Headquarters U.S. Air Force

Integrity - Service - Excellence

Examples of Air Force Data Management and Information Systems: *GTS and EDITT*

AFCEE/TDV
Philip Hunter, P.G.
2009 May

U.S. AIR FORCE

Overview

- ✓ Data management fly-over
- ✓ Electronic data resources
- ✓ Focus: GTS & EDITT
- ✓ Application highlights
- ✓ Benefits & payoffs

Products and Services

AFCEE Restoration Branch

- ✓ Organization
- ✓ Staff
- ✓ Mission
- ✓ Goals
- ✓ Products and Services
- ✓ Funding
- ✓ Issues

- Remedial Process Optimization
- Peer Review Support
- Decision Support & Analysis
- Rapid Site Characterization
- Innovative Technologies
- Performance Based Contracting
- Consulting Services
- Exit Strategy Development
- ROD Reviews
- 5-Year Review Support
- LTM Optimization
- Emerging Issues

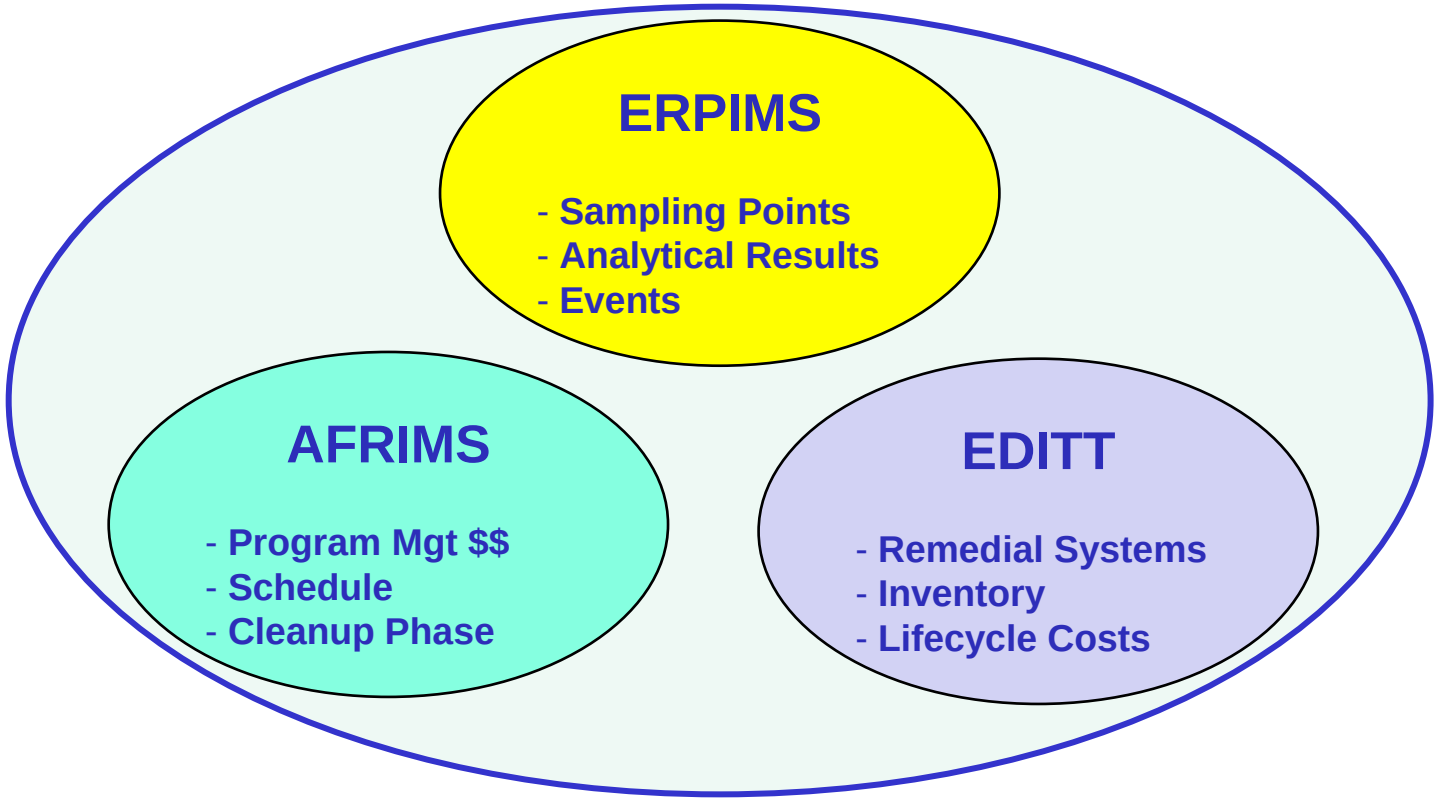
Partnerships and Working Groups
Restoration Branch

- ✓Technology Transfer
- ✓Technology "Needs"
- ✓BAA
- ✓Partnerships
- ✓Training/ Education

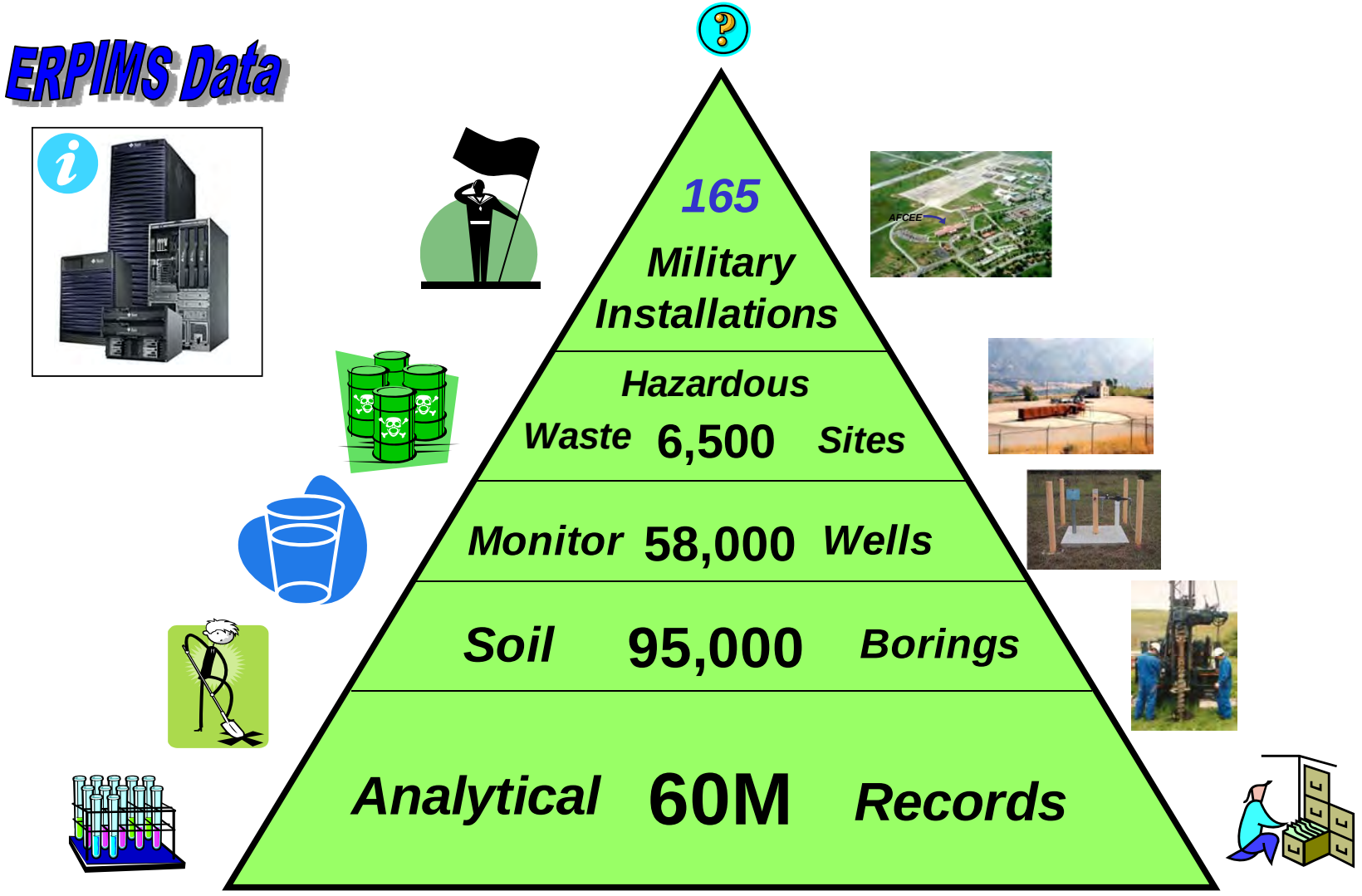
- Tri-Service Environmental Risk Assessment Workgroup
- OSD Materials of Emerging Regulatory Interest Team (MERIT)
- EPA Federal Remediation Technologies Roundtable (FRTR)
- Environmental Data Quality Workgroup (EDQW)
- Sustainable Remediation Forum (SuRF)
- Strategic Environmental Research & Development Program (SERDP)
- Environmental Security Technology Certification Program (ESTCP)
- Interstate Technology Regulatory Council (ITRC)

Key Databases

Data Management is < 0.5% of Environmental Budget

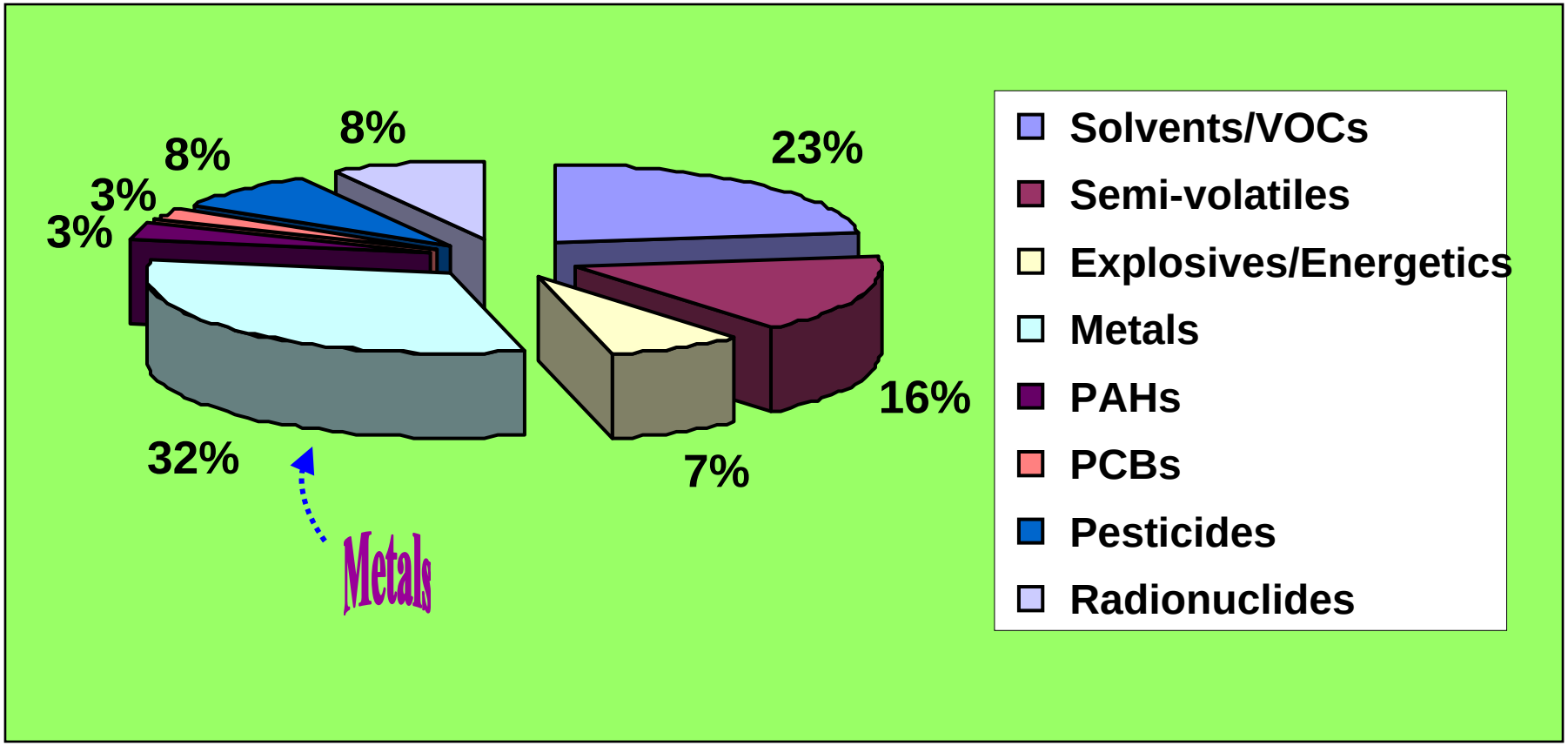


Environmental Resources Program Information Management System (ERPIMS)



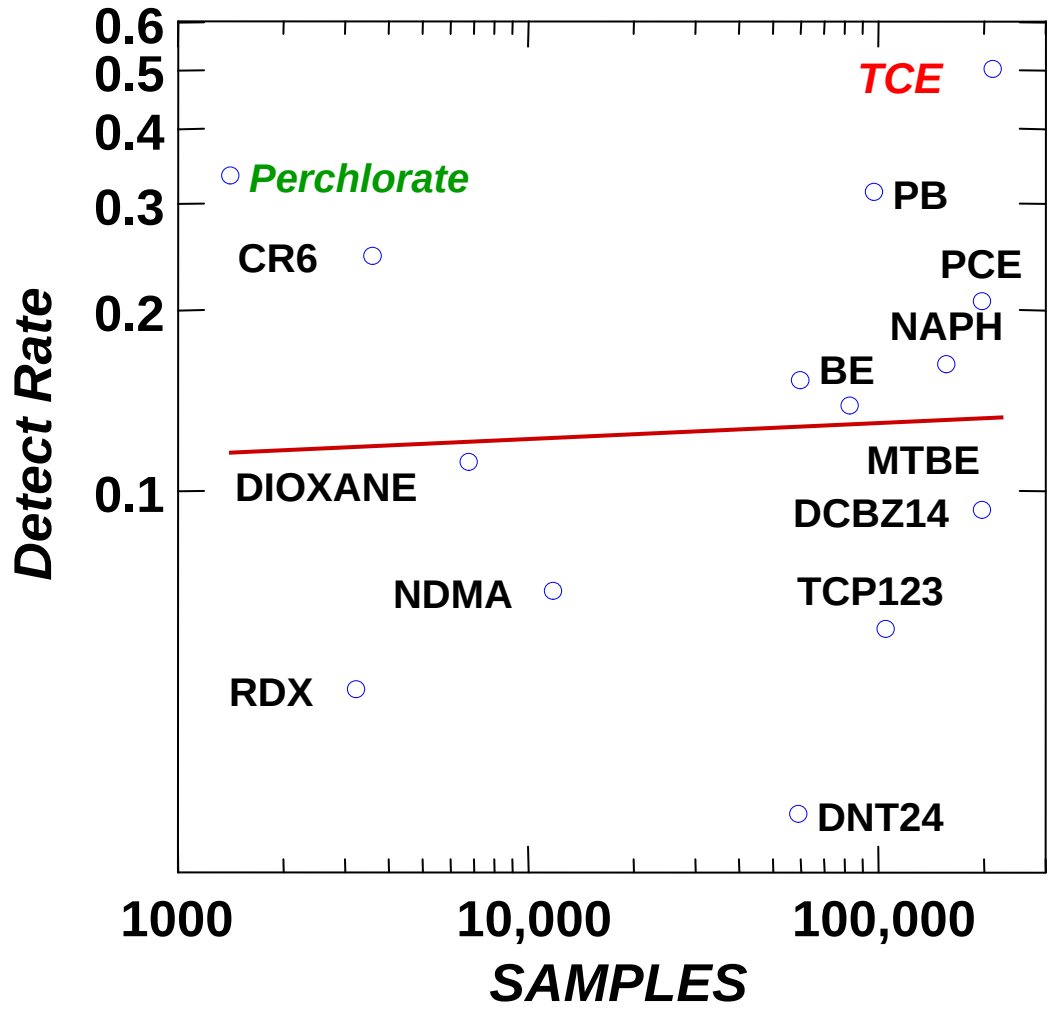
Types of Constituents Detected in GW

Air-Force Wide Analysis



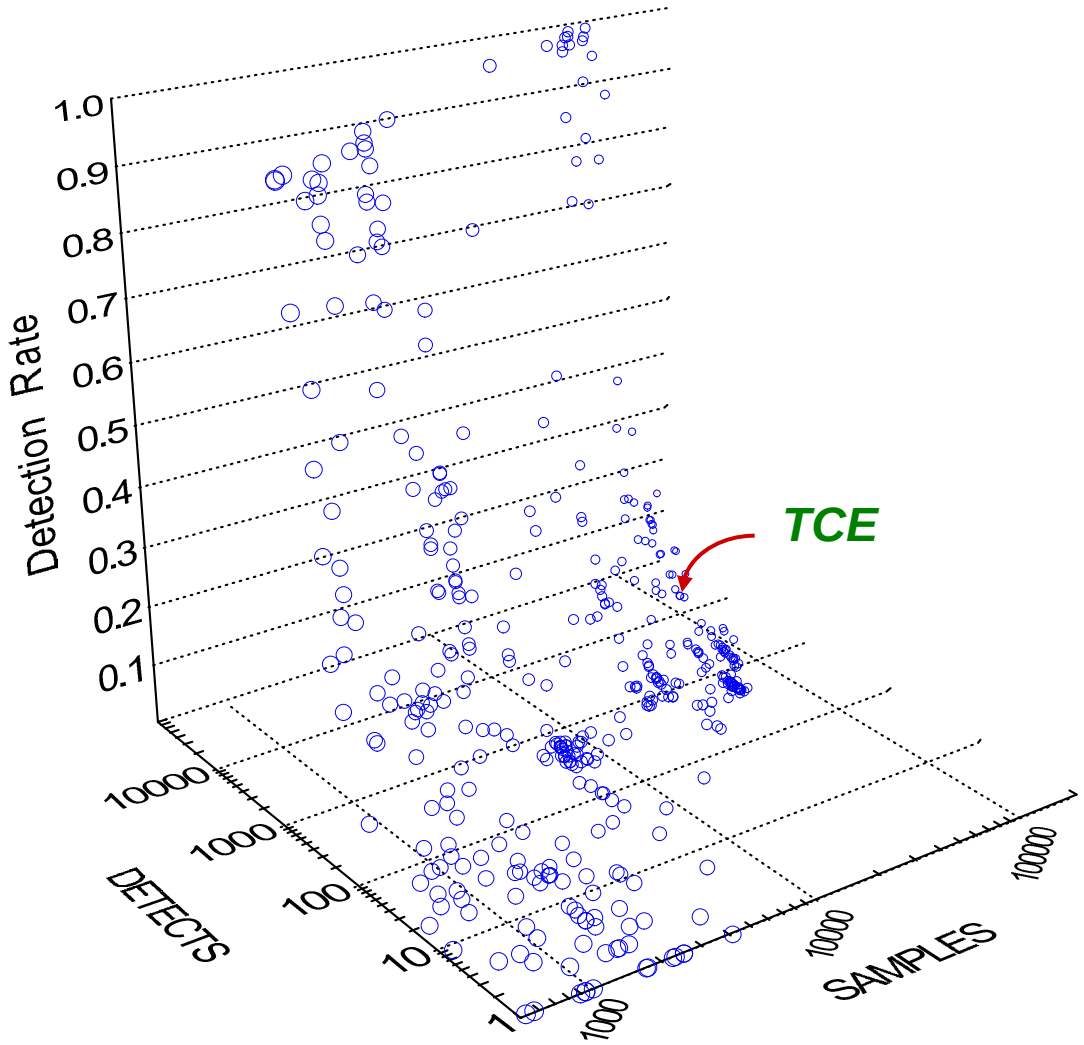
Detect Rates in Groundwater

Air-Force Wide Analysis



Detect Rates in Soil

Air-Force Wide Analysis



GW Analytes Detected Above PRGs

Air-Force Wide Analysis

Constituent	Bases w/ Detects	Wells w/ Detects	Median Detect	Sample Size (n)	Detect Rate	Units
TCE	124	19,909	19	227,374	52%	ug/L
MANGANESE	118	17,044	101	68,821	86%	ug/L
LEAD	128	13,453	5	97,739	31%	ug/L
ARSENIC	128	12,127	7	88,447	38%	ug/L
NICKEL	118	10,247	18.4	78,517	44%	ug/L
PCE (TETRACHLOROETHYLENE)	110	9,785	2.7	212,357	21%	ug/L
VANADIUM	103	9,351	7.4	54,713	43%	ug/L
NAPHTHALENE	116	7,423	10	162,706	17%	ug/L
COBALT	100	6,507	5.2	55,129	28%	ug/L
CADMIUM	114	6,032	1.1	86,284	14%	ug/L
1,1 - DICHLOROETHANE	108	5,521	2	205,257	13%	ug/L
BERYLLIUM	100	4,690	0.6	59,662	15%	ug/L
CHLOROMETHANE	100	4,593	2	201,375	6%	ug/L
MOLYBDEMUM	73	3,555	6.7	30,562	31%	ug/L
n-PROPYLBENZENE	83	3,495	5.8	92,769	16%	ug/L
MTBE (tert-Butyl Methyl Ether)	70	2,888	5.0	100,771	13%	ug/L
PCA (1,1,2,2-Tetrachloroethane)	69	1,735	1	198,601	4%	ug/L
1,2,3-TRICHLOROPROPANE	36	1,015	1	111,189	6%	ug/L
NITROBENZENE	31	474	10	57,977	3%	ug/L
2,4 - DINITROTOLUENE	26	472	10	58,765	3%	ug/L
CHROMIUM, HEXAVALENT	23	463	12.9	3,728	26%	ug/L
2,6 - DINITROTOLUENE	24	413	10	57,802	3%	ug/L
NDMA (N-NITROSODIMETHYLAMINE)	10	358	1.2	12,379	7%	ug/L
1,4-Dioxane	10	229	10	7,439	12%	ug/L
ANILINE	6	178	2.3	8,442	3%	ug/L
PERCHLORATE	10	140	62	1,992	43%	ug/L
RDX	11	97	2.5	3,281	5%	ug/L

Constituents Not Sampled

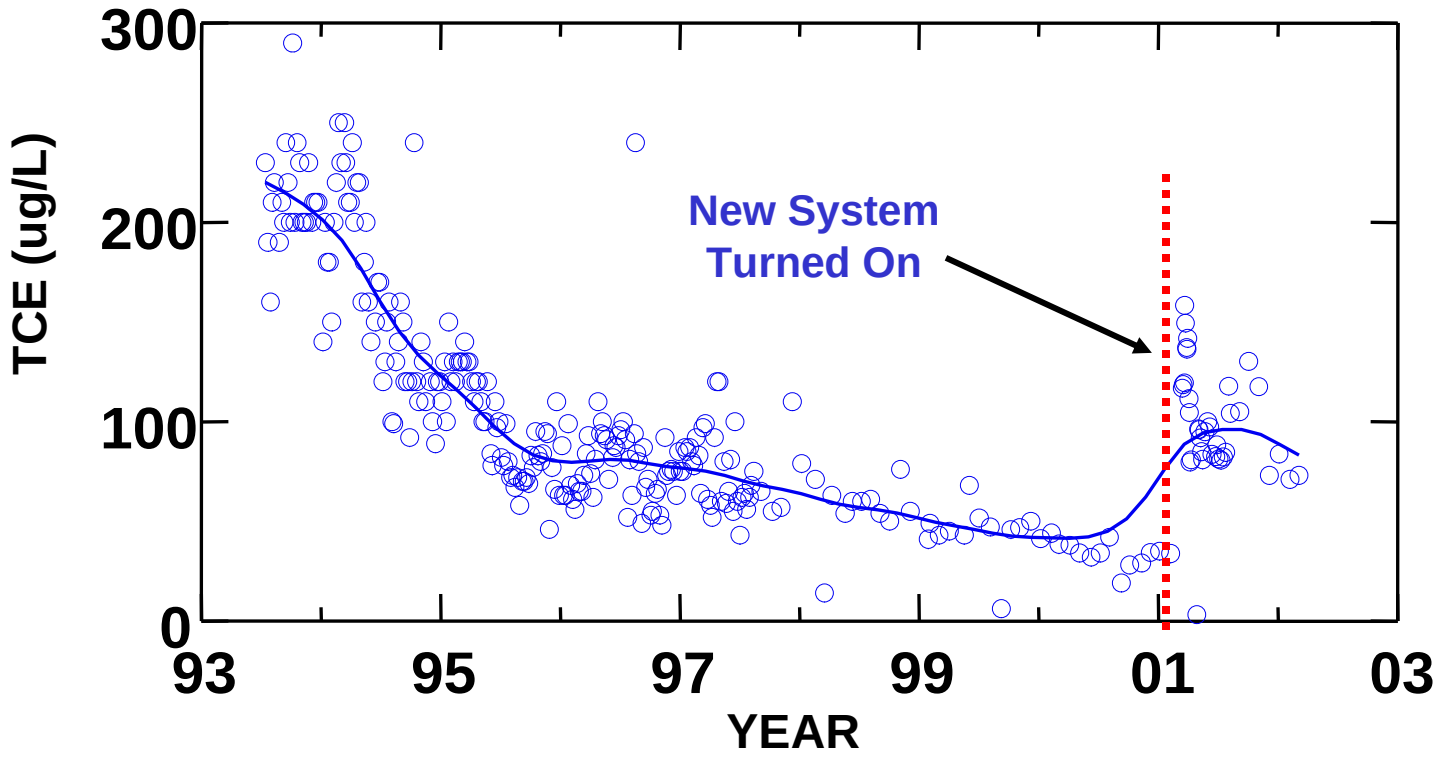
Air-Force Wide Analysis

Constituent	Media
2-METHOXYETHANOL	Groundwater, Soil
PBDEs	Groundwater, Soil
PFOA and PFOS	Groundwater, Soil
2-PROPEN-1-OL	Groundwater, Soil
ACEPHATE	Groundwater, Soil
DICROTOPHOS	Groundwater, Soil
METHAMIDOPHOS	Groundwater, Soil
NITROFEN	Groundwater, Soil
PERMETHRIN	Groundwater, Soil
SULFUR HEXAFLUORIDE	Groundwater, Soil
ETHYLENE THIOUREA	Groundwater
ZIRAM	Groundwater **
3-HYDROOXYCARBOFURAN	Soil
ACETOCHLOR	Soil
FENAMIPHOS	Soil *

Time Series Analysis

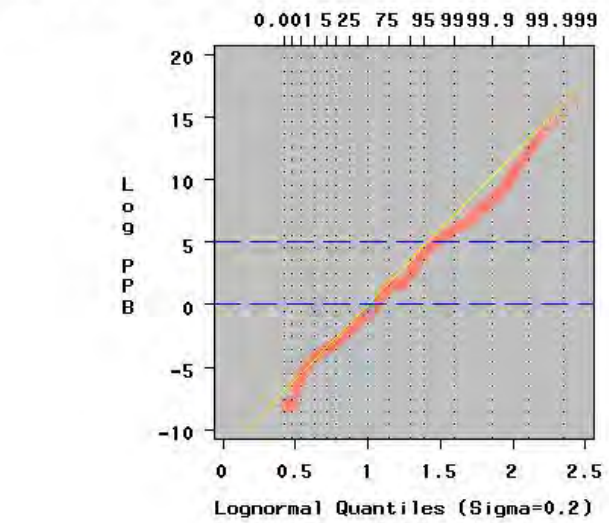
Treatment System Analysis

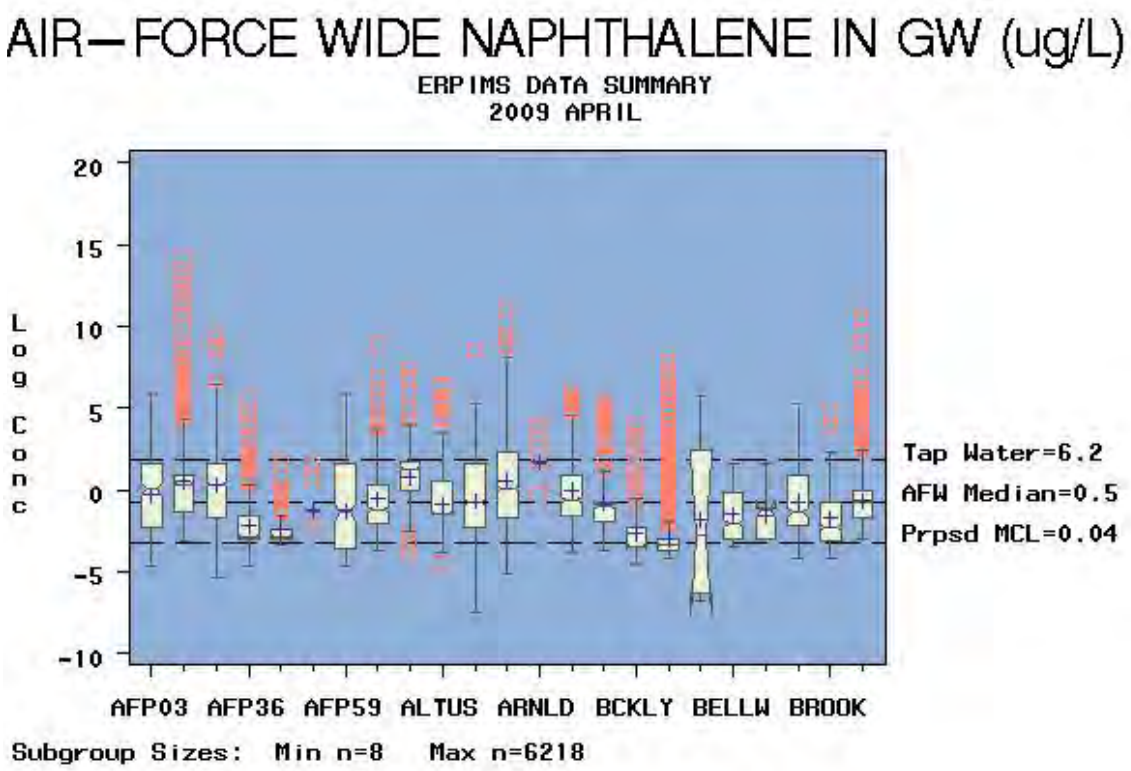
Example: Influent TCE, Mission St Treatment Facility



Statistical Analysis of Individual COCs

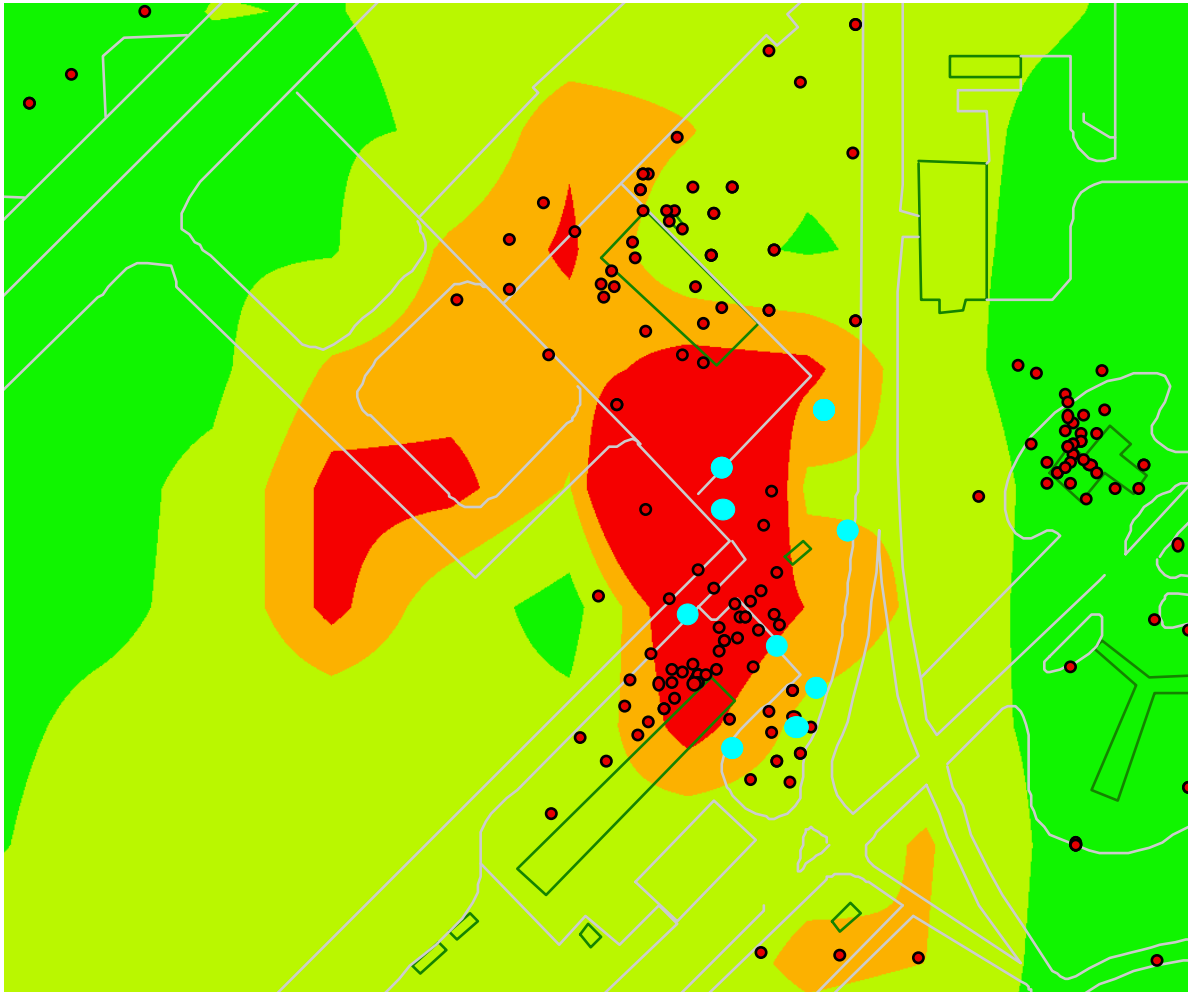
Air-Force Wide and Installation Level





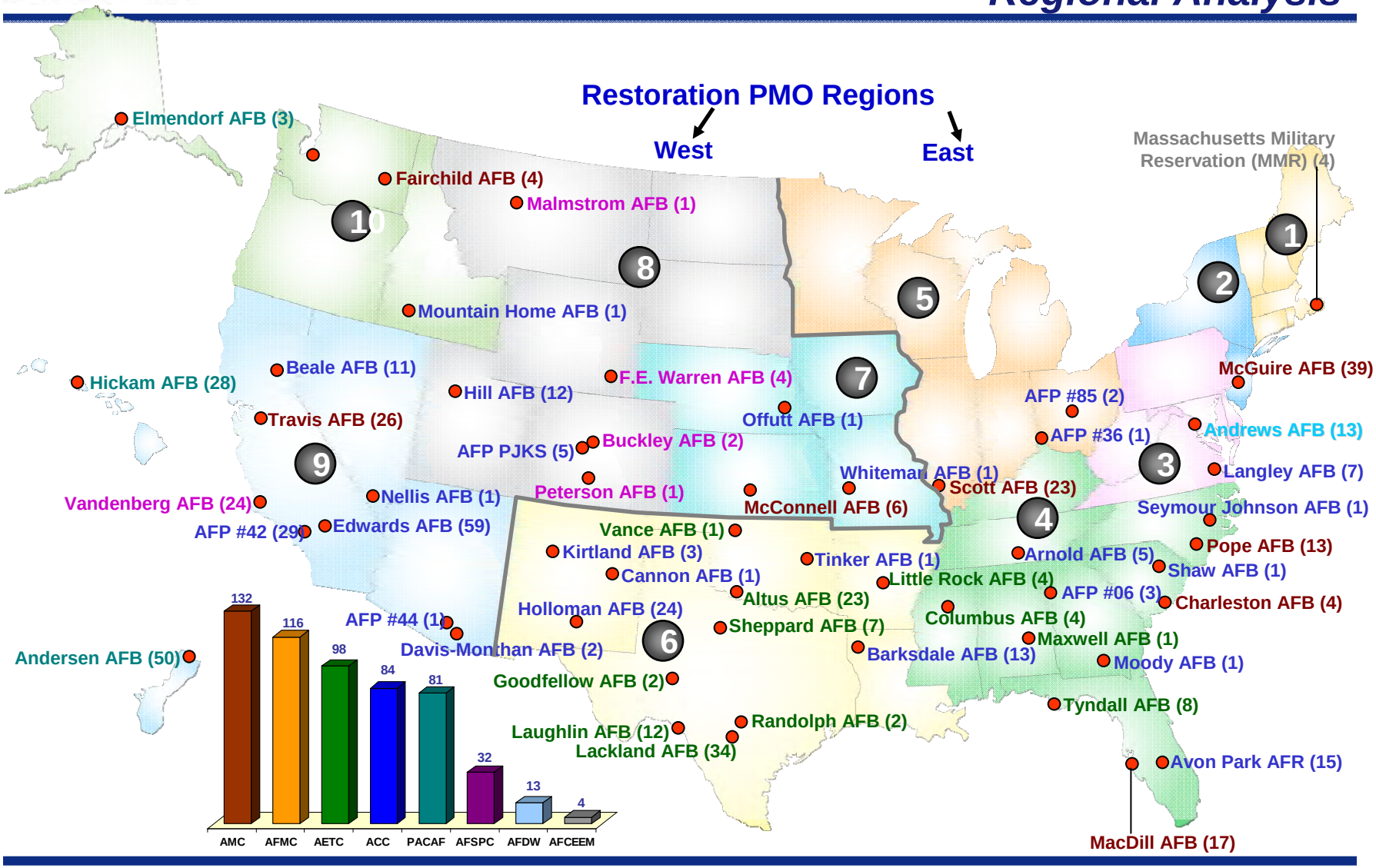
GIS & Anthropogenic Background Analysis of PAHs in Soil

Site and Installation Level



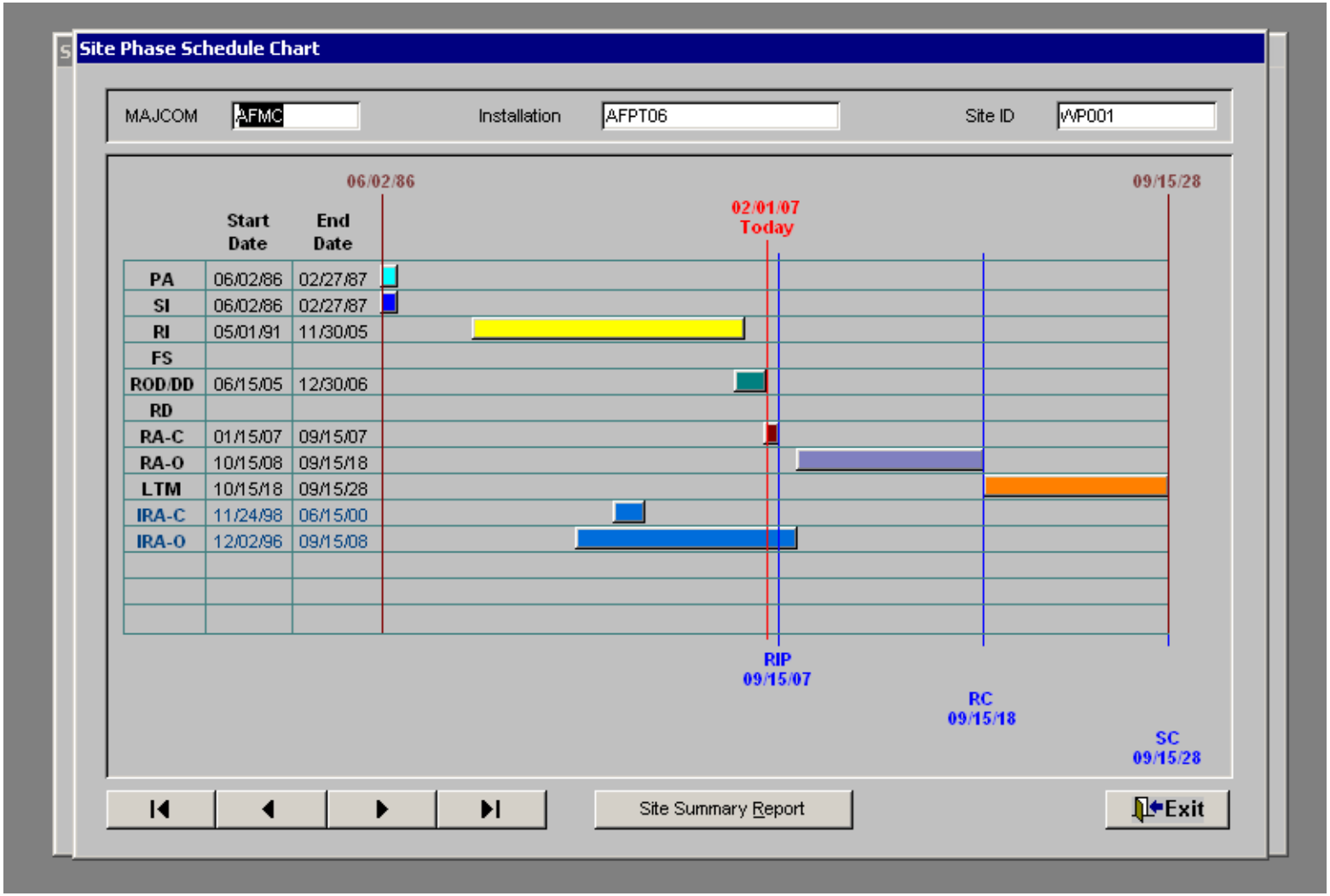
Sites That Have Not Achieved RIP

Regional Analysis



Cleanup Phase & Timeline

Installation Analysis

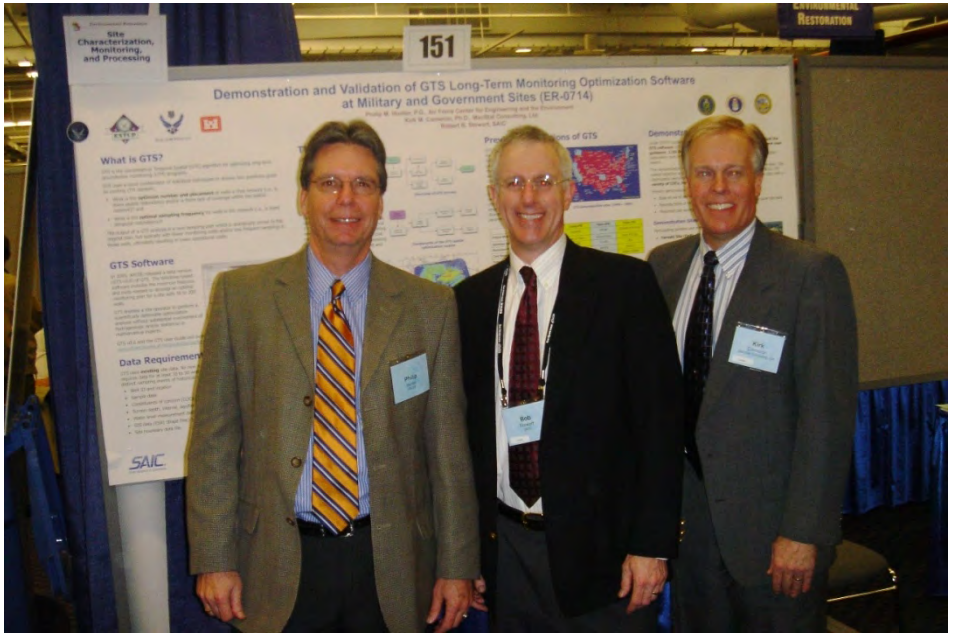


U.S. AIR FORCE

GTS Discussion

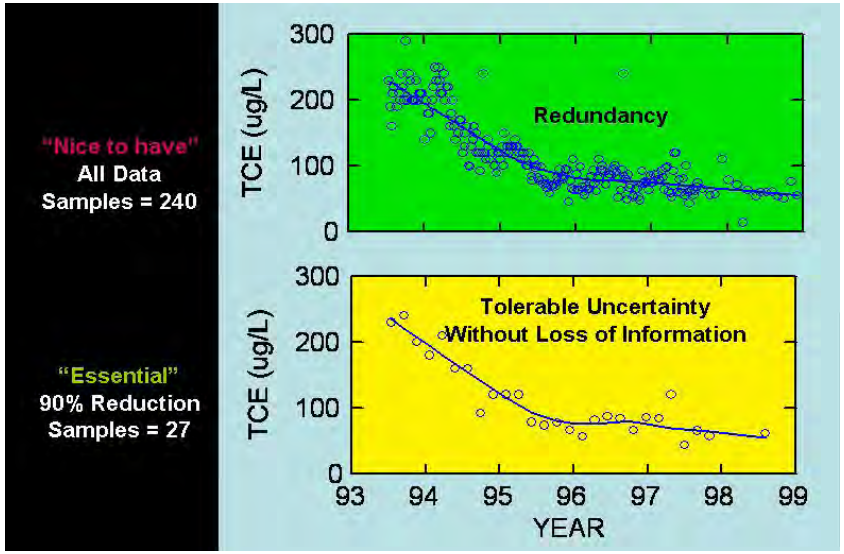
GTS

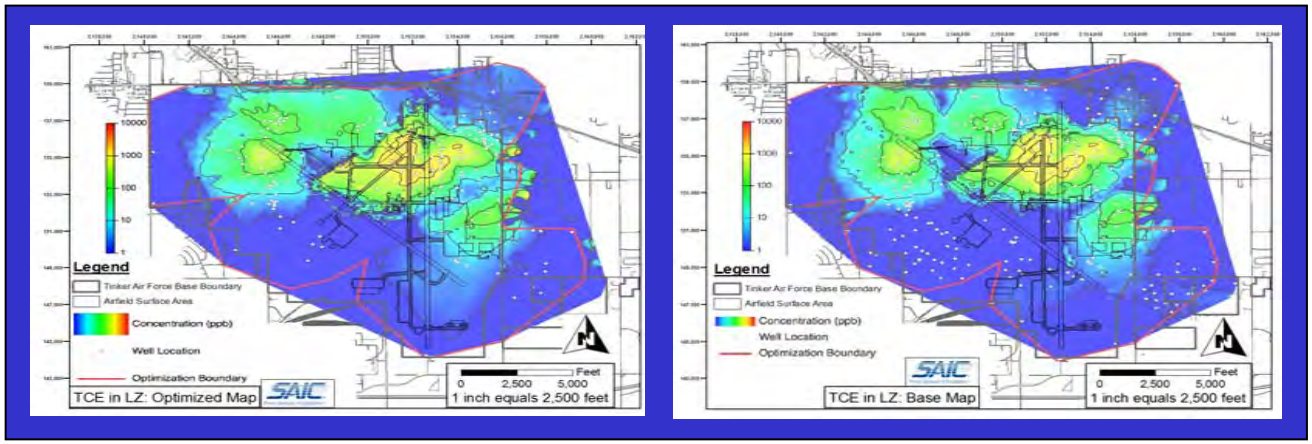
Geostatistical Temporal/Spatial Algorithm Software



Why Optimize?

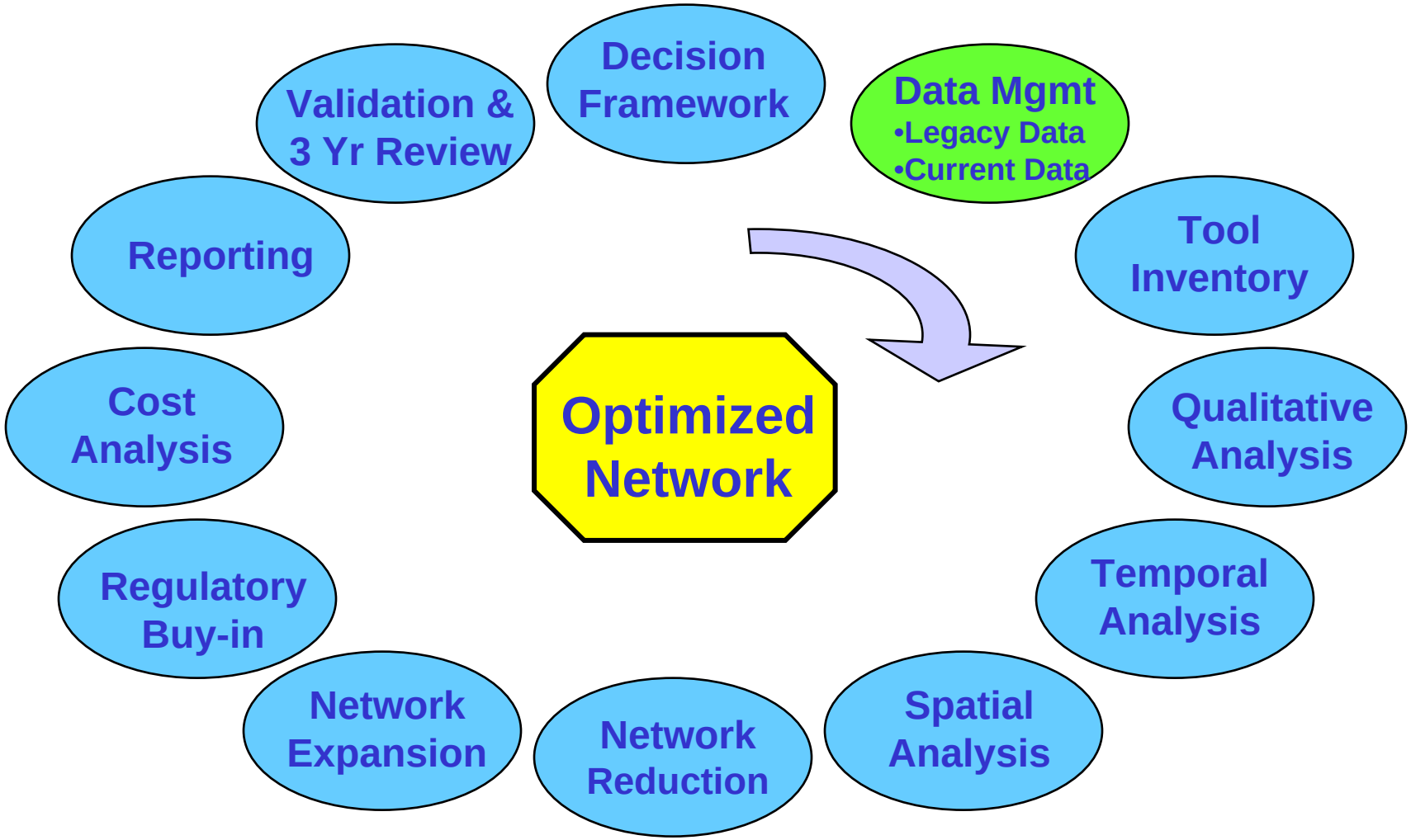
Data Redundancy Over Time & Space





LTM Optimization

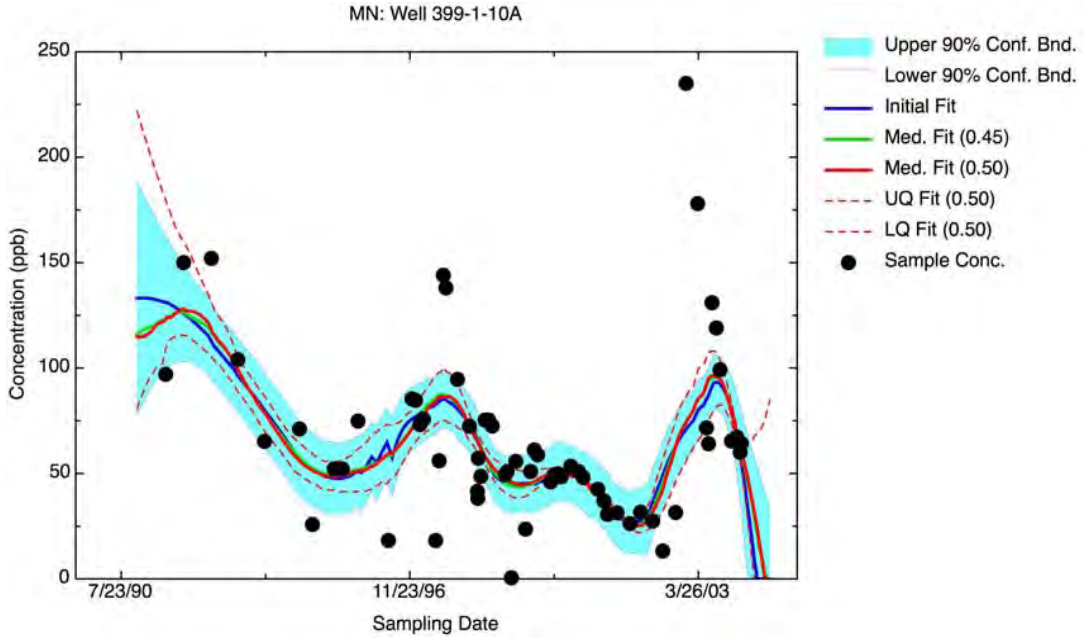
Requires Electronic Data



Technology Description
GTS

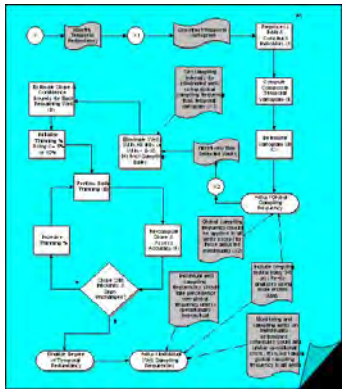
- Determines optimum number, placement of wells
- Optimal sampling frequency
- Analyzes & reduces statistical redundancy
- Typical LTM cost savings: 25-50% per site, up to $1M per installation; savings are cumulative

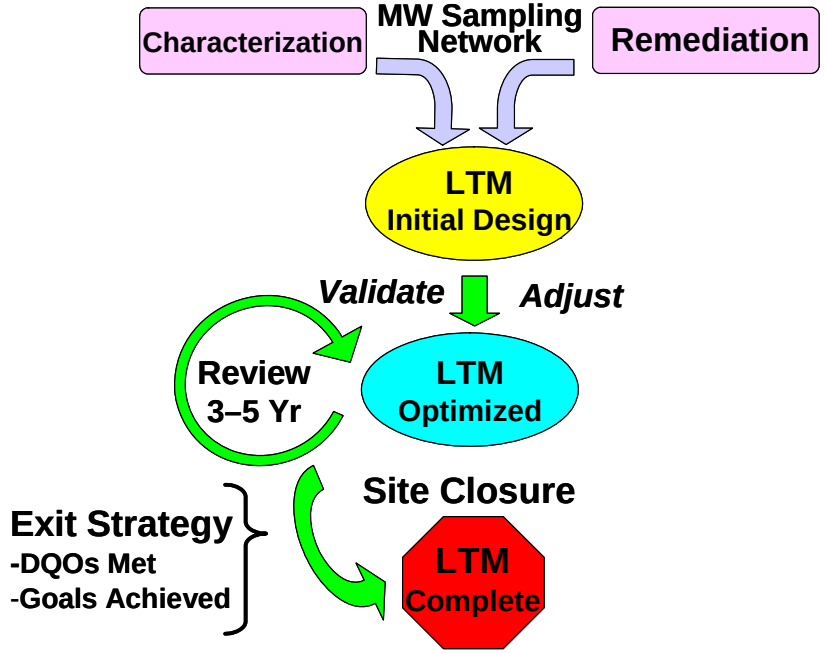
-Costs to perform optimization is about 10% of O&M budget
-Return on Investment = 1-2 yrs



Key Features
GTS

- **Algorithm-based**





- **Unique Features**
  - **Free, public-domain, open-source software**
  - **Wizard-type interface**
  - **Balance between full-scale expert system & heuristic model**
  - **Designed to be run by midlevel analysts**

U.S. AIR FORCE

Other Key Features
GTS

- Modular design
  - Five modules: Prepare, Explore, Baseline, Optimize, Predict
  - Intermediate ‘stopping’ points
- Visually focused: statistical graphics, tables, maps
- Numerous report summaries; printed, saved, or exported
- Imports GIS shape files; facility/site boundary, flight line, roads, buildings, etc.
- Geospatial analysis uses:
  - Quasi-genetic search algorithm
  - Cost-accuracy tradeoff curves

Optimization and Prediction
Features

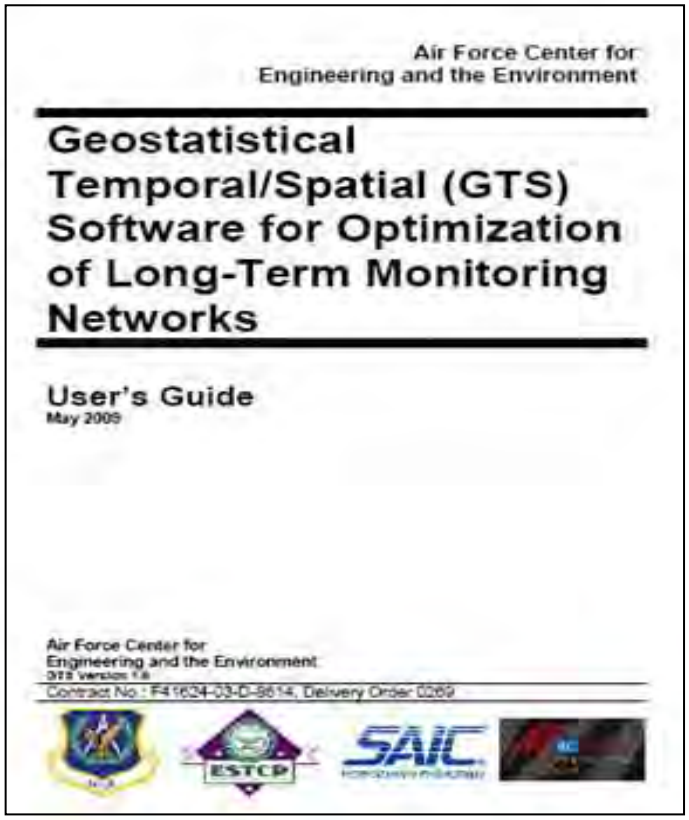
- Flexible Temporal Optimization
  - Two methods: Temporal variograms or iterative thinning
  - Iterative thinning: how much data can be removed, yet still reconstruct baseline trends?
- Smart Spatial Optimization
  - Baseline maps are constructed (*all* data from all wells)
  - Optimized maps (reduced well set) compared to baseline maps to assess information loss
- Prediction of new rounds of data
  - Trend and plume anomalies identified

U.S. AIR FORCE

Software Installation
GTS

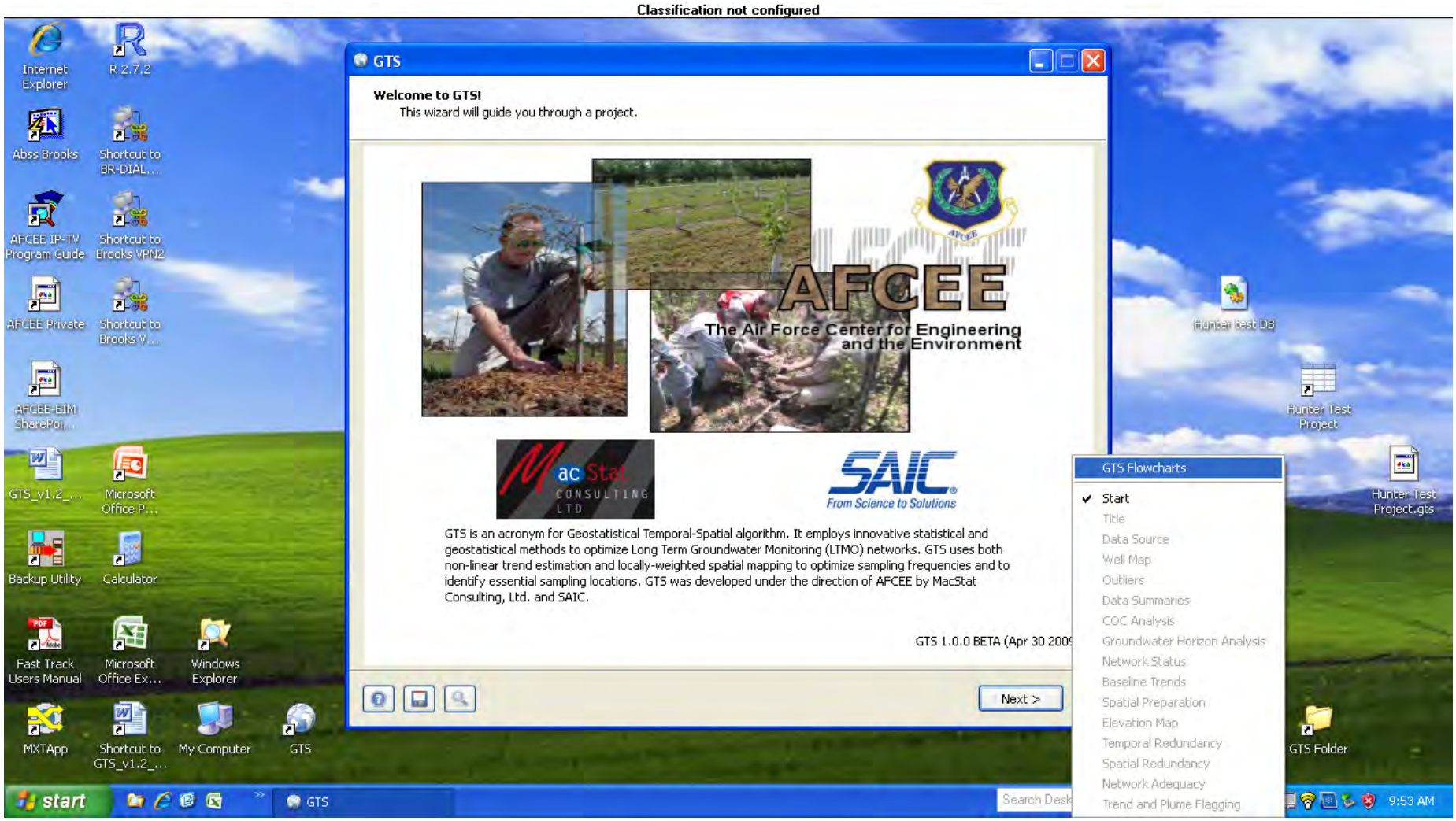
Installation components:

- R Statistical suite
- Qt GUI tool kit
- MatLab Compiler Runtime
- MS Visual C++2008 Runtime
- SQLite database & test data set



Opening Screen

GTS

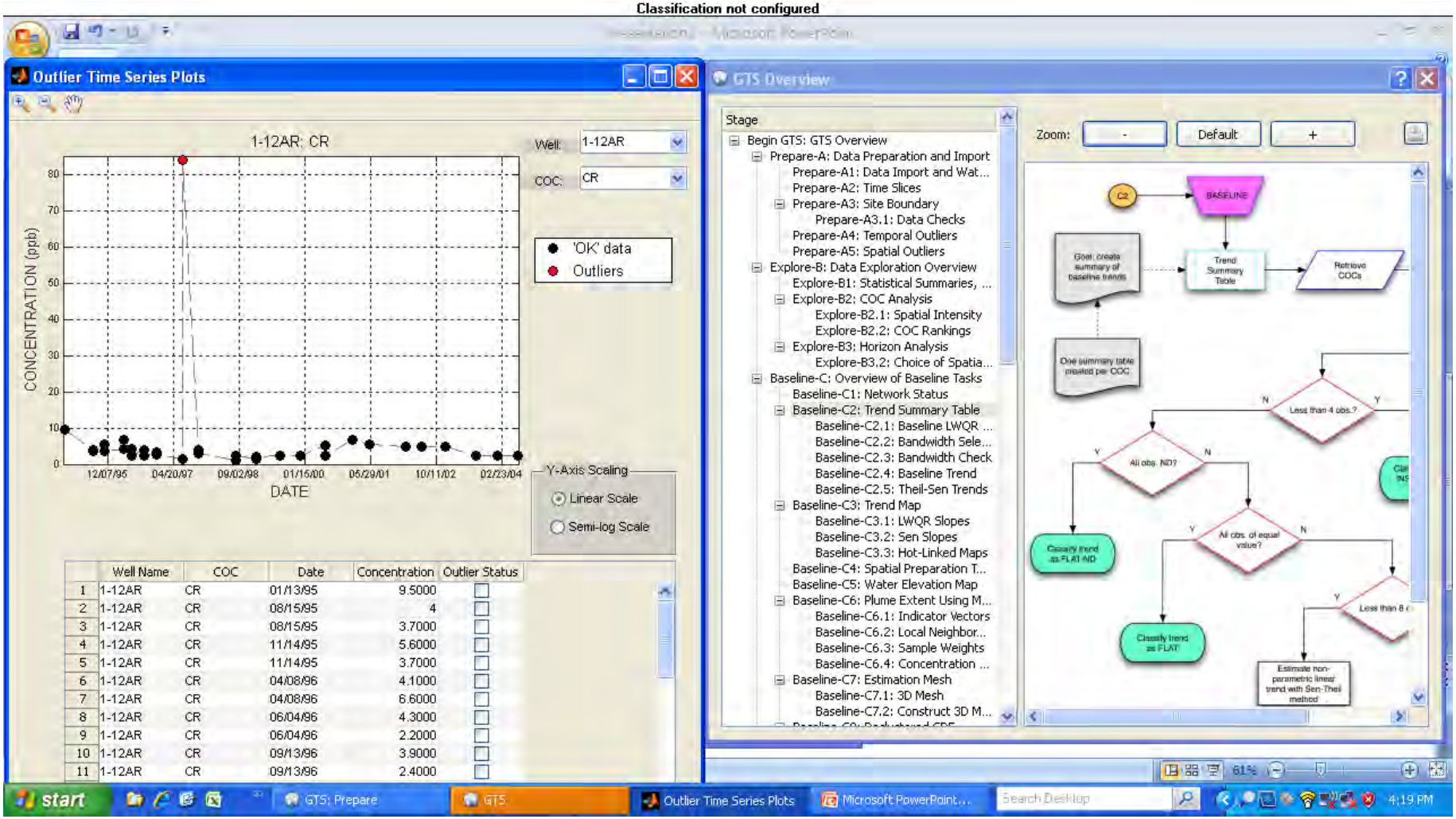


U.S. AIR FORCE

Algorithm Call-up

GTS

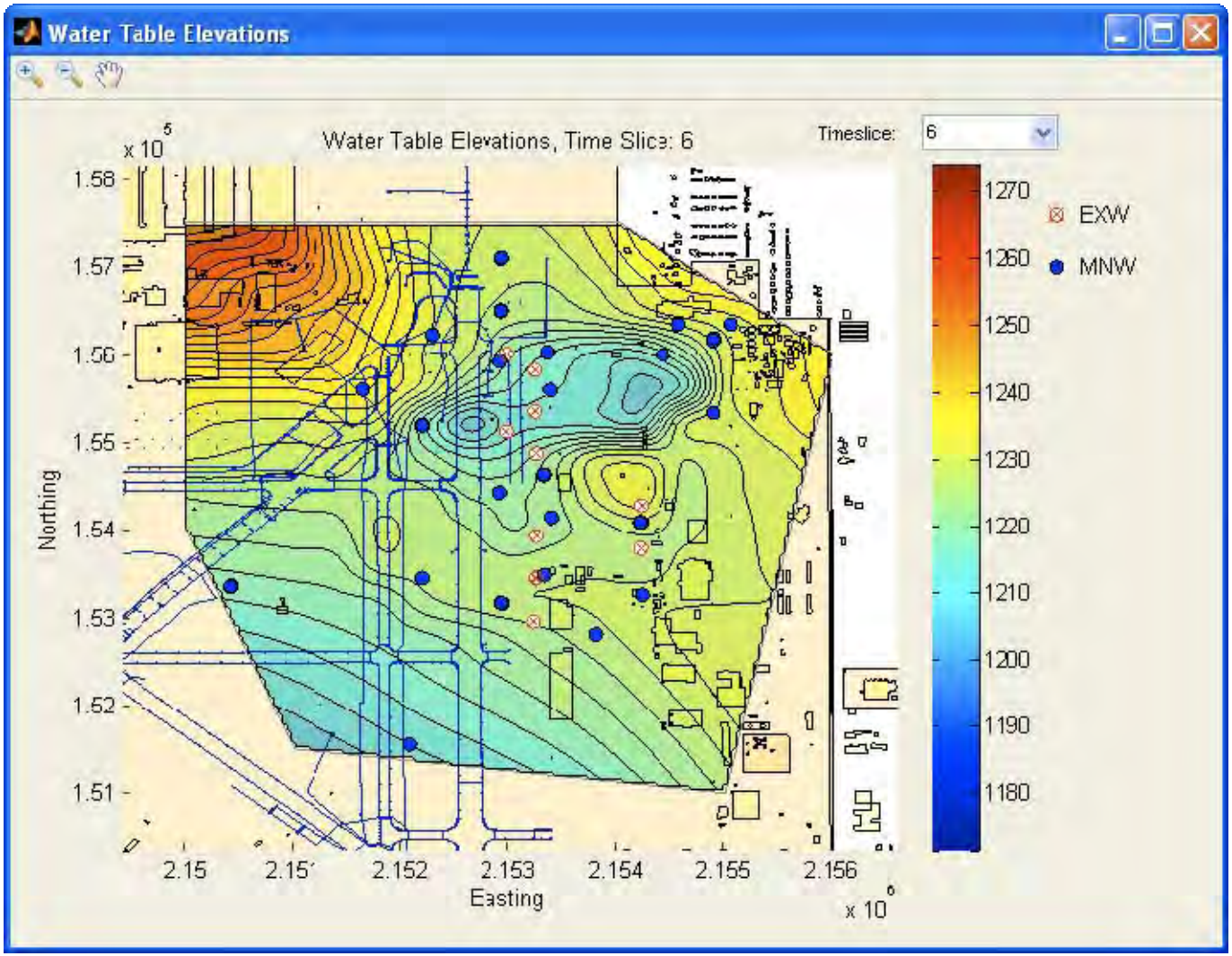
Classification not configured



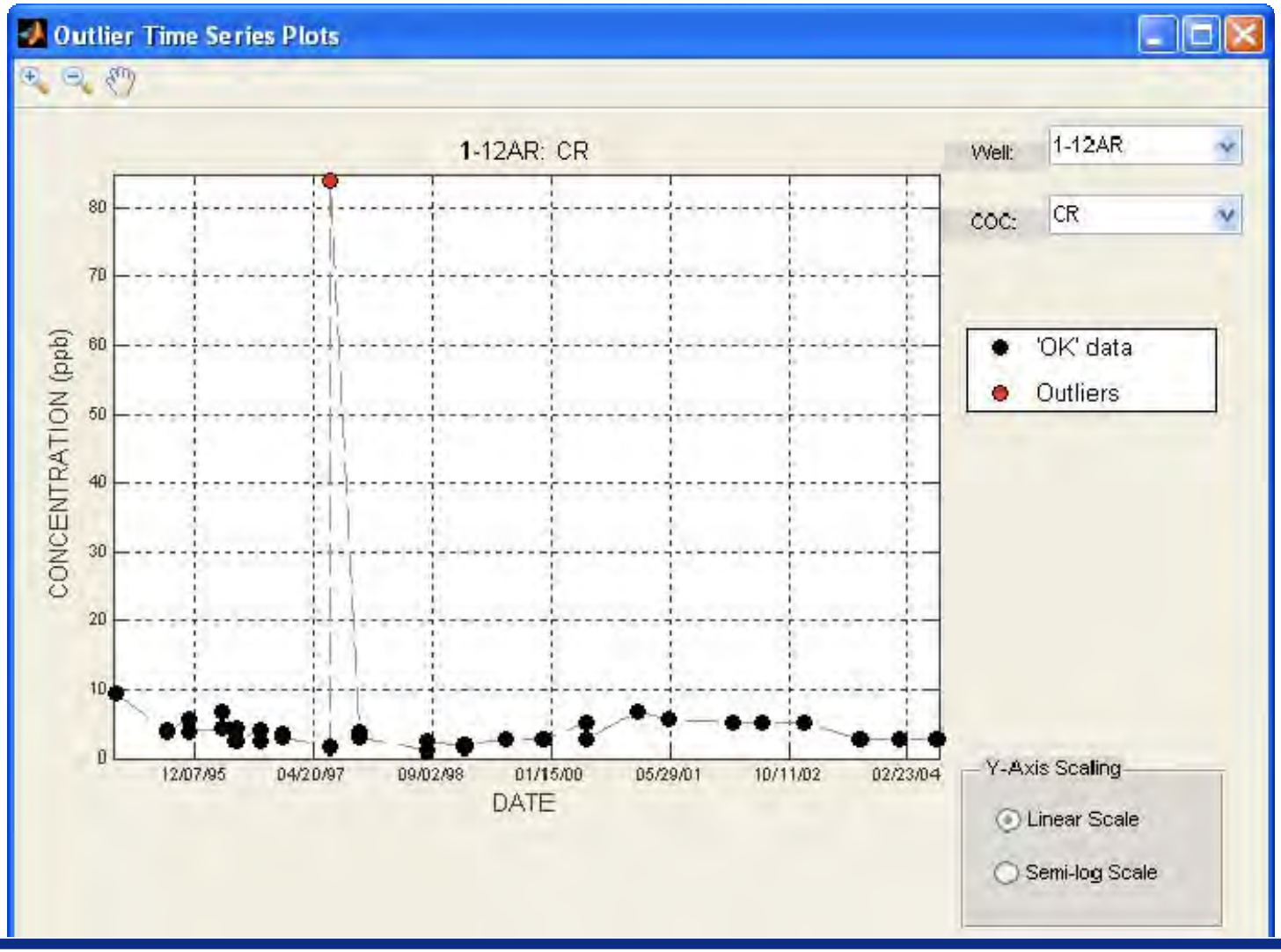
Integrity - Service - Excellence

U.S. AIR FORCE

Water Table Elevation Maps

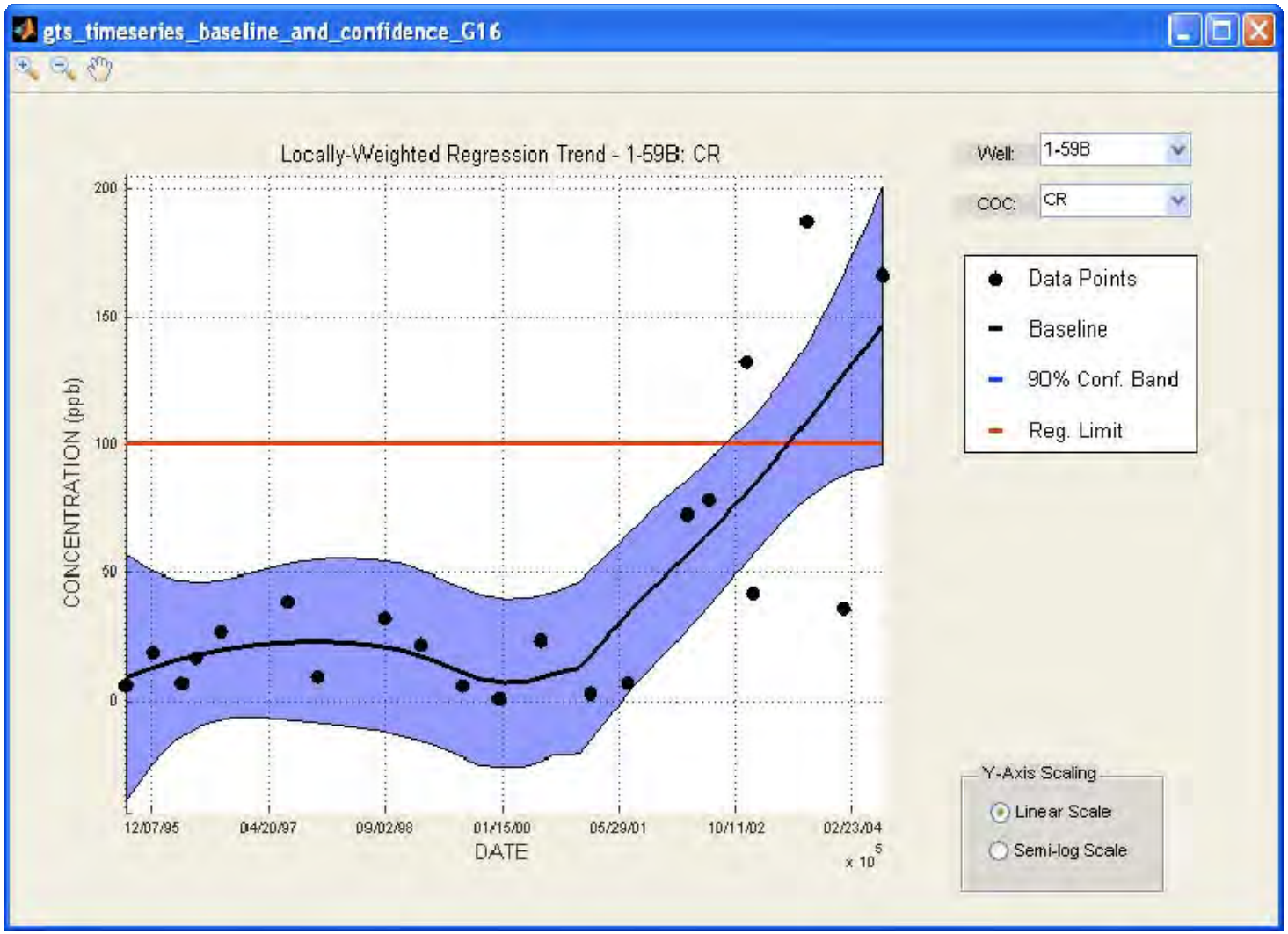


Time Series Analysis
Outlier Plots



Non-Linear Baseline Trends

Using Locally-Weighted Regression

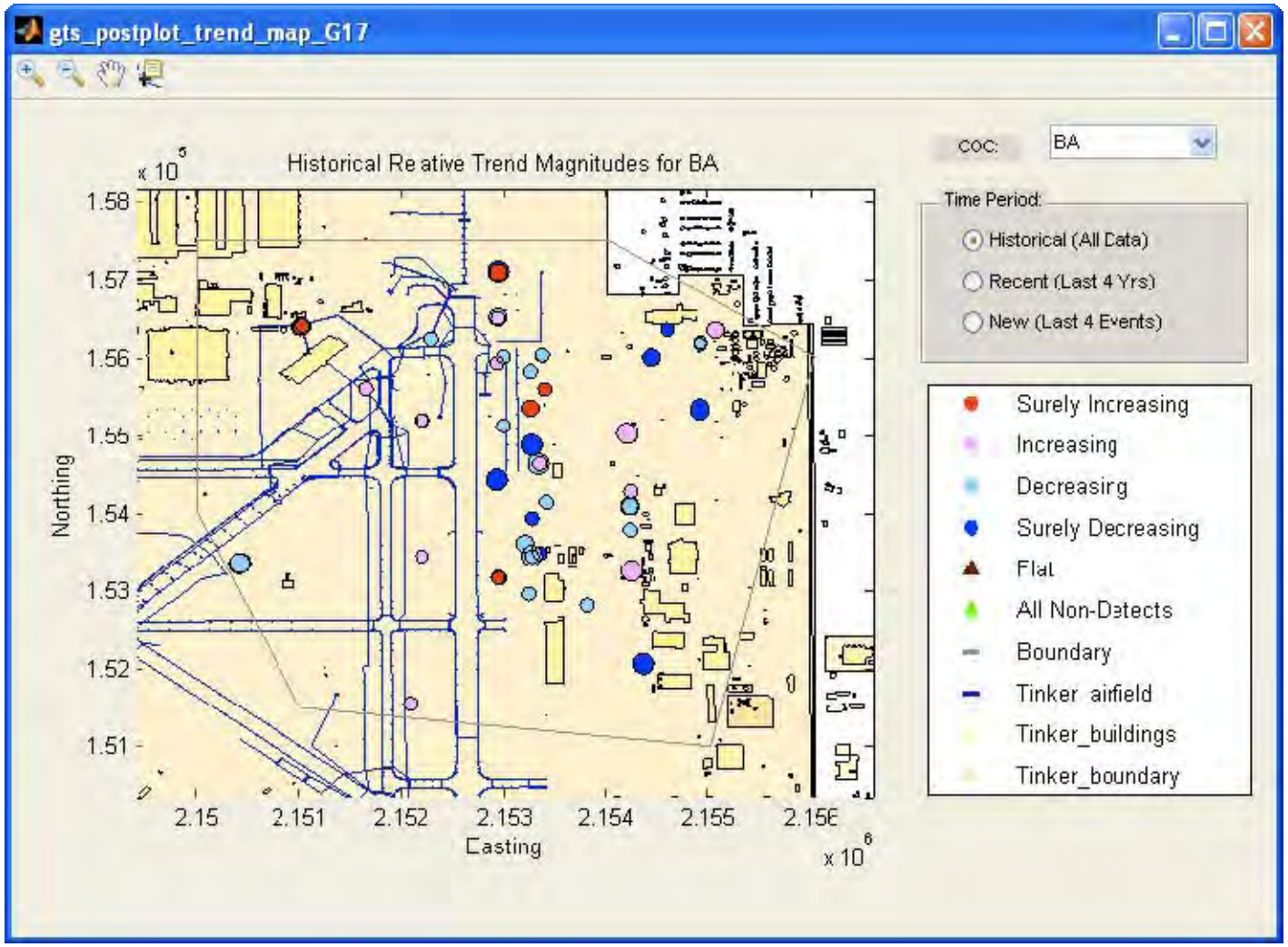


Time Series Analysis

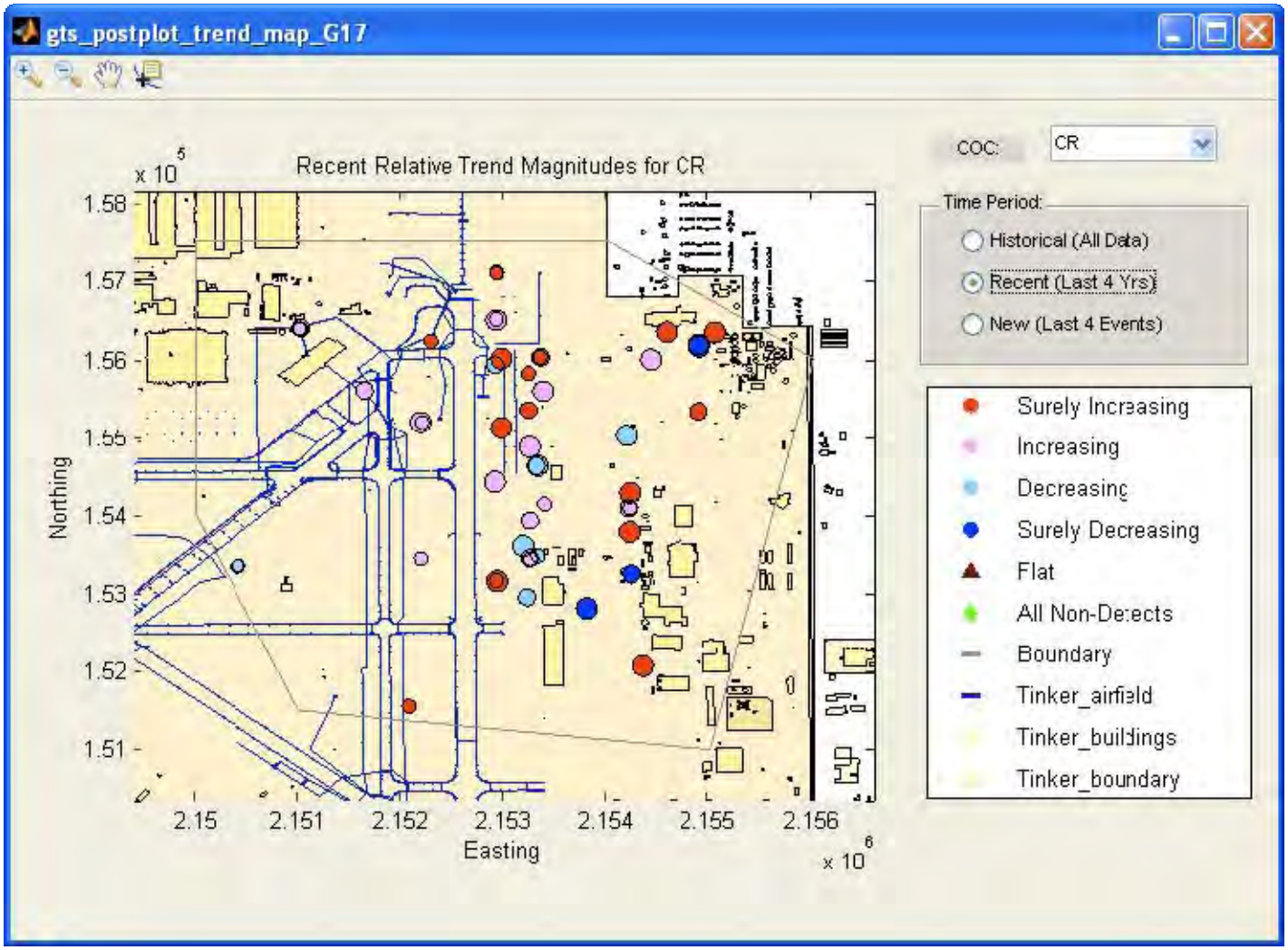
Formal Test for Trend

GTS Well ID	Loc ID	Trend Type	COC	Easting	Northing	Slope (ppb/day)	Slope Significant	Lower Confidence Bound (ppb)	Upper Confidence Bound (ppb)	Regulatory Limit (ppb)	Trend Direction	Regulatory Exceedance
1	1-11A	LWQR	BA	2154891.6	156156.15	-0.01212	Yes	67.117	99.706	2000	DECR	NO
3	1-12AR	LWQR	BA	2152912.45	155920.63	0.00389	No	310.174	370.027	2000	FLAT	NO
4	1-14AR	LWQR	BA	2152910.235	154422.8	-0.09008	Yes	567.928	713.658	2000	DECR	NO
6	1-1A	LWQR	BA	2154414.9	155990.95	-0.05047	Yes	352.016	546.276	2000	DECR	NO
8	1-2A	LWQR	BA	2154201.55	154086.62	-0.08807	No	85.672	227.996	2000	FLAT	NO
10	1-3AR	LWQR	BA	2154225.075	153254.505	0.18038	No	685.666	981.53	2000	FLAT	NO
11	1-45AR	LWQR	BA	2152931.795	153158.665	0.00252	No	637.983	712.93	2000	FLAT	NO
14	1-60A	LWQR	BA	2154567.77	156340.93	-0.0058	Yes	89.459	110.438	2000	DECR	NO
15	1-62A	LWQR	BA	2151019.25	156382.67	0.07904	No	739.517	857.306	2000	FLAT	NO
17	1-62C	LWQR	BA	2151002.93	156378.41	0.03207	Yes	457.197	525.723	2000	INCR	NO
18	1-66A	LWQR	BA	2150401.63	153347.38	-0.10688	Yes	609.988	928.66	2000	DECR	NO

Historical Trend Map
All Data

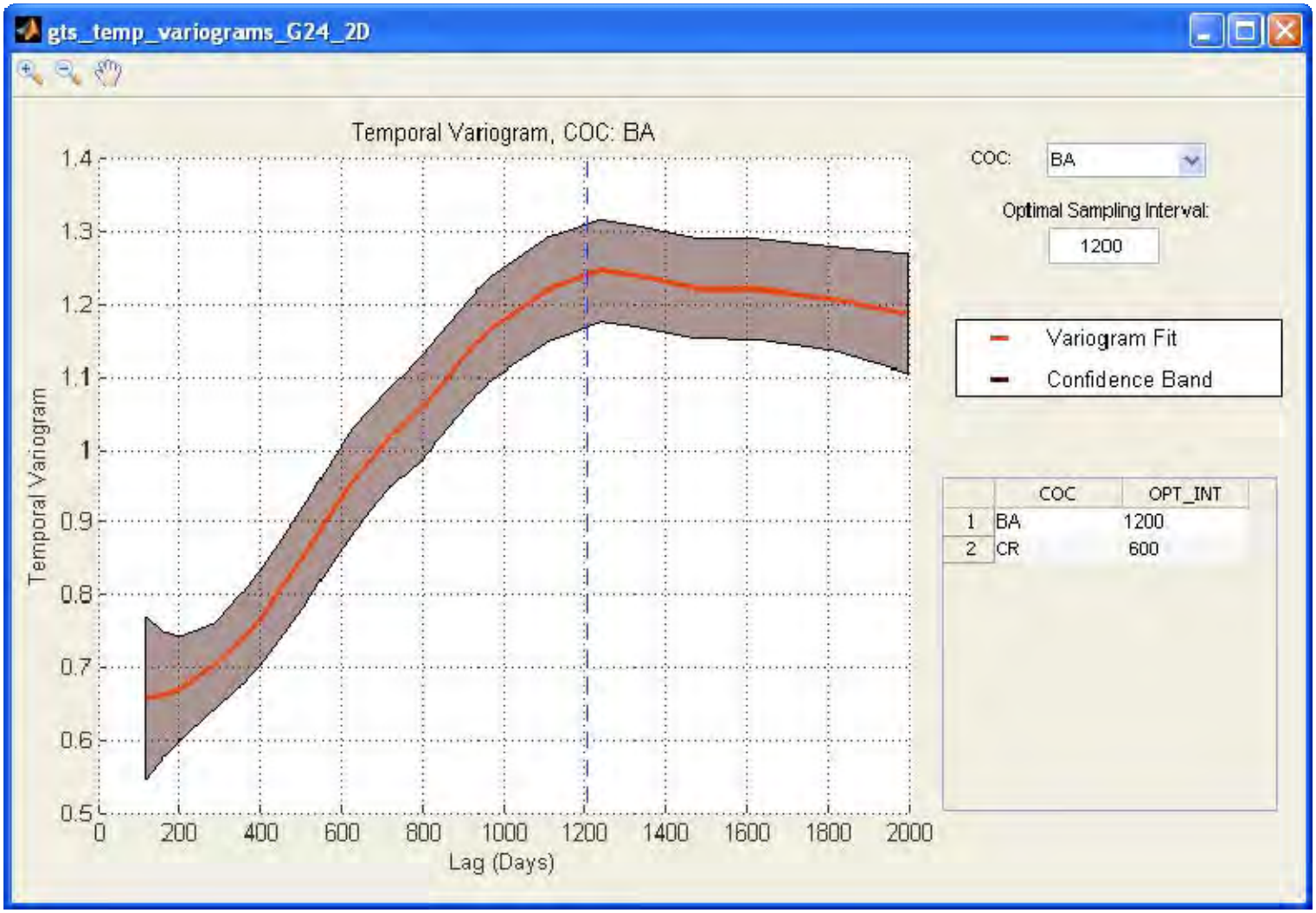


Recent Trend Map
Last 4 Years



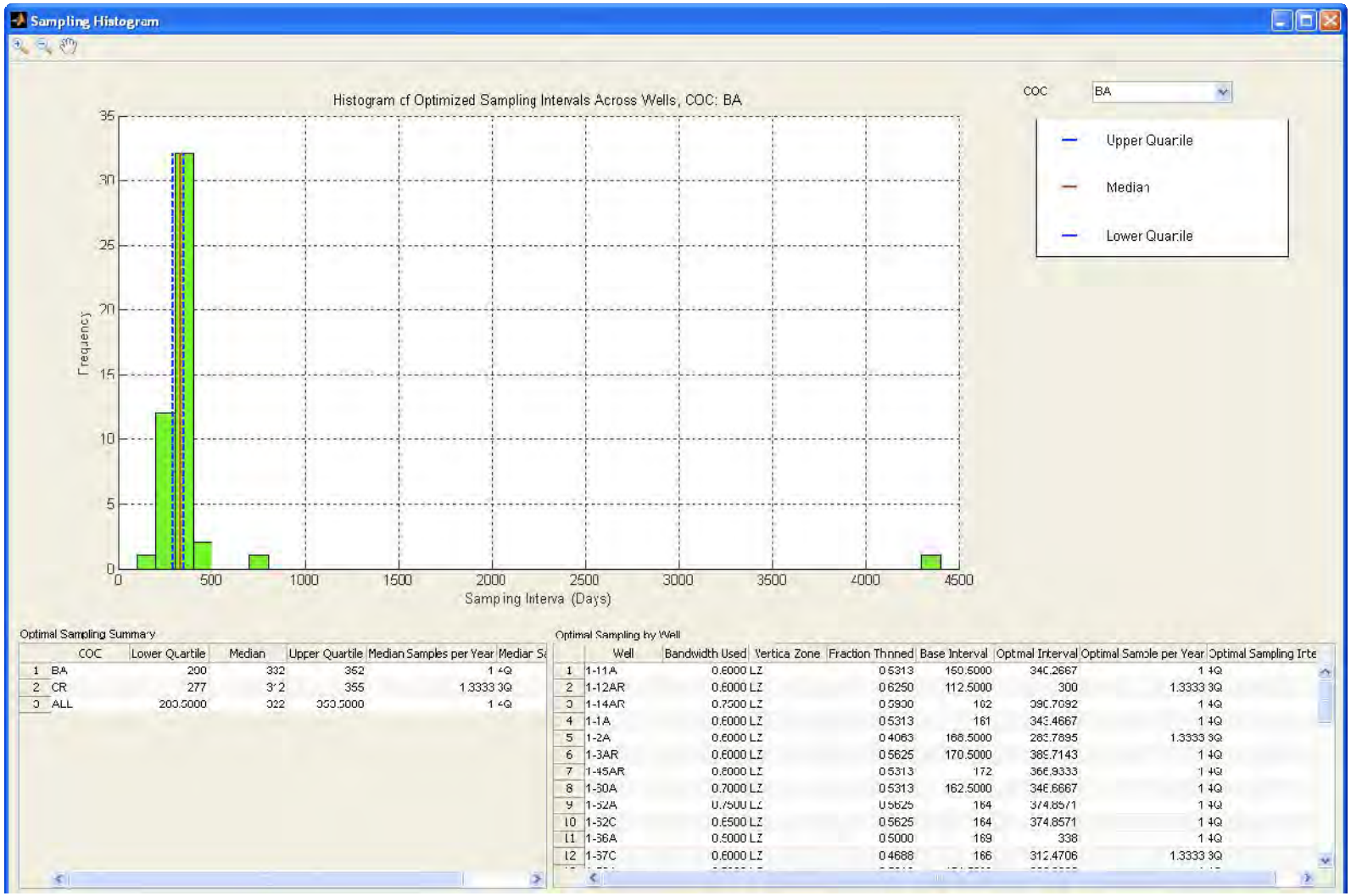
Temporal Variograms

Help Determine Optimal Sampling Interval



Iterative Thinning Summary

Histogram of Well-Counts vs Optimal Sampling Interval



Optimal Sampling Summary

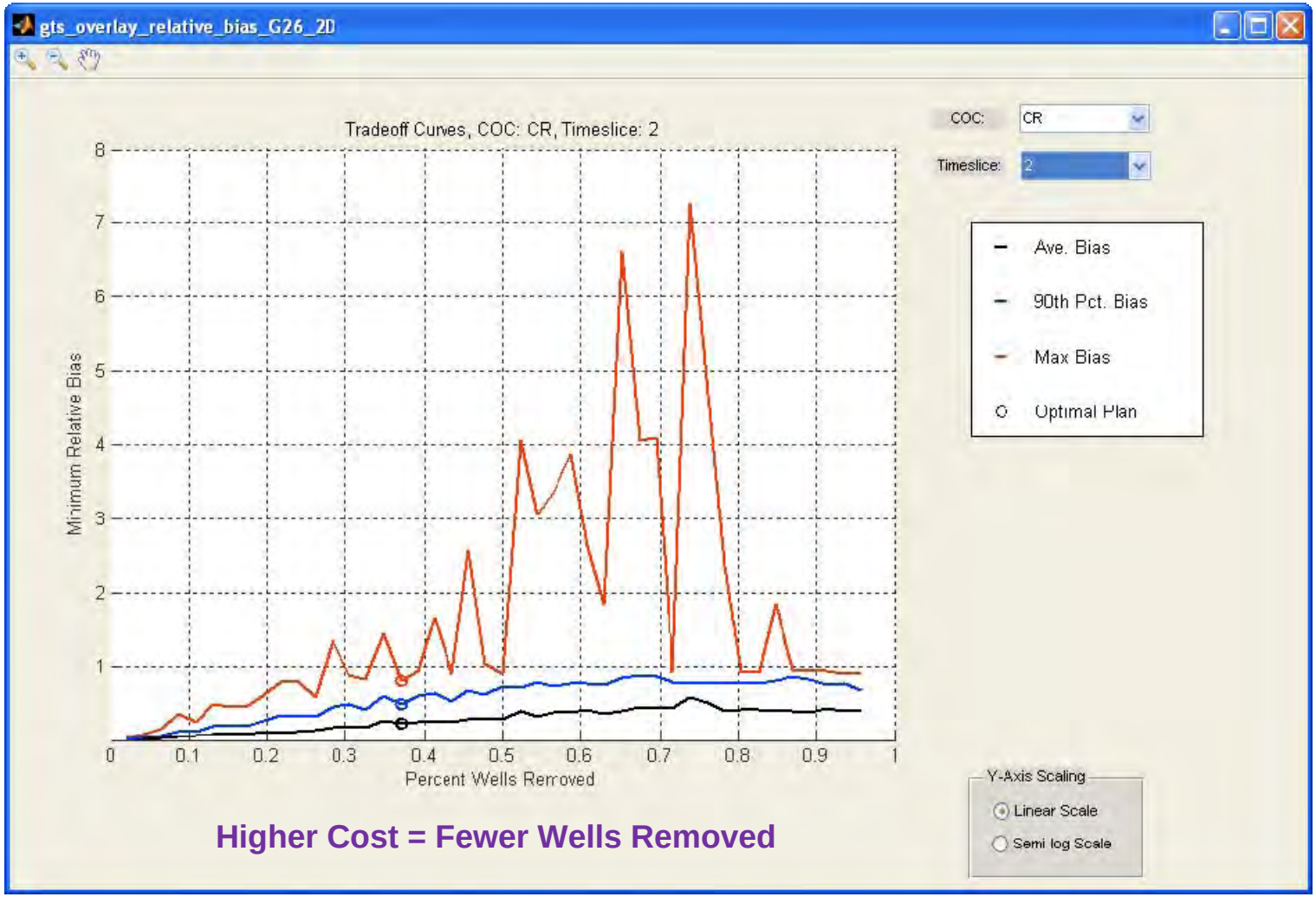
	COC	Lower Quartile	Median	Upper Quartile	Median Samples per Year	Median Sa
1	BA	200	332	352	1 4Q	
2	CR	277	312	355	1.3333 3Q	
3	ALL	200.5000	322	353.5000	1 4Q	

Optimal Sampling by Well

	Well	Bandwidth Used	Vertica Zone	Fraction Thinned	Base Interval	Optmal Interval	Optimal Sample per Year	Optimal Sampling Inte
1	1-11A	0.6000 LZ		0.5313	150.5000	340.2667	1 4Q	
2	1-12AR	0.6000 LZ		0.6250	112.5000	300	1.3333 3Q	
3	1-14AR	0.7500 LZ		0.5938	162	390.7692	1 4Q	
4	1-1A	0.6000 LZ		0.5313	161	343.4667	1 4Q	
5	1-2A	0.6000 LZ		0.4063	168.5000	285.7895	1.3333 3Q	
6	1-3AR	0.6000 LZ		0.5625	170.5000	388.7143	1 4Q	
7	1-45AR	0.6000 LZ		0.5313	172	366.9333	1 4Q	
8	1-30A	0.7000 LZ		0.5313	162.5000	346.6667	1 4Q	
9	1-32A	0.7500 LZ		0.5625	164	374.8571	1 4Q	
10	1-32C	0.6500 LZ		0.5625	164	374.8571	1 4Q	
11	1-36A	0.5000 LZ		0.5000	169	338	1 4Q	
12	1-37C	0.6000 LZ		0.4688	166	312.4706	1.3333 3Q	

Cost-Accuracy Tradeoff Curves

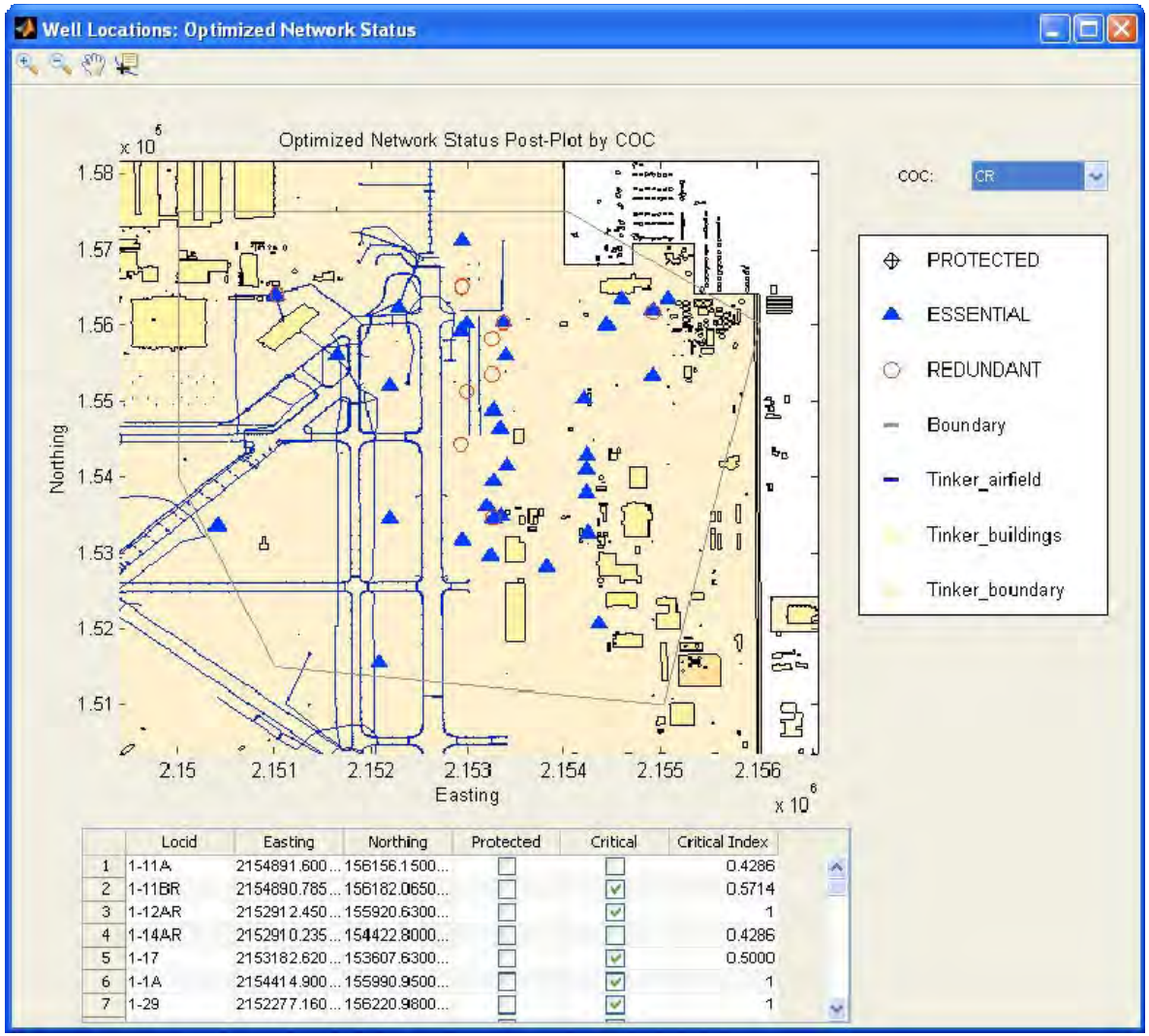
Bias Measures Divergence from Baseline Concentrations



Higher Cost = Fewer Wells Removed

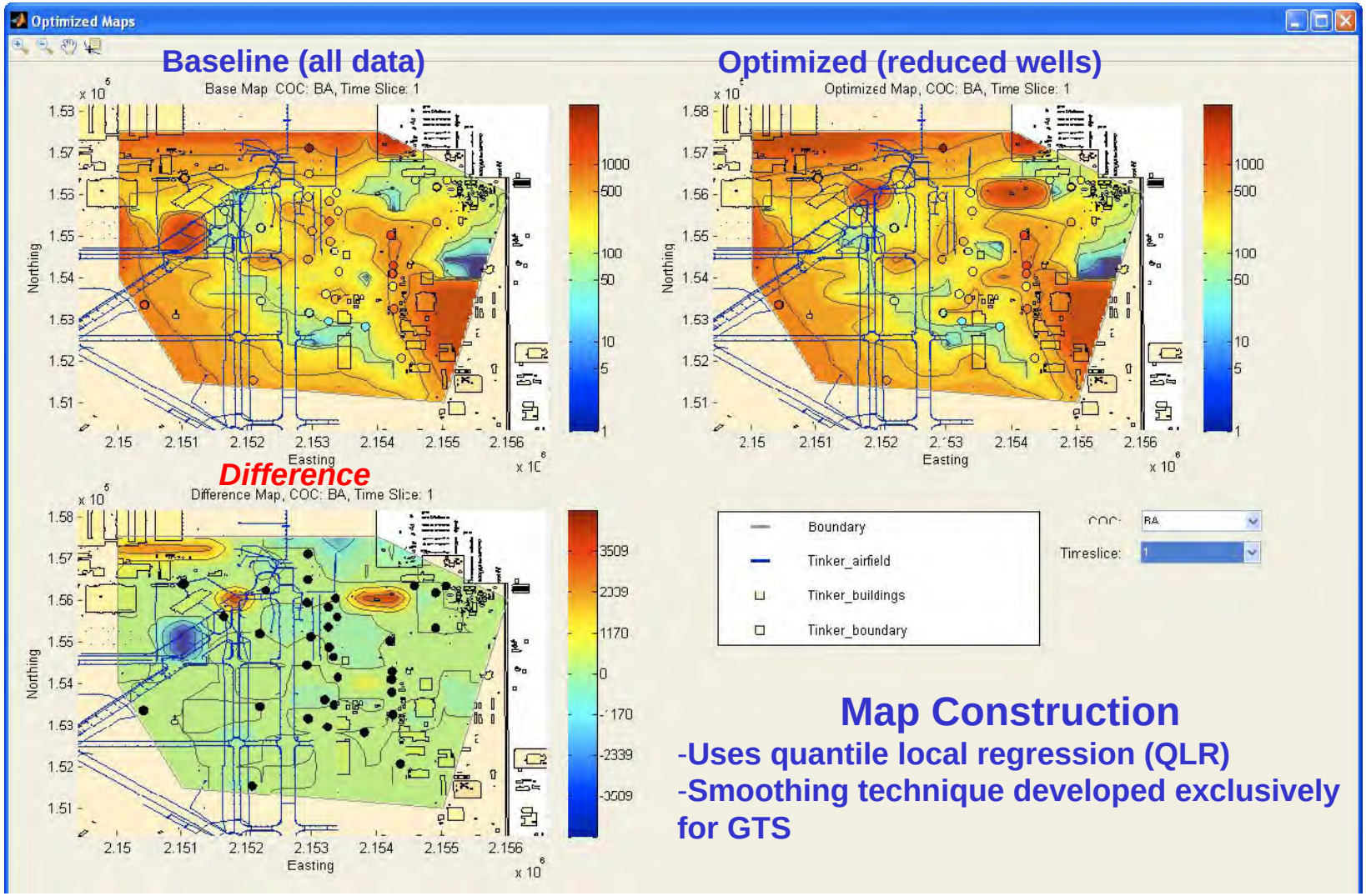
Optimized Network Postplot

Essential and Redundant Wells



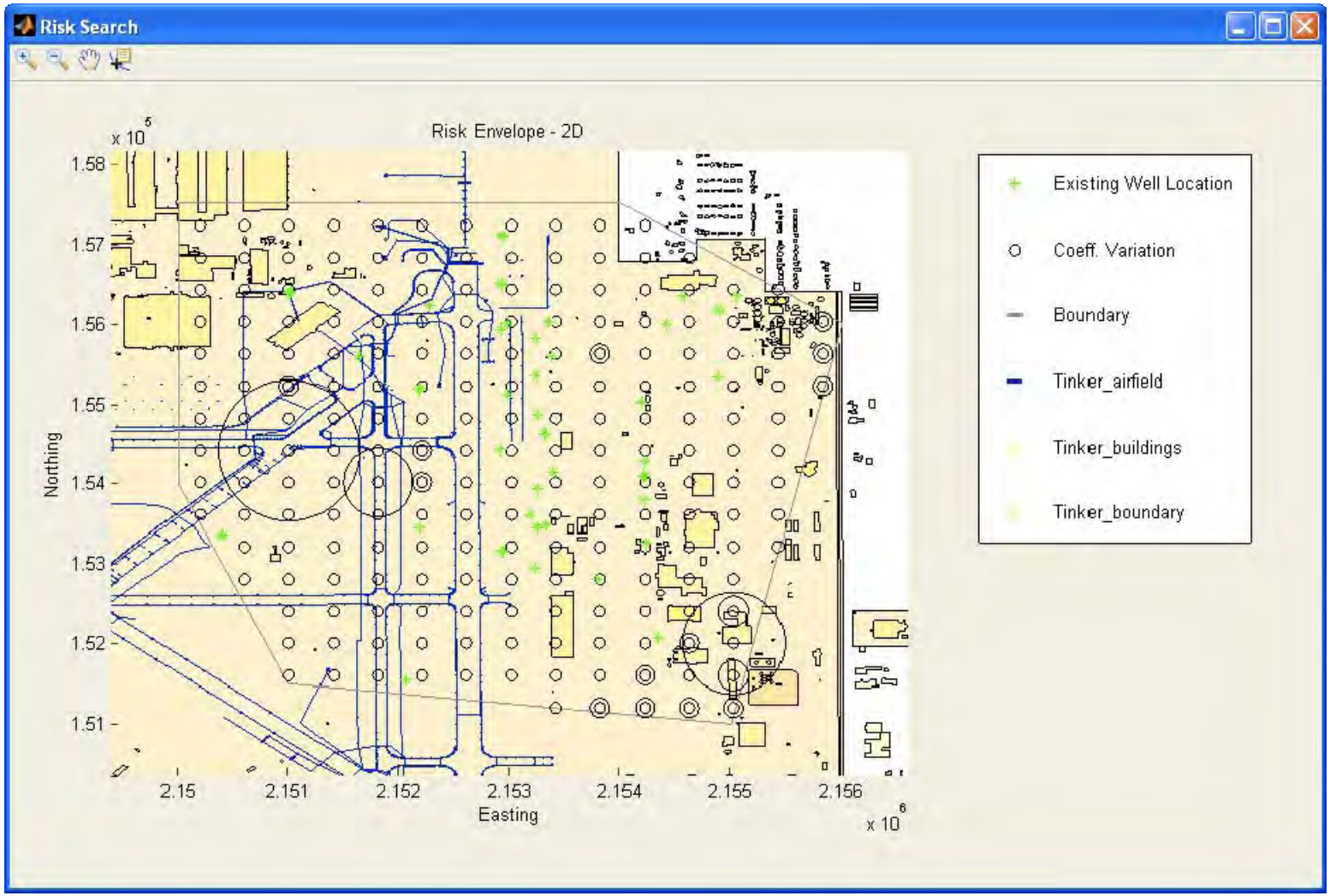
	Locid	Easting	Northing	Protected	Critical	Critical Index
1	1-11A	2154891.600...	156156.1500...	☐	☐	0.4286
2	1-11BR	2154890.785...	156182.0650...	☐	☑	0.5714
3	1-12AR	2152912.450...	155920.6300...	☐	☑	1
4	1-14AR	2152910.235...	154422.8000...	☐	☐	0.4286
5	1-17	2153182.620...	153607.6300...	☐	☑	0.5000
6	1-1A	2154414.900...	155990.9500...	☐	☑	1
7	1-29	2152277.160...	156220.9800...	☐	☑	1

Optimized Map Comparison



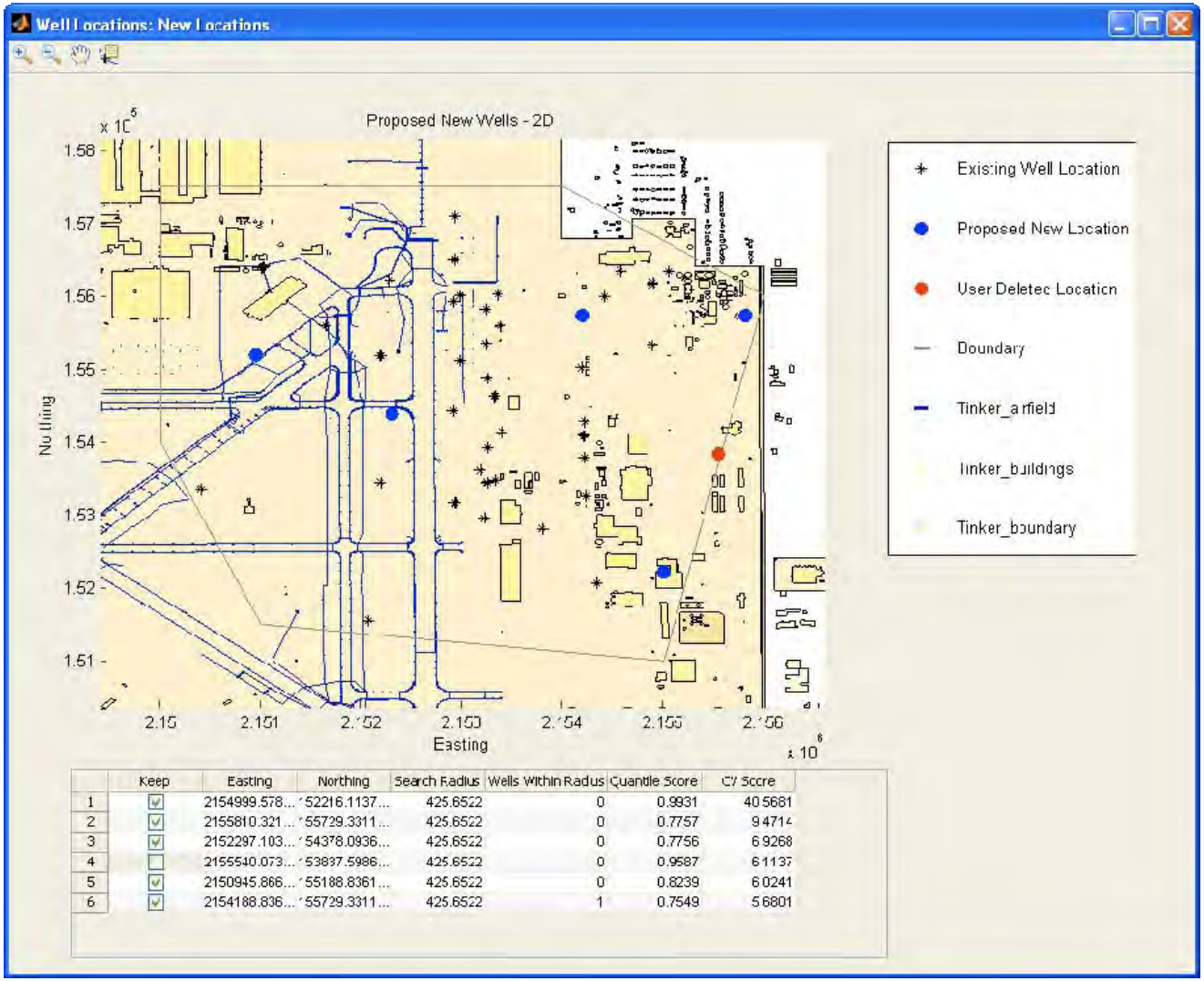
Baseline Well Network Adequacy

Risk Envelope & Areas of Uncertainty



Proposed New Well Locations

"Got-to-Have" Wells Retained



	Keep	Easting	Northing	Search Radius	Wells Within Radius	Quantile Score	CV Score
1	☑	2154999.578...	52216.1137...	425.6522	0	0.9931	40.5681
2	☑	2155810.321...	55729.3311...	425.6522	0	0.7757	9.4714
3	☑	2152297.103...	54378.0936...	425.6522	0	0.7756	6.9268
4	☐	2155540.073...	53837.5986...	425.6522	0	0.9587	6.1137
5	☑	2150945.866...	55188.8361...	425.6522	0	0.8239	6.0241
6	☑	2154188.836...	55729.3311...	425.6522	1	0.7549	5.6801

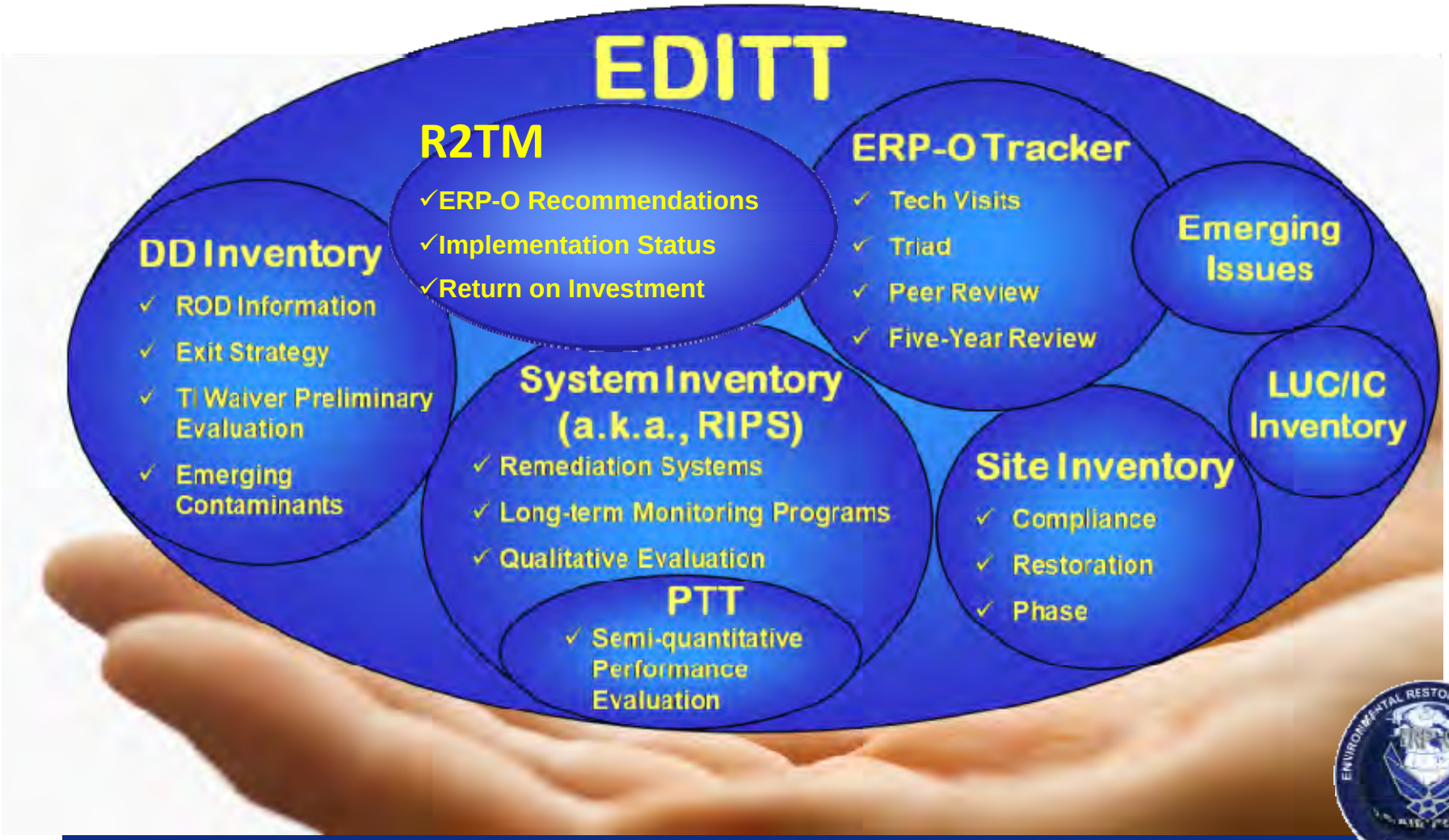
Environmental Decision Information Tracking Tool - EDITT

EDITT

Discussion

U.S. AIR FORCE

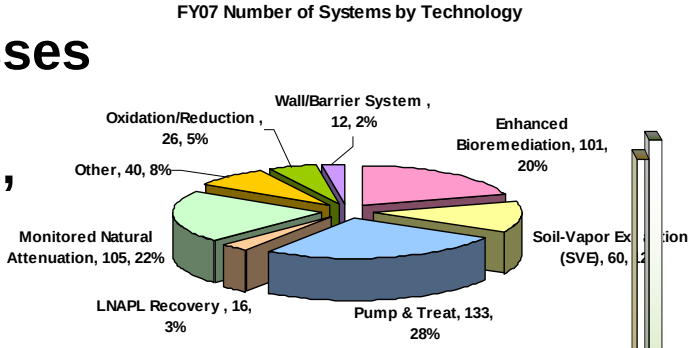
EDITT Modules



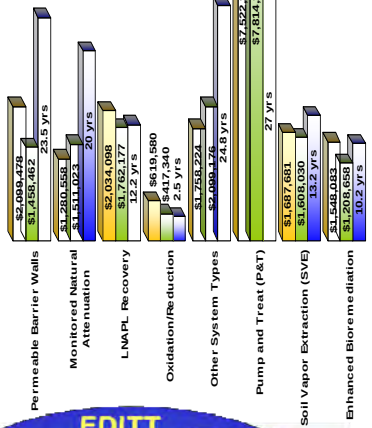
Environmental Decision Information Tracking Tool (EDITT)

- ✓Definition
- ✓Mission
- ✓Purpose
- ✓Components
- ✓Tools/ Products
- ✓Analysis/ Impact

- **Why EDITT?... Business Processes**
  - **AF enterprise database that captures remedial system type, cost and performance**



- **What?... Data**
  - **System & Technology Inventory and Performance Data**
  - **System capital construction data**
  - **System O&M cost, life-cycle, legal drivers**
  - **Decision document inventory**



- **Results**
  - **Better understanding of the number and type of remediation systems, when installed, and the O&M cost for each system**
  - **Technology trend towards more energy efficient technologies; away from the more active and longer life-cycle technologies**

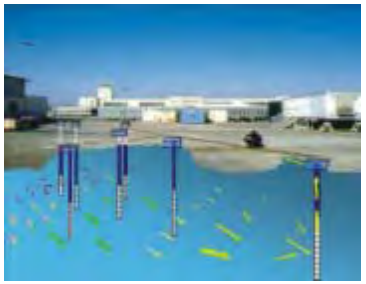
Decision Support
EDITT

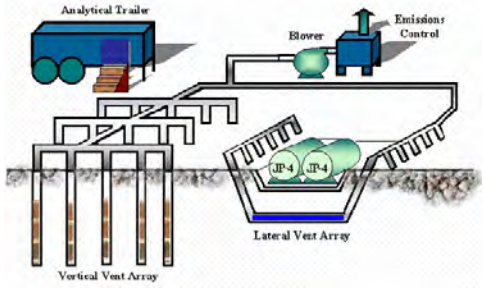
- **EDITT provides decision-making information on:**
  - ✓ **Which systems/sites are the risk drivers**
  - ✓ **RODs/TI Waivers – evaluation for potential revision of RODs or application for TI Waiver**
  - ✓ **Emerging/Evolving Contaminants – distribution & frequency across the AF**
- **Exit Strategies – focus on the process to reach site closure**

This capability will improve future decision making

EDITT – System Inventory (SI)

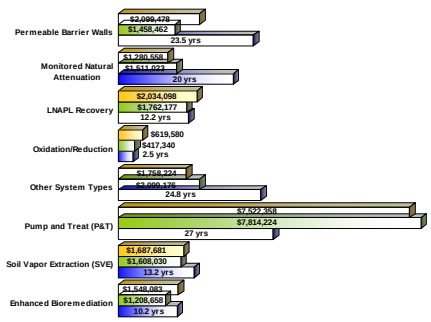
- Formerly Remedial Process Optimization (RPO) Inventory and Performance System (RIPS)
- Provides an AF-wide inventory of remediation systems and Long-term Monitoring programs
- Cost accounting of the O&M of systems/monitoring and details of system performance are tracked
- Assists in prioritization of systems in terms of optimization potential
- System Inventory must be updated annually
- Data cut-off is end of FY, complete entry by end of CY

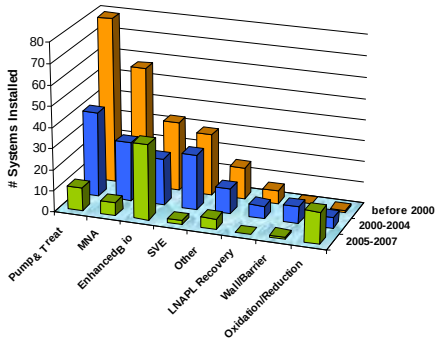


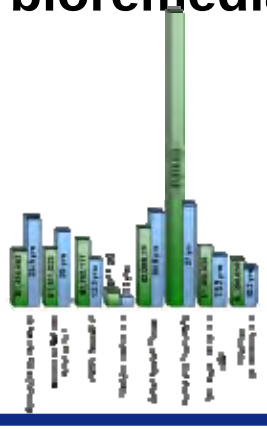


Analysis of SI Data

- **Results of System Inventory (SI) analysis:**
  - ✓ **Better understanding of the number and type of remediation systems and when they were installed**
  - ✓ **Better understanding of O&M cost for each system**
  - ✓ **Technology trend towards more energy efficient technologies**
  - ✓ **Costs for active treatment systems have been reduced**
  - ✓ **Funds better spent on more energy efficient technologies (e.g., oxidation/reduction and enhanced bioremediation)**







U.S. AIR FORCE

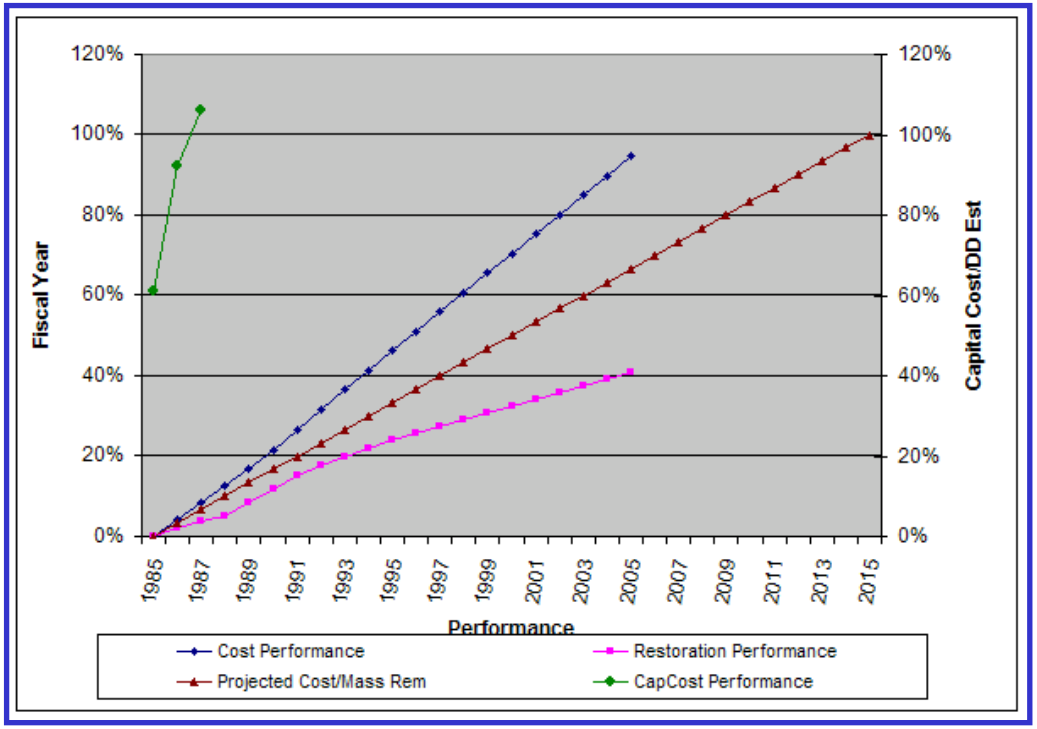
Performance Tracking Tool (PTT)

Cost & Mass Removed

Capital Cost by Fiscal Year	Operation & Maintenance Cost by Fiscal Year	Projected Costs/Mass Removed (from DD)	Capital Cost as Percent DD Est.	O&M as Percent of CTC	Total Pecent Mass Removed
$ 195,000	$ -	0%	61%	0%	0%
$ 100,000	$ 290,000	3%	92%	4%	2%
$ 45,000	$ 290,000	7%	106%	8%	4%
	$ 300,000	10%		13%	5%
	$ 310,000	13%		17%	8%
	$ 305,000	17%		21%	12%
	$ 375,000	20%		27%	15%
	$ 340,000	23%		32%	18%
	$ 340,000	27%		36%	20%
	$ 340,000	30%		41%	22%
	$ 340,000	33%		46%	24%
	$ 340,000	37%		51%	26%
	$ 340,000	40%		56%	27%
	$ 340,000	43%		61%	29%
	$ 340,000	47%		66%	31%
	$ 340,000	50%		70%	32%
	$ 340,000	53%		75%	34%
	$ 340,000	57%		80%	36%
	$ 340,000	60%		85%	37%
	$ 340,000	63%		90%	39%
	$ 340,000	67%		95%	41%
		70%			
		73%			
		77%			
		80%			
		83%			
		87%			
		90%			
		93%			
		97%			
		100%			

Total Mass at RA-O Start-Up (lb	30000
Cost-To-Complete (CTC) ($)	$ 7,000,000
DD Capital Cost Est	$ 320,000
Impacted Acres	23
Acre-ft of groundwater impacte	265
RA-O Start Year (from DD)	1985
RA-O Completion Year	2015

	To Date	Estimated total cost
Cost/Acre	$ 288,261	$ 117,832
Cost/Acre feet	$ 25,019	$ 10,227
Cost/lb removed	$ 541	
Total O&M Costs	$ 6,630,000	
Total Mass Removed	12,263 lbs	
Portion of DD Mass Rem	40.9%	



Integrity - Service - Excellence

RPO Recommendations Tracking Tool (R2TM)

- **Track Recommendations (ERP-O Phase IV)**
  - **Phase II, III**
  - **Track**
    - ✓ Implementation
    - ✓ Risk reduction
    - ✓ RC Acceleration
    - ✓ Total Investment
    - ✓ Cost avoidance
    - ✓ ROI

	2008 Phase I Wrigh-Patterson AFB RPO Report Recommendations	Site	Recommendation Author	Status of Recommendation	OPR	Estimated Implementation Date	Impact on Risk to Human Health and the Environment	Impact on Time to Site Closure	Estimated Cost Avoidance Annual/Life Cycle	Cost to Implement Recommendations	Documented Cost Avoidance Annual/Life Cycle	Recommendations Presented and Approved by Regulators Y/N = 1/0 N/A	Implementation Contract Awarded Y/N = 1/0 N/A
FY08WPAFB01	Prepare Basewide CSM (consolidated, concise, current) for use as a management tool	Basewide/Program Wide	JGibbs	Planning	RPO Phase II	3Q09	None	Shorten				0	0
FY08WPAFB02	Record decision inputs, technical approaches, and exit strategies to document institutional knowledge in a management summary	Basewide/Program Wide	JGibbs	Planning	RPO Phase II	3Q09	None	Shorten				0	0
FY08WPAFB03	For future optimization efforts, perform LTM Optimization (LTMO) on monitoring wells according to the criteria described in the data quality objectives (DQOs) in QAPP	Basewide/Program Wide	SMadabhushi	Planning	PMO and Base	1Q10	Lower Risk	Shorten				0	0
FY08WPAFB04	Develop Exit Strategies for all sites (including a clear definition of the endpoint)	Basewide/Program Wide	SMadabhushi	Planning	PMO and Base	4Q09	None	Shorten				0	0
FY08WPAFB05	Prepare CSM for each site exceeding VIP screening criteria (BS 5; Bldg 59; FAA-B; LF 8, residential area; OU 2; MW20-23 and SV06 areas; OU 4, MW-12B; OU 10 MW-11S)	Basewide/Program Wide	RKutzman	Planning	RPO Phase II	4Q09	None	Shorten				0	0
FY08WPAFB06	Develop site-specific CSM for GWOU	GWOU	JSpencer	Planning	PMO and Base	4Q09	None	Shorten				0	0
FY08WPAFB07	OU1: Validate need for leachate extraction wells and optimize if needed	OU1	SBrock	Planning	PMO and Base	4Q09	None	None				0	0
FY08WPAFB08	Perform further optimization to reduce groundwater monitoring	OU1	SBrock	Planning	PMO and Base	1Q10	None	None				0	0
FY08WPAFB9	OU1: Complete a stand alone OU1 CSM to document current conditions and focus additional optimization until the site is closed (use as a template for other site-specific CSMs)	OU1	SBrock	Planning	PMO and Base	4Q09	None	None				0	0
FY08WPAFB10	OU2: Build a 3-D CSM to explain the anomalies	OU2	SMadabhushi	Planning	PMO and Base	4Q09	Lower Risk	Shorten				0	0
FY08WPAFB11	OU2: Negotiate RB cleanup levels as applicable and appropriate	OU2	SMadabhushi	Planning	PMO and Base	1Q10	Lower Risk	Shorten				0	0
FY08WPAFB12	OU2: Monitoring for NA parameters less	OU2	SMadabhushi	Planning	PMO and Base	NA	None	None				0	0
FY08WPAFB13	Develop Site-Specific Exit Strategy	OU5	JGibbs	Planning	PMO and Base	1Q10	None	None				0	0
FY08WPAFB14	Develop program summary for rick	OU5	JGibbs	Planning	PMO and Base	4Q09	None	Shorten				0	0
FY08WPAFB15	Document transition of objectives to life cycle minimization (risk, duration, cost)	OU5	JGibbs	Planning	PMO and Base	3Q09	None	None				0	0
FY08WPAFB16	Consider low energy treatment alternatives in remedy selection/alternative analysis for GWTP	OU5	JGibbs	Planning	PMO and Base	1Q10	None	Shorten				0	0
FY08WPAFB17	Document management rationale, decisions, logic to preserve institutional knowledge	OU5	JGibbs	Planning	PMO and Base	4Q09	None	None				0	0
									0	0	0	0	0

Blue Shading =	Phase 2 general conceptual recommendations.
Tan Shading =	Phase 2 field work items.
Green Shading =	Phase 2 technical studies or tasks (may include additional sample collection).
Grey Shading =	Canceled, postponed, or completed recommendation
No Shading =	No shading indicates base/PMO OPR

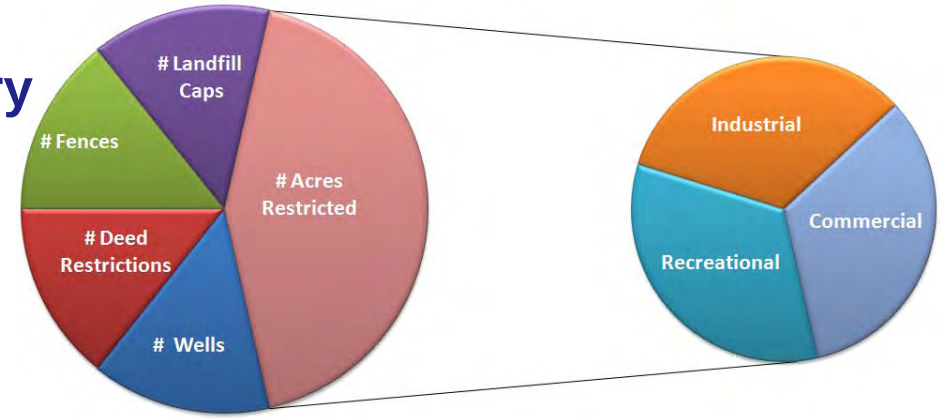
EDITT Land Use Control / Institutional Control (LUC/IC) Inventory

U.S. AIR FORCE

- ✓Definition
- ✓Mission
- ✓Purpose
- ✓Components
- ✓Tools/ Products
- ✓Analysis/ Impact

- **Includes annual reminder of LUC/IC requirements**
- **Meets required reporting and O&M requirements**
- **The LUC/IC Inventory is available in EDITT as a single web page with the following input:**
  - MAJCOM & Installation
  - Site ID (AFRIMS)
  - LUC/IC ID
  - Type and Classification of LUC/ID Matrix affected
  - Acres Impacted
  - Current and Future Land use
  - LUC/IC Objective/goals
  - O&M requirements (activities and frequency)
  - LUC/IC Termination Criteria
  - LUC/IC Termination Date
  - OPR & POC
  - OPR and POPC Contact Information

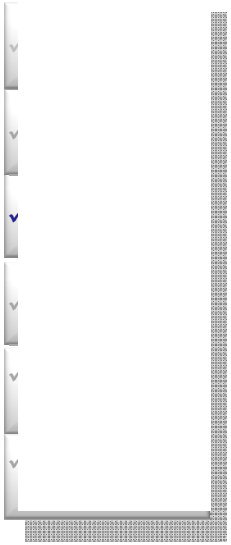
LUC/IC Module Includes Inventory Graphics*



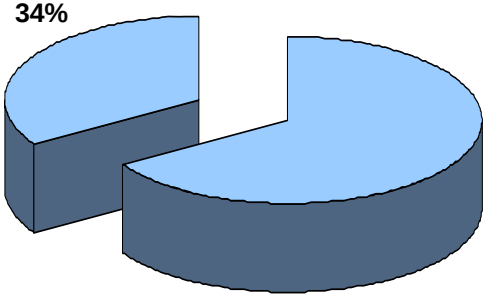
*Notional (Module by June 2009)

Analysis of Sustainable Technologies & Costs

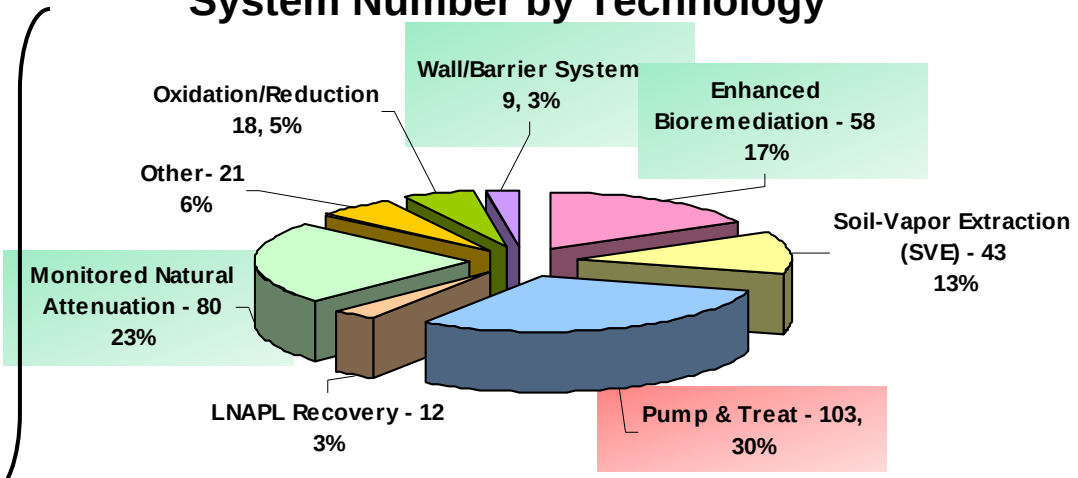
EDITT



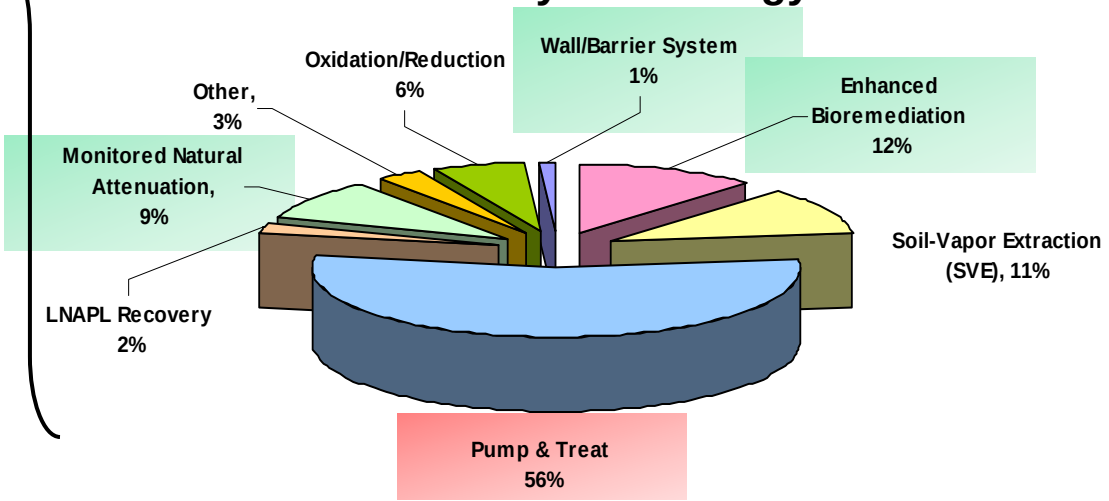
Air Force Restoration Program



System Number by Technology



Percent of Cost by Technology

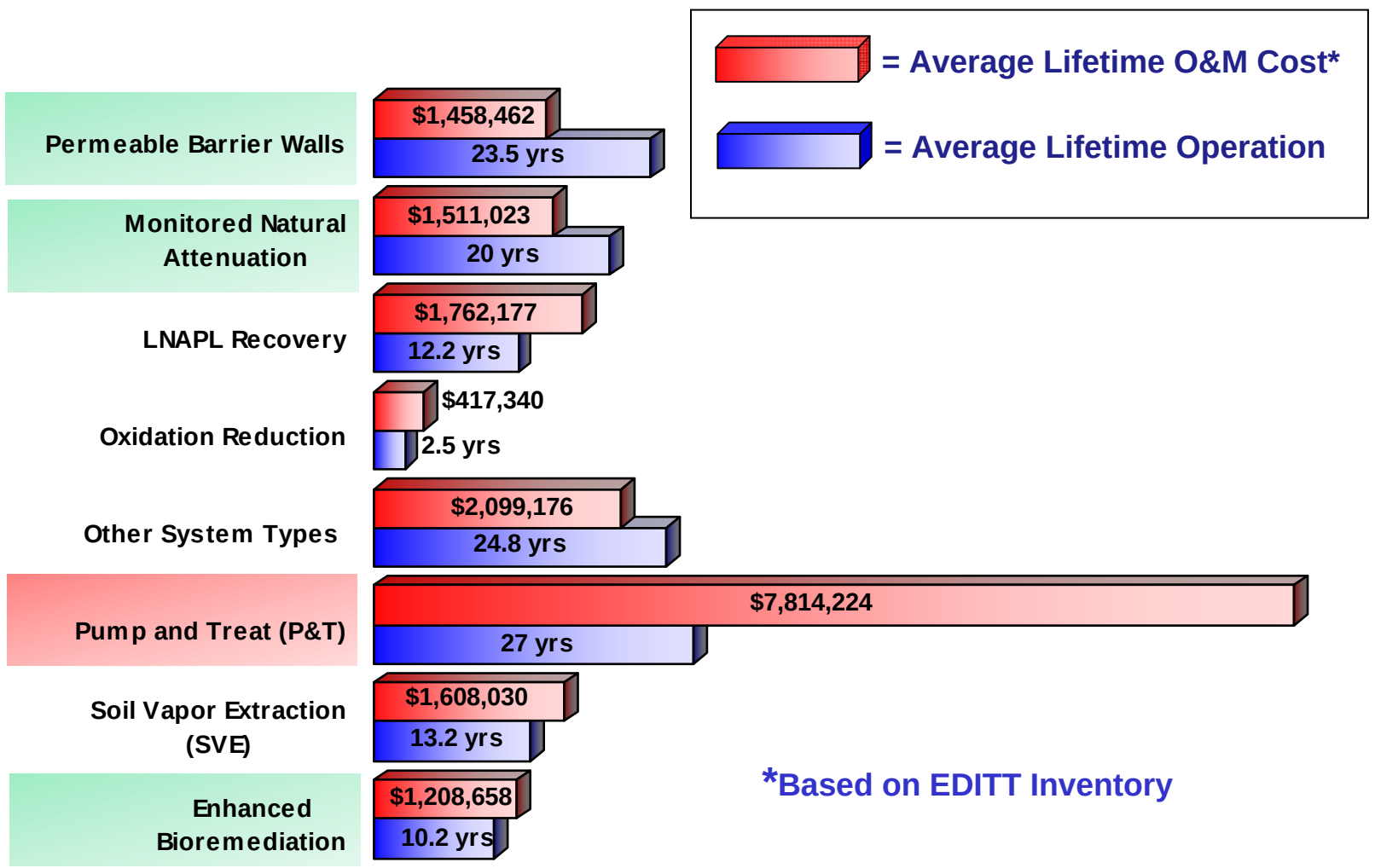


30% Pump & Treat ➡ **56% of Total Costs**

43% Green Remediation ➡ **22% of Total Costs**

Impact of Sustainable Technologies on CTC EDITT

- ✓ Organization
- ✓ Mission
- ✓ Challenge
- ✓ ERP-O
- ✓ Technology Transfer
- ✓ Emerging Issues



U.S. AIR FORCE

Thanks

Discussion?

Philip Hunter, P.G.
AFCEE/TDV
Tel 210 536-7237
DSN 240-7237
philip.hunter@brooks.af.mil