Cox-Colvin
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ENVIRONMENTAL SERVICES

Successful Closure of a DNAPL Site

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Topics for Discussion

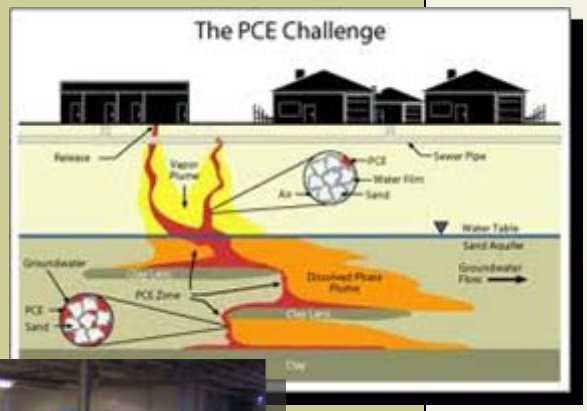
- What is DNAPL and why are DNAPL sites so difficult to close.
- What is DNAPL site closure.
- What is the approach to successful closure.
- Case study of a successful DNAPL site closure.
- Lessons Learned.

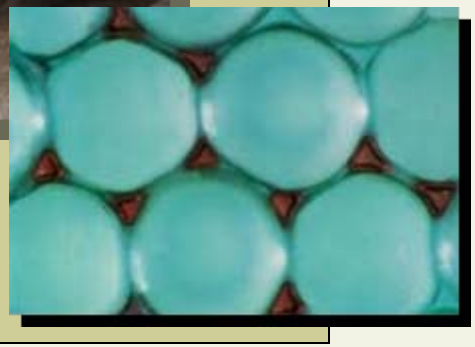
What is a DNAPL?

- DNAPL is a “Dense Non-Aqueous Phase Liquid”
- DNAPLs include:
  - halogenated solvents,
  - coal tar and creosotes, and
  - PCB oils.
- Most common form at environmental sites are the halogenated solvents.

Why are DNAPL Sites Difficult?

- Extreme concentration,
- High toxicity,
- Varied migration mechanisms,
- Location of the source, and
- Wetting (residual saturation).





What is DNAPL Site Closure?

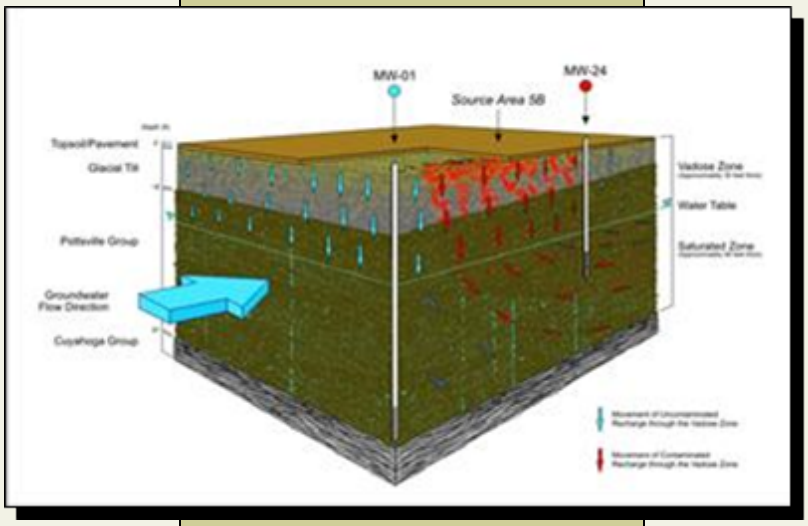
- DNAPL site closure is a negotiated truce based on:
  - Setting and meeting realistic expectations,
  - Reducing source strength,
  - Containment, and
  - Risk reduction.
- Requires a prolonged partnership between the site owner, the regulator, and the community.

What is DNAPL Site Closure?

- Relies on:
  - Detailed site characterization activities,
  - Establishing and attaining site-specific alternate concentration limits (ACLs),
  - The likely require use of institutional controls.
- Expensive and time consuming.

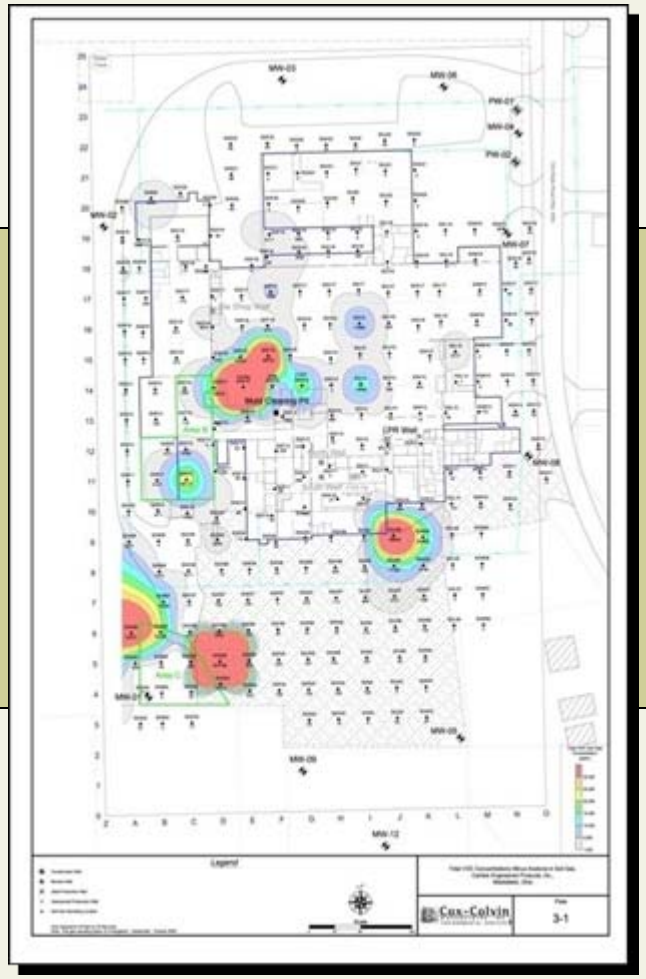
Approaching Closure – Step 1

- Prepare for assessment:
  - Develop a Conceptual Site Model (CSM) and a Conceptual Site Exposure Model (CSEM),
  - Develop Data Quality Objectives,
  - Review site history,
  - Get the “Real Story”, and
  - Expect to manage lots of data.



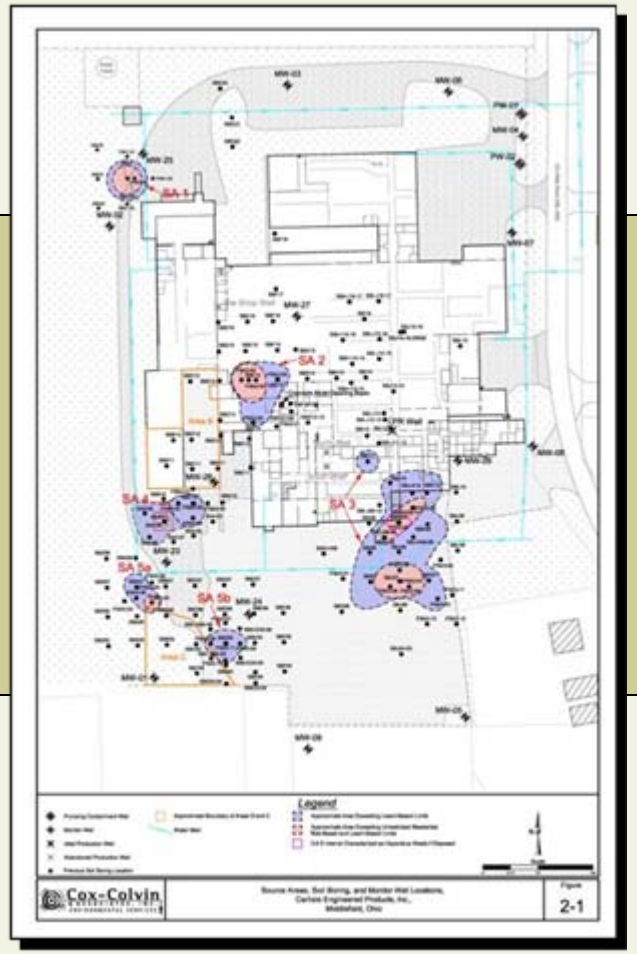
Approaching Closure – Step 2

- Complete an initial assessment:
  - Use screening methods to focus your efforts,
  - Work from the outside – in,
  - Update the CSM and CSEM,
  - Discuss, if possible, your findings and the proposed scope of investigative activities with your regulator.



Approaching Closure – Step 3

- Begin a detailed, phased-investigation to evaluate source strength.
  - Work in 3-dimensions,
  - Collect complete data sets,
  - Establish extent,
  - Don't disregard certain rules of thumb – DNAPLS can be difficult to locate.
- Establish weight- or volume-based source strength estimates.



Approaching Closure – Step 4

- Establish “Phase-Specific” performance goals to direct remediation:
  - Short-term (mitigation of the immediate risks),
  - Intermediate-term (source depletion and reduction of dissolved load),
  - Long-term (achieve regulatory compliance or risk-based criteria).
- Not necessarily numeric standards.

Approaching Closure – Step 5

- Begin phased remediation effort to meet the short-, intermediate-, and long-term goals.
- Expect to change technologies as your goals change.
- Collect real-time data to document source depletion efforts.
- Collect confirmation samples.

Approaching Closure – Step 6

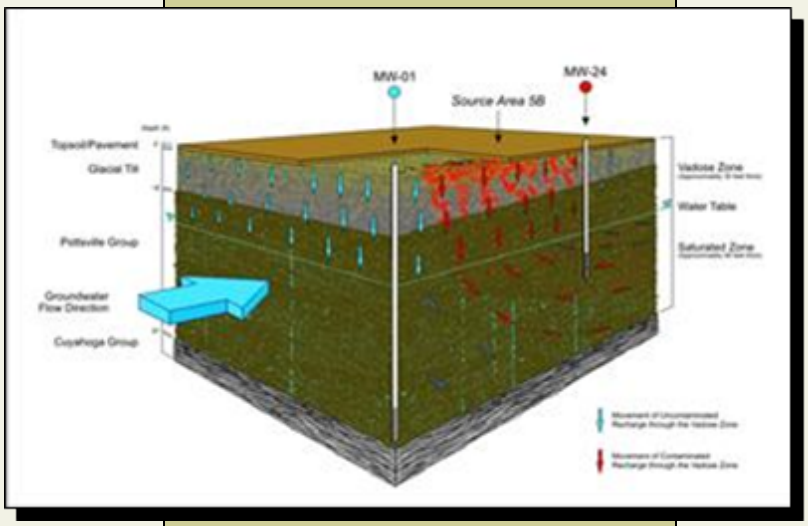
- Repeat Step 5
- Develop and Implement Post-Closure Care and Monitoring Strategies.
- Establish Institutional Controls.

Case Study

- Background:
  - Metal recycler using TCE as a degreaser.
  - Catastrophic release of 500 gallons from a ruptured tank within the facility.
  - Site underlain by glacial till with shallow perched water zones.
  - Regional aquifer lies approximately 100 feet below grade.
  - Heavily industrialized area.

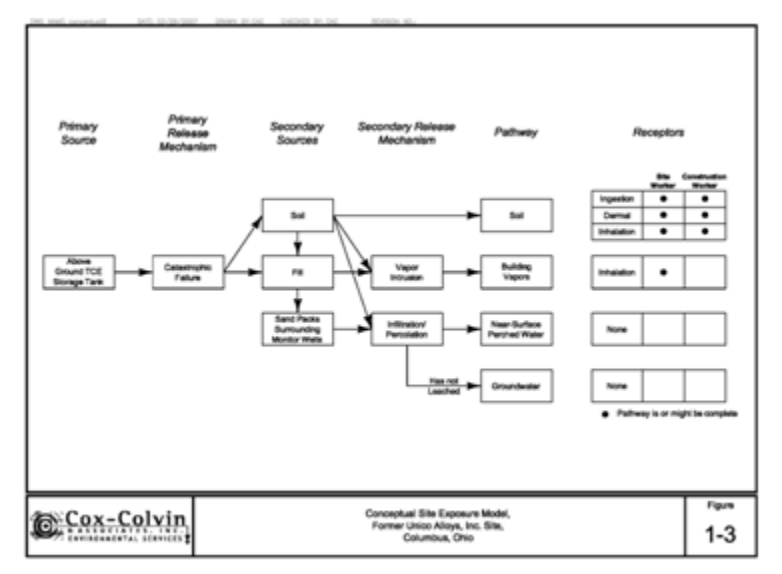
Case Study

- Conceptual Site Model:
  - Unknown quality of TCE affected soils adjacent to the building.
  - Bulk of the TCE trapped beneath the building slab.
  - Sub-slab vadose zone is very thin due to near-surface perched water zone.
  - TCE contained on-site.
  - TCE concentrations decrease with depth.
  - Regional aquifer protected by thick, dense till layer.



Case Study

- Conceptual Site Exposure Model:
  - Potential for site and construction workers to be exposed to TCE in soil through ingestion, dermal contact, and inhalation.
  - Potential for site workers to be exposed to TCE in indoor air through inhalation.

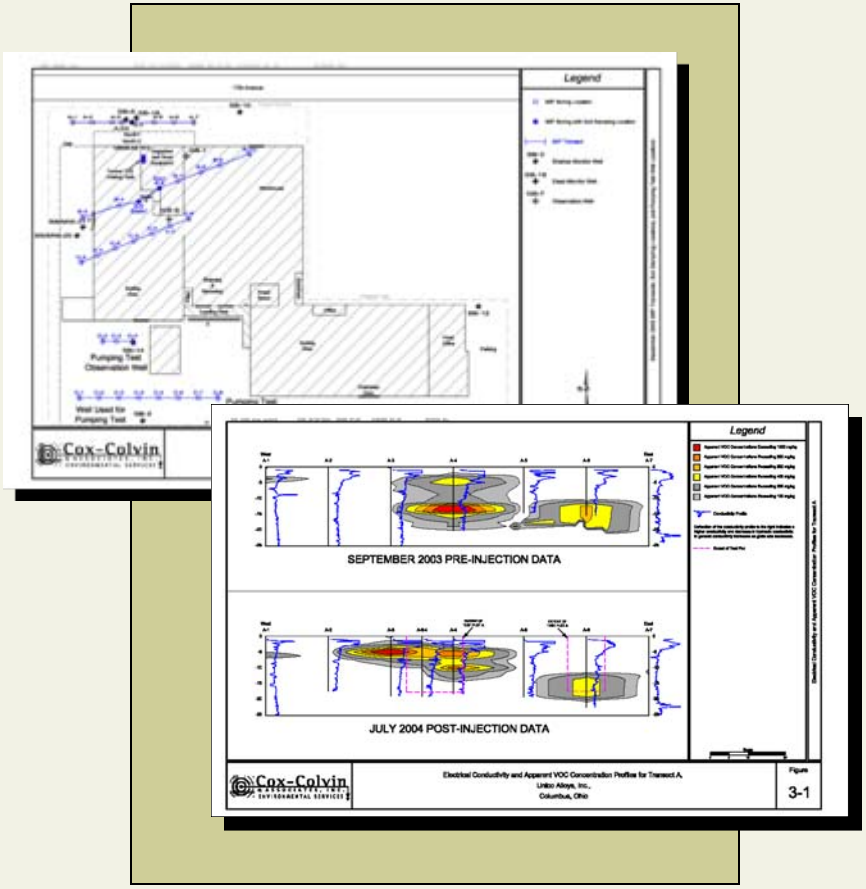


Case Study

- Implement short-term response.
  - Excavation and disposal of affected soils surrounding the building.
  - Excavation of a small drainage swale along the highway.
- Activities reduce the source strength by an estimated 20% (approximately 100 gallons).

Case Study

- Assessment/Investigation
  - Reviewed historic site concentration data in soil and groundwater.
  - Refined the 3-dimension understanding using a Membrane Interface Probe (MIP) and additional soil and groundwater sampling.
  - Established intermediate-term goal of depleting TCE concentrations to below 580 mg/kg (soil saturation limit).

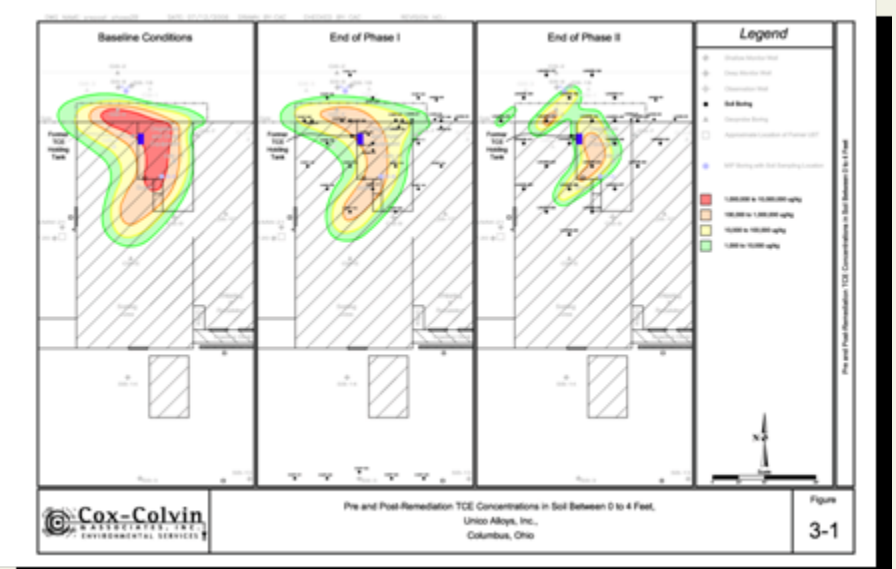


Case Study

- Implement intermediate-term response
  - Two phases of HVDPE and chemical oxidant (potassium permanganate) flooding.
  - Log vapor concentrations in the extracted air stream using an in-line PID.
  - Analyzed TCE concentrations in extracted water prior to disposal.
  - Completed detailed 3-dimensional re-sampling of soil profile after each phase.

Case Study

- Implement intermediate-term response (continued)
  - Used volumetric mapping techniques to evaluate remaining TCE mass in place.
  - Collected additional groundwater data.
- TCE source depleted by an additional 70% (approximately 366 additional gallons, 466 gallons in total).

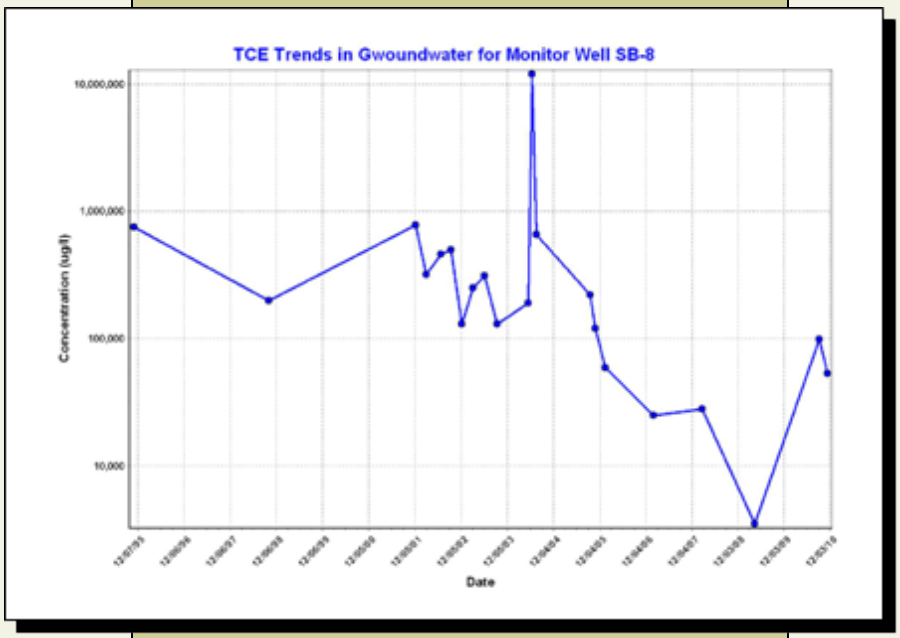


Case Study

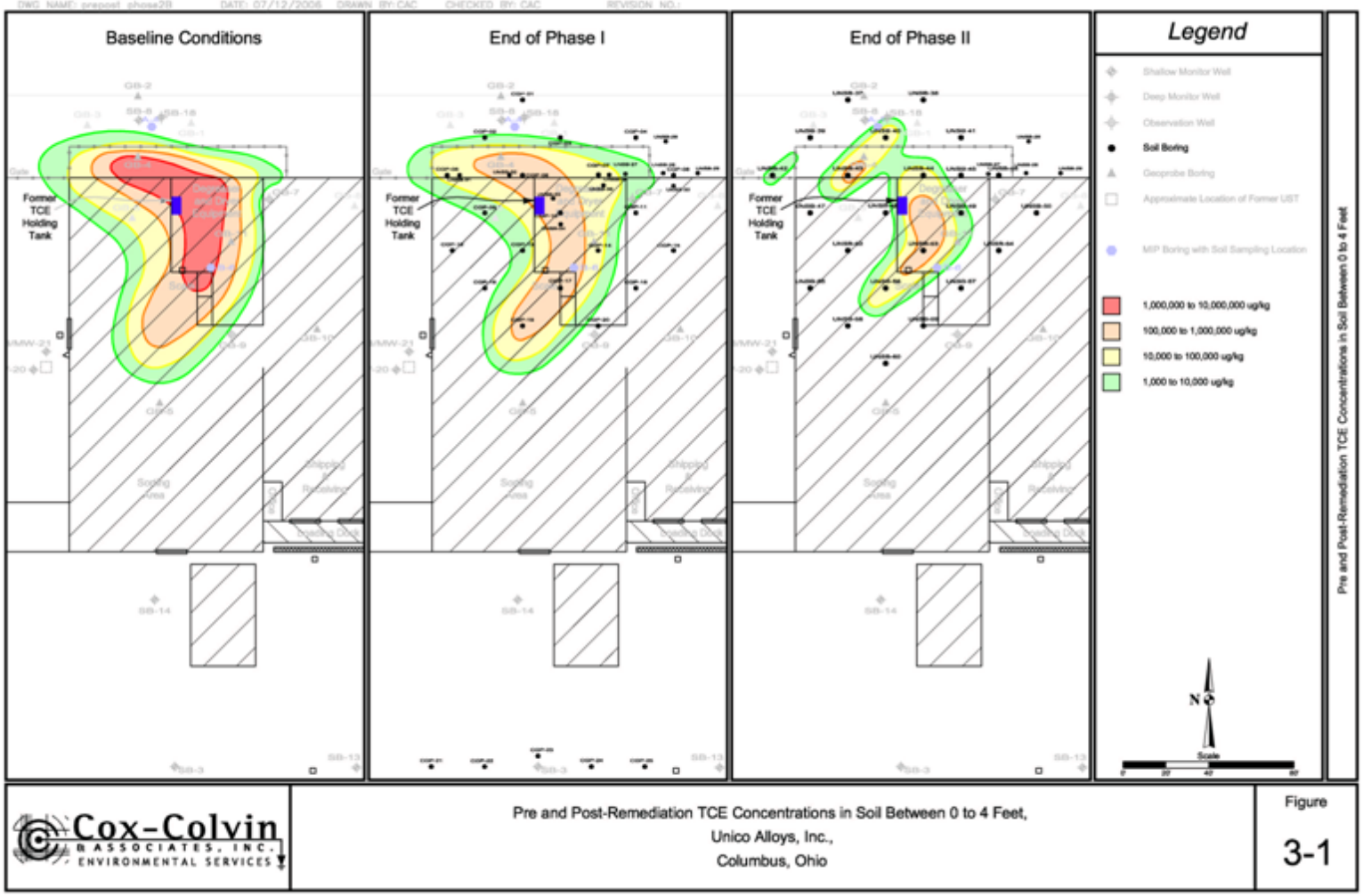
- Risk Assessment
  - Collected and evaluated sub-slab and indoor air samples.
  - Completed risk assessment based on air samples and post-remediation soil and groundwater samples.
  - Hazard index and excess lifetime cancer risk were within acceptable risk ranges.

Case Study

- Implement long-term response
  - Prepared a Post-Closure Care and Monitoring Program.
  - Established deed restrictions prohibiting groundwater use.
  - Established a groundwater ACL of 36,000 ug/l as a predictor of vapor intrusion for a potential future off-site receptor.
  - Monitor groundwater semi-annually and indoor air annually.



Remedy


Baseline Conditions
End of Phase I
End of Phase II
Former TCE Holding Tank
Legend
Shallow Monitor Well
Deep Monitor Well
Observation Well
Soil Boring
Geoprobe Boring
Approximate Location of Former UST
MIP Boring with Soil Sampling Location
1,000,000 to 10,000,000 ug/kg
100,000 to 1,000,000 ug/kg
10,000 to 100,000 ug/kg
1,000 to 10,000 ug/kg
N
Scale
Pre and Post-Remediation TCE Concentrations in Soil Between 0 to 4 Feet
Cox-Colvin & Associates, Inc.
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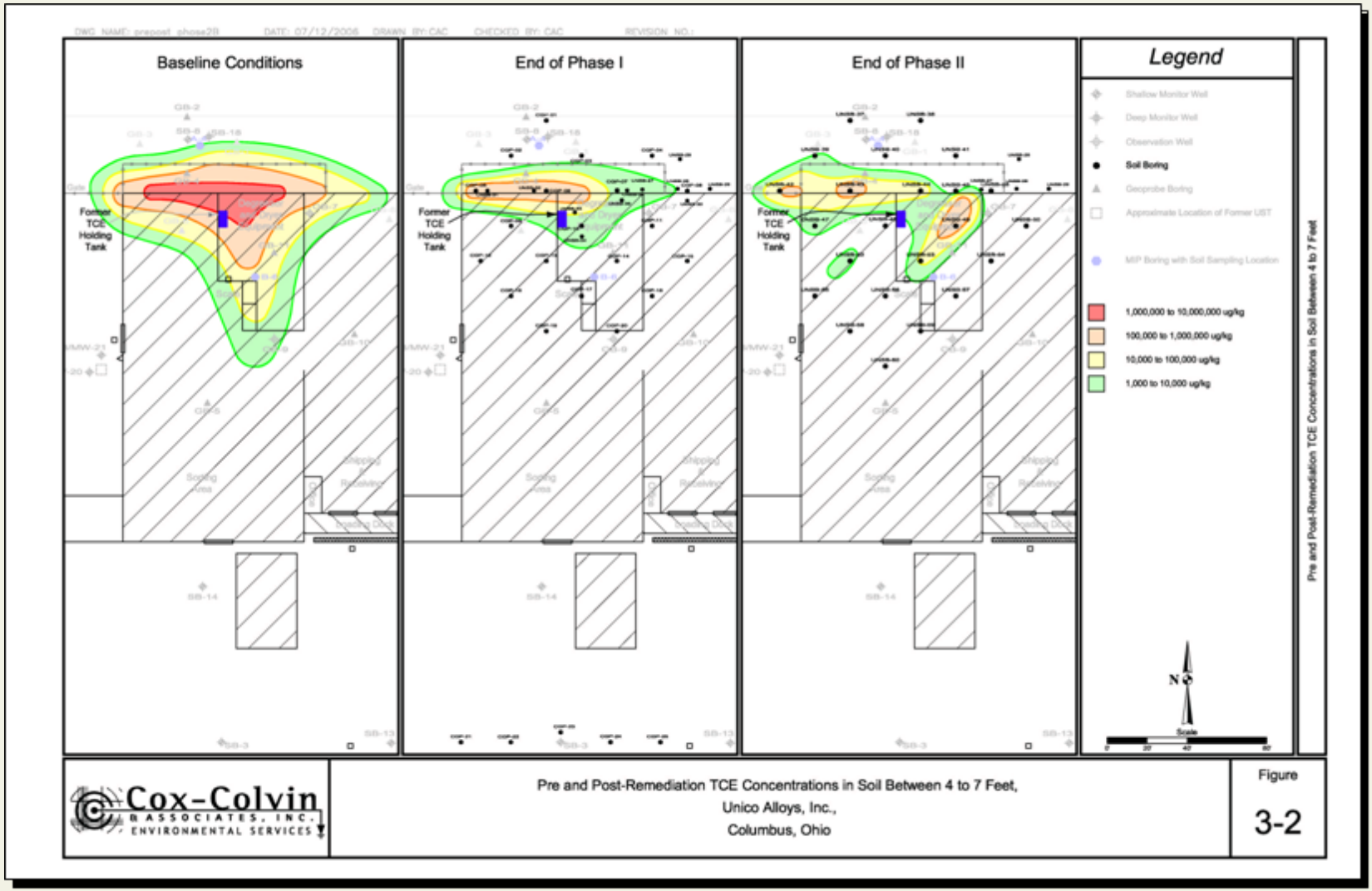
Pre and Post-Remediation TCE Concentrations in Soil Between 0 to 4 Feet,
Unico Alloys, Inc.,
Columbus, Ohio
Figure
3-1

Remedy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Scale
Pre and Post-Remediation TCE Concentrations in Soil Between 4 to 7 Feet
Cox-Colvin & ASSOCIATES, INC.
ENVIRONMENTAL SERVICES
Pre and Post-Remediation TCE Concentrations in Soil Between 4 to 7 Feet,
Unico Alloys, Inc.,
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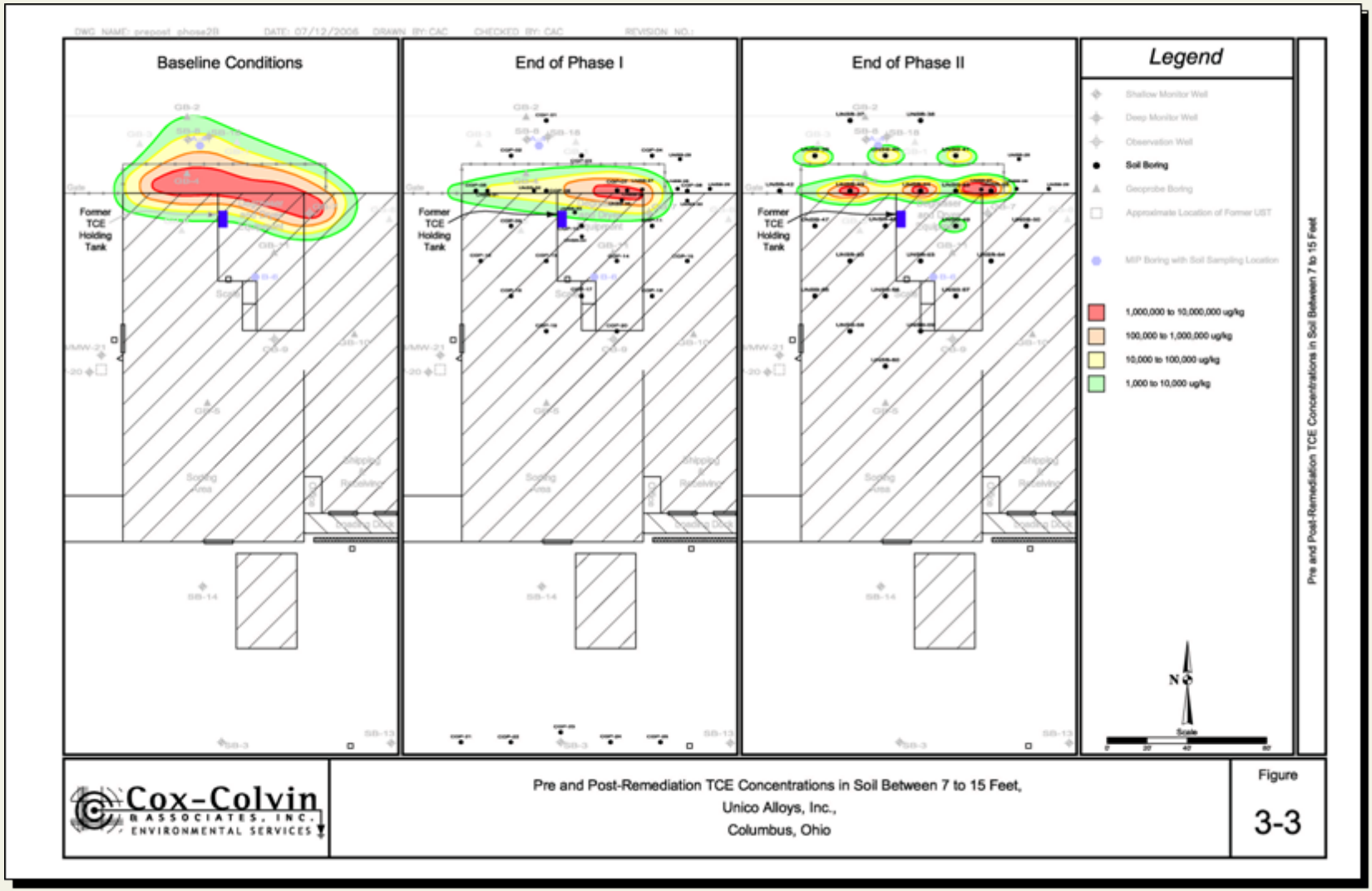
Figure
3-2

Remedy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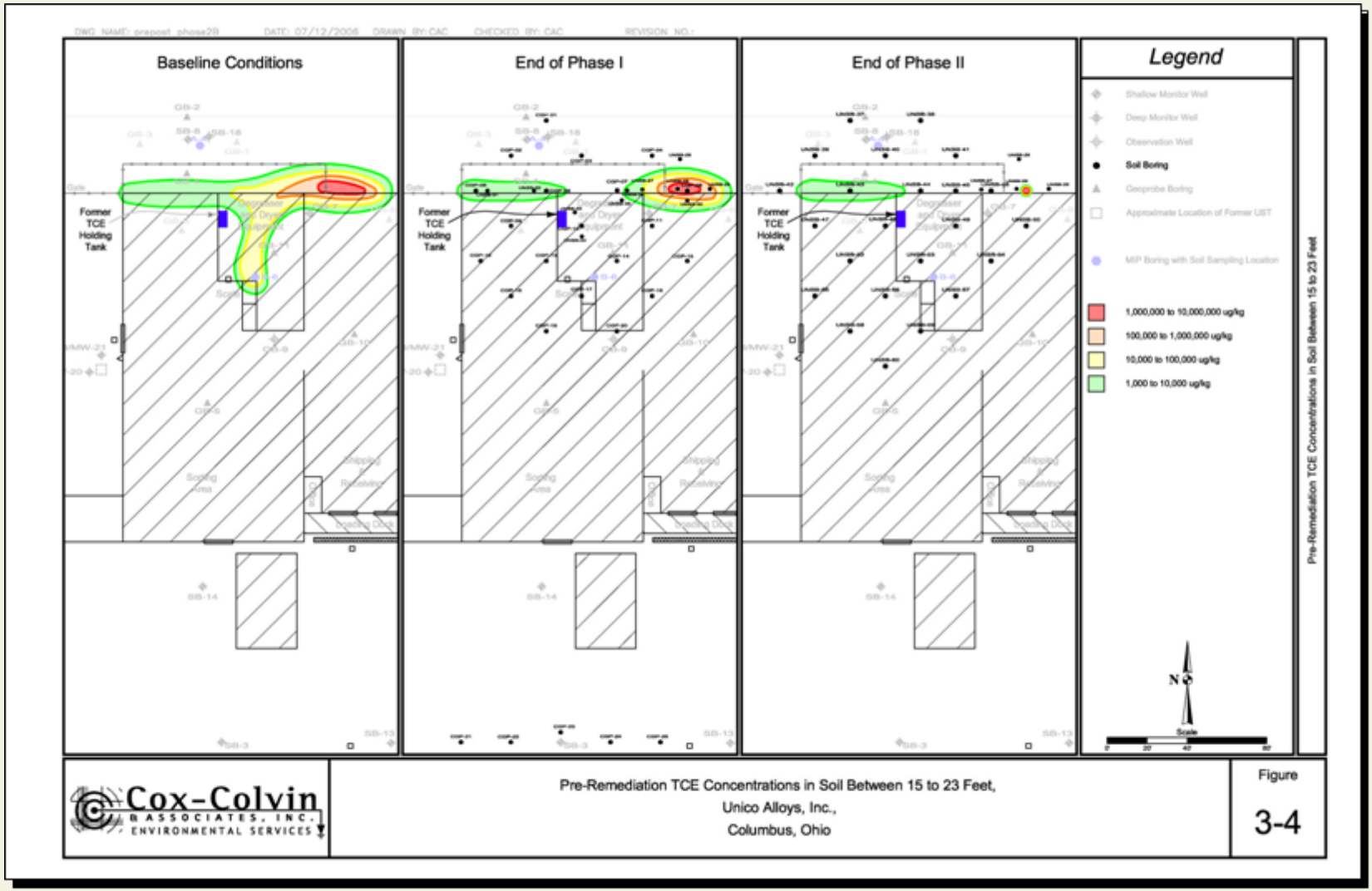
100,000 to 1,000,000 ug/kg
10,000 to 100,000 ug/kg
1,000 to 10,000 ug/kg
N
Scale
Pre and Post-Remediation TCE Concentrations in Soil Between 7 to 15 Feet
Cox-Colvin & Associates, Inc.
Environmental Services
Pre and Post-Remediation TCE Concentrations in Soil Between 7 to 15 Feet,
Unico Alloys, Inc.,
Columbus, Ohio
Figure
3-3

Remedy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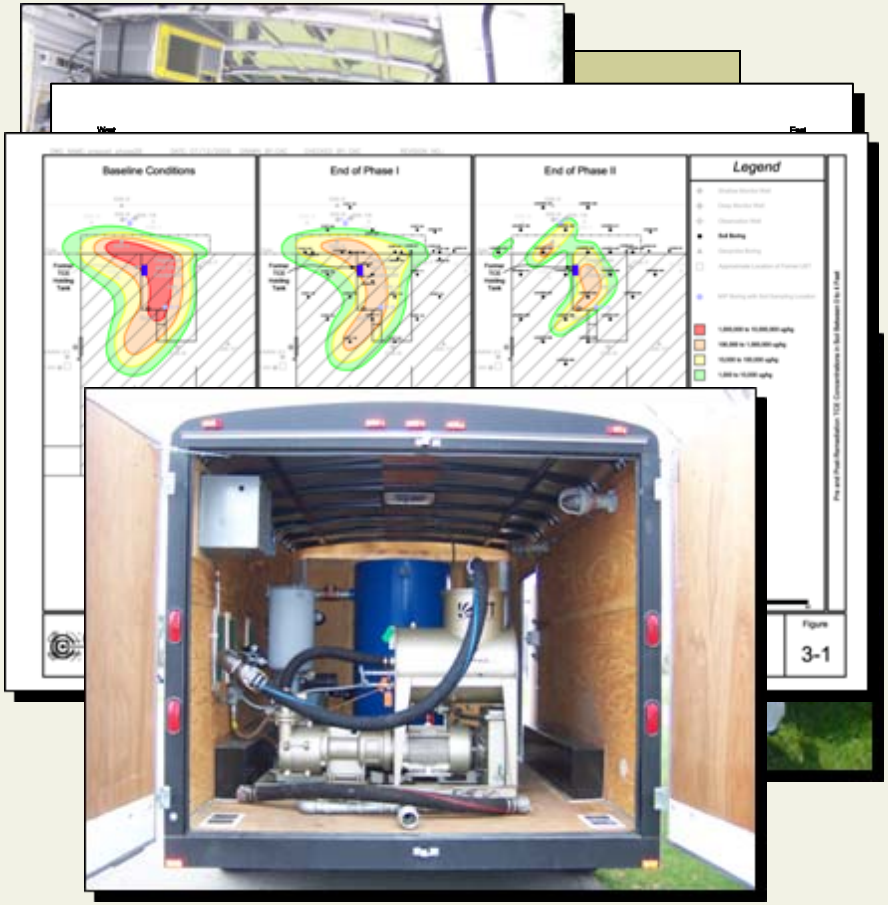
1,000,000 to 10,000,000 ug/kg
100,000 to 1,000,000 ug/kg
10,000 to 100,000 ug/kg
1,000 to 10,000 ug/kg
Pre-Remediation TCE Concentrations in Soil Between 15 to 23 Feet
N
Scale
Cox-Colvin & Associates, Inc.
Environmental Services
Pre-Remediation TCE Concentrations in Soil Between 15 to 23 Feet,
Unico Alloys, Inc.,
Columbus, Ohio
Figure
3-4

Lessons Learned

- Use MIP to sneak up on the source.
- Injecting fluids can move the source and provide a false indication of success.
- Document source depletion through extensive sampling efforts.
- Use volumetric mapping techniques to estimate source strength.
- Be flexible in choosing treatment technologies.
- It is possible to remediate tills using HVDPE.



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