Headquarters U.S. Air Force

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Pump and Treat and SVE Optimization

Presented By

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Parsons

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Air Force Center for Environmental Excellence

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Pump and Treat Optimization

- Extraction System Effectiveness
- Alternative Technologies/Approach
- Extraction System Efficiency
- Treatment System Efficiency vs. Alternatives
- Groundwater Monitoring Optimization
  - Reduce the Number of Wells
  - Reduce Sampling Frequency
  - Reduce the Analytical Requirements

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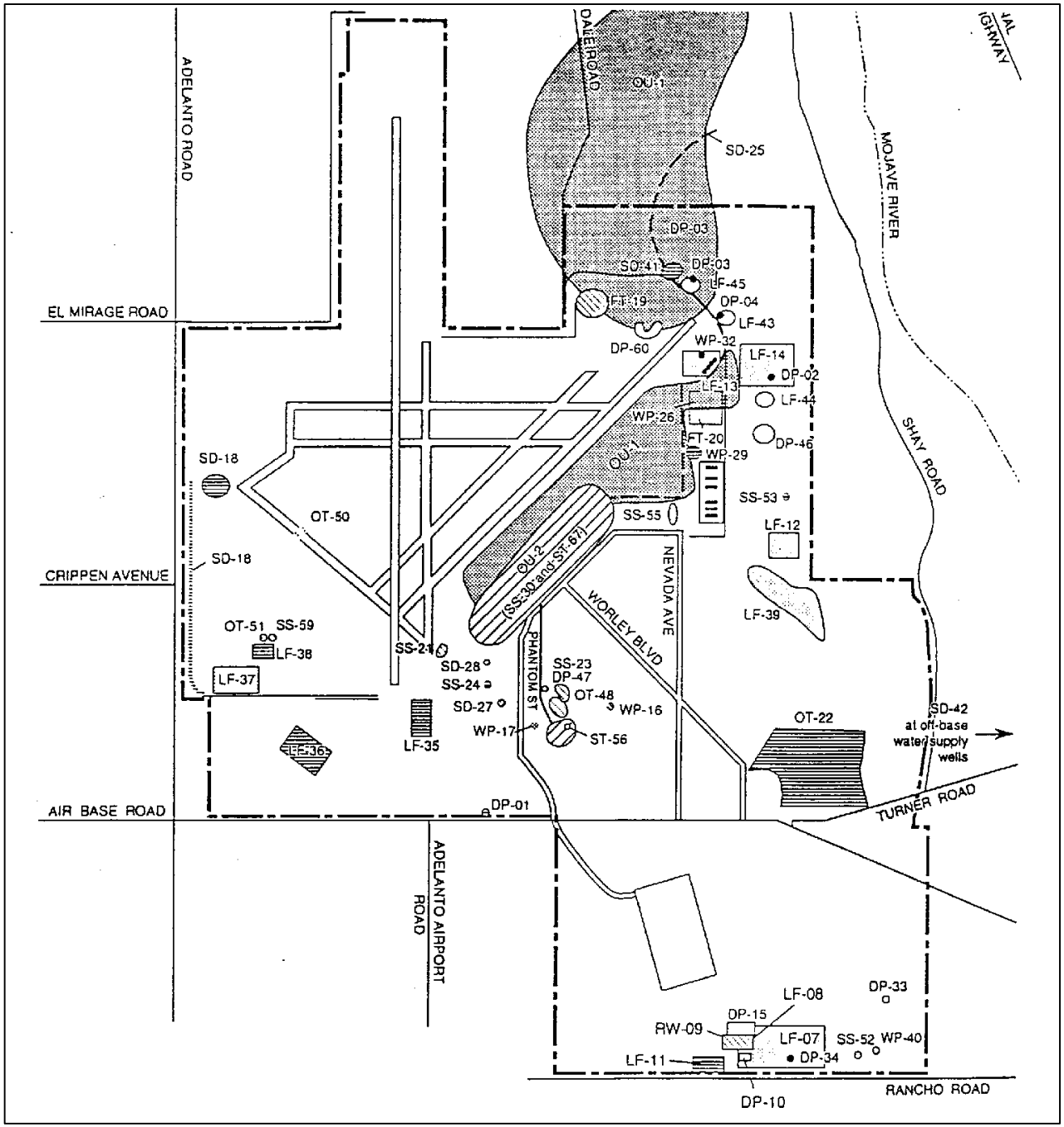
Pump and Treat Optimization Case Studies – George and Edwards AFBs

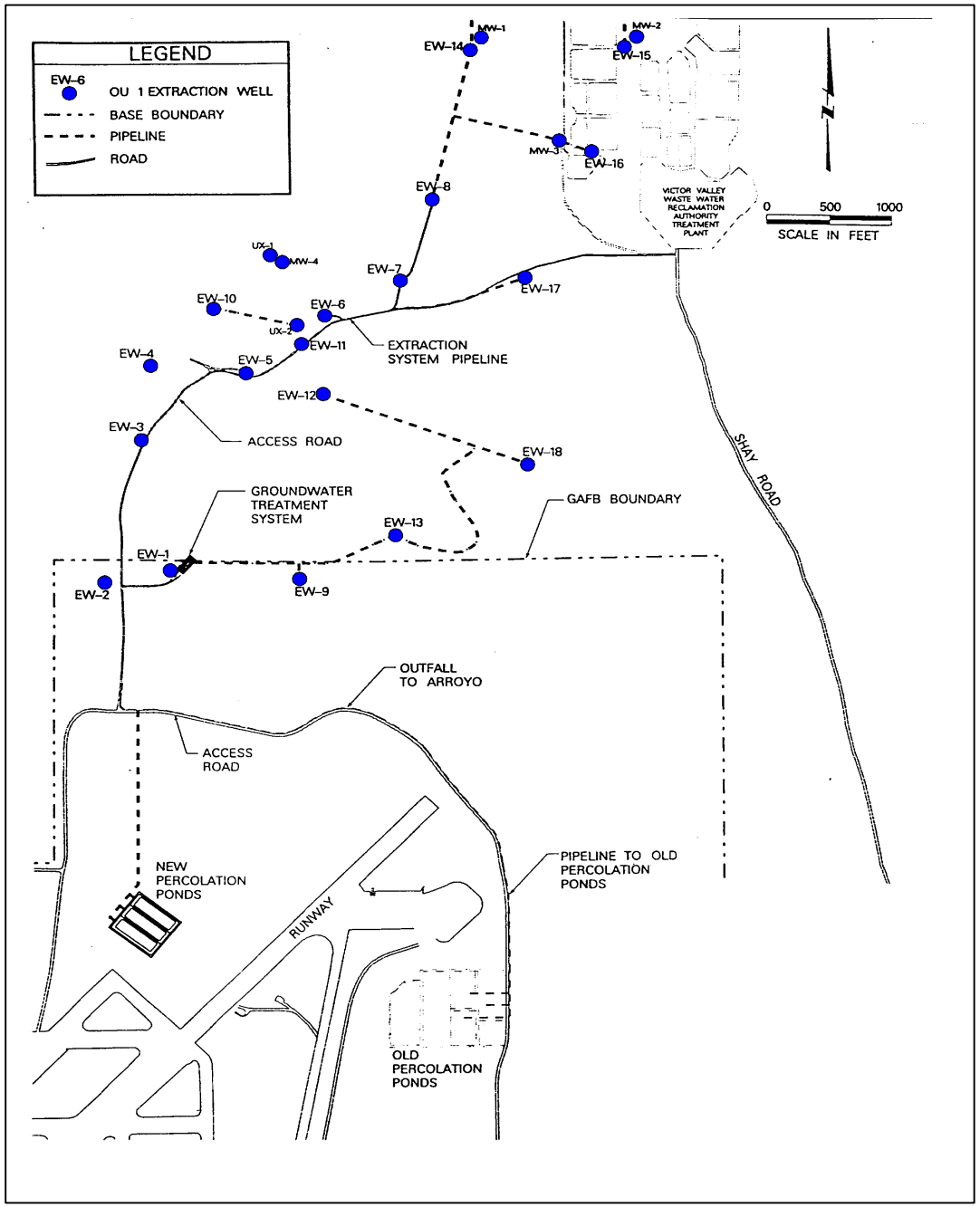
- **Pete Guest, John Anthony, Bill Plaehn - Parsons**
- **Javier Santillan, John Matthews- AFCEE ERT/ERC**



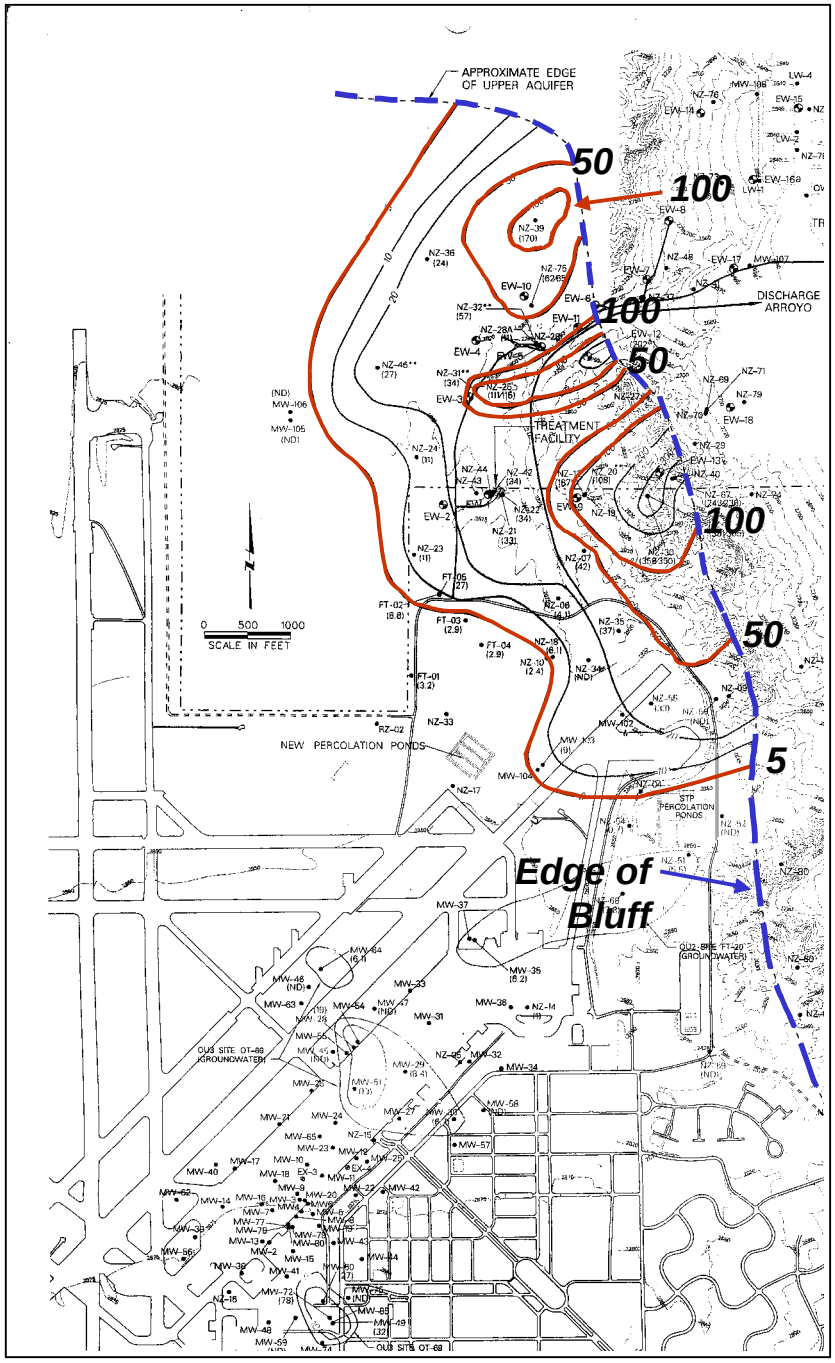
Location of OU-1

Remediation System Description

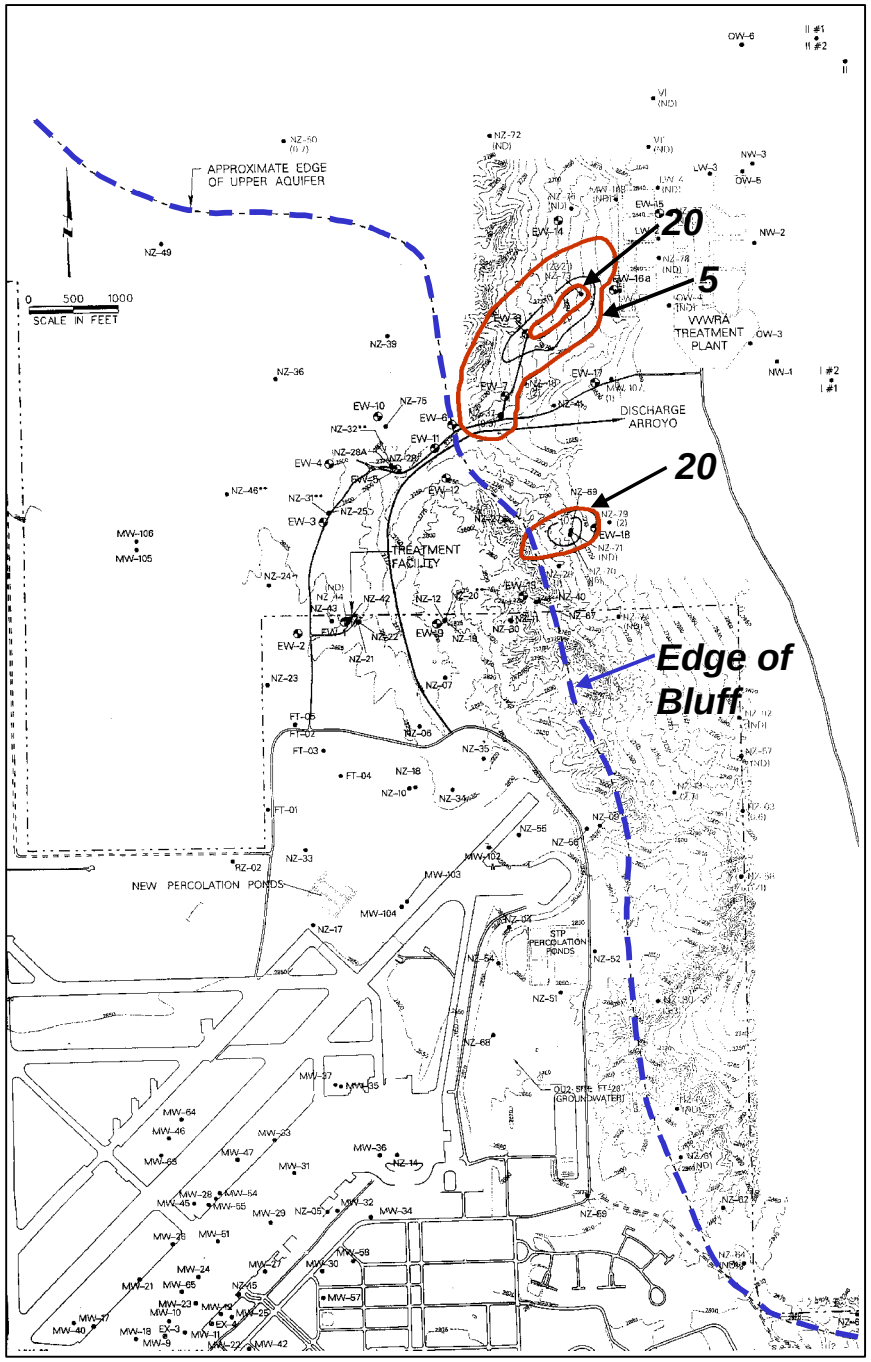
- **OU-1 Groundwater Extraction and Treatment System**
  - **Eighteen groundwater extraction wells -- ten in Upper Aquifer, eight in Lower Aquifer**
  - **Counterflow air stripping towers**
  - **860 gpm groundwater treatment system**
  - **Three ponds to re-infiltrate treated groundwater**



Location of Extraction Wells



TCE in Upper Aquifer Groundwater - October 1998



TCE in the Lower Aquifer Groundwater - October 1998

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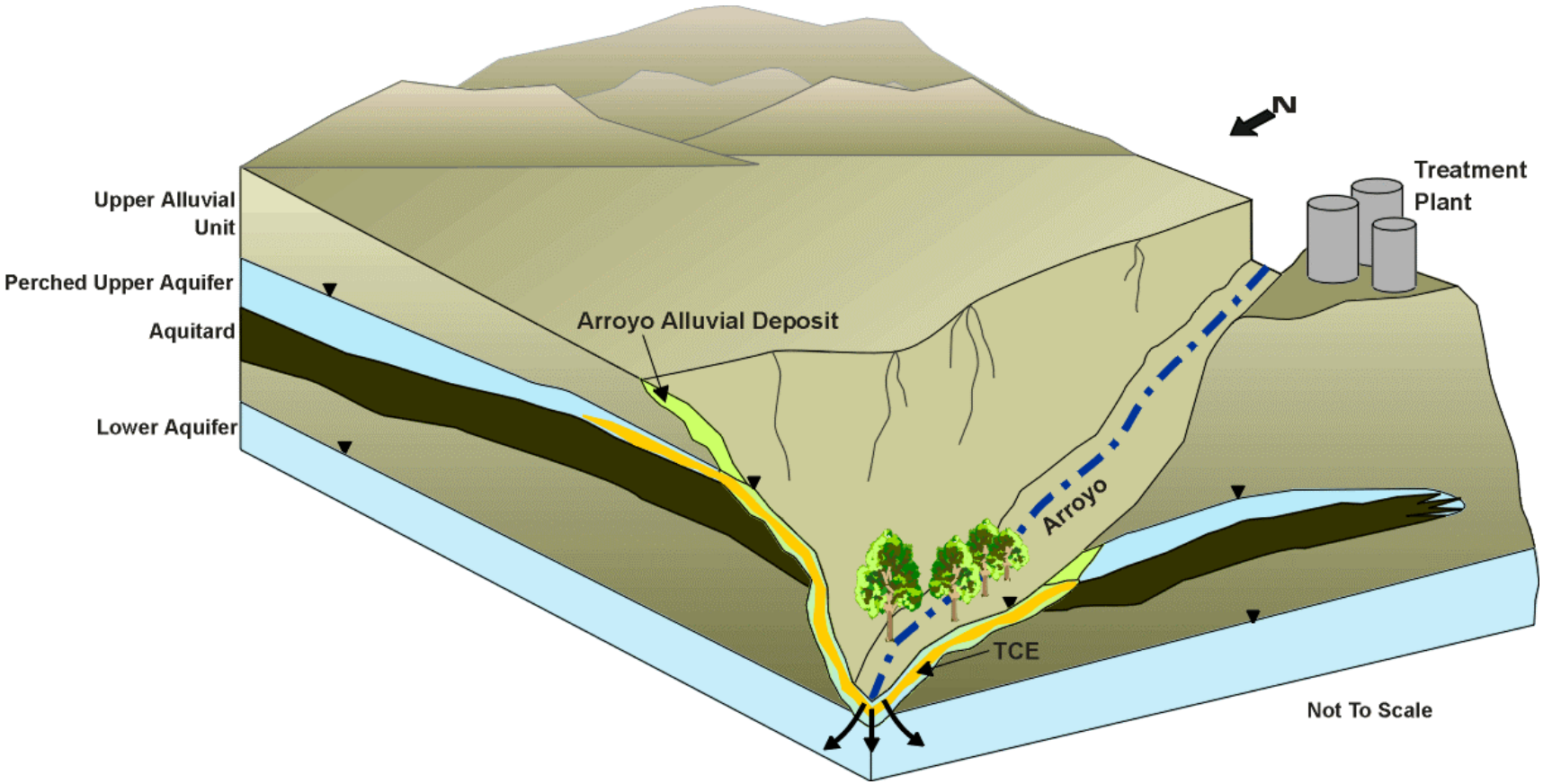
Conceptual Model



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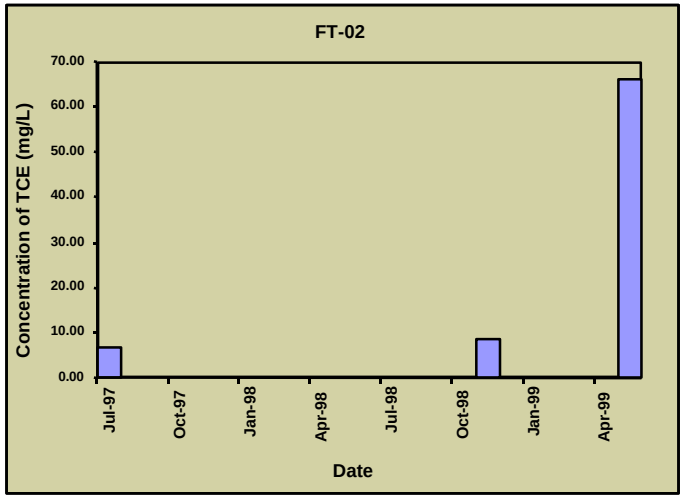
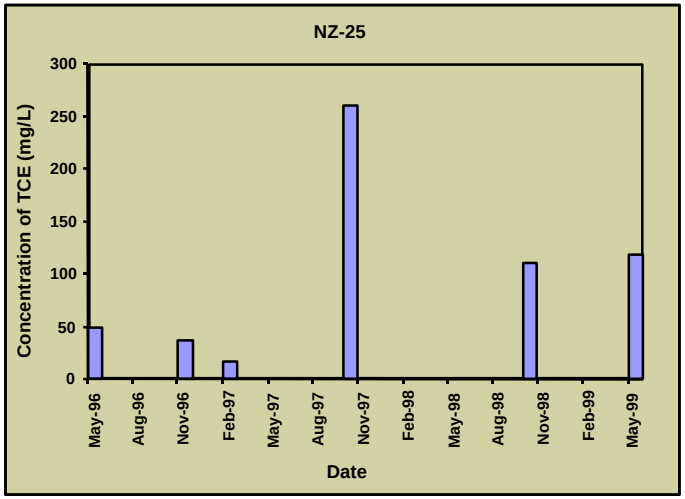
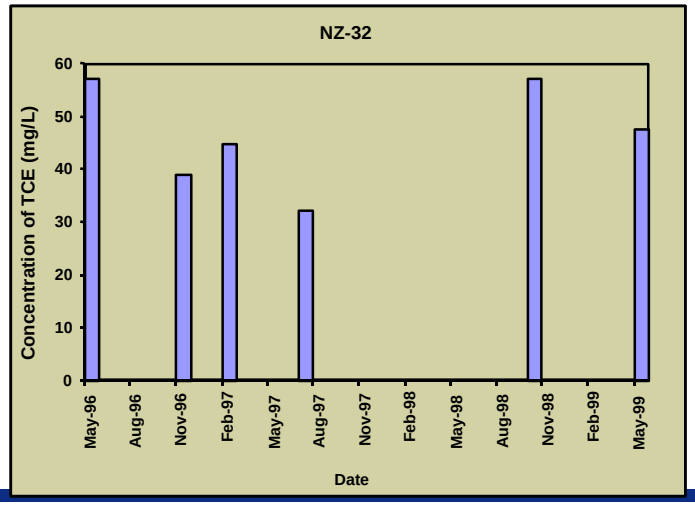
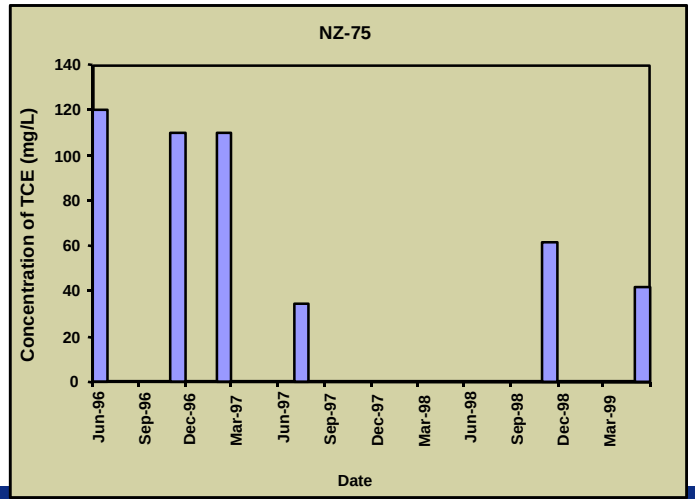
TCE Concentration Trends in the Upper Aquifer Through Time

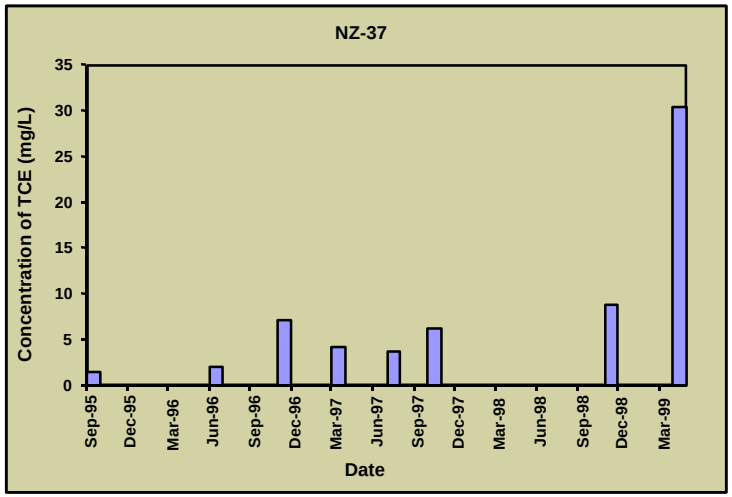


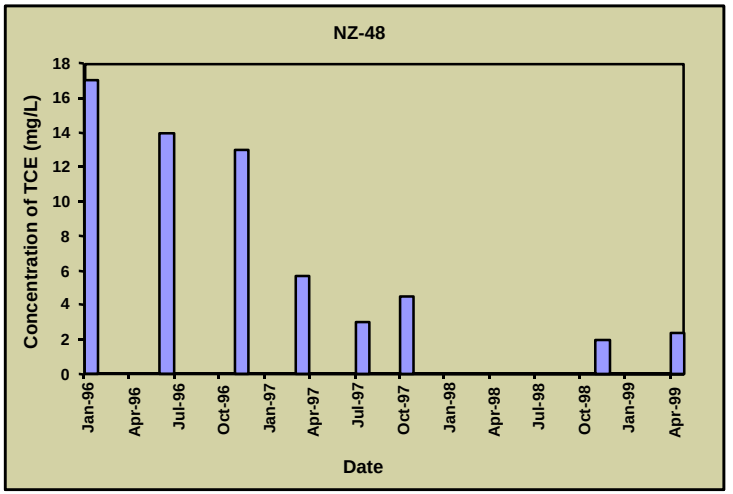


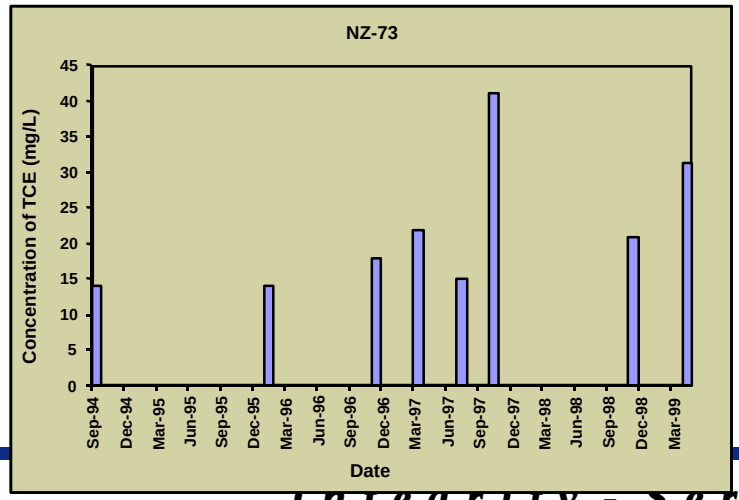


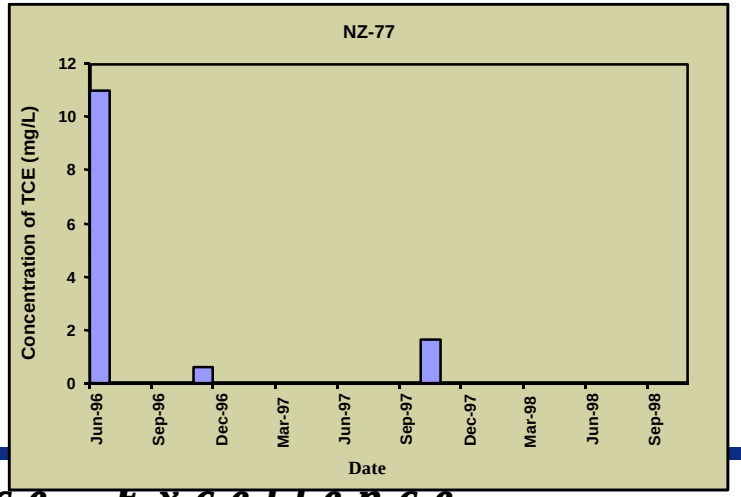


TCE Concentration Trends in the Lower Aquifer Through Time









Primary Remediation Objective for OU-1

"Reduce volume and concentration of TCE contamination in the subsurface…and… clean up all groundwater contamination to acceptable health-based levels or to the extent technically feasible."

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Remedial Action Objectives

1. **Prevent receptor exposure to contaminated water that presents a risk of greater than $1x10^{-6}$. (*Risk Objective*)**
2. **Reduce the TCE contaminants in OU-1 groundwater to concentrations below the federal MCL of 5 µg/L. (*Cleanup Objective -- performance criterion for extraction system)***
3. **Reduce the TCE concentrations in treated ground-water effluent to meet the enforceable level of 2.5 µg/L on a median basis with a maximum discharge level of 5 µg/L. The concentrations of TCE in the percolation ponds are not to exceed 0.5 µg/L. (*Discharge Objective -- performance criterion for treatment system*)**

Remedial Action Objectives (Cont)

4. **Eliminate or reduce the potential for further migration of the existing TCE plume in groundwater. (*Containment Objective -- performance criterion for extraction system*)**
5. **Specify a treatment system that can be expanded to address a larger area/volume of groundwater, if needed. (*Design Objective*)**

Effectiveness of the Extraction System

A. Removal of TCE Mass

Measurable Quantities	Current Conditions	Percent Complete	Relative Effectiveness
880 lbs of TCE estimated to be originally present in the subsurface	About 113 lbs of TCE removed (January 1992 through October 1998	13 percent	Ineffective

Effectiveness of the Extraction System

B. Containment of TCE Plume

Measurable Quantities	Current Conditions	Relative Effectiveness
Areal extent of plumes	Extent of plumes not well defined	Uncertain
Trends in chemical concentrations	Concentration trends generally decreasing (or no trend apparent)	Somewhat

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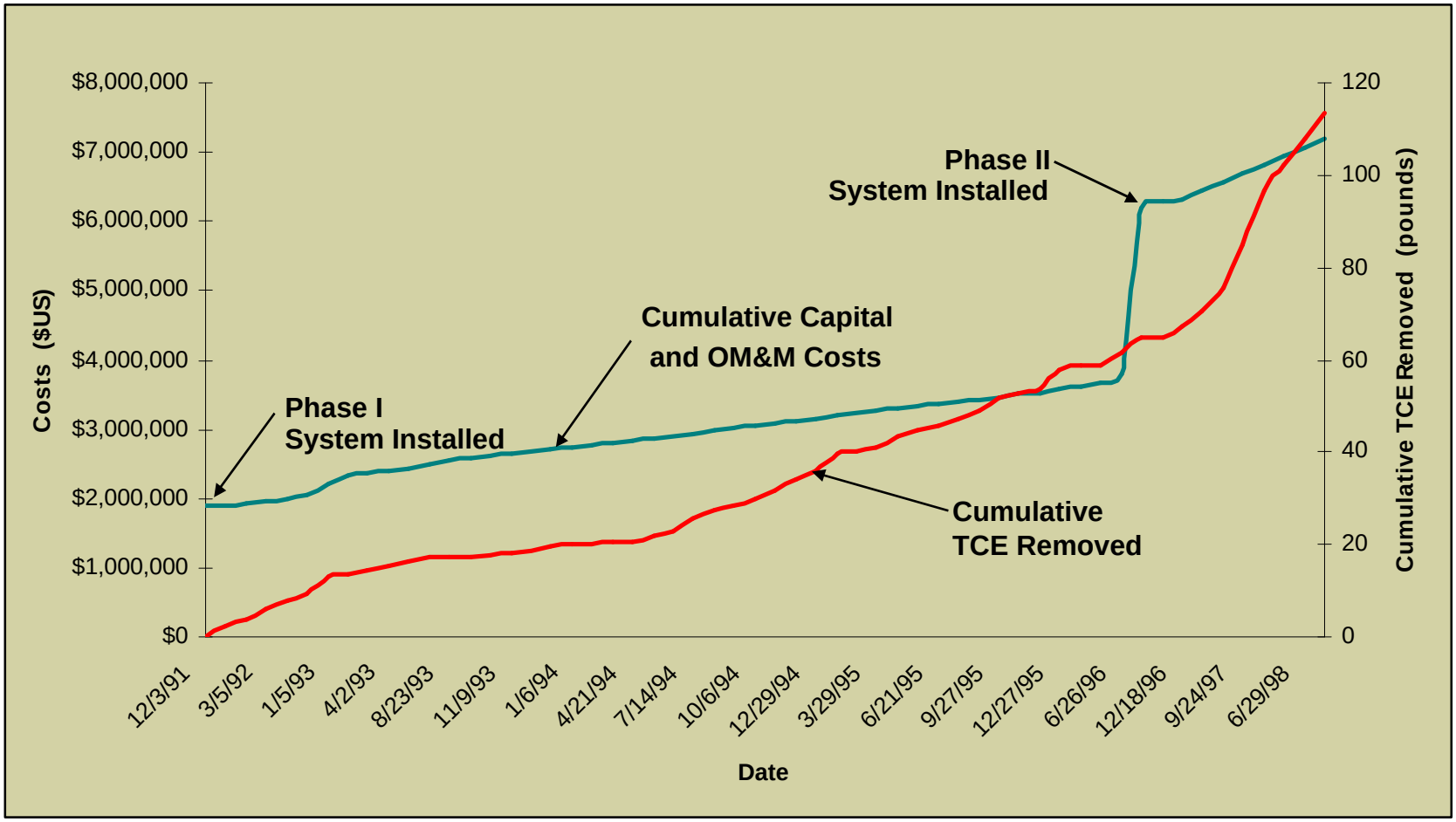
Cumulative TCE Mass Removal and Costs Through Time



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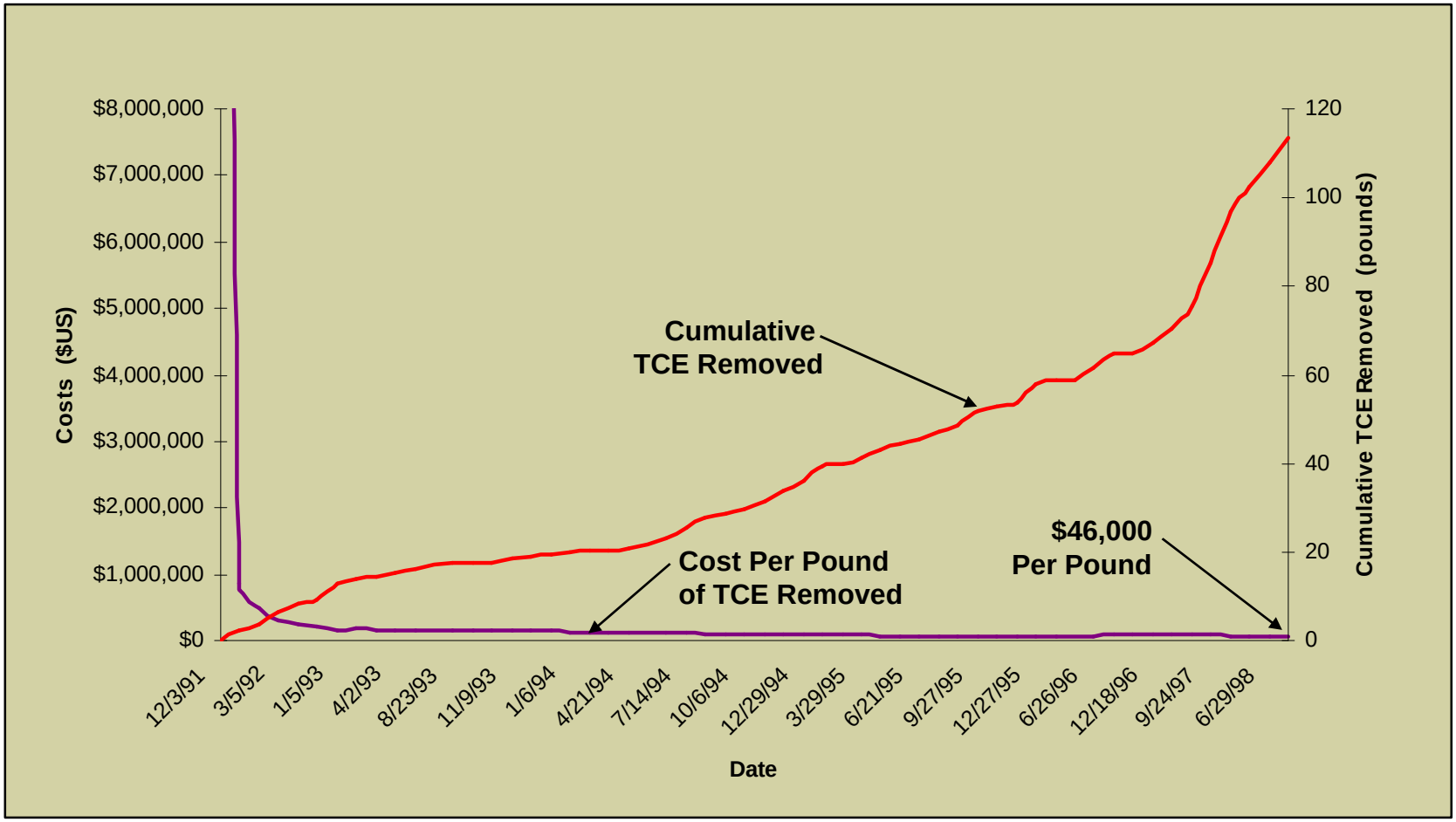
Cost Per Pound of TCE Removed



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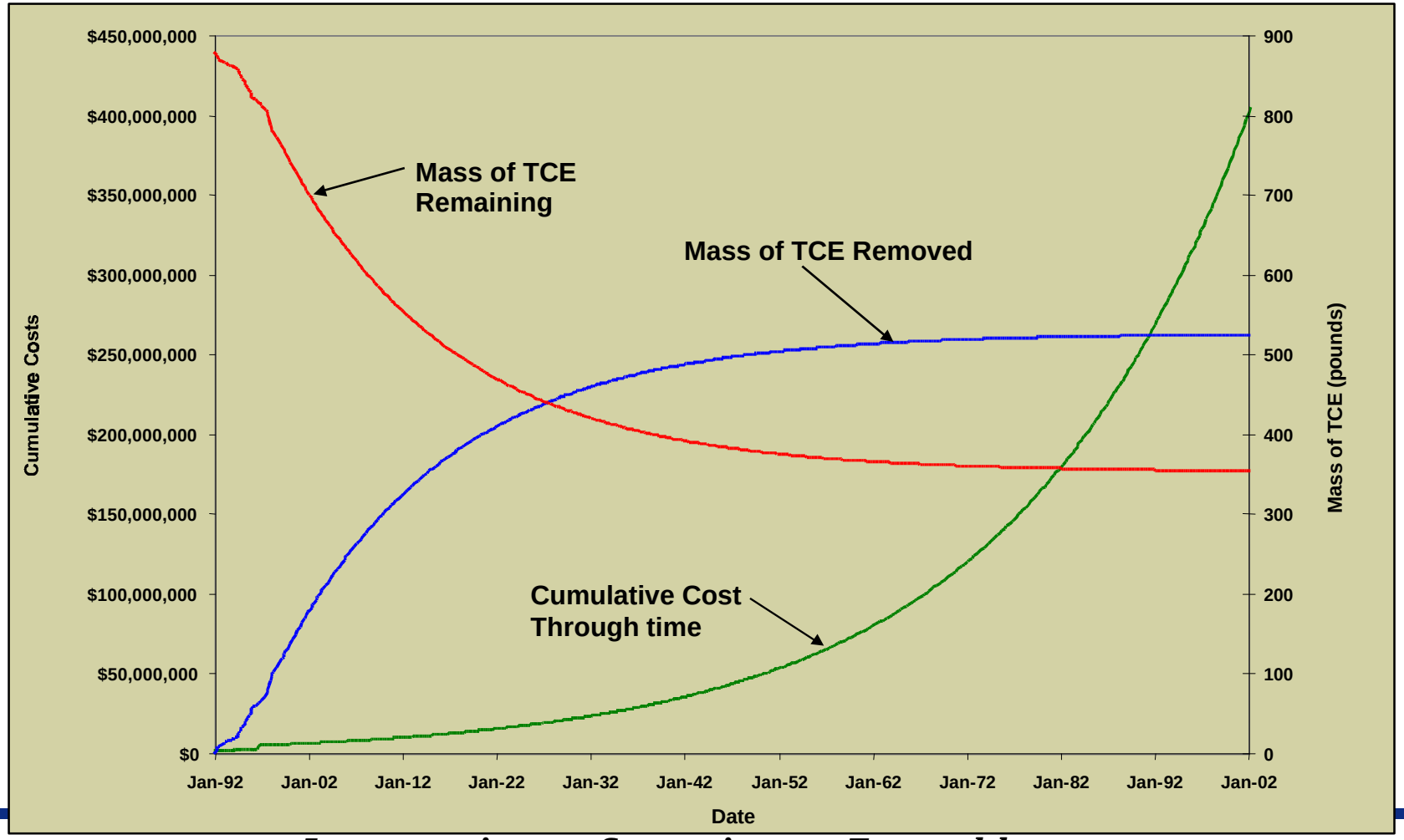
Projected TCE Mass Removal and Costs Through Time



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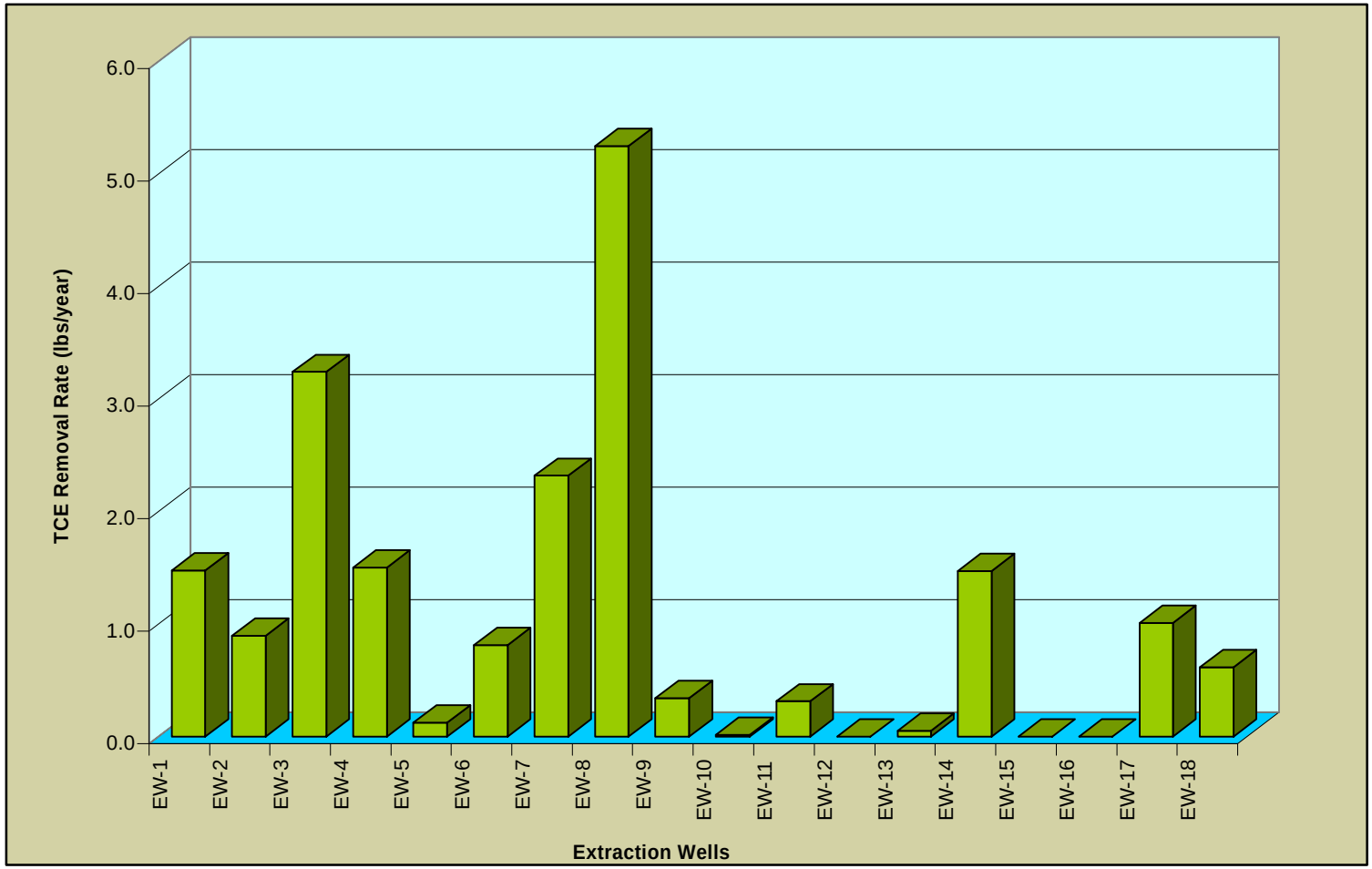
Annual Mass Removal Rates of TCE By Well



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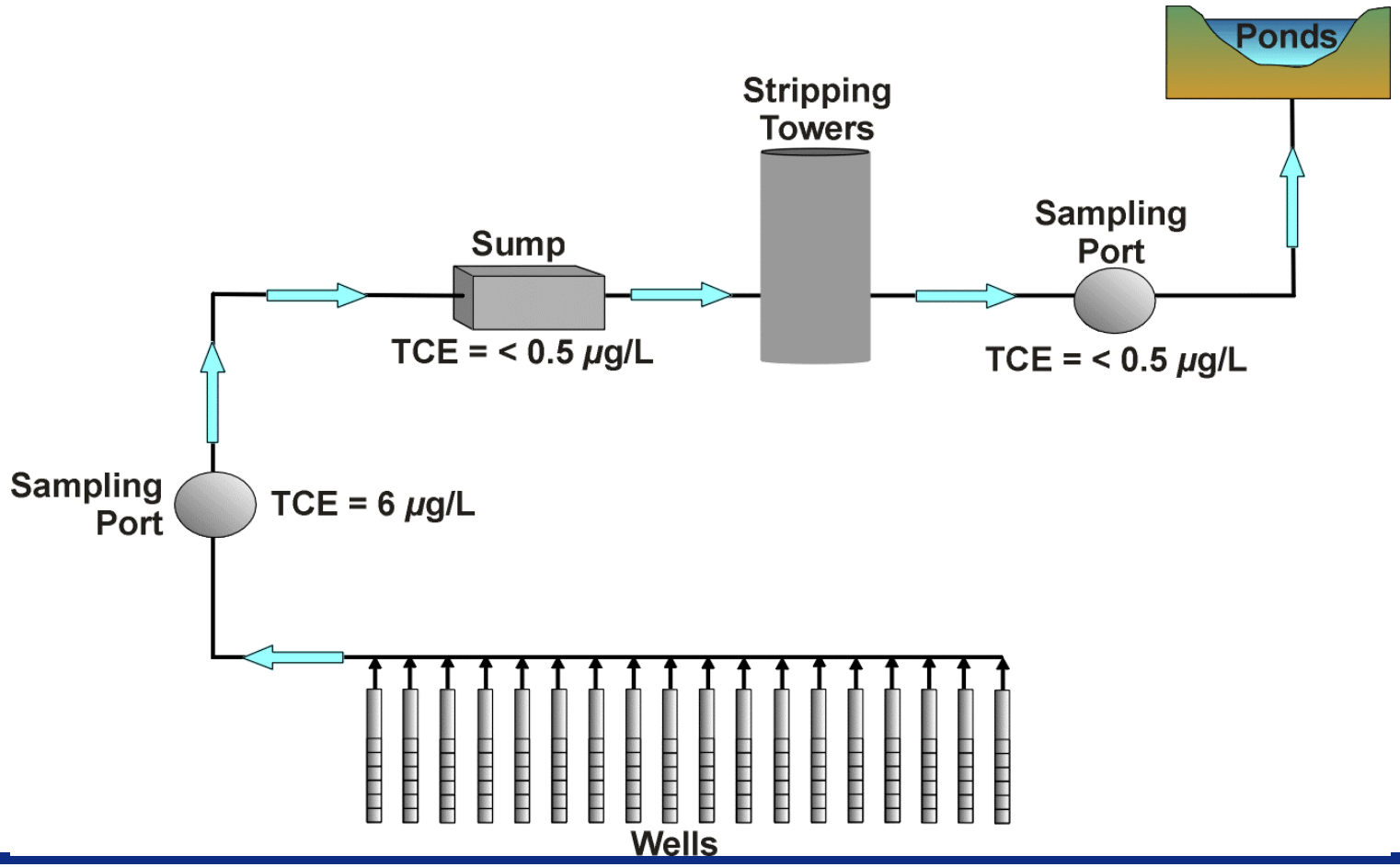
Treatment System Evaluation



Current Groundwater Monitoring Program

- Semiannual Sampling
- About 50 Monitoring Wells - VOCs
- 18 Extraction Wells - VOCs
- Estimated Annual Cost » $120,000

Recommended Groundwater Monitoring Program

- Annual Sampling
- 34 Monitoring Wells - VOCs
- Estimated Annual Cost » $40,000

RPO Summary: Short-Term Recommendations

- Remove 11 of 18 extraction wells from service
- Terminate air-stripping treatment of extracted groundwater
- Optimize long-term monitoring program

George AFB RPO Study
Short-Term Opportunities

Opportunity	Annual Cost Savings	Life Cycle Cost Savings	Time Savings	ROI	Difficulty of Implementation	Cost to Implement
Remove 11 of 18 wells	$90K	$8.3M	None	86%	Moderate	$100K
Terminate air-stripping	$60K	$6.0M	None	57%	Moderate	$ 50K
Optimize Long-Term Monitoring	$70K	$2.1M	None	67%	Low	$ 75K
Total	$220K	$16.4M		120%		$225K

Cost of George RPO Phase II Study = $105K

RPO Summary: Long-Term Opportunities

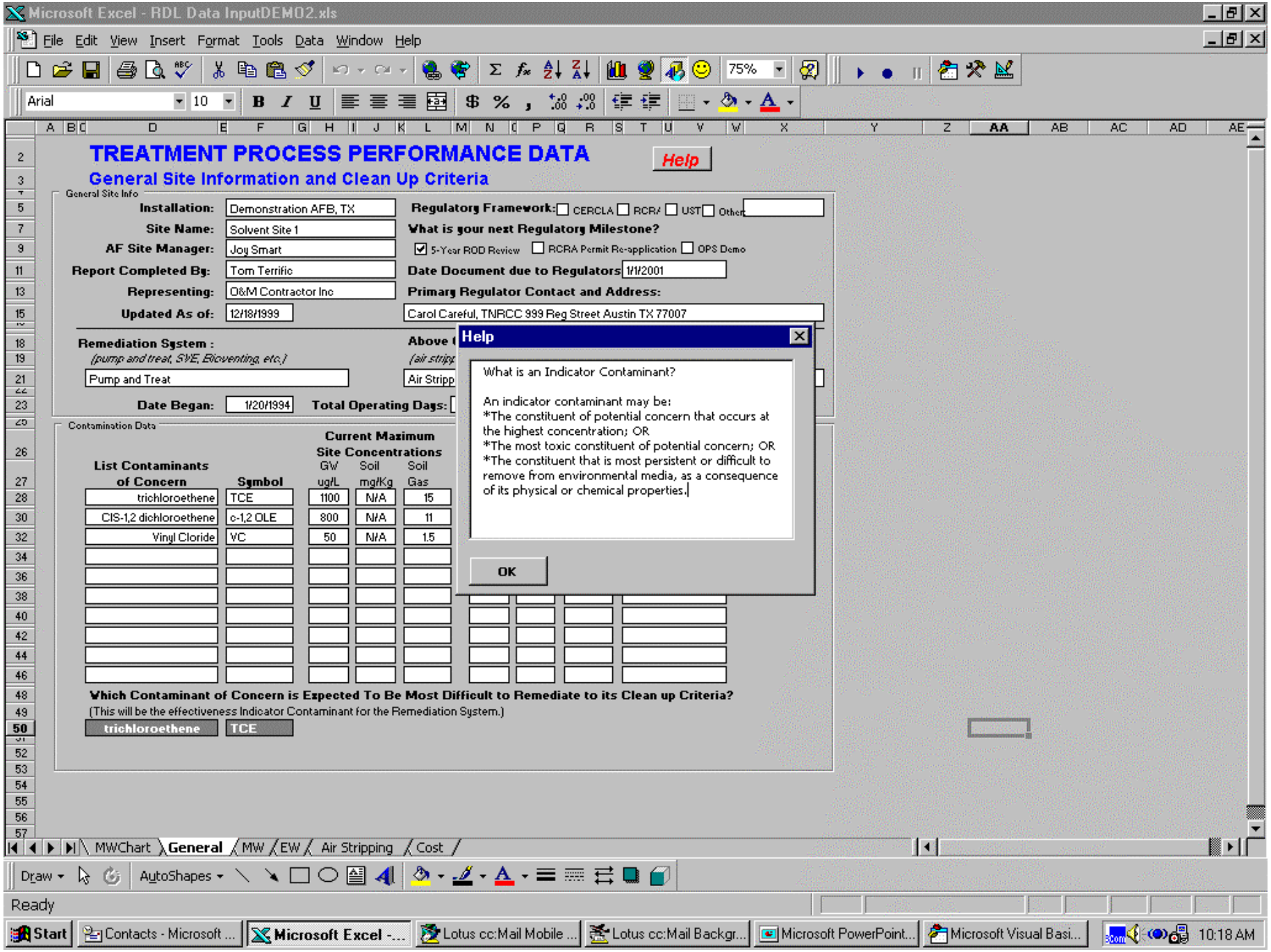
- Establish site-specific, risk-based cleanup goals
- Evaluate monitored natural attenuation (dispersion)
- Evaluate/implement phytoremediation option

George AFB RPO Study
Long-Term Opportunities

Opportunity	Annual Cost Savings	Life Cycle Cost Savings	Time Savings	ROI	Difficulty of Implementation	Cost to Implement
Evaluate MNA/ terminate pump and treat system	$180K	$16M	TBD	180%	High	$150K
Refine Hydrologic model / terminate all or part of pump and treat system	$150K	$14M	TBD	123%	Moderate to High	$150K

Pump and Treat Performance Tracking Tool

- Assists O&M contractor and site manager with annual performance evaluations
- Excel™ Spreadsheet data entry and graphic presentations to include in annual report
- Will provide upper management with an annual snapshot of system performance and the cost-effectiveness


Microsoft Excel - RDL Data InputDEMO2.xls
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TREATMENT PROCESS PERFORMANCE DATA
Help
General Site Information and Clean Up Criteria
General Site Info
Installation: Demonstration AFB, TX
Regulatory Framework: CERCLA RCRA UST Other
Site Name: Solvent Site 1
What is your next Regulatory Milestone?
AF Site Manager: Joy Smart
5-Year ROD Review RCRA Permit Re-application OPS Demo
Report Completed By: Tom Terrific
Date Document due to Regulators 1/1/2001
Representing: O&M Contractor Inc
Primary Regulator Contact and Address:
Updated As of: 12/18/1999
Carol Careful, TNRCC 999 Reg Street Austin TX 77007
Remediation System :
(pump and treat, SVE, Bioventing, etc.)
Pump and Treat
Air Stripp
Date Began: 1/20/1994
Total Operating Days:
Contamination Data
Current Maximum Site Concentrations
List Contaminants of Concern
Symbol
GW ug/L
Soil mg/Kg
Soil Gas
trichloroethene TCE 1100 N/A 15
CIS-1,2 dichloroethene c-1,2 DLE 800 N/A 11
Vinyl Cloride VC 50 N/A 1.5
Which Contaminant of Concern is Expected To Be Most Difficult to Remediate to its Clean up Criteria?
(This will be the effectiveness Indicator Contaminant for the Remediation System.)
trichloroethene TCE
Help
What is an Indicator Contaminant?
An indicator contaminant may be:
*The constituent of potential concern that occurs at the highest concentration; OR
*The most toxic constituent of potential concern; OR
*The constituent that is most persistent or difficult to remove from environmental media, as a consequence of its physical or chemical properties.
OK
MWChart General MW EW Air Stripping Cost
Draw AutoShapes
Ready
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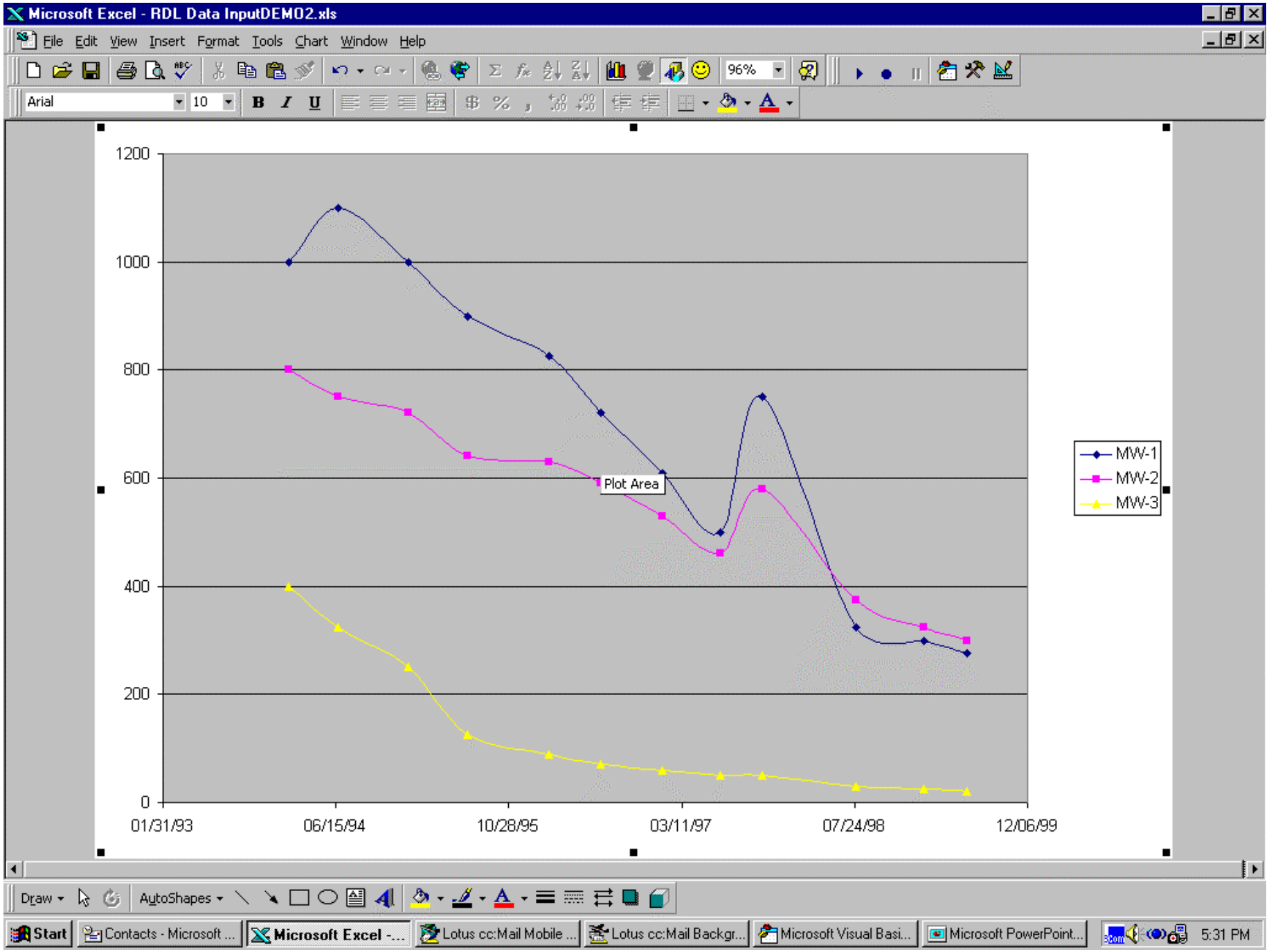
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07/24/98
12/06/99
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MW-3
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Microsoft Excel -...
Lotus cc:Mail Mobile ...
Lotus cc:Mail Backgr...
Microsoft Visual Basi...
Microsoft PowerPoint...
5:31 PM

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Dual-Phase Extraction Optimization Case Study – Edwards AFB

- **Pete Guest, Tom Larson, Bill Plaehn - Parsons**
- **Javier Santillan – AFCEE/ ERT**

Remediation System Description

- Site 5/15 Dual-Phase Extraction System
  - Ten dual extraction wells
  - Four vapor extraction wells
  - A 30 gpm groundwater treatment system
  - A 550 scfm SVE System
  - A 1,500 scfm vapor treatment system

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Site Photo

Remediation System Description

- Site 14 Groundwater Extraction and Treatment System
  - Four groundwater extraction wells
  - Granular activated carbon treatment system
  - Two injection wells
- Downgradient Containment

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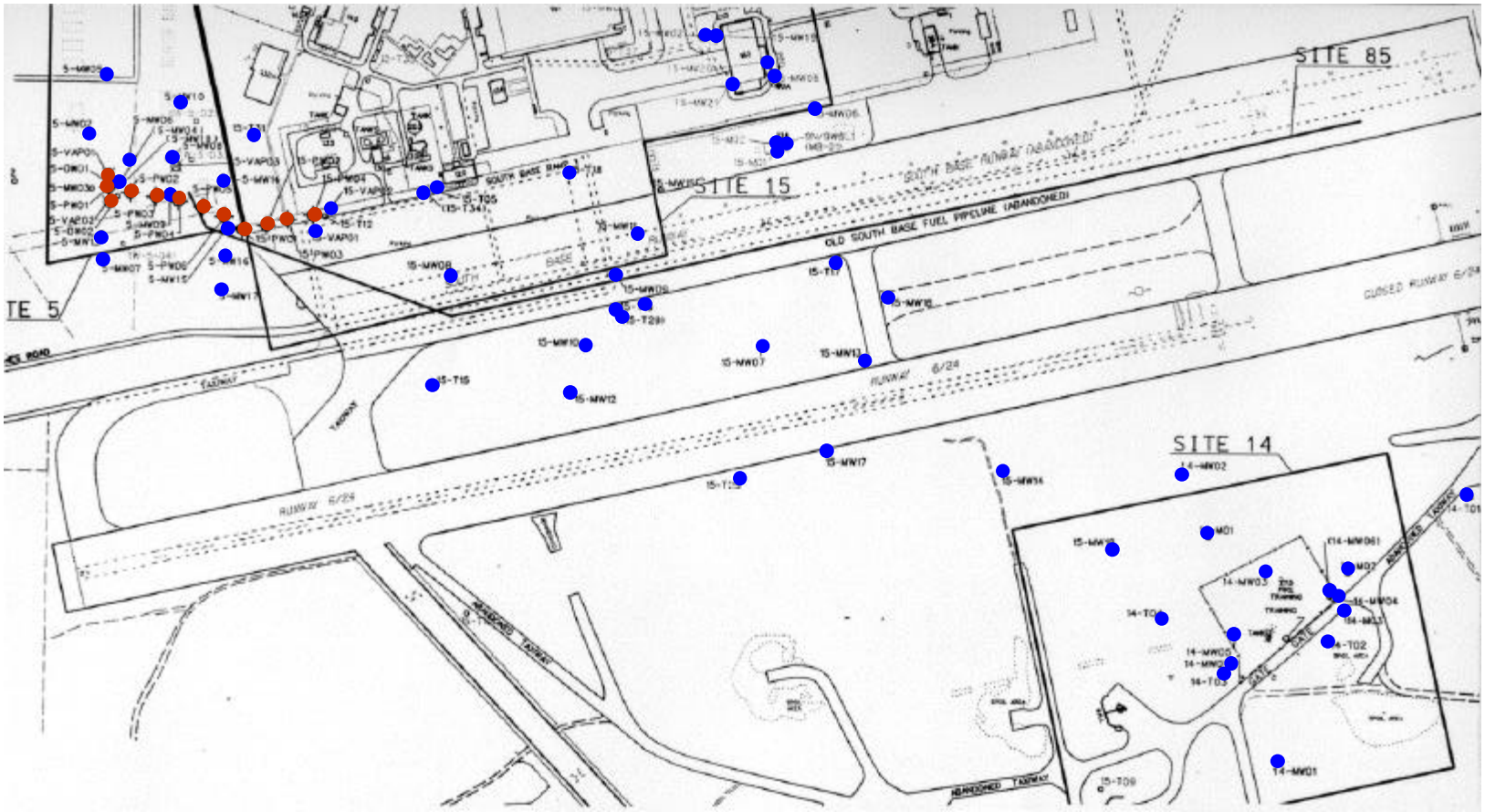
Location of Monitoring and Extraction Wells



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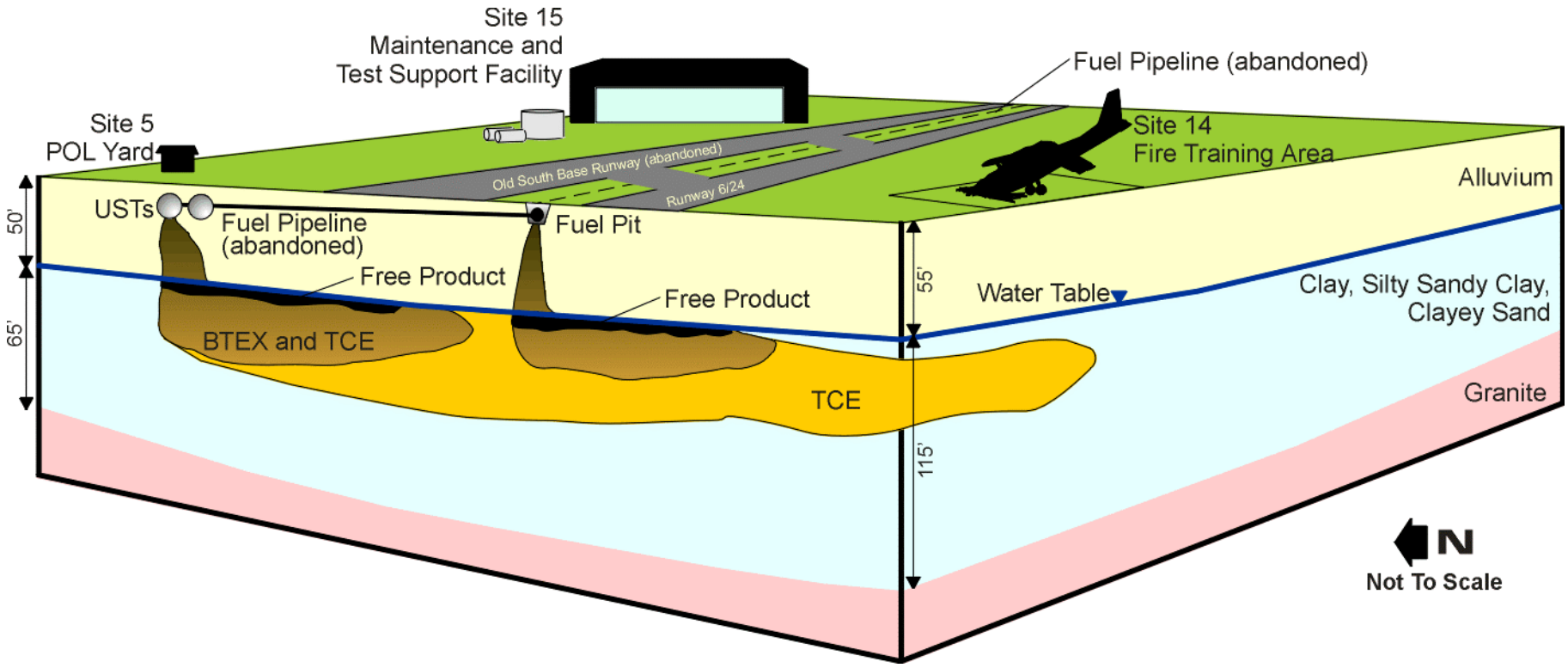
Conceptual Site Model



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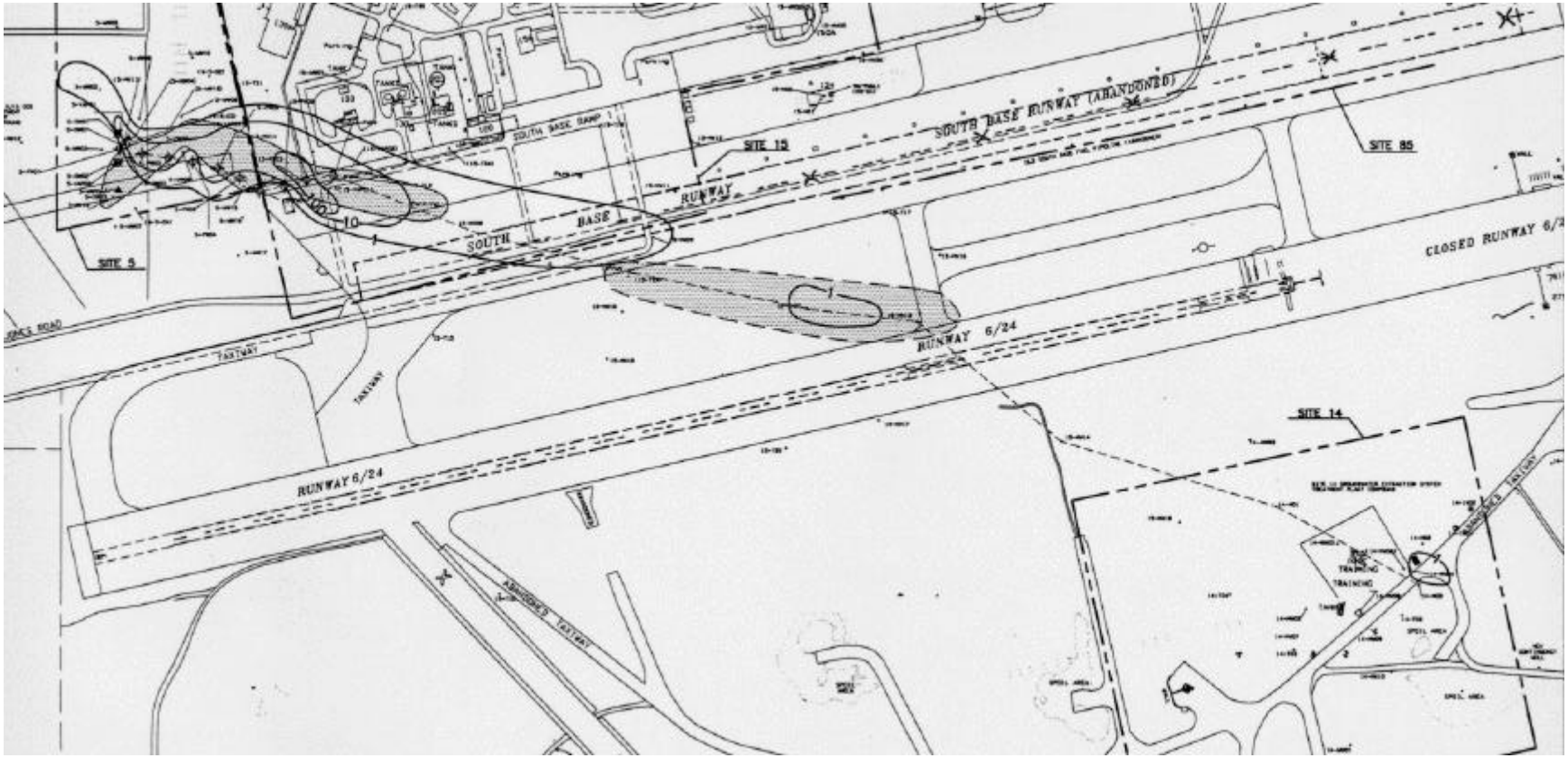
Benzene and Free Product in Groundwater - April 1999



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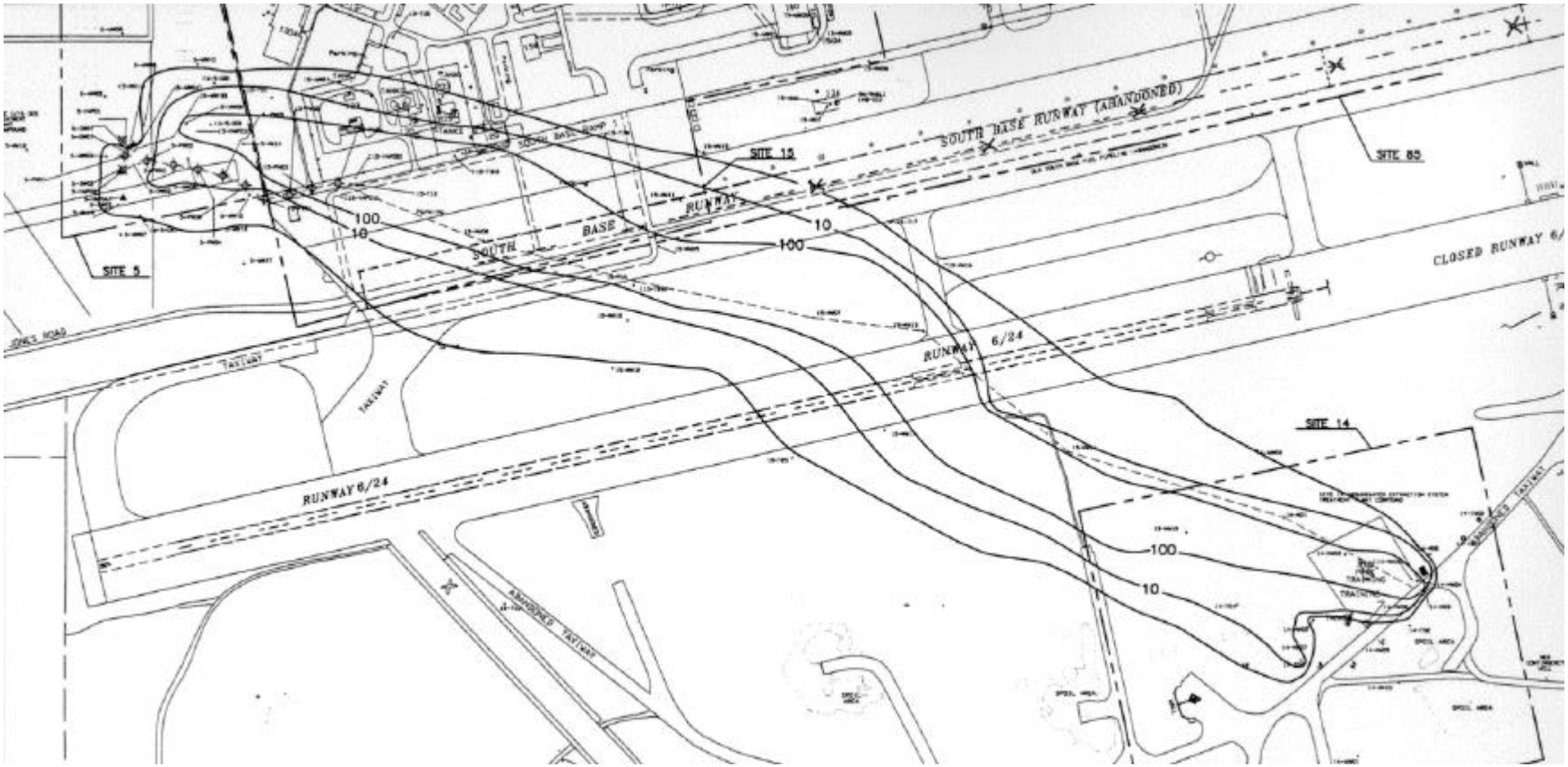
TCE in Groundwater - April 1999



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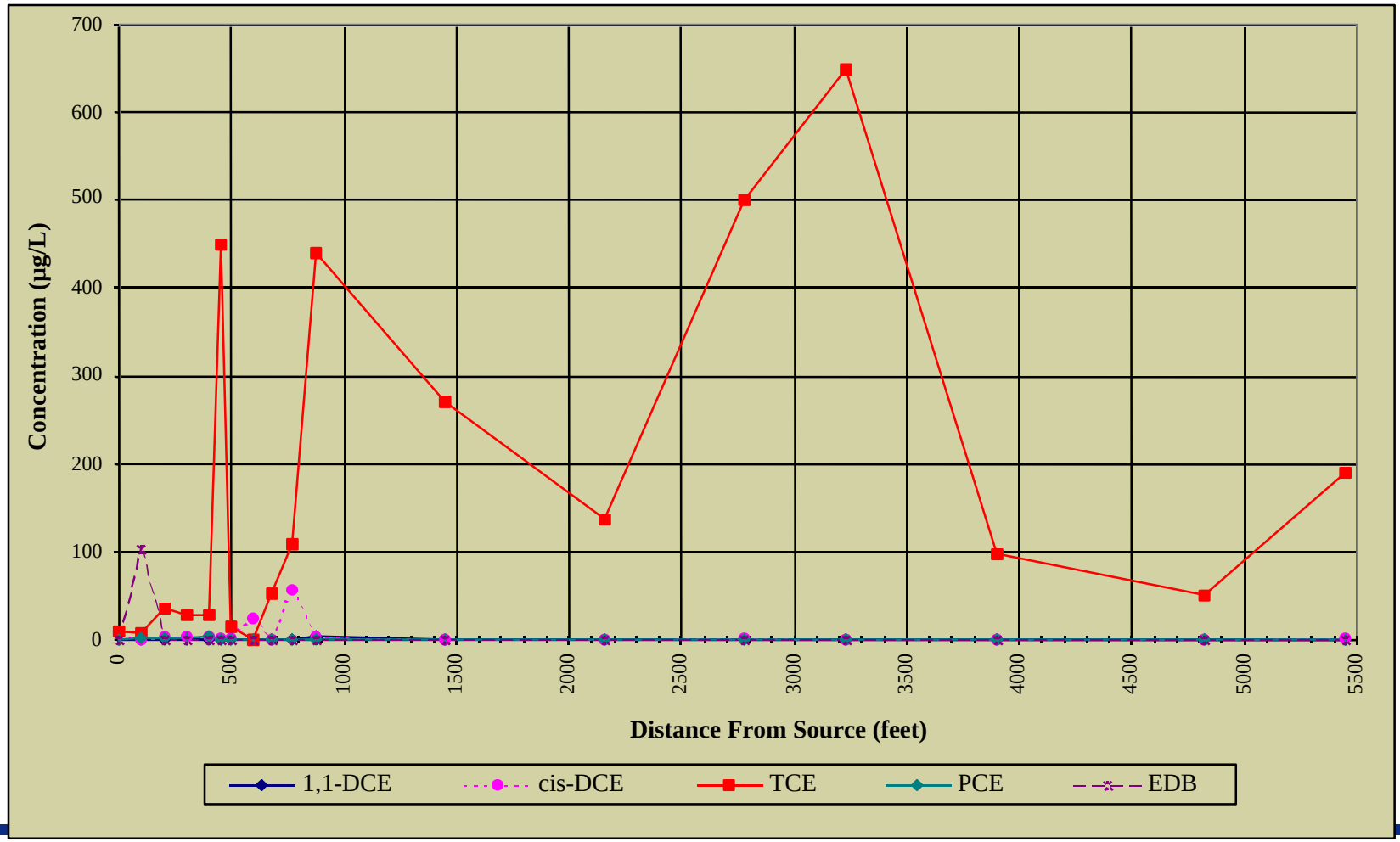
Chlorinated VOC Concentration Versus Distance From Source



Groundwater Geochemical Data

LOCID	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Sulfate (mg/L)
5-MW12	113.3	6.9	80.2
5-MW04	-35.1	0.35	99.7
5-MW06	-107.1	3.11	83
15-MW08	15.7	3.68	525
15-T16	-281.8	0.00	1450
15-MW11	74.7	0.41	365
15-MW07	49.1	1.89	92.9
14-MW03	141.2	0.58	131

Primary Objective of Site 5/15 IRA

"Reduce volume and concentration of hydrocarbon, solvents, and LNAPL contamination in the subsurface…and… cleanup all soil and groundwater contamination to acceptable health-based levels or to the extent technically feasible."

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DPE System Effectiveness and Cost

Parameter	Vapor	Liquid (Free Product Recovery)
Days of Operation	651	651
Total Mass Removed (lbs organics)	350,597	5,171
Mass Removal Rate (lbs/day)	538	8.0
Cost Per Mass Removed ($/lb)	$2.40	$171

Current Groundwater Monitoring Program

- Semiannual Sampling
- 56 Wells - VOCs
- 42 Wells- TVPH,TEPH, and EDB
- Estimated Annual Cost = $85,000

Recommended Groundwater Monitoring Program

- Annual Sampling
- 16 Wells - VOCs and EDB
- Estimated Annual Cost = $15,000

Edwards AFB RPO Study
Short-Term Opportunities

Opportunity	Annual Cost Savings	Life Cycle Cost Savings	Time Savings	ROI	Difficulty of Implementation	Cost to Implement
Terminate product recovery system	$97K	$2.9M	None	107%	Moderate	$100K
Reduce SVE Flow Rate	TBD	TBD	None	TBD	Low	$ 25K
Optimize Long-Term Monitoring	$70K	$2.1M	None	78%	Low	$ 75K
Total	$167K	$5M		185%		$200K

Cost of Edwards RPO Phase II Study = $90K

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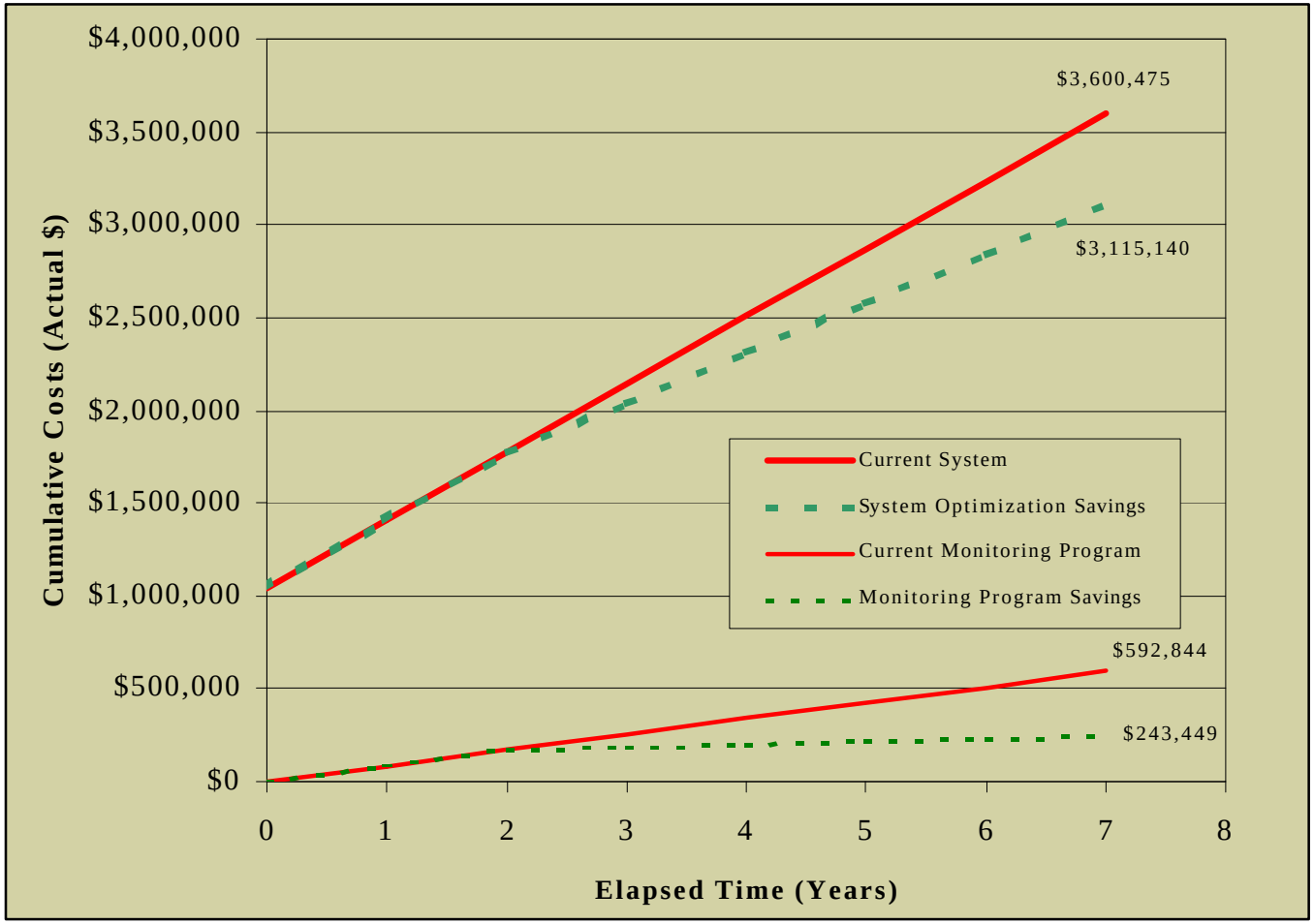
Potential Optimization Savings



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RPO Study
Long-Term Opportunity

Opportunity	Annual Cost Savings	Life Cycle Cost Savings	Time Savings	ROI	Difficulty of Implementation	Cost to Implement
TI Waiver – Source Removal	$365K	$10.9M	30 yrs.	405%	High	$250K
Enhance TCE Biodegradation	$125K	$3.8M	10 yrs.	139%	Moderate	$750K

Soil Vapor Extraction Optimization Initiatives

- SVE Optimization Protocol
- Advanced Characterization Tools
- Well Screen and Flow Optimization
- Performance Monitoring
- Off-gas Treatment Optimization

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SVE Optimization Protocol

- **Objective – Provide operators of existing SVE systems with practical tools for improving performance and obtaining remediation goals sooner.**
- **Major Topics – Recharacterization, Revising Conceptual Site Models, Understanding Site Closure Criteria, Performance Monitoring, Optimization Methods, and Obtaining Site Closure**

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Advanced Characterization Tools

- **PRAXIS Pneulog™ Well Logging Device**
- **Geoprobe ™ Membrane Interface Probe (MIPs)**
- **Simul-Probe ™ Cone Penetrometer**
- **Low-Cost, Discrete Monitoring Points**

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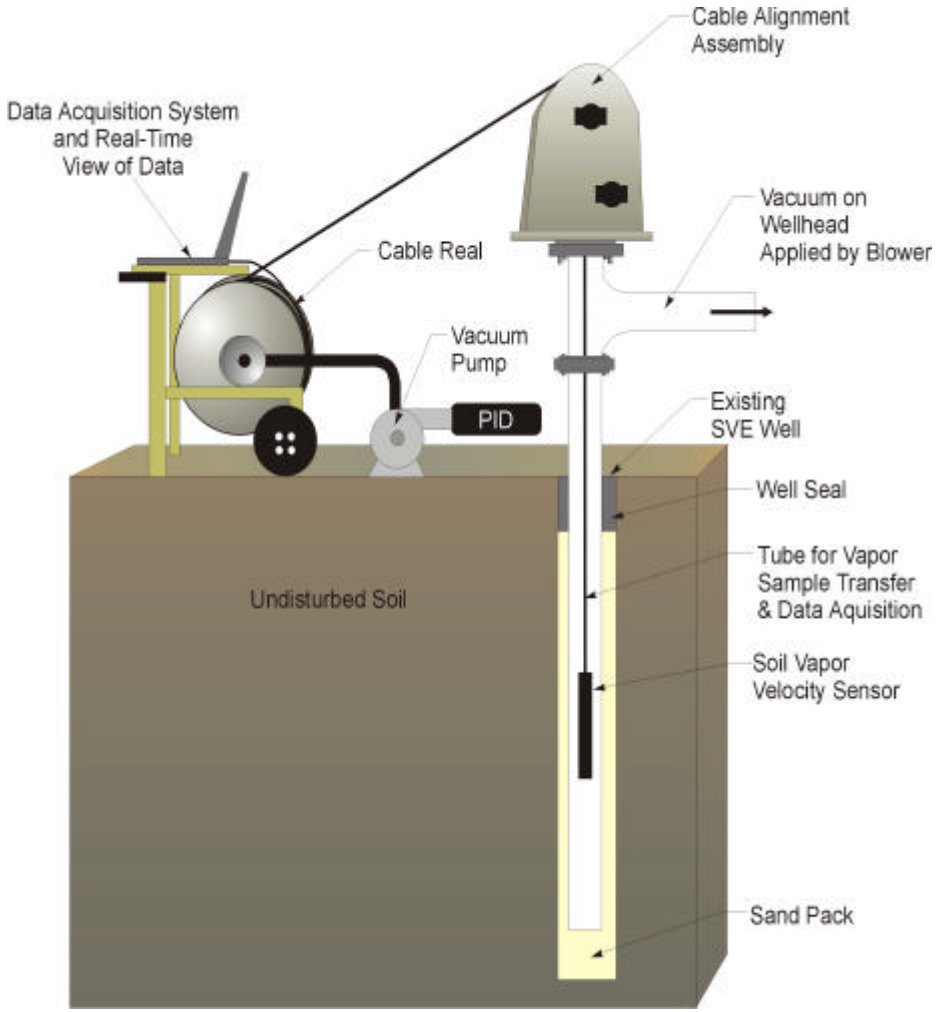
PRAXIS PneuLog ™ Schematic



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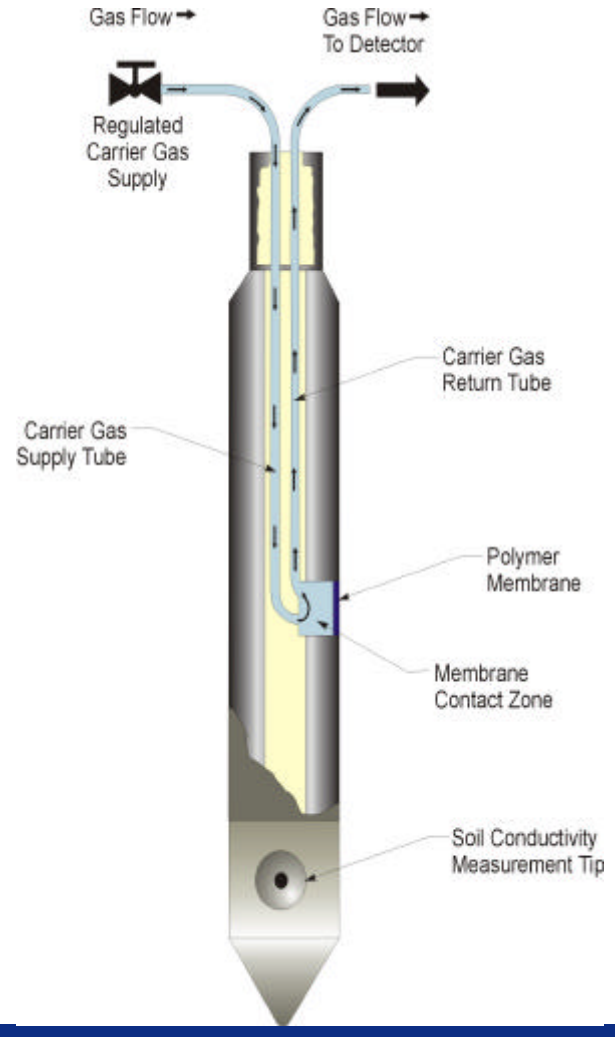
Geoprobe™ Membrane Interface Probe MIPS™ System Diagram



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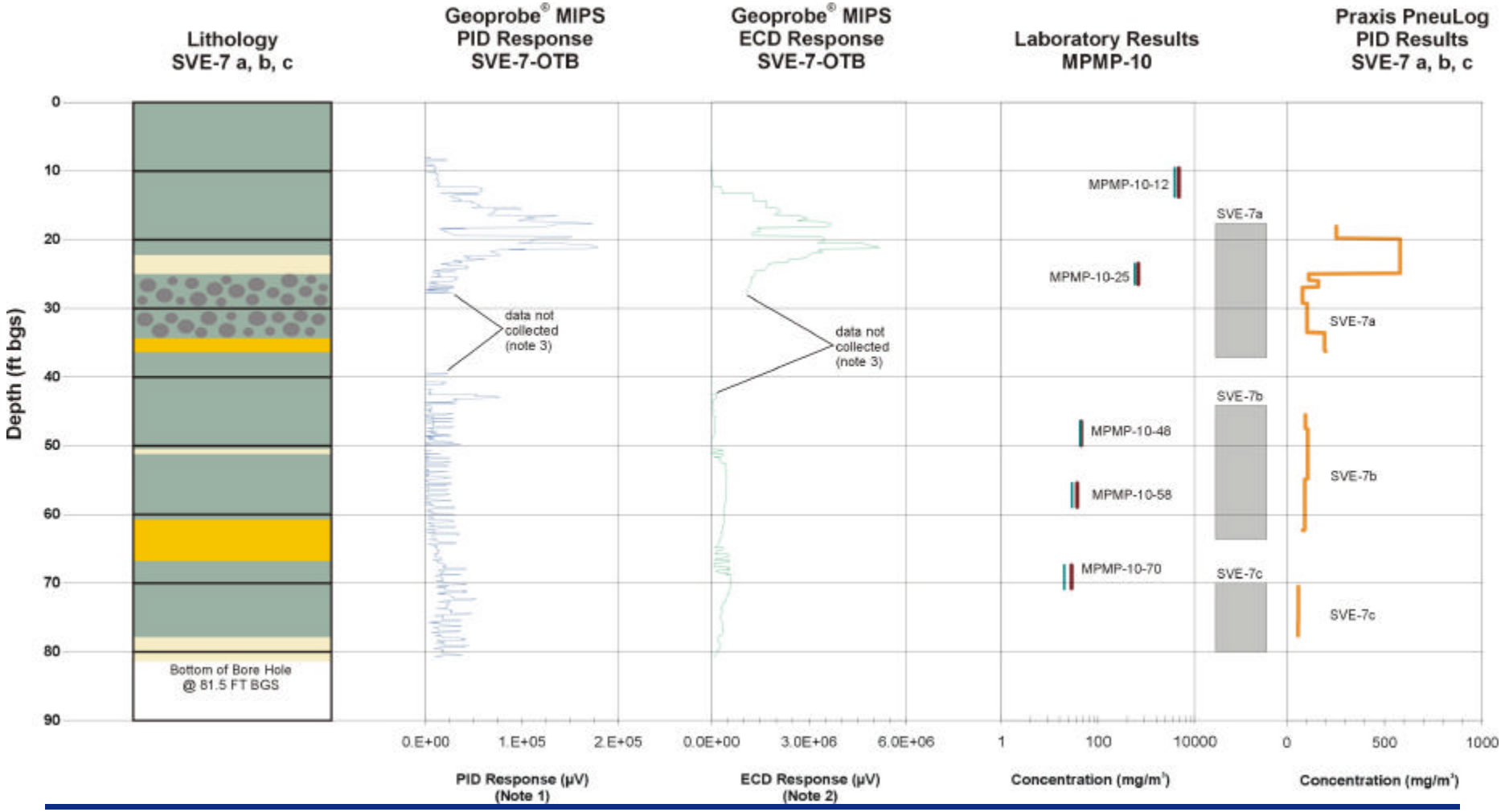
SVE-7, SVE-7-OTA and MPMP-10 Concentration Comparison Charts



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MIPS, Field and PneuLog Permeability Comparison Charts

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Well Screen and Flow Optimization

- **PRAXIS Pneulog™ Well Logging Device**
- **Identify Diffusion Limited Zones**
- **Design Well Screen to Utilize High Permeability Soils**
- **Reduce Flow Rates to Match Diffusion Rates ➔Big Savings in Thermal Units**
- **Consider Pulsed Operation When There is Economic Benefit ➔Big Savings in Thermal Units**

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Performance Monitoring

- **Establish Remediation Standards Based on Vapor Equilibrium**
- **Monitor Reductions in Vapor Monitoring Points**
- **Equilibrium Testing – Rebound Analysis**
- **Negotiate Soil Column Averaging To Determine Compliance**
- **MIPSÔ Device Can Provide Multiple Vertical Profiles of Soil Column**

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Performance Monitoring

- Example of Cleanup Goals at PCE/DCE Site
  - Cleanup Goal Based on Preventing MCLs Using EPAs Default Dilution Attenuation Factor of 20
    - 60 ug/kg for PCE
    - 60 ug/kg for DCE
  - Use of Average Concentrations in Soil Column Based on 40+ Samples to Determine if Goal Achieved
  - Equilibrium Soil Gas Monitoring
    - PCE at 2 ug/kg
    - DCE at <1 ug/kg

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Vapor Treatment Optimization

- **Most Over Designed and Expensive Element of SVE**
- **Rapid Decrease in Vapor Concentrations Require a More Forward-Looking Approach**
- **Thermal→Carbon →No Treatment**
- **Carbon Prevails at < 200 ppmv**

Vapor Treatment Optimization

- McClellan AFB OUD Example
  - Designed at 600 scfm from 27 wells
  - After optimization 400 scfm from 13 wells
  - 200-300 ppmv VOC influent
  - Catalytic Oxidation Vapor Treatment
    - Current Cost $8- $10 per Pound
    - Projected Over $20 per Pound
    - High Maintenance
    - Rising Energy Costs
  - Evaluated Carbon Alternative
    - Cost $20- $24 per Pound

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Thank You