Role of Treatability Testing in Remediating Dry Cleaner Sites

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Treatability Basics

- Treatability testing = bench-scale testing
- Treatability testing is performed in the lab to
  - evaluate an emerging remediation technology
  - obtain design parameters for field application
  - address site-specific issues
- Treatability testing provides better understanding of technology
  - enables better design of remediation approach
  - raises comfort level of client, regulators, and stakeholders

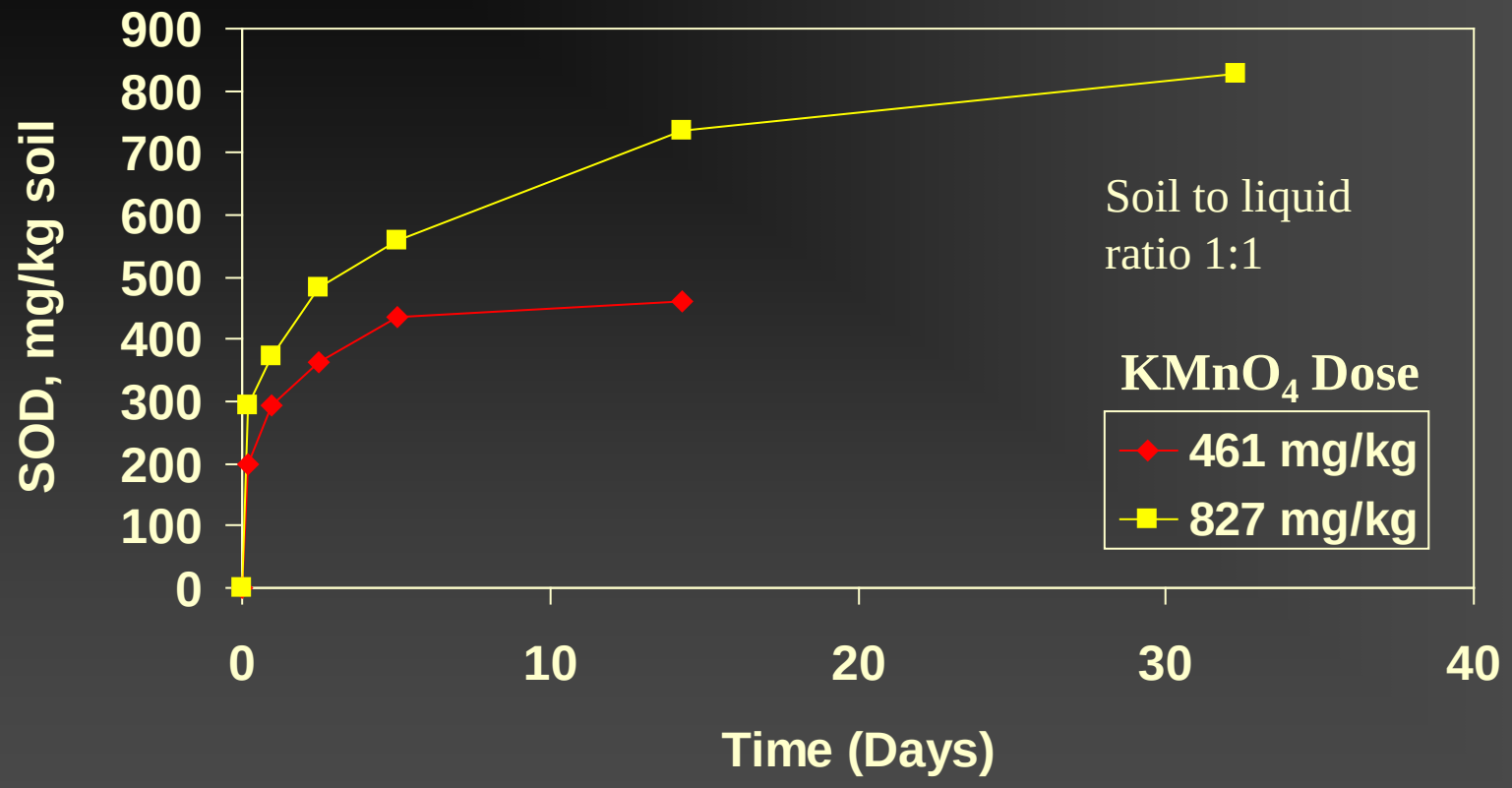
Site 1--Background

- Dry cleaner site in Glenn County, CA
- Soil is slightly weathered gravel, sand, silt, and clay (Modesto Formation)
- Depth to groundwater is 15-20 ft
- Plume extends 11,000 ft from source
  - Max PCE concentration ~ 61 μg/L
  - Several private wells affected
  - No natural bio-attenuation (reductive dechlorination) apparent (ie, no PCE daughter products; high DO; and low TOC, nitrite, sulfide and ferrous iron)

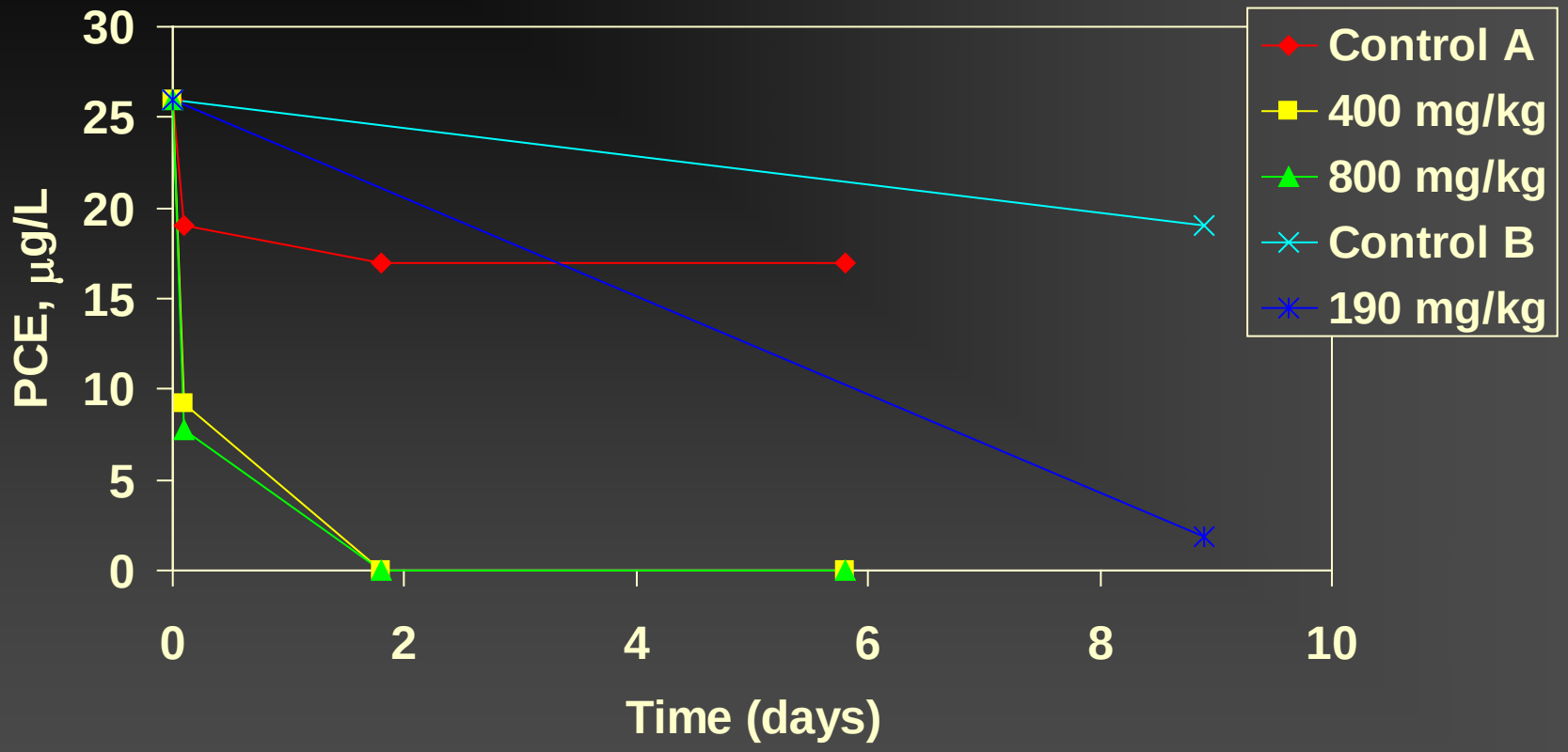
Site 1—Treatability Test Goals

- Evaluate $KMnO_4$
  - Confirm removal of PCE by $KMnO_4$
  - Measure $KMnO_4$ soil oxidant demand (SOD)
  - Measure effect of treatment on secondary water quality parameters such as pH, Cr(VI)
- Assess fate of Cr(VI), if necessary

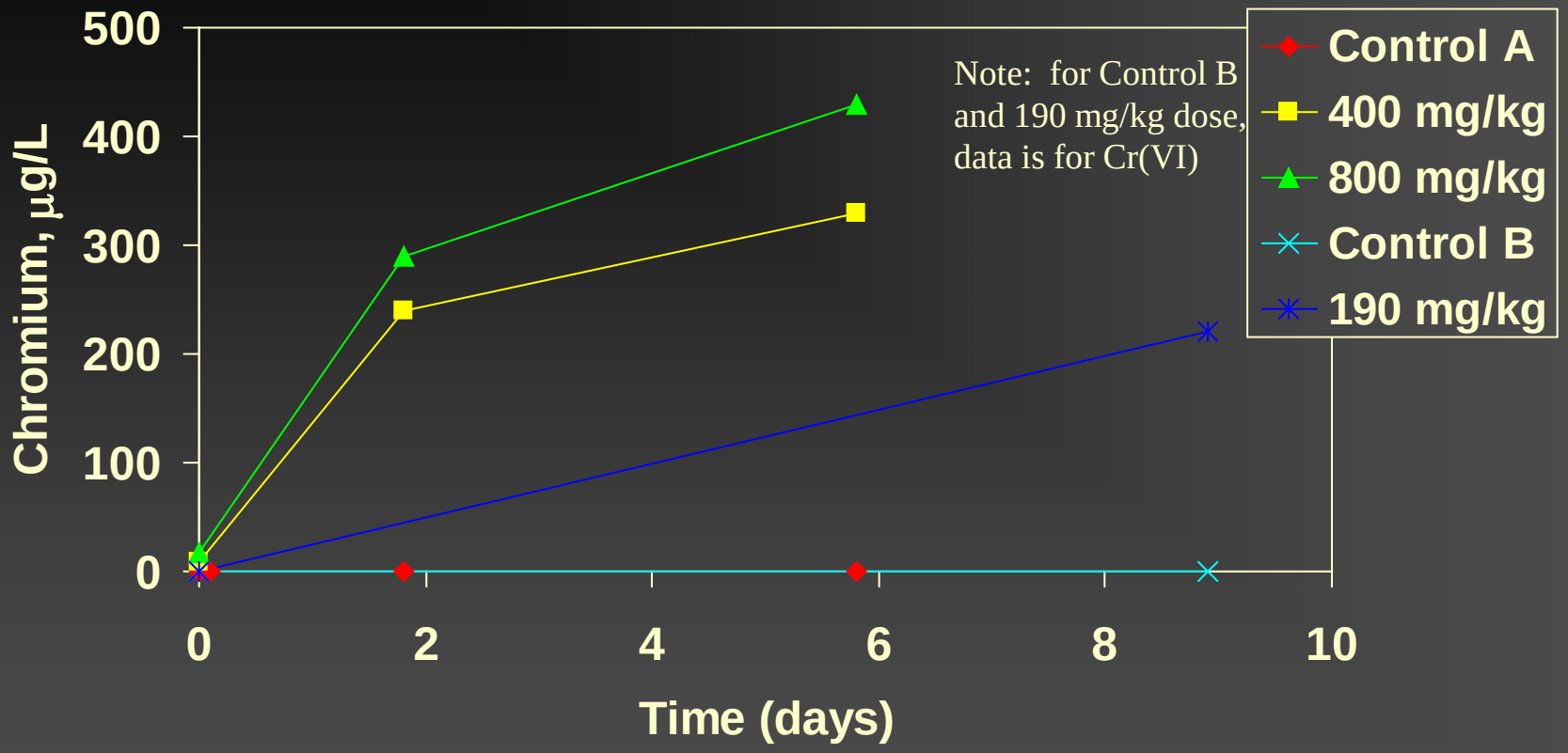
Site 1—Soil Oxidant Demand



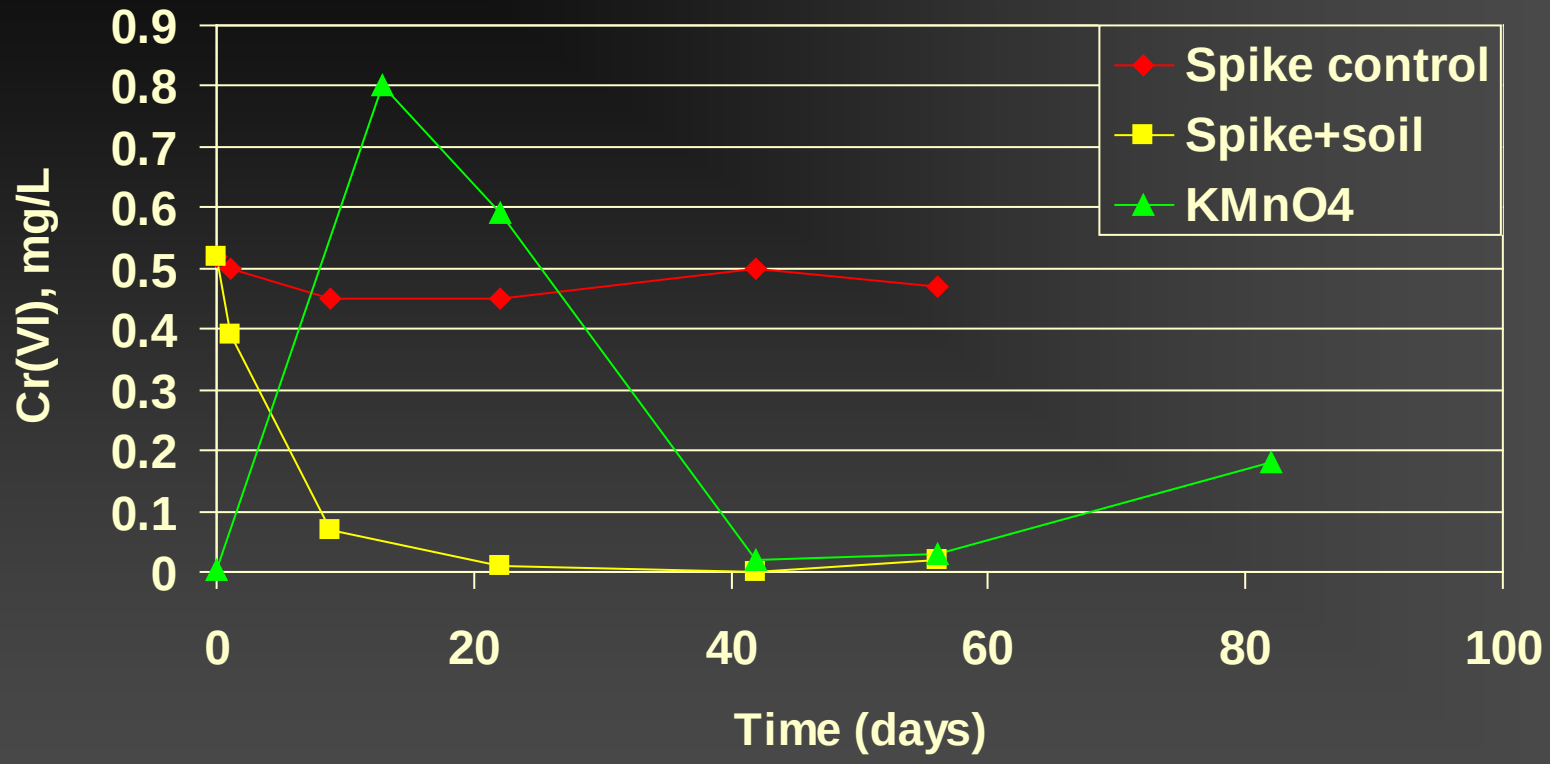
Site 1—PCE Removal



Site 1—Total Chromium



Site 1—Fate of Cr(VI)



Site 1—Summary & Conclusions

- PCE removed at $KMnO_4$ dose of 400 mg/kg soil, but not 190 mg/kg soil
- SOD low—about 430-560 mg/kg at 5 days
- Cr(VI) formed upon exposure of soil to $KMnO_4$
- Cr(VI) attenuated but was not completely removed in lab tests
- *$KMnO_4$ eliminated as a remediation option for this site*

Site 2--Background

- Dry cleaner site in Sacramento Valley
- Soil is mostly fine-grained sediment and sand
- Groundwater is about 85 ft bgs
- Max PCE concentration about 300 μg/L as of April 2002
- No natural attenuation apparent (ie, no PCE daughter products)

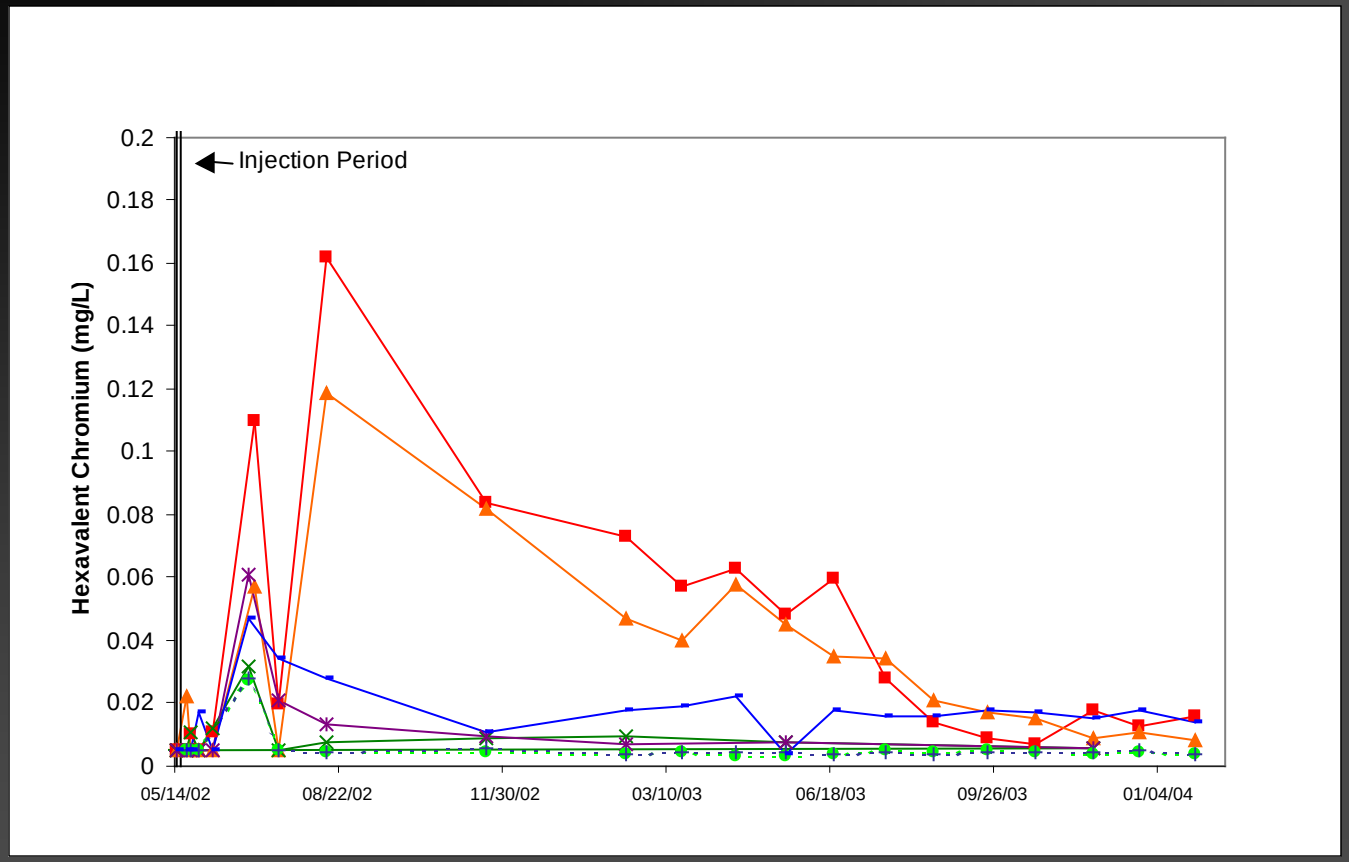
Site 2—Background, cont'd

- $KMnO_4$ bench test performed in 2001
  - SOD found to be 110-160 mg/kg soil
  - PCE rapidly removed at $KMnO_4$ dose of 1,200 mg/kg
  - $KMnO_4$ treatment did not increase Cr(VI) concentration

Site 2—Field Pilot Test

- Field pilot test performed in May 2002
- PCE concentrations were initially non-detect after one $KMnO_4$ injection, then rebounded slightly; overall reduction of 83-90% after 22 months
- Cr(VI) concentrations rose, then declined, but remain above background
  - Max concentration 160 μg/L
  - Concentrations below 20 μg/L by 14 months
  - Background 3-6 μg/L

Site 2—Post-Injection Cr(VI)



Site 2—Treatability Test Goals

Identify post-treatment options to address Cr(VI) after full-scale treatment with $KMnO_4$

- Evaluate calcium polysulfide (Cascade) for *in situ* reduction of Cr(VI) to below background
- Evaluate Sulfur-Modified Iron (SMI) for *ex situ* remediation of Cr(VI)

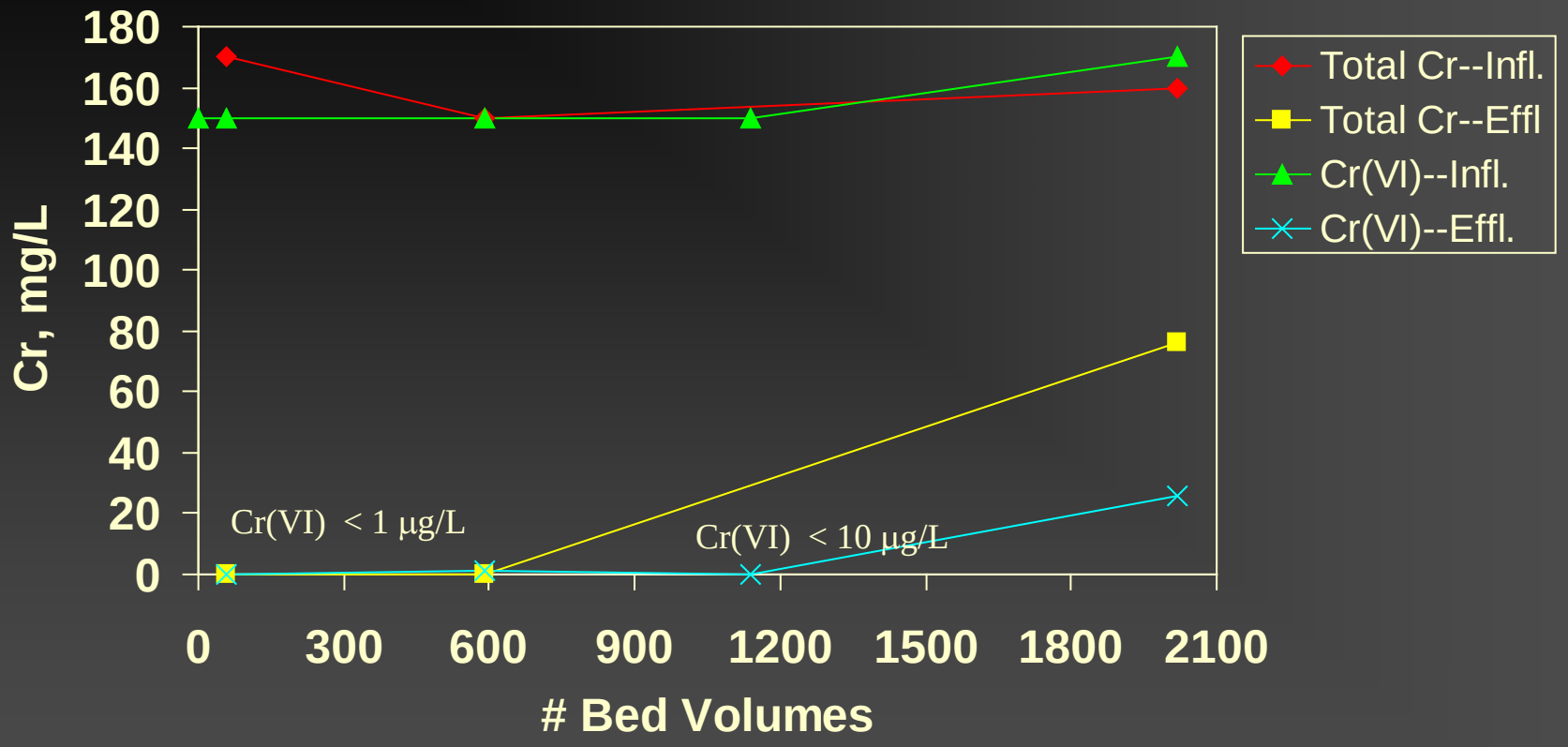
Site 2--Procedures

- Evaluation of Cascade—batch tests
  - Combine soil, groundwater (with $KMnO_4$ or spiked with Cr(VI)) and various doses of Cascade
  - Measure pH and Cr(VI) after suitable time
- Evaluation of SMI—column test
  - Run column upflow at 4 mL/min (5 min EBCT)
  - Influent is Cr(VI)-spiked GW
  - Periodically, measure Cr(VI), total Cr, and or pH in influent and effluent

Site 2—Cascade Results

Test	Total Cr, μg/L	Cr(VI), μg/L
$KMnO_4$: Control	15	Not meas.
with 5 mL Casc/L	< 2	< 1
High Cr: Control	210	180
with 5 mL Casc/L	< 2	< 1
with 2.5 mL Casc/L	Not meas.	< 1
with 1 mL Casc/L	Not meas.	2.0
Low Cr: Control	26	26
with 5 mL Casc/L	< 2	< 1

Site 2—SMI Results



Site 2—Summary & Conclusions

- Cr(VI) formed during $KMnO_4$ treatment can be managed *in situ* with Cascade
  - Cr(VI) and Cr removed to below background at dose of 1 mL Cascade/L soln.
  - Cascade also removed excess $KMnO_4$
- Total Cr and Cr(VI) can be managed *ex situ* using an SMI column
  - Optimum operating conditions to be determined
  - Post-treatment to remove iron may be needed

Conclusions

- Treatability testing can evaluate potential remediation technologies for dry cleaner sites—focus may be on secondary effects rather than oxidation of PCE
- Treatability testing can determine design parameters for field applications
- Treatability testing can help resolve unexpected issues that arise during field implementation