

Lessons Learned Applying Multiple Remediation Technologies at Air Force Plant 4





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Air Force Plant 4



- Occupies ~750 acres near Fort Worth, Texas
- Manufacturing military aircraft since 1942
- Includes portions of former Carswell AFB/NAS Fort Worth Joint Reserve Base







Hydrogeologic Setting





- Groundwater divide along Bldg 5
 - Eastward West Fork of the Trinity River
 - Westward flow to Meandering Road Creek (MRC)

- Terrace alluvial deposits
- Goodland Limestone
- Walnut Formation
- Paluxy Formation
 - Upper, middle and lower zones
- Glen Rose Formation





TCE Plume Areas of Concern





- Building 181 (B181)
 - Source of eastern plume
- East Parking Lot (EPL)
 - Dissolved-phase plume
- Carswell Area (CWA)
 - Southern Lobe of the EPL Plume
- Landfill 1 and Landfill 3 (LF1&3)
 - DNAPL source and dissolved-phase plume
- Chrome Pit 3 (CP3)
 - Chrome waste disposal pit
 - Separate TCE source from B181



AFP4 Remedial Technologies

Technology assessments bolded and underlined



LF1

Excavation (1983/1984) **ISCO** (2008) EISB (2010)





EPL

P&T (1993-2015)

EISB (2013-2018)

CWA P&T (1994-2002) Phyto (1996-2005) **ZVI PRB** (2002) Off-base ICs (2007) **PRB** extension & conversion to EISB (2013 - 2015)





AFP4 Regulatory Status

- Current 1996 Record of Decision (ROD) contains alternate concentration limits for on-Federal-property groundwater
- ROD Amendment (ROD-A) requested to address long-term protectiveness of groundwater
- Air Force planning for ROD-A under an AFCEC Complex Site Initiative (CSI)
 - Deep dive into site data
 - Identify data gaps
 - Provide in-depth assessments/updates of remediation strategies
 - Determine feasibility of reaching remedial objectives using existing technology
 - Formulate action plans to take sites toward closeout





Remediation History and "Select" Technology Assessments



B181 Remediation History



In 1991, 20,000 gallons of TCE spilled from the bottom of a vapor degreaser tank

- B181 technologies discussed below
 - SVE
 - 1993 2002
 - ERH (6-phase) with SVE
 - 2002 2004





Building 181 SVE Performance Assessment



- Pilot test in 1993, full scale in 1999
- Operation from 1993 to 2002
- Removal rates started high and became asymptotic by 2000
- ~ 1,500 lbs of TCE were removed through SVE as of April 2000
- System augmented with ERH to facilitate volatilization and increase the TCE removal rate

Cumulative TCE removal from August 1999 through April 2000





B181 ERH Layout and Operation



- 6-phase heating
- Pilot tested for 13 weeks
- Scaled up to cover ~ 22,000 ft²
 - (200 ft × 140 ft)
- Design Summary
 - 73 electrodes placed to 35 ft bgs
 - 10 TMPs at 7 discrete depths
 - 81 groundwater sampling points
 - ~150 soil-vapor locations
- Larger-scale system operated for ~8 months
 - 5/13/02 to 12/19/02
 - Heated GW to ~90°C





ERH Performance Assessment



- Total TCE mass removed (1,417 lbs)
- Soil-vapor concentrations:
 - Mean SV TCE concentration was reduced by 93%
 - Max conc. decreased from > 5,200 to 1,358 ppmv
 - Vapor plume greater than 100 ppmv reduced in size
- Groundwater TCE concentrations:
 - Mean GW TCE concentration reduced by 87% (33.2 to 4.3 mg/L)
 - 353% increase in average chloride concentration
- Follow-on includes ISCO (hot spot) and EISB
 - Note: TCE concentration rebounded and was measured at 16,400 μg/L in 1/18





- EPL technologies discussed below
 - Pump and treat
 - 1993 2015





EPL Systems Layouts



- Pump and treat
 - Installed in 1993 with 7 extraction wells
 - Expanded to 51 extraction wells in 1999
 - Down to 50 extraction wells in 2011
 - Down to 10 extraction wells in 2013
 - 8 extraction wells in 2014
 - System shutdown in 2015
 - EISB continues





EPL P&T Performance



- P&T operated ~25 years
- Design for 150 gpm, ~50 gpm max achieved
- Initial influent TCE concentrations ~10,000 to 15,000 μg/L
- Below 5,000 μg/L in ~ 3 years
- Asymptotic at ~400 µg/L for ~7 to 8 years
- Overall TCE mass removed estimated at ~4,500 lbs





OTIE Overall Performance Analysis (EPL)



2015

Remedial System Effectiveness

- Uniform decay rate regardless of remedial actions (P&T, biowalls, MNA)
- Engineered remedies have no greater impact than natural attenuation on plume mass
- Back diffusion mass flux may overwhelm mass removed by engineered systems



20.00

2005

cDCE

CWA Remediation History





CWA Systems Layouts



• ZVI PRB

- Designed to prevent further migration of TCE beyond installation boundary
- 1,170 foot long, 2 foot wide, 35 foot deep
- 50-50 mix of iron filings and sand
- Construction Completion on September 15, 2006





CWA PRB Assessment



- PRB performance Assessment
 - Adversely effected GW flow pattern; violating design constraints
 - ZVI has lost its effectiveness
 - No method to effectively rejuvenate
 - Conversion to biobarrier
 - Downgradient VC concentrations increasing
 - Benefit for TCE degradation is not sustainable for long-term effectiveness







LF1&3 Background



LF1

- Former landfill with multiple waste pits
- Converted to a parking lot

LF3

- Received misc. wastes, including mixed oils and solvents, from 1942 to 1945
- Inactive from 1945 to 1966
- Dirt and rubble used to fill and grade the landfill in 1966 and 1967





- LF1 technology discussed below
 - DNAPL Recovery
 - 2001 Present



LF1 DNAPL Recovery



Objective

- Determine practicability of removing mass through DNAPL extraction wells
- Installed 4 new extraction wells in the Walnut Formation
 - Recover DNAPL via pumping or bailing
 - Frequency based on how quickly product accumulates in the well
- Monitor DNAPL thickness in neighboring Walnut wells monthly to determine how recovery is affecting surrounding area





LF1 DNAPL Recovery





Landfill 3 Remedial History







LF3 EISB Pilot Study



Objective

- Inject biostimulants into the biowall and ART well area to reduce LF3 groundwater cVOC concentrations
- Implementation Overview
 - First injections performed May -October 2013
 - EHC-L (food)
 - KB-1 (bacteria)
 - Second injections performed March - September 2015
 - EHC-L (food)
 - EHC (food + ZVI)





Landfill No. 3 Pilot Study





ART Well Area Results Total cVOC Concentrations (~28% decrease overall)







Landfill No. 3 Pilot Study





Summary of Lessons Learned



- A combination of engineered technologies effectively treated source area
- Technologies removed mass in localized areas, but quickly became mass transfer limited
 - Substantial mass in lower permeability soils
 - Back diffusion governs plume responses
- Comprehensive CSMs are crucial for technology selection and design at complex sites
 - Site Characterization is key
 - HRSC can improve complex site CSMs
 - MNA data are essential to assess NA potential and evaluate remedial alternatives
 - Biogeochemical data provide insight into:
 - Existing degradation pathways and the potential to enhance those or stimulate others
 - Potential challenges for select remedial technologies



Summary of Lessons Learned



- Technology guidance documents should be consulted when selecting and implementing remedial approaches
- Monitoring must include the necessary parameters and spatial coverage to:
 - Effectively assess technology performance
 - Understand causes for poor technology performance
- AFCEC's CSI approach has benefitted remedial programs
 - Teams that include regulators, Base contractors, AFCEC support contractors, and SMEs to brainstorm and develop remedial approaches
 - Enhances communication among concerned parties
 - Benefit from the collective experience/expertise of the group
 - Substantially shortens regulatory approval times
 - Ensures proper technology selection, implementation, optimization, and termination