

U. S. Geological Survey, Minnesota Water Science Center
Quarterly Project Progress Report
Quarter ending December 31, 2007
September 30, 2008

Project Name: Fate and Transport of Petroleum Hydrocarbons in Ground Water, Cass Lake, Minnesota

Project Number: 8607CXW (246) **Begin Date:** June 2007 **End Date:** September 2010

Project Chief: D.S. Hansen **Cooperator:** Leech Lake Band of Ojibwe, Department of Resource Management (DRM)

Objectives:

The objectives of this study are to: (1) Delineate the plume of dissolved petroleum hydrocarbons at the South Cass Lake pumping station in three dimensions; (2) Characterize the redox zones in the Cass Lake plume and use this to evaluate the depletion rate of the natural attenuation capacity of the aquifer; and (3) Estimate ground-water recharge to evaluate the possible effects of focused recharge on enhanced biodegradation of petroleum hydrocarbons. The study approach is to use the push-probe technique to investigate a series of vertical profiles at increasing distance down gradient, followed by field gas chromatograph (GC) to quantify BTEX concentrations, and then use these results to evaluate the existing well monitoring network

Progress and Significant Results Since Last Reporting Date:

Eleven Observation well installations were completed this past summer outside the fenced area to further delineate the plume. One core was collected within the fenced in area of the pumping station. Core and water samples were collected and shipped to Reston, VA for further processing. The results of these analyses will provide further information on degradation processes in the Cass Lake plume. Once the concentrations and distribution of electron acceptors is known, a simple mass balance calculation can provide information on the expected long-term expansion rate, extent of the dissolved hydrocarbons, redox conditions in the plume; and microbial population distribution.

Preliminary results of the push probe work indicated that the direction of the groundwater flow and plume is to the southeast at about 6 meters per year. The Benzene plume (>10 mg/L) extends ~400 ft further down gradient than previously observed. Using an estimated flow velocity of 6.3 m/yr yields a benzene attenuation rate estimate of 280 mg/l/yr along this flow path. The following illustrations show the groundwater and plume movement and BTEX concentrations.

Cass Lake Site

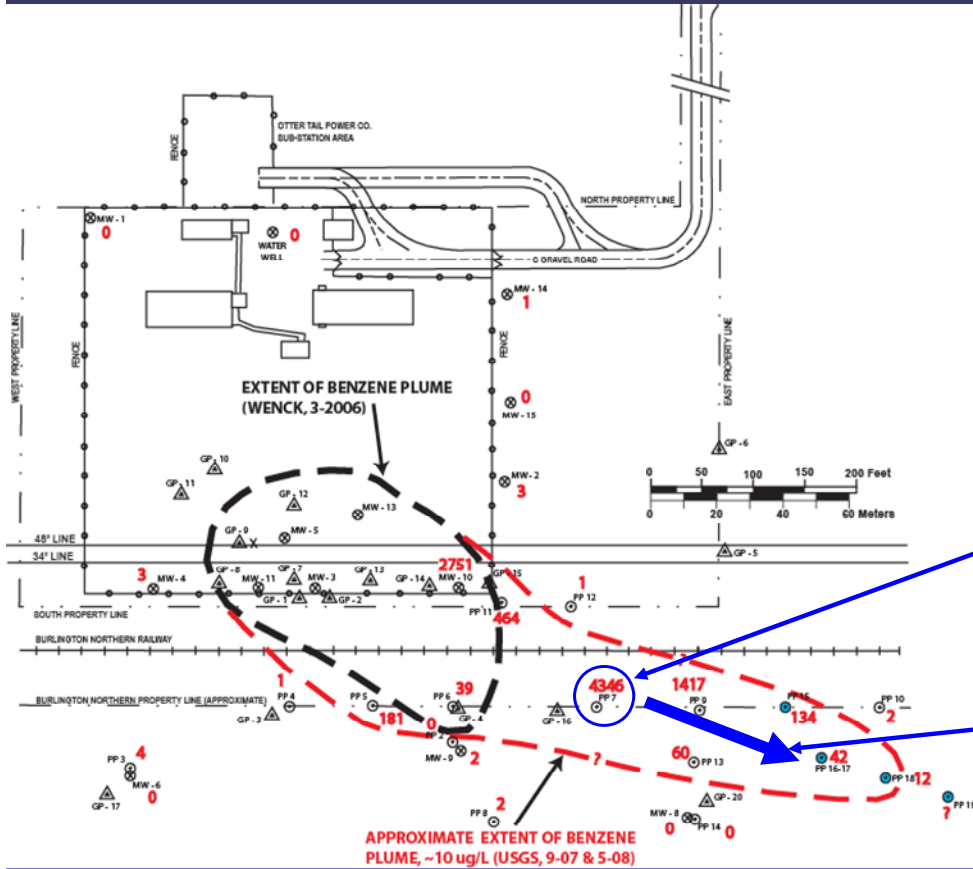
- ❖ Located in north-central Minnesota
- ❖ Unconfined sand and gravel aquifer
- ❖ Groundwater flow is to southeast
- ❖ Velocity ~ 6 m/yr



[Bemidji web site:](http://mn.water.usgs.gov/bemidji)
mn.water.usgs.gov/bemidji



Results



Benzene plume (>10 µg/L) extends ~400 ft further down gradient than previously observed.

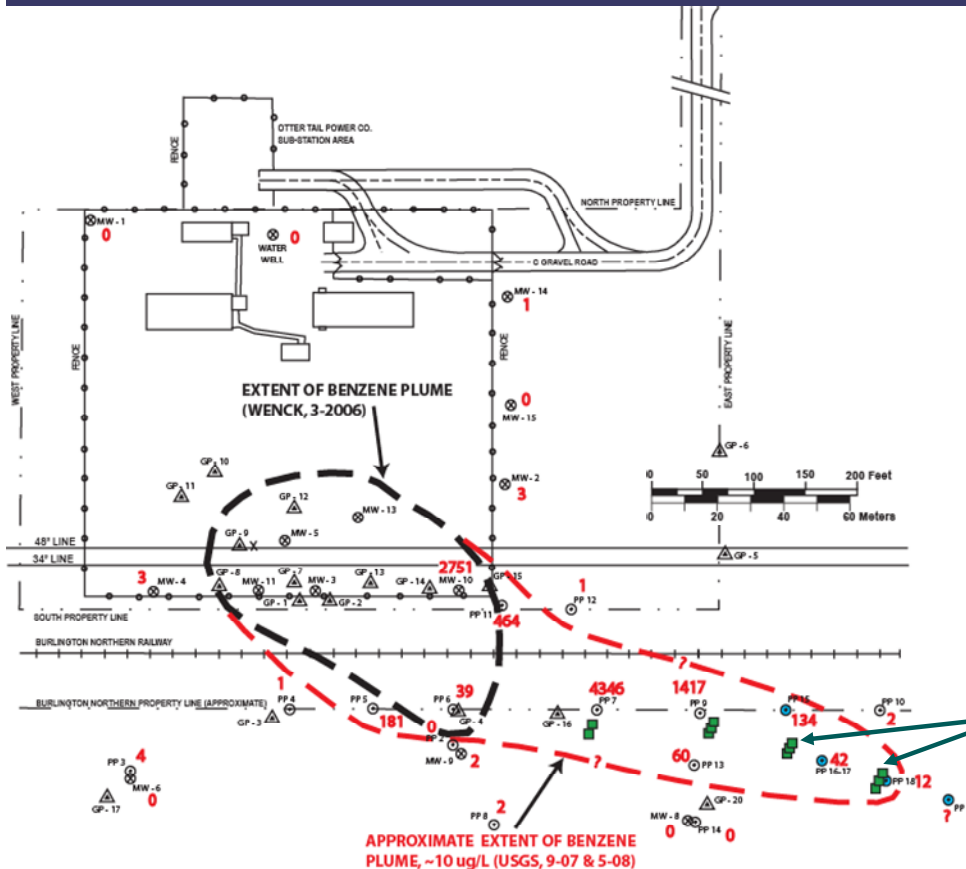
Using an estimated flow velocity of 6.3 m/yr yields a benzene attenuation rate estimate of 280 mg/l/yr along this flow path.

Push-probe hole and benzene concentration in µg/L

Direction of ground-water flow



Results – Continued



Based on push-probe results, 11 new observation wells were installed.

Observation wells



Plans for Next Reporting Period

Water samples and core samples will be analyzed for major ion concentrations and dissolved methane and bioavailable iron at the USGS in Reston, VA to further characterize the degradation processes in the Cass Lake Plume. These data would provide the necessary information to delineate redox zones in the plume, determine the important degradation processes, and assess the future potential for plume expansion.