

Combining Source Area Treatment with Monitored Natural Attenuation, NSB Kings Bay

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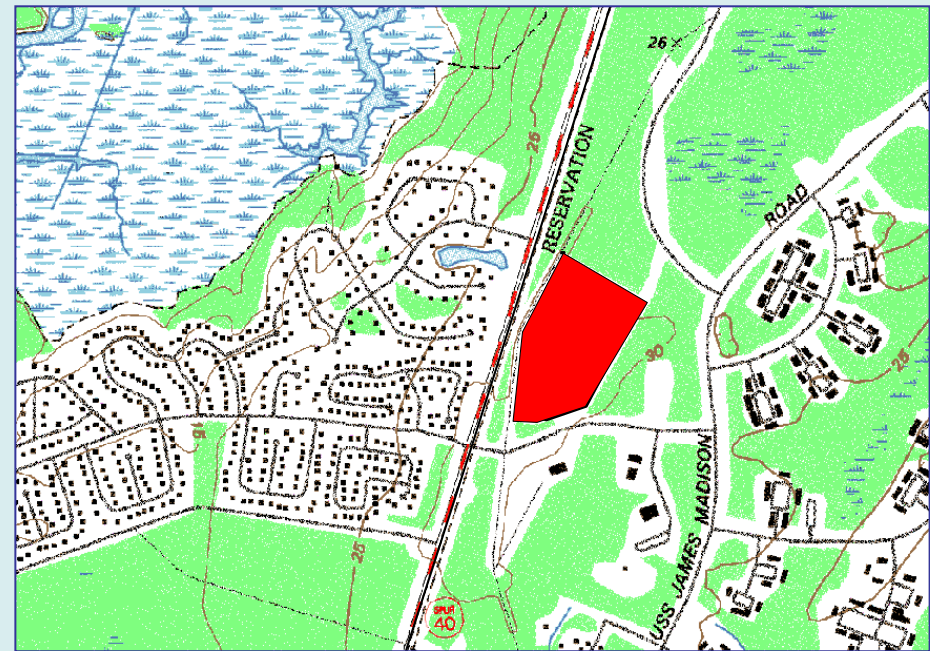


Naval SubBase Kings Bay

- ▶ Pump-and-treat (1993)
- ▶ Natural attenuation (1997)
- ▶ Source-area removal (Fenton's reagent, 1998)
- ▶ Enhanced attenuation (vegetable oil 2001)

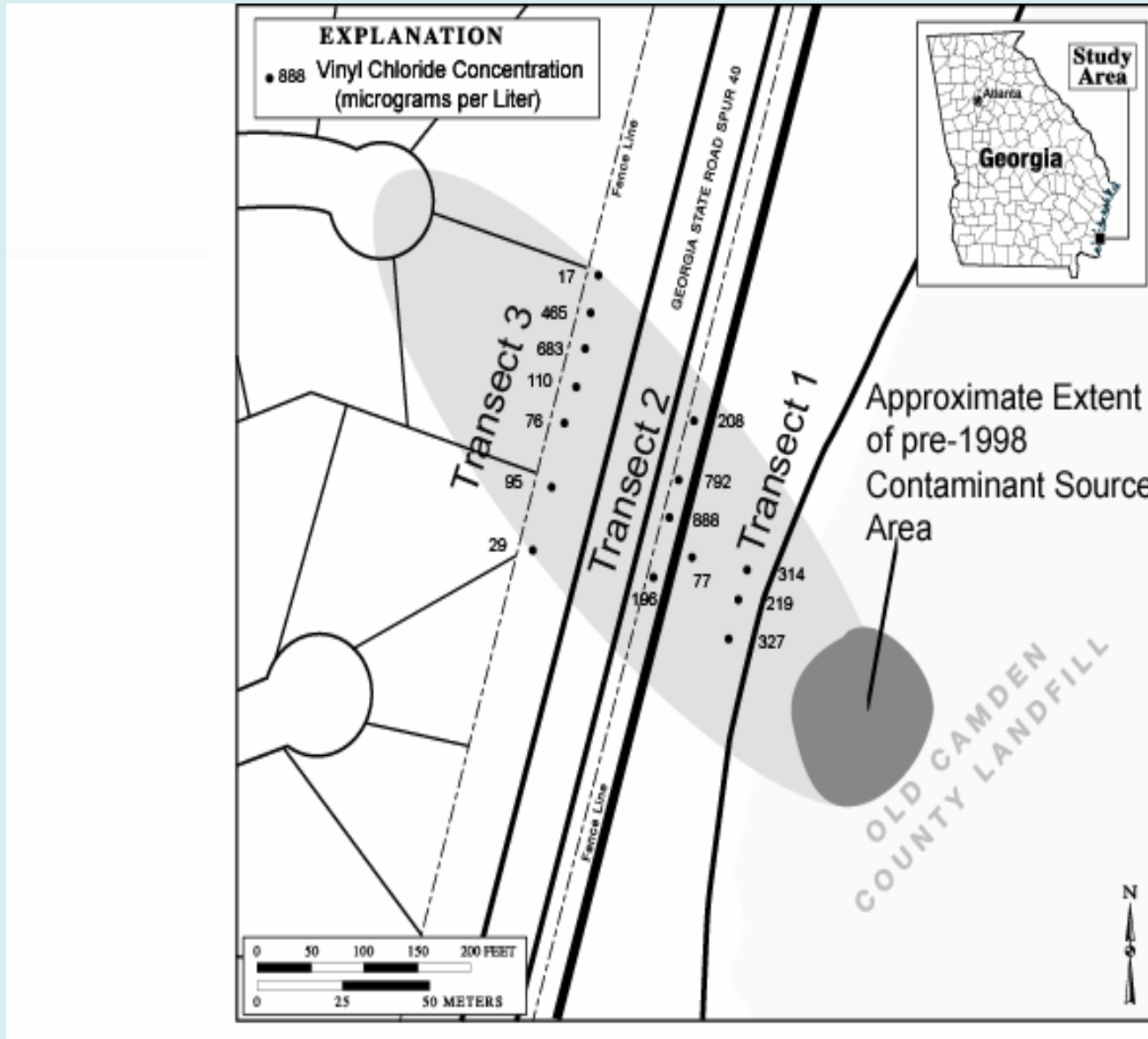


Source: Dan Waddill, Southern Div, NAVFAC

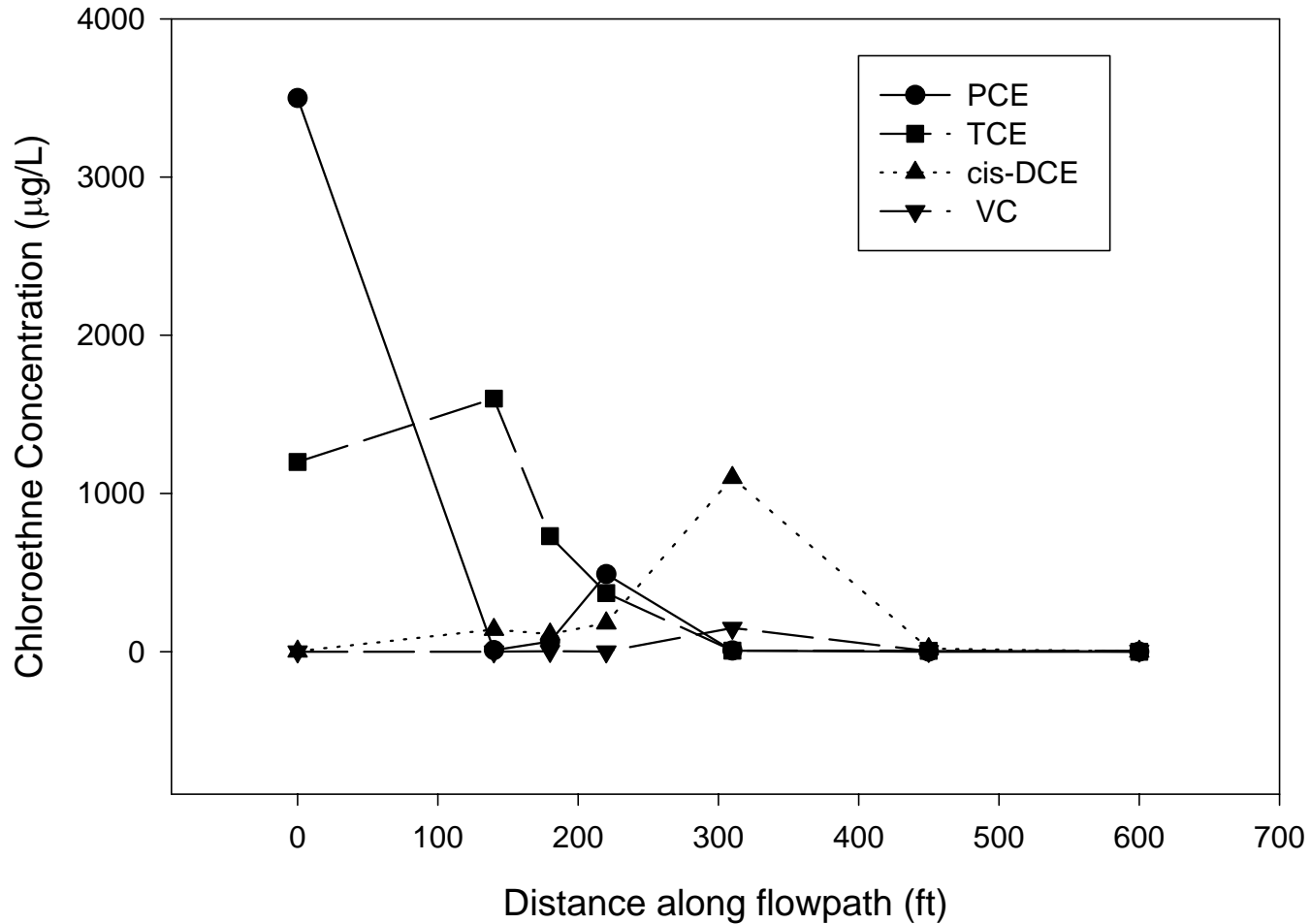


- Flat, grassy meadow
- Fine sands with silt beds
- PCE/TCE/DCE/VC plume

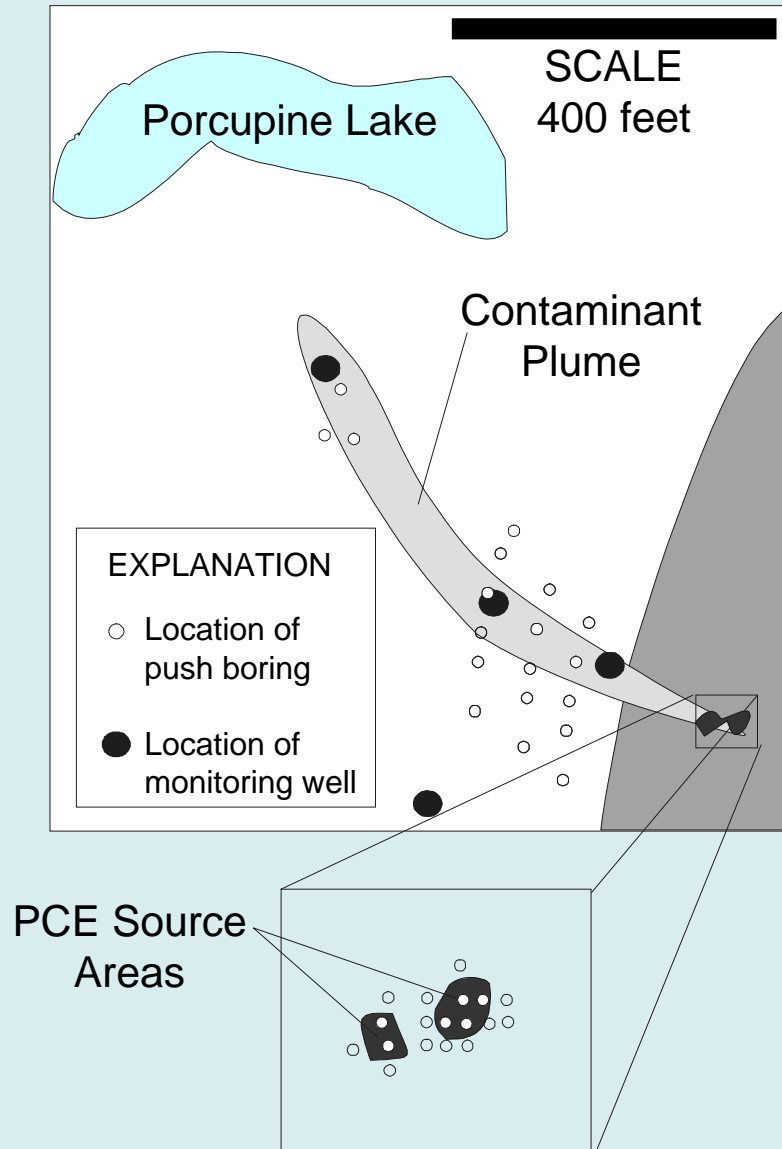
Kings Bay, August 1998



Efficient Natural Attenuation of Chlorinated Ethenes along Flow Path



Location of Source Areas and Contaminant Plume



Quantifying DNAPL Mass

- ▶ Testimonial evidence
- ▶ Mode of delivery (disposed of from 55-gallon barrels).
- ▶ Geoprobe/field GC measurements of PCE.

NAPL Mass (kg) in source-area	Estimated Time of Remediation (yrs)
280	160
560	300
1120	500

Virginia Tech

USGS science for a changing world

Naval Facilities Engineering Command Southern Division

NAS Natural Attenuation Software

Home Software Support Training Authors Publications Links

The Technical Problem at Kings Bay:

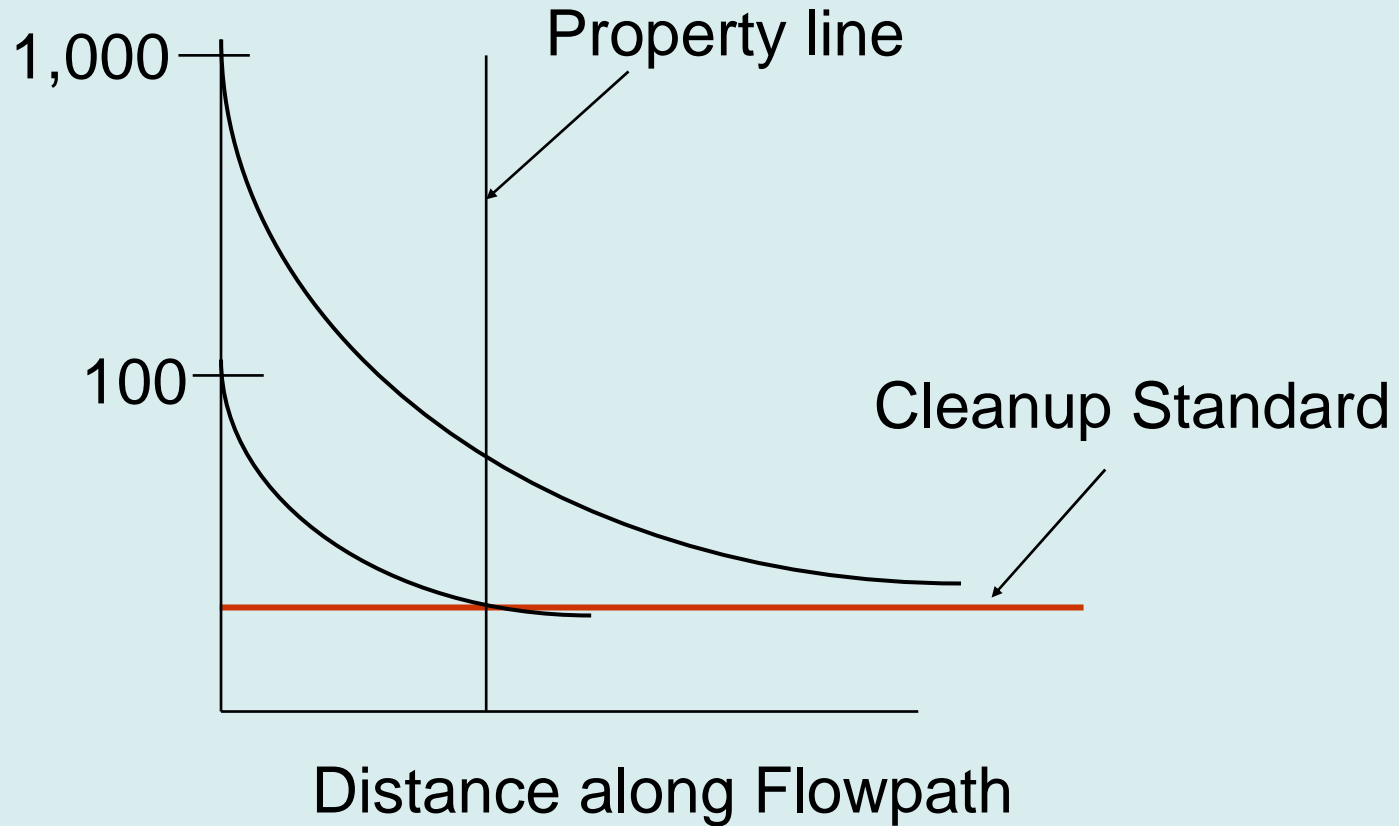
- ▶ We had very efficient natural attenuation.
 - But did not reach site-specific goals
- ▶ We knew where and how large the source areas were.
- ▶ How could we combine source-area control with MNA?
 - Pump-and-treat?
 - Excavation?
 - Chemical treatment?

The Conceptual Design:

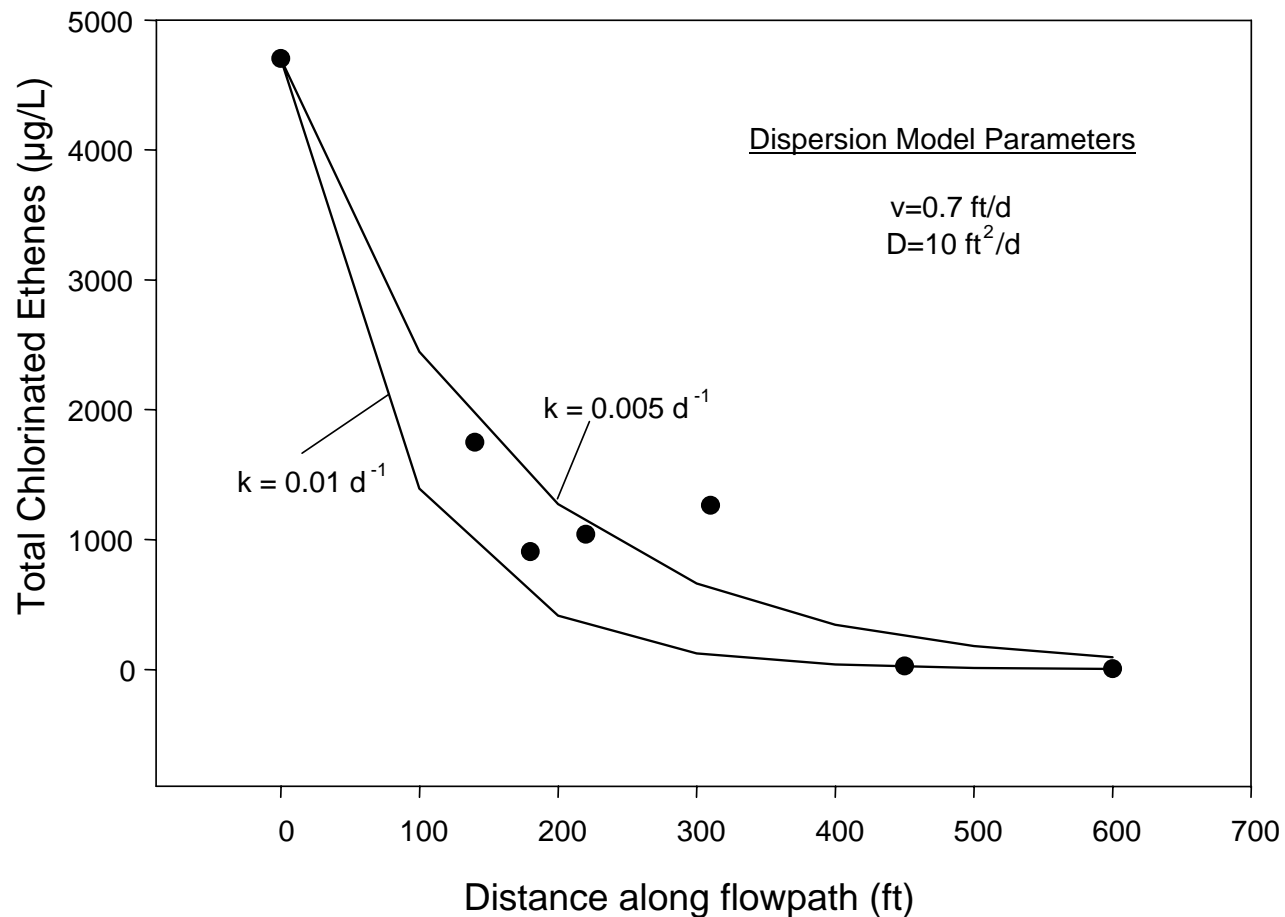
- ▶ Lower source-area contamination using chemical treatment (Fenton's reagent).
- ▶ Use natural attenuation to disperse contaminant plume.
- ▶ Problem: **what source-area concentration would be the remedial goal?**
 - The contractor could not commit to "zero".
 - What non-zero concentration was acceptable?

Can we use this natural attenuation capacity to identify cleanup goals?

Graphical View of the Problem



Natural Attenuation Capacity is indicated by the efficiency of observed contaminant degradation



Natural Attenuation Software (NAS)

(<http://www.cee.vt.edu/NAS>)

The screenshot displays the NAS software interface. At the top, there are logos for Virginia Tech, USGS (science for a changing world), and the Naval Facilities Engineering Command Southern Division. The main title "NAS Natural Attenuation Software" is prominently displayed in red. Below the title is a navigation menu with buttons for Home, Software, Support, Training, Authors, Publications, and Links.

The software window shows a menu bar (File, Site, TOS, TOR, Output, Window, Help) and a sidebar with a tree view containing "Cont. Datasets", "Redox Datasets", "Site Data", and "Data and Results Tabular Summary". The main window displays "TOS Graphical Output" with a sub-window titled "TOS Concentration vs. Time Curve".

The graph is titled "Total Chl. Eth. at 200.00 ft" and plots Concentration [µg/L] on the y-axis (0 to 70) against Time [yr] on the x-axis (2001 to 2003). A dropdown menu indicates the "Date of Source Reduction" is set to "6 / 1 / 2000". A checkbox labeled "View Range in Velocity" is checked. The graph shows three curves: a dashed line for "Min TOS", a solid line for "Ave TOS", and a dotted line for "Max TOS".

Time [yr]	Min TOS [µg/L]	Ave TOS [µg/L]	Max TOS [µg/L]
2001	10	60	60
2002	10	20	60
2003	10	10	45



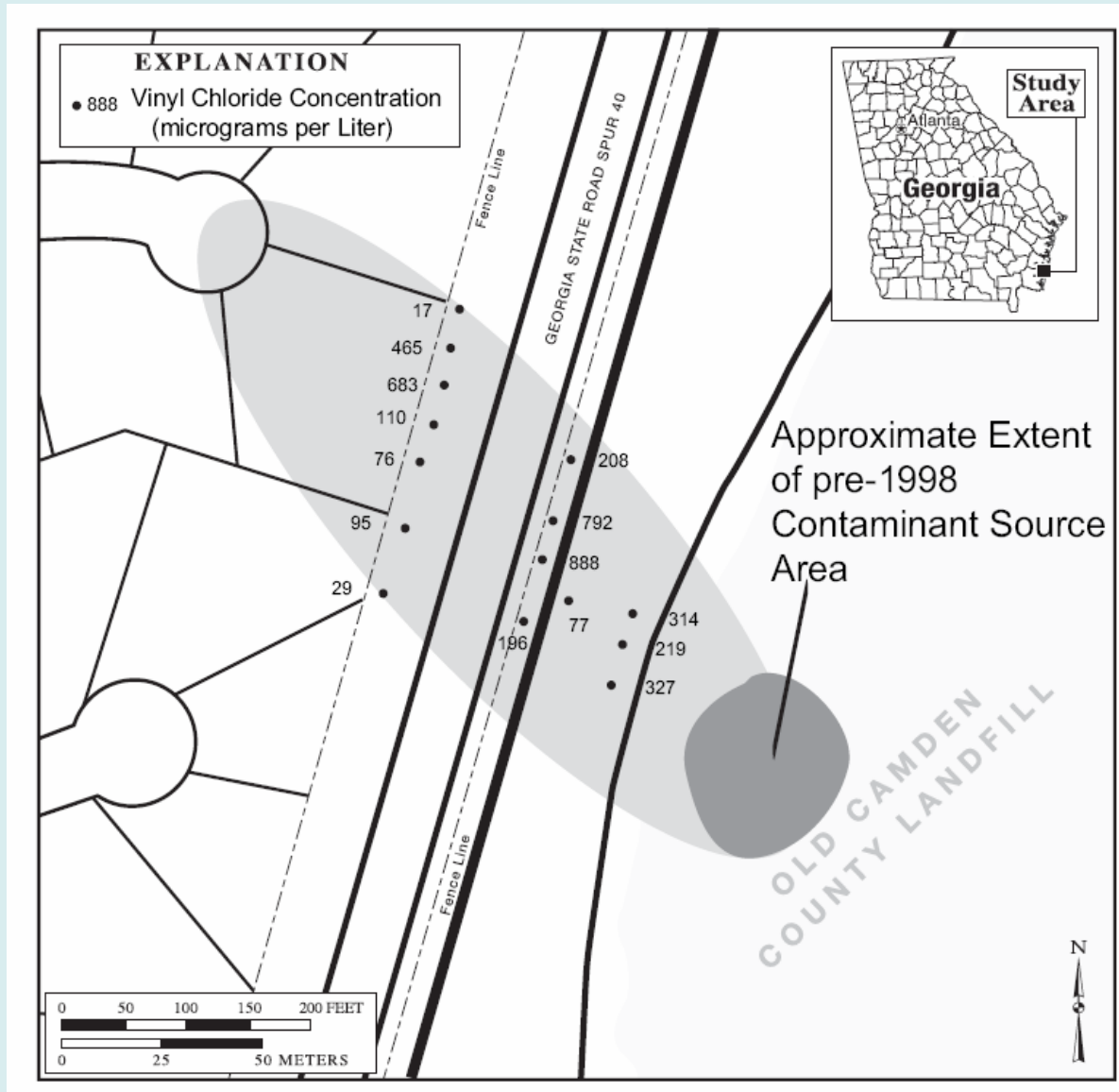
Fenton's Reagent : Injection Process



■ Geo-Cleanse
International, Inc.

Source: Dan Waddill, Southern Div, NAVFAC

Kings Bay, August 1998



KBA-13A Before & After Fenton's Treatment

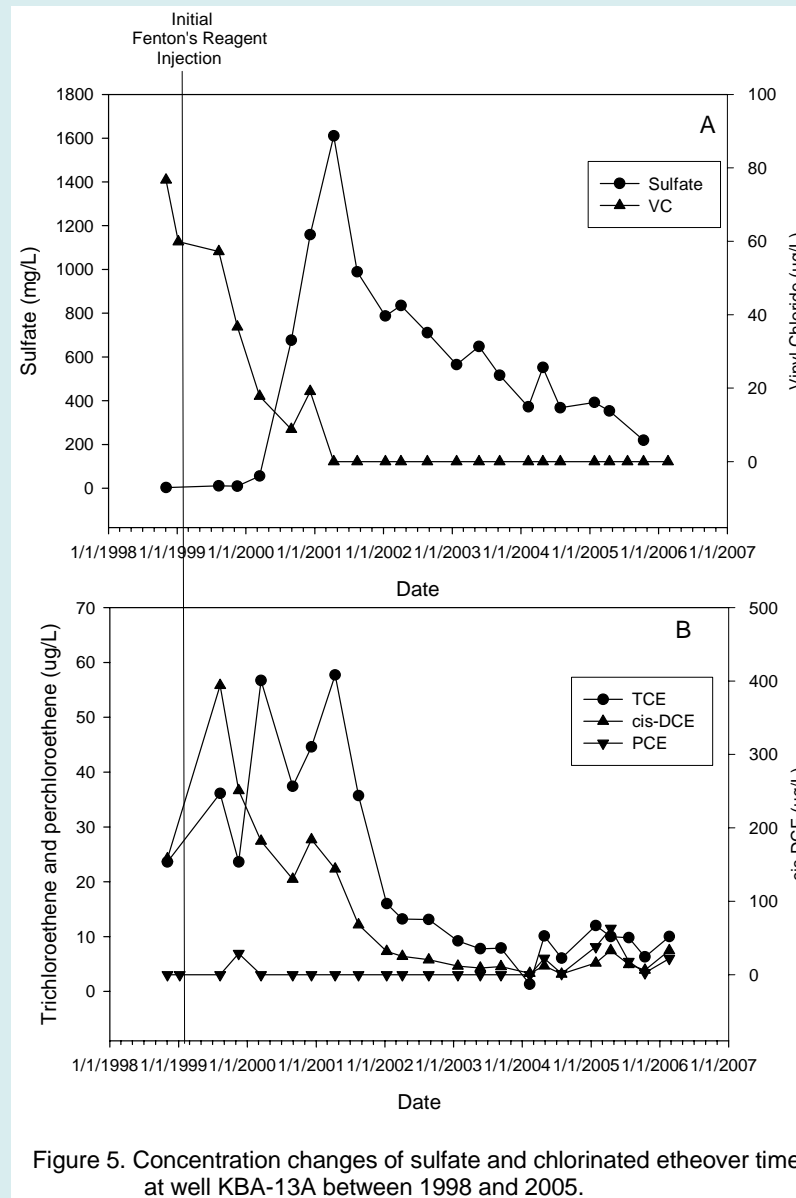


Figure 5. Concentration changes of sulfate and chlorinated ethene over time at well KBA-13A between 1998 and 2005.

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The software interface shows a menu bar with File, Site, TOS, TOR, Output, Window, and Help. The main window is titled "Natural Attenuation Software" and contains several panes: "Cont. Datasets", "Redox Datasets", "Site Data", "Data and Results Tabular Summary", and "TOS Graphical Output". The "TOS Graphical Output" pane is active, showing a graph titled "TOS Concentration vs. Time Curve".

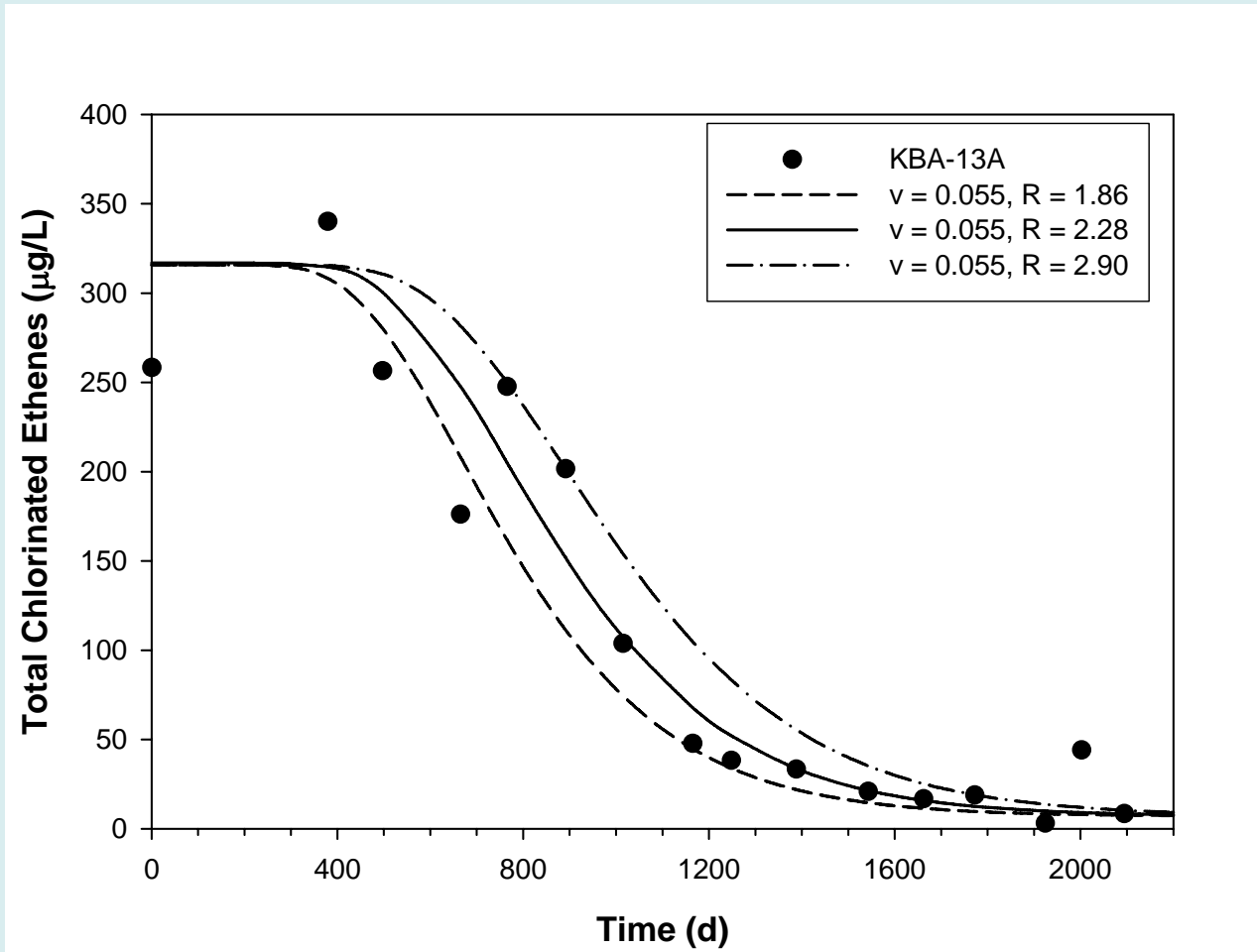
The graph displays "Total Chl. Eth. at 200.00 ft" on the y-axis (Concentration [µg/L]) and "Time [yr]" on the x-axis (years). The y-axis ranges from 0 to 70, and the x-axis ranges from 2001 to 2003. The graph shows three curves: a solid line for "Ave TOS", a dashed line for "Min TOS", and a dotted line for "Max TOS". The "Ave TOS" curve starts at approximately 60 µg/L in 2001 and decreases to about 10 µg/L by 2003. The "Min TOS" curve starts at approximately 60 µg/L in 2001 and drops sharply to about 10 µg/L by 2002. The "Max TOS" curve starts at approximately 60 µg/L in 2001 and decreases to about 40 µg/L by 2003.

Below the graph, there is a legend:

- Min TOS
- Ave TOS
- ... Max TOS

At the top of the graph area, there is a text box: "1. Enter the Date of Source Reduction if different from the current Dataset Date." with a dropdown menu showing "6/1/2000". There is also a checkbox labeled "View Range in Velocity" which is checked.

NAS Simulation of KBA-13A



Remediation at Kings Bay is proceeding as expected



Kings Bay is an example of how, when hydrologic conditions are favorable, combining source area removal with MNA can be an effective remediation strategy