Biopolymer Slurry Wall Installation of a Zero Valent Iron Permeable Reactive Barrier

Former Carswell AFB, Texas

Cynthia Crane, Ph.D.

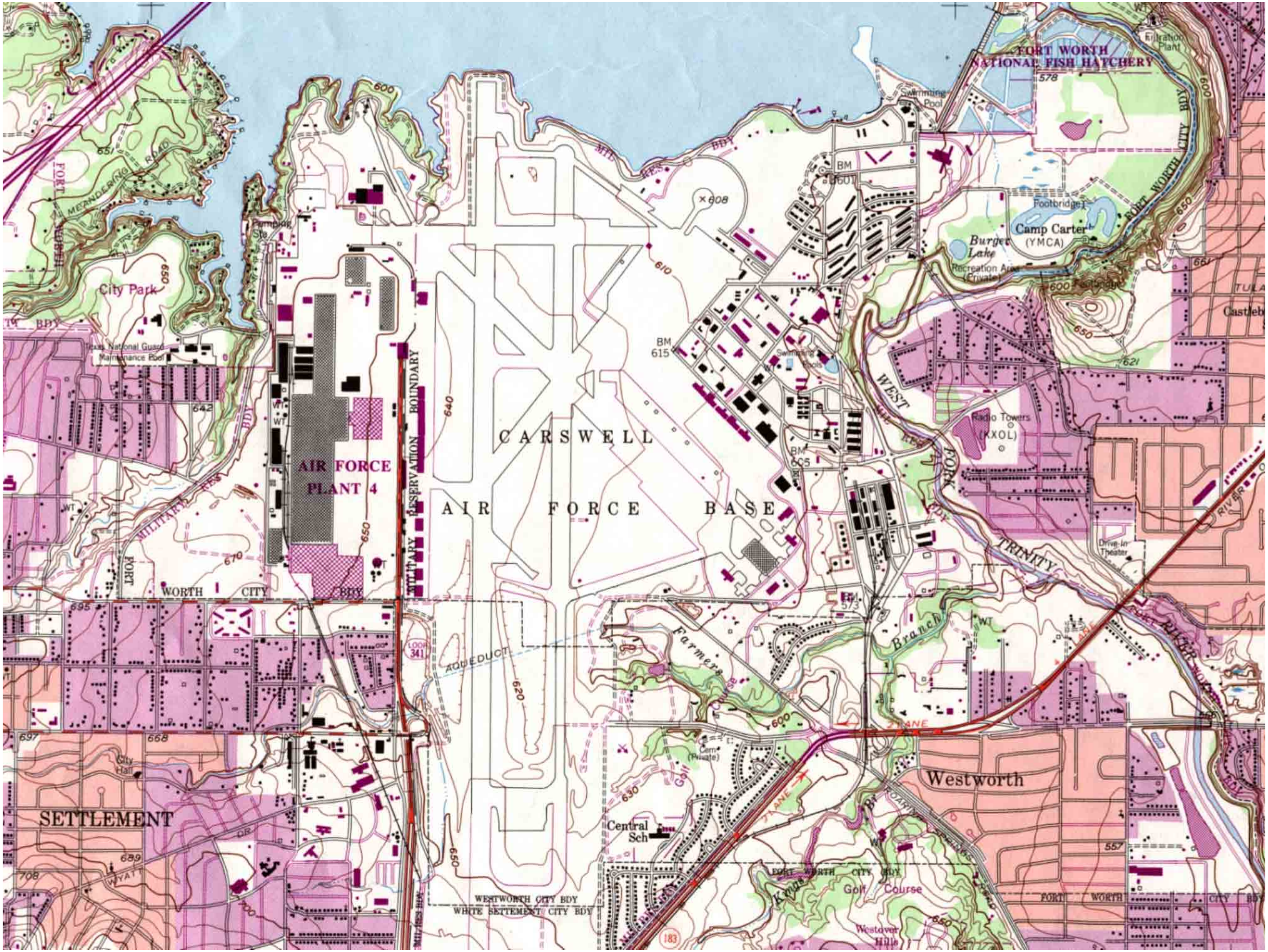
November 6, 2002

Objectives

- Technology Demonstration Project (funded by AFCEE, AFBCA and ASC)
- Use of innovative construction technique

Overview

- Background information
- Description of biopolymer slurry wall
- Problems encountered/resolved during installation
- Lessons learned on biopolymer slurry wall installation technique



FORT WORTH NATIONAL FISH HATCHERY
Filtration Plant
Swimming Pool
Footbridge
Camp Carter (YMCA)
Burger Lake
Recreation Area (Private)
Castleberry
City Park
Texas National Guard Maintenance Pool
Pumping Sta
MEANDERING ROAD
AIR FORCE PLANT 4
MILITARY RESERVATION BOUNDARY
CARSWELL AIR FORCE BASE
WEST FORK TRINITY RIVER
Radio Towers (KXOL)
Drive-in Theater
AQUEDUCT
Farmers Branch
FORT WORTH CITY BDY
Cem (Private)
Central Sch
SETTLEMENT
City Hall
Westworth
Golf Course
Westover Hills
WESTWORTH CITY BDY
WHITE SETTLEMENT CITY BDY

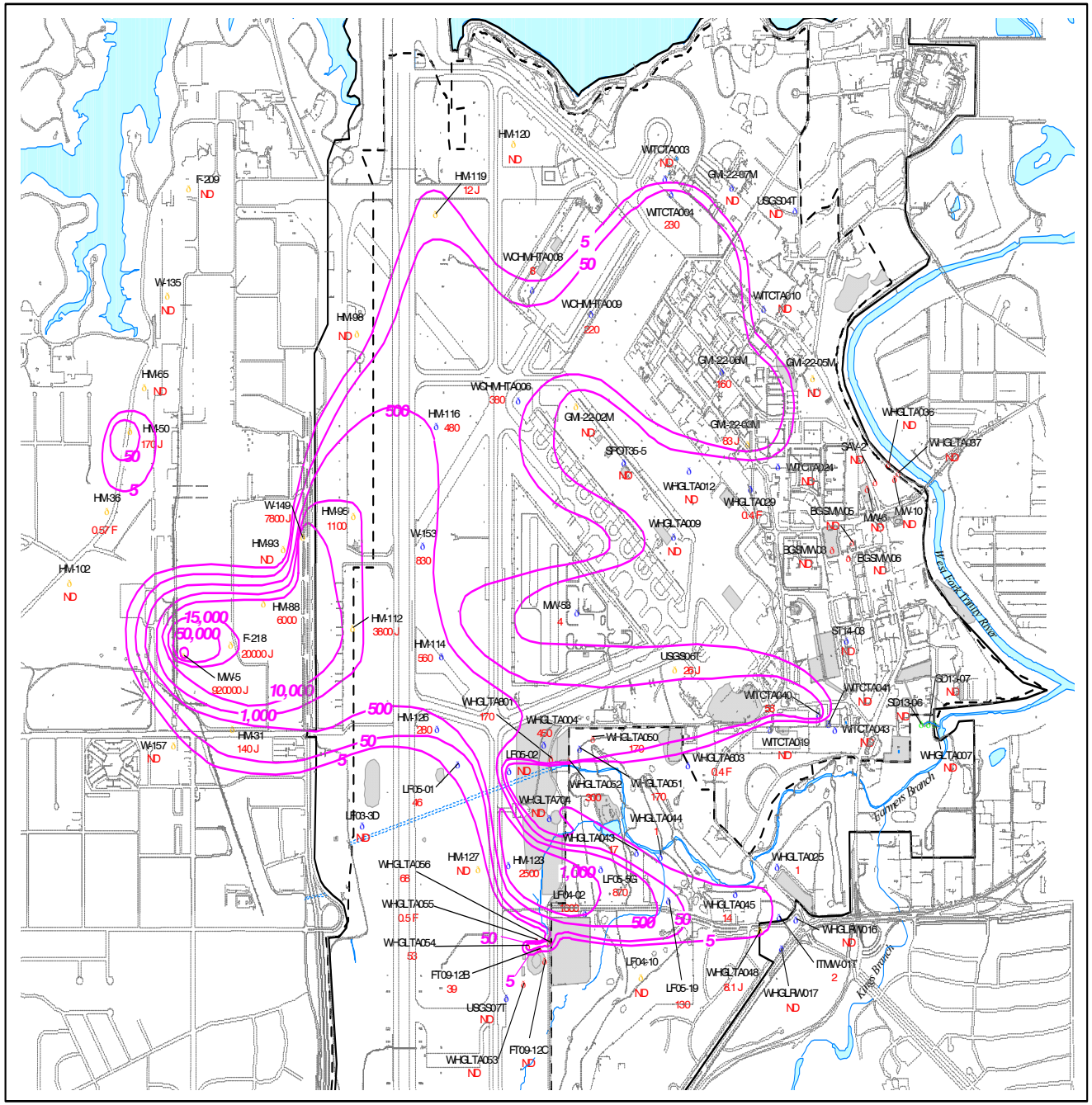
Former Carswell AFB

- Downgradient of Air Force Plant No. 4 (AFP 4)

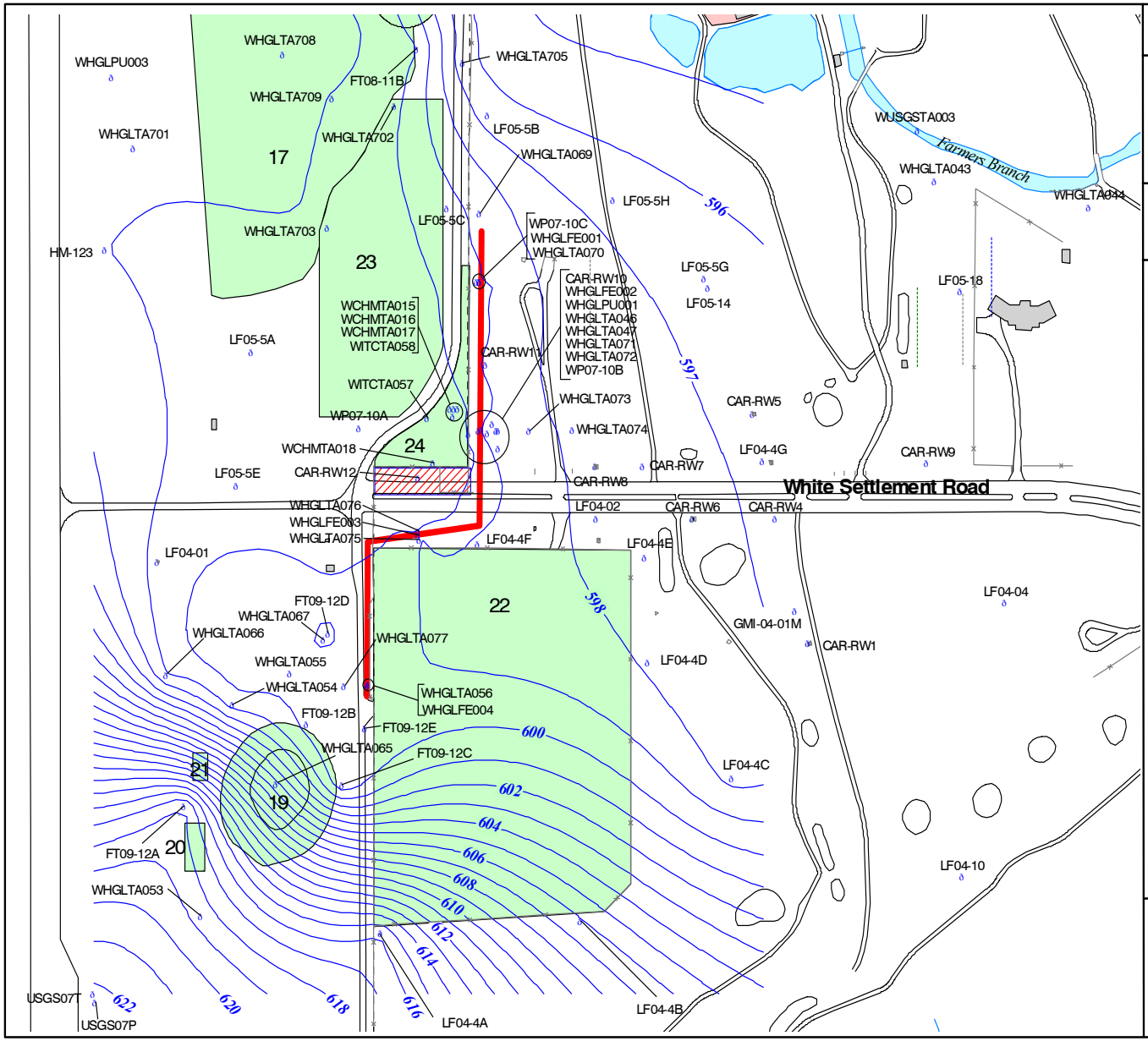
- AFP 4 placed on the NPL in 1990
  - TCE is the major contaminant
  - Other contaminants = *cis*-1,2-DCE with some *trans*-1,2-DCE, PCE, and VC
  - In 2000, leading edge of plume at the federal property line

Site Selection

- Considered several sites
- Collected bedrock and aquifer data
- Evaluated
  - aquifer characteristics
  - contaminant distribution
  - logistics



X:\AFC001\PRB_Conference_ITRC.apr



HydroGeoLogic, Inc.—NAS Fort Worth JRB, Texas

Figure 3

Groundwater Elevation Map
June 12, 2002

U.S. Air Force Center for Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Groundwater Treatment System
- PRB
- 600 — Groundwater Elevation
- Monitoring Well
- Area of Concern
  - 9 Golf Course Maintenance Yard
- Solid Waste Management Unit
  - 17 Landfill No. 7
  - 18 Fire Training Area No. 1
  - 19 Fire Training Area No. 2
  - 20 Waste Fuel Storage Tank
  - 21 Waste Oil Tank
  - 22 Landfill No. 4
  - 23 Landfill No. 5
  - 24 Waste Burial Area No. 7
  - 25 Landfill No. 8

N

250 125 0 250

SCALE IN FEET

Filename: X:\Afc001\PRB_Conference_ITRC\Report\gwe_06-12-2002.apr
Project: AFC001-035-10
Created: 07/02/02 jbelcher
Revised: 11/05/02 ASC
Map Source: HGL ArcView GIS Database 2002

HydroGeoLogic Inc

Selected Site

- Groundwater velocity ~ 2 ft/day
- Depth to bedrock ~ 40 feet
- Saturated thickness = 10-12 feet
- Physical structures close to alignment

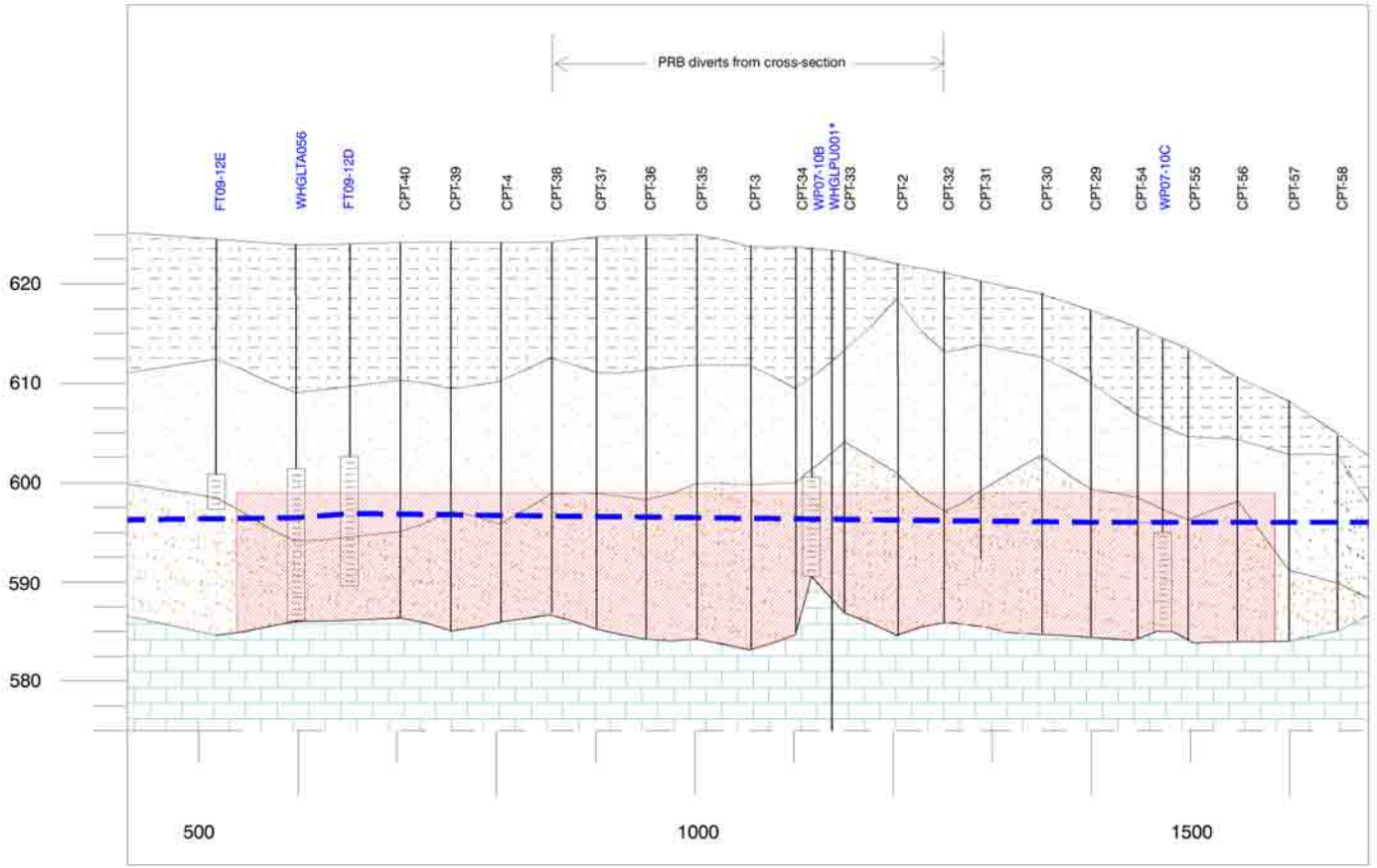
Design

- 50% ZVI and 50% sand, 2 feet thick
- Reactive media from bedrock to 2-3 feet above high water table
- Fine sand above reactive media
- Final length = 1,126 feet

Figure 3.3

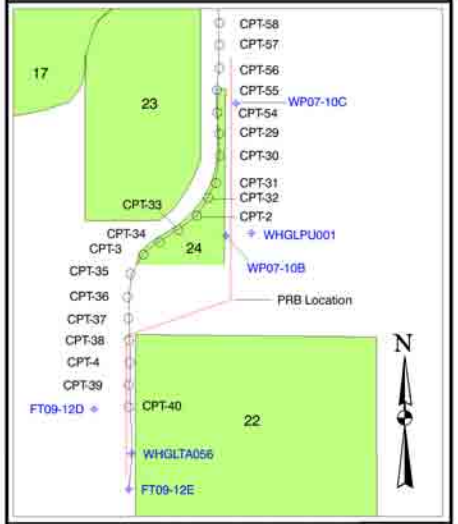
PRB Cross Section

U.S. Air Force Center for Environmental Excellence



Legend

- Silt & Clay
- Sand
- Sand & Gravel
- Limestone
- SWMU
- Biopolymer Slurry Wall
- Estimated Bedrock Depth
- Water Table
- Well Screen
- CPT Boring Location
- FT09-12D Monitoring Well



Notes
1. PRB should be anchored into competent bedrock. The top of the iron/sand reactive media shall be at 599 ft. above mean sea level, as shown in the cross-section.
2. Bedrock elevations obtained from CPT data. Water elevations obtained from monitoring wells, April 2001 data.
* Total depth is 90 feet below ground surface.

Filename: X:\Afc001\35dc\Report\CPT_Final_Cross_Section-Rev.dwg
Project: AFC001-035-04-03
Created: 03/08/01 jhr
Revised: 01/24/02 asp
Map Source: HydroGeoLogic, Inc. 2001

HydroGeoLogic, Inc.

Construction Technique

- Considered one-pass trenching and biopolymer slurry wall
- Selected biopolymer slurry wall:
  - Depth capability
  - Ability to install PRB in limited area
  - Minimal site work requirements
  - Quality control
  - Health and Safety Considerations

Biopolymer Slurry

- Made of guar gum (biodegradable)
- Promoted sidewall stability through:
  - viscosity
  - exclusion of water
  - slurry column height

Biopolymer Slurry (cont)

- Biostat to stabilize slurry during construction
- Enzymes to “break” slurry after installation
- Wall development to promote slurry breaking

Biopolymer Slurry (cont)

- Concerns with use of biopolymer slurry
  - Post-installation groundwater flow effects
  - Formation of coatings on iron surface
  - Slurry “breaking” during installation

Construction Process

- Excavate trench to bedrock
- Use biopolymer slurry for liquid shoring
- Backfill
- “Break” biopolymer slurry
- Cap trench

Installation

- Reactive media mixing:
  - Slowest part of process
  - Addition of water
  - Use of cement mixer
- Reactive media emplacement
  - Slots in tremie
  - Discharged directly from mixer


Team Leaprobe

Installation (cont)

- Wave action from excavator
  - Pulled reactive media into excavation area
  - Pulled fine sand onto reactive media
- Effect of fine sand backfill on slurry pH
- Slurry remained stable

Wall Development

- Recirculation wells every 40 feet
  - Installed with reactive media
  - Removed sediment prior to wall development
- Injection points between wells
- Injected enzyme, then recirculated

Wall Development (cont)

- Attempted tracer study
- Slug tests before and after wall development:
  - Conductivity (K) increased by order of magnitude
  - Average K in PRB = 9.6 ft/day
  - K = 6.7 and 34.9 ft/d in two background wells

Lessons Learned

- Select better backfill sand
  - Sand containing limestone
  - Coarse gradation
- Limit amount of sediment allowed in slurry
- Use shorter trenches

PRB Performance

- Most recent data from September 2002
- No indication of bypass
- Groundwater levels indicate flow returning to pre-PRB patterns
- Substantial removal of TCE

September 2002 TCE Data

Transect	Influent TCE (ppb)	Effluent TCE (ppb)
1	1300	7.6
2	1800	11
3	1500	ND
4	28	6.2

Cost

- Total cost per linear foot = $1,760 (includes Prime Contractor and Subcontractor costs)
- Estimated cost per 1,000 gallons treated = $17
- Estimated cost per pound VOC removed = $685