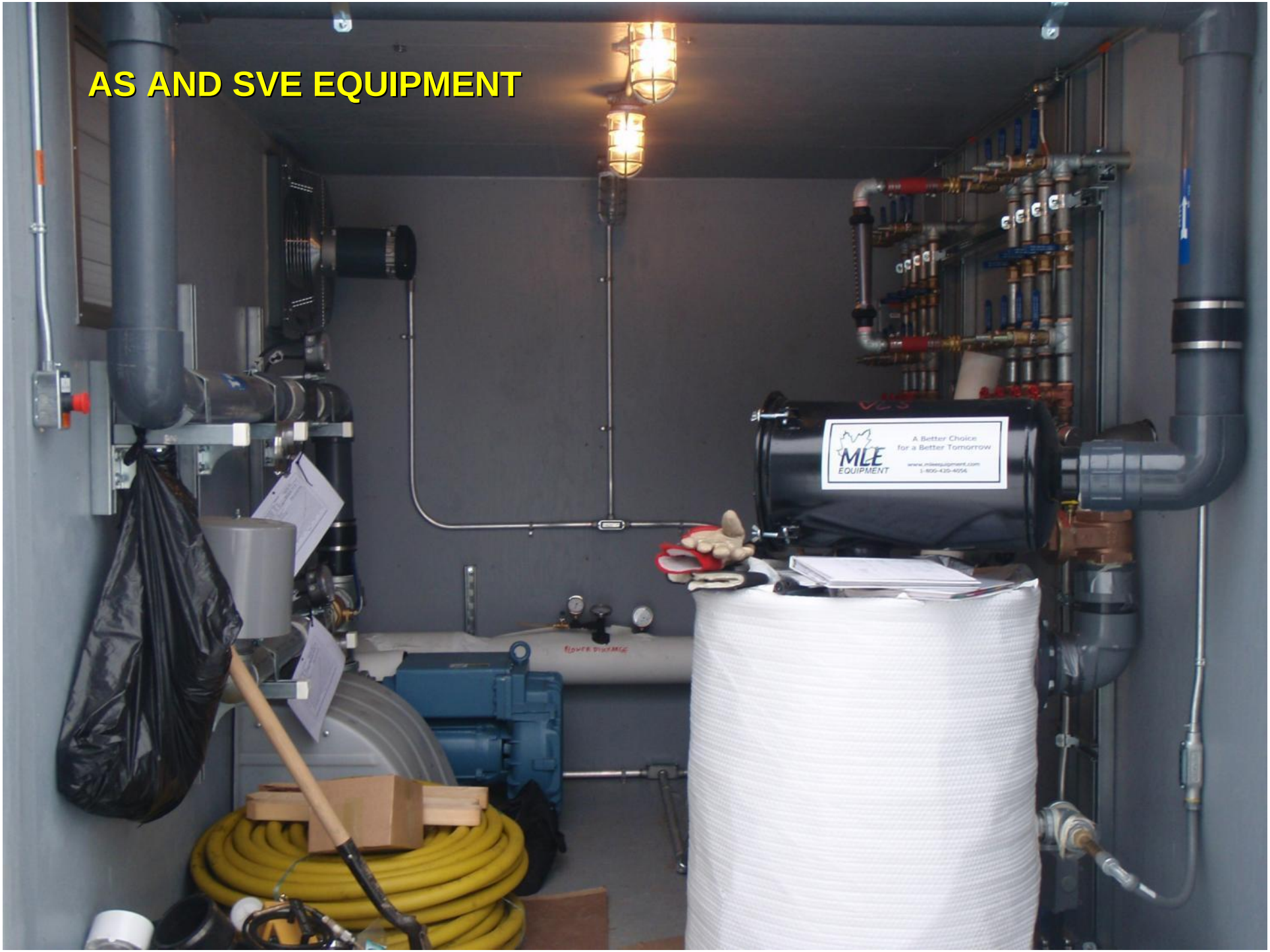
AS AND SVE EQUIPMENT




ABOVEGROUND SVE PIPING AND HOSE

CURRENT STATUS & WHAT'S NEXT

- Monitoring has not detected LNAPL at any monitoring well in 2011
- Sampling has shown dissolved phase concentrations have decreased since the remediation equipment start up
- Installation of additional air sparge wells in 2012 as required
- Installation of air phase carbon vessels to reduce energy consumption associated with the electric oxidizer in 2012

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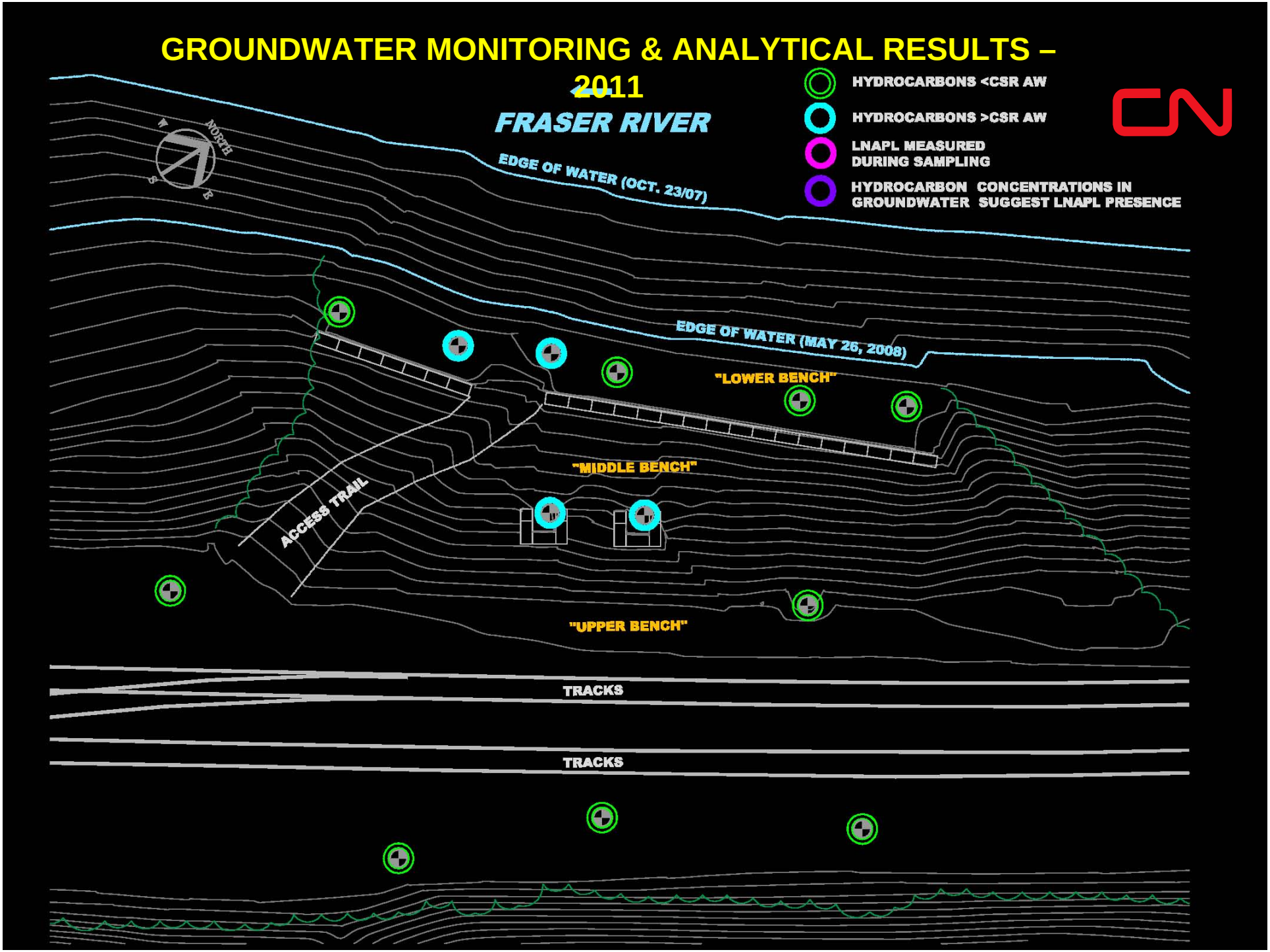
GROUNDWATER MONITORING & ANALYTICAL RESULTS – 2011



SUMMARY

- Successfully completed investigation of spill area despite challenging site conditions
- Following an evaluation of site conditions, AS/SVE was identified as most suitable remediation option
- Completed installation of AS/SVE system and associated electrical service in 2010 within budget.
- AS/SVE system noted to have met remediation objectives of reducing the potential for LNAPL migration towards the Fraser River, and the occurrence of LNAPL in the spill area

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