

CASE STUDY OF THE EFFECT OF REVERSE MATRIX DIFFUSION ON REMEDIAL TIME FRAME AT A SUPERFUND SITE

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Bette Nowack, PE Stone Environmental, Inc. Andrew Hoffman, PE NH Dept of Environmental Services



KEARSARGE METALLURGICAL CORP SUPERFUND SITE, CONWAY, NH

- Chlorinated Solvent Site (TCA/DCE)
- × ROD signed in 1990
- Remedial Activities began in 1992
- Contaminated Soil above
 GW Table Removed 1992
- GW Pump and Treat
 Initiated in 1993





SITE HISTORY



- × 1993 Startup of P&T
- × 2000 Remedial progress stagnated.
- × 2001 Continuing source suspected.
- × 2002 Vertical profiling performed.
 - 2003 Saturated source removed (>3ppm TCA/DCE).



CROSS-SECTION A (EAST-WEST)





VERTICAL PROFILE - GROUNDWATER





CROSS-SECTION B (NORTH-SOUTH)





VERTICAL PROFILE - SOIL





PLAN VIEW OF SOIL CONTAMINATION





SOIL REMOVAL (>3PPM)



All soil with >3ppm VOCs excavated.



EXTENT OF SOIL EXCAVATION



Maximum VOC concentration reduced from 83 ppm to 3 ppm.



POST EXCAVATION PUMP & TREAT

- Excavation backfilled with crushed stone and used as extraction trench.
- Groundwater extracted from trench for two years (2004 and 2005).
- Plume diminished, minimal exceedances of DCE in 3 monitoring wells.
- Maximum groundwater concentrations:
 - + 19 ppb DCE vs. 7 ppb standard
 - + 112 ppb TCA vs. 200 ppb standard
- × P&T shutdown December 2005.



POST REMOVAL DIMINISHED PLUME





2007 PLUME REBOUND



- Area of exceedances increased.
- Maximum DCE concentration increased to 177 ppb.
- Plume approaching site boundary.
- × Highest
 - concentrations shift toward the east.



2009 PLUME CONFIGURATION





CONCENTRATION TRENDS IN MW 3010



TCA (ug/L)



REMEDY CHANGE TO MNA?

- Is there a case for a remedy change to monitored natural attenuation?
- × Questions to be answered:
 - + Why have the concentrations in source area wells continued to increase?
 - + Could plume expand beyond the property boundary?
 - + Has the plume stabilized yet?
 - + How long until cleanup goals (MCLs) are attained?



CONCEPTUAL MODEL

- Contaminants leaching out of low permeability silt and clay layer
 - Out of sidewall of former excavation.
 - Through sand stringers in silt and clay layer

Remaining soil contamination with VOC concentrations 1 to 3 ppm (TCA/DCE)





REMAINING SOURCE



TCA/DCE concentrations in ug/kg



PUMPING GROUNDWATER CONTOURS



Pumping from
 backfilled excavation
 captured
 contaminants
 released from silt and
 clay soils.



NON-PUMPING GROUNDWATER CONTOURS



 When pumping stopped, groundwater flow from source area directed contaminants to east, north, and west.



MW-9

w-203A 460.93

460.92

4

MW-301

48

CB 6-

59.79

EW-S

-215

WILL PLUME EXTEND BEYOND PROPE

2006





Groundwater flow from source to east, north, and west.

Groundwater flow from source predominantly to east.

AREA OF SOURCE

WS-113

MWS-204

EW-6

459.41



HAS THE DCE PLUME STABILIZED?



Phase I - Expansion LEGEND AUGUST 2006 **JUNE 2007** AUGUST 2007 NOVEMBER 2007 Phase II - Contraction **LEGEND** NOVEMBER 2007 APRIL 2008 AUGUST 2008 Phase III – Stabilization **LEGEND** AUGUST 2008 APRIL 2009 SEPTEMBER 2009

APRIL 2010



HAS THE TCA PLUME STABILIZED?







HOW LONG UNTIL MCLS ATTAINED?

- Developed two simplistic analytical models to predict remedial time frame.
 - + Mass Balance Method
 - + Pore Volume Flush Method
- Estimated remedial time frame for MNA and for resumed Pump & Treat for comparison.



MASS BALANCE MODEL ASSUMPTIONS



- All groundwater passing through source flows east.
 - Calculate flow volume through cross-sectional area.
- Use 6 month model steps to account for seasonal variations.
- Concentrations in wells along cross-section used to calculate contaminant mass removed from source in first model step.
- Assume concentrations in each subsequent step decreased by the same % as source mass reduction in prior step.



PORE VOLUME FLUSH METHOD ASSUMPTIONS



- Time required for one flush based on Darcy velocity through source zone.
- Pore water assumed to be in equilibrium with soil.
- Contaminant mass removed in each flush subtracted from source.
 - 20% conversion of TCA to DCE.



MODEL PREDICTIONS

Modeling Approach	Monitored Natural Attenuation Alternative	Pump and Treat Alternative
Mass Balance Method	18.5 Years	15.4 Years
Pore Volume Flush Method	17.3 Years	13.9 Years



ANSWERS TO QUESTIONS

- Concentrations have increased because of slow reverse matrix diffusion out of silt and clay aquitard.
- Unlikely that plume will expand beyond property boundary because of current groundwater flow patterns.
- Plume size appears to have stabilized, but concentrations could still increase.
- Estimate of remedial time frame for:
 - + Monitored Natural Attenuation: 17.9 years
 - + Resume Pump & Treat: 14.6 years



REMEDY CHANGE TO MNA?



× What do you think?