US Air Force

Environmental Restoration Program – Optimization and Sustainable Remediation

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E2S2

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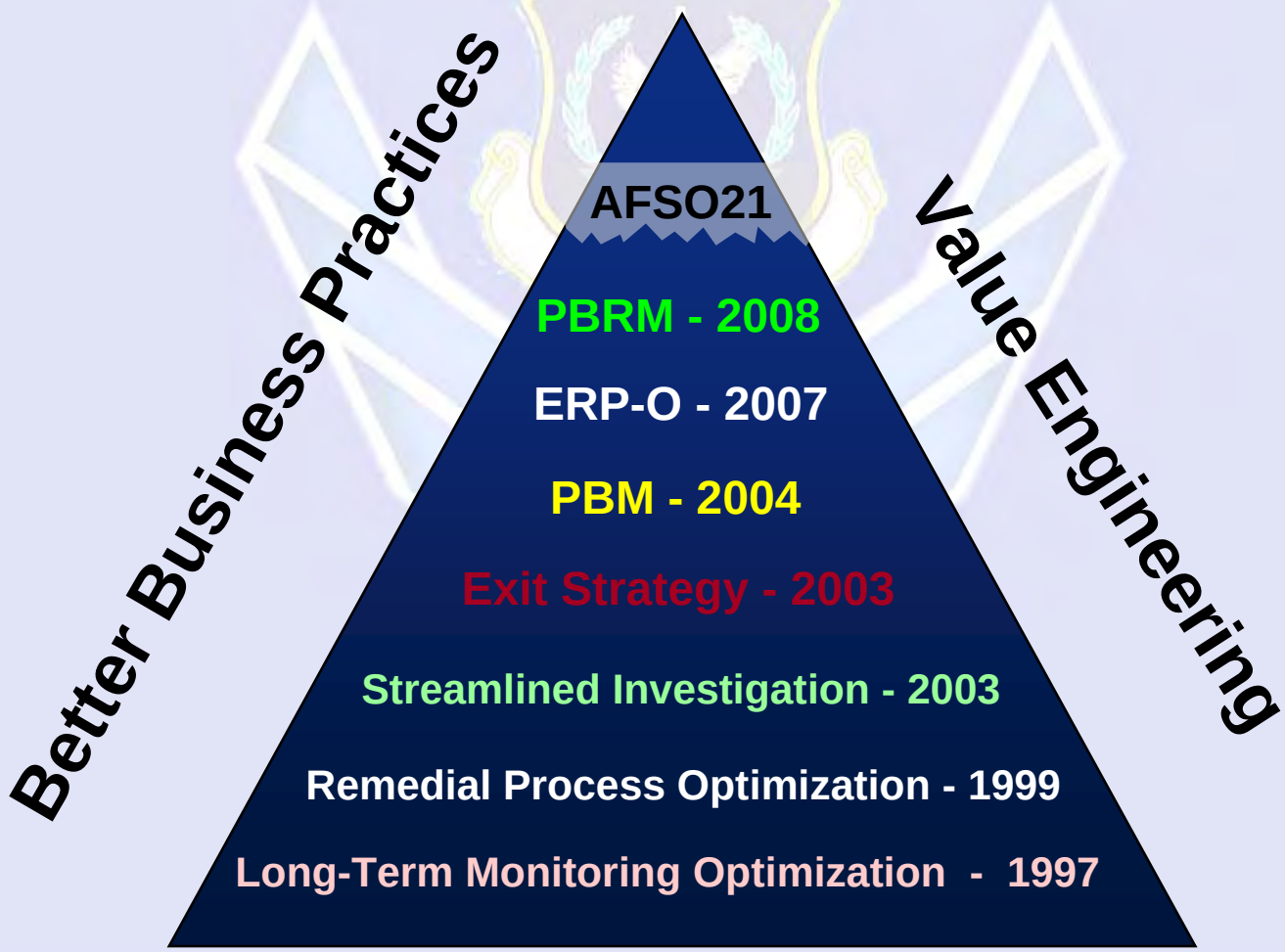
Foundation for ERP-O



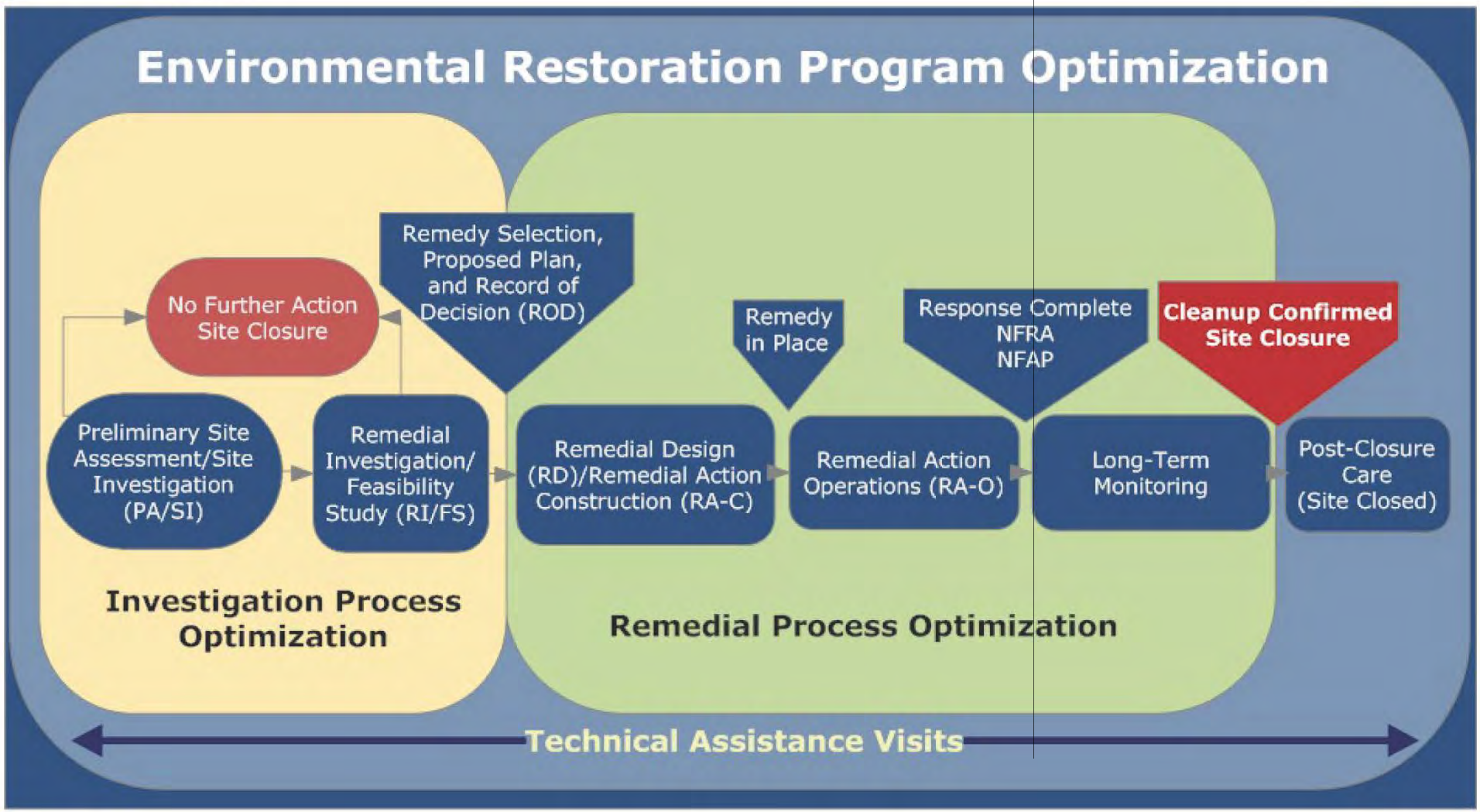
ERP-O Definition

Definition:

Environmental Restoration Program Optimization (ERP-O) is a comprehensive and systematic review of an installation's past, current and planned cleanup activities whose goal is to ensure protection of human health and the environment over the entire restoration life-cycle at minimal risk and optimal costs

ERP-O provides all the needed tools to manage risk and complies with AFSO21

ERP-O Flow Chart



Investigation Process Optimization (IPO)

Definition:

An Iterative/Systematic Planning Approach for *Evaluating Remedial Study Programs* with the Goal of Improving Overall:

- ✓ **Study Program Effectiveness**
- ✓ **Time and Cost to Achieve Site RIP Milestone**
- ✓ **Timely Feedback to Decision Makers**

A component of the overall AFCEE ERP-O

Remedial Process Optimization (RPO)

Definition:

An Iterative/Systematic Planning Approach for *Evaluating Existing/Proposed Remediation Processes* with the Goal of Improving Overall:

- ✓ **Control Effectiveness**
- ✓ **Site Cleanup Time and Costs**
- ✓ **Timely Feedback to Decision Makers**

A component of the overall AFCEE ERP-O

Technical Assistance

Definition:

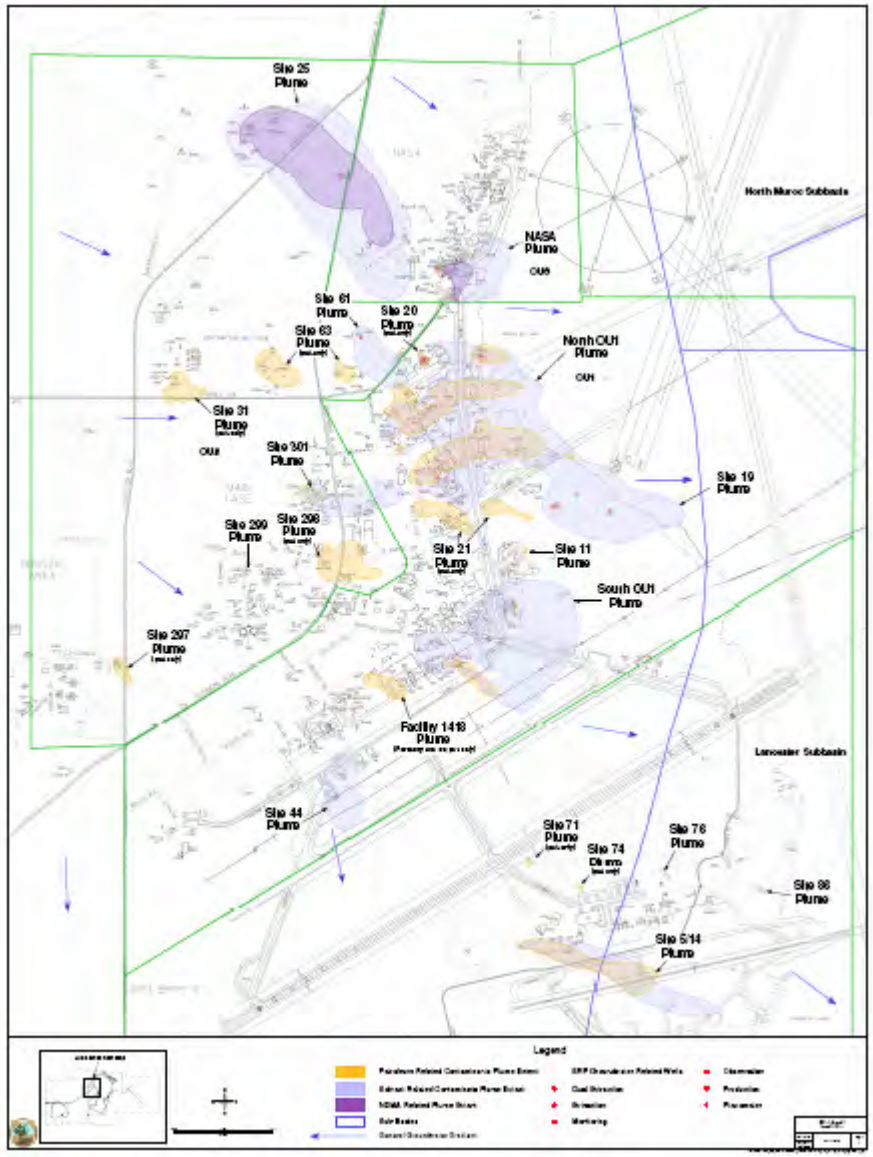
A Systematic Analytical Approach for *resolution of regulatory, technical, contractual, programmatic issues*

- ✓ Conceptual Site Models and Exit Strategies
- ✓ Decision Documents
- ✓ Contractual Strategies
- ✓ Decision Logic
- ✓ Background Studies

A component of the overall AFCEE ERP-O

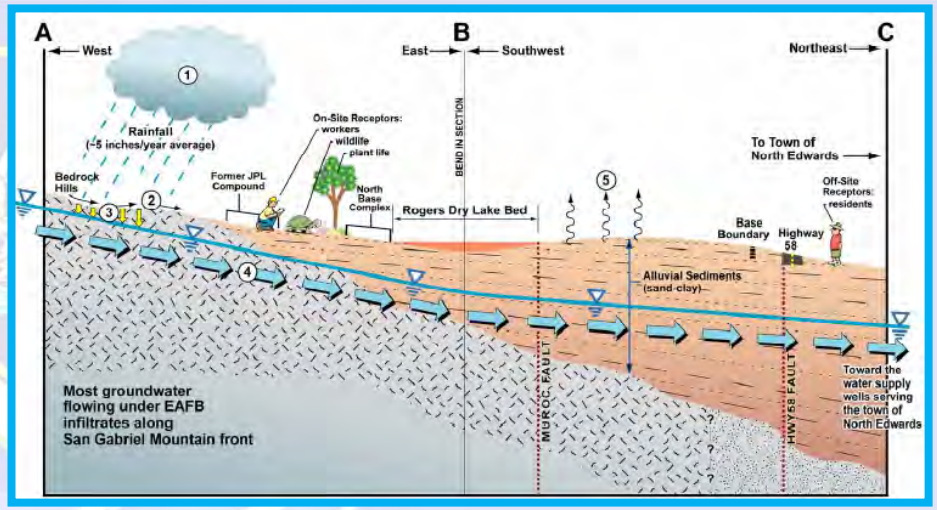
Example Site: EAFB

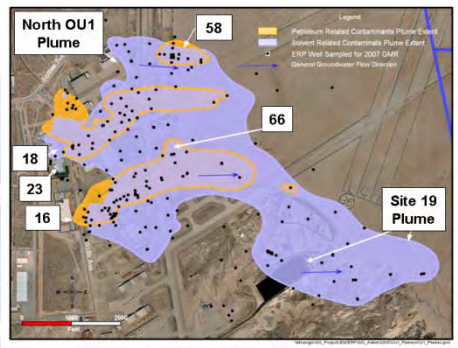
- Edwards Air Force Base
- Technical Impracticability waivers
- Base-related practices for over 50 years
- Several large plumes in complex geology including fractured bedrock
- A variety of cleanup technologies
- Chemicals of Concern:
  - ✓ TCE, BTEX, MTBE, Perchlorate, NDMA, etc.



EAFB : ERP-O Team Recommendations

- Continue Technical Impracticability waivers where applicable
- Establish a base-wide LTMO process, build an LTMO decision tree (based on a DQOs), and share with the RPMs
- Prepare a detailed performance monitoring plan to ensure that remedy maintains effectiveness and efficiency
- Consider an overall strategy that does not require perpetual extraction well network to contain the down-gradient migration of the plume

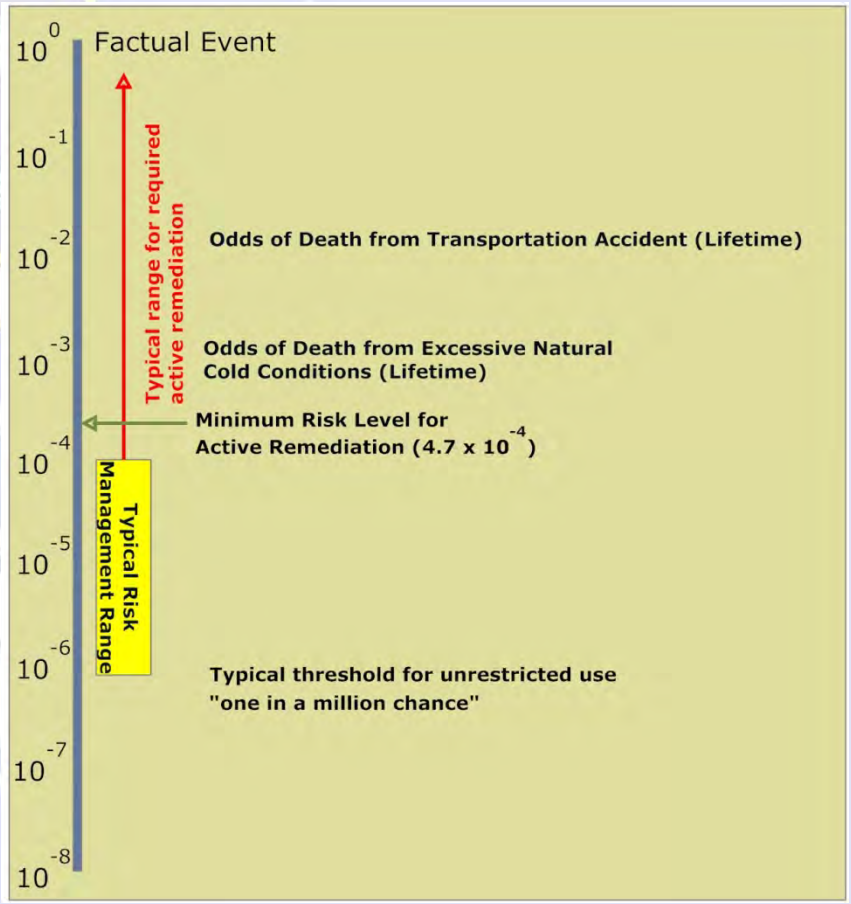




Example: Risk to Workers

Which site at which facility

- By operating the groundwater treatment system:
  - ✓ Risk to workers – 1 X10^{-3}
  - ✓ Risk to community – 1 X10^{-4}
- Risk to HH & Eco from ground water – 1 X10^{-6}
- Is active remediation really justified?
  - ✓ Alternative to remediation



Resources Utilized vs. Resources Protected

Which site at which facility

- Evaluation of resources being protected
- Technology vs. Energy Use
- Is active remediation really justified?
  - ✓ Alternative to remediation

Groundwater restoration

California installation

Consuming 1.5M KWH/yr

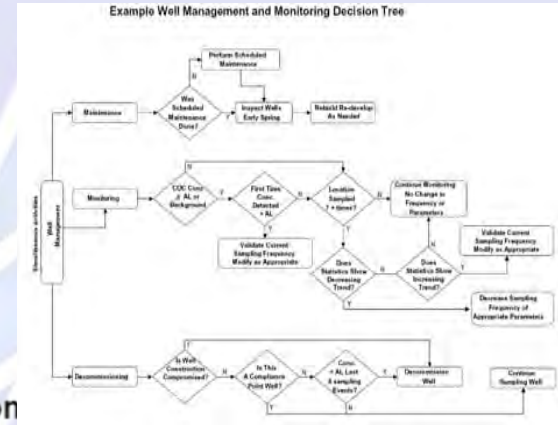
Removing < 50 grams of TCE

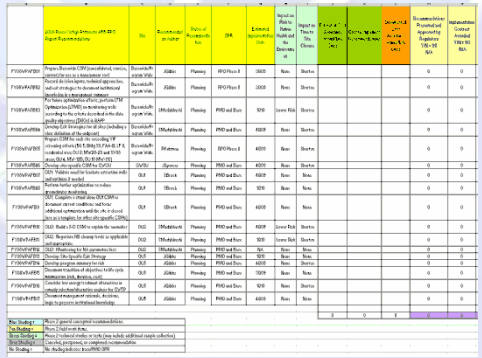
$3.6M/lb removed

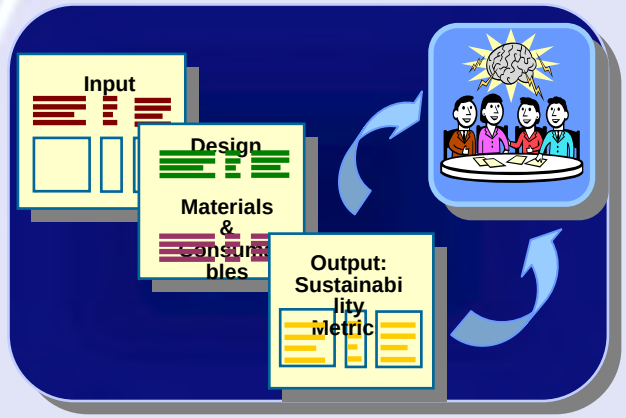
ERP-O Tools

Support Tools

- ✓Uncertainty Tool
- ✓Sustainability Tool
- ✓Performance Tracking
- ✓Recommendation Tracking
- ✓LTMO

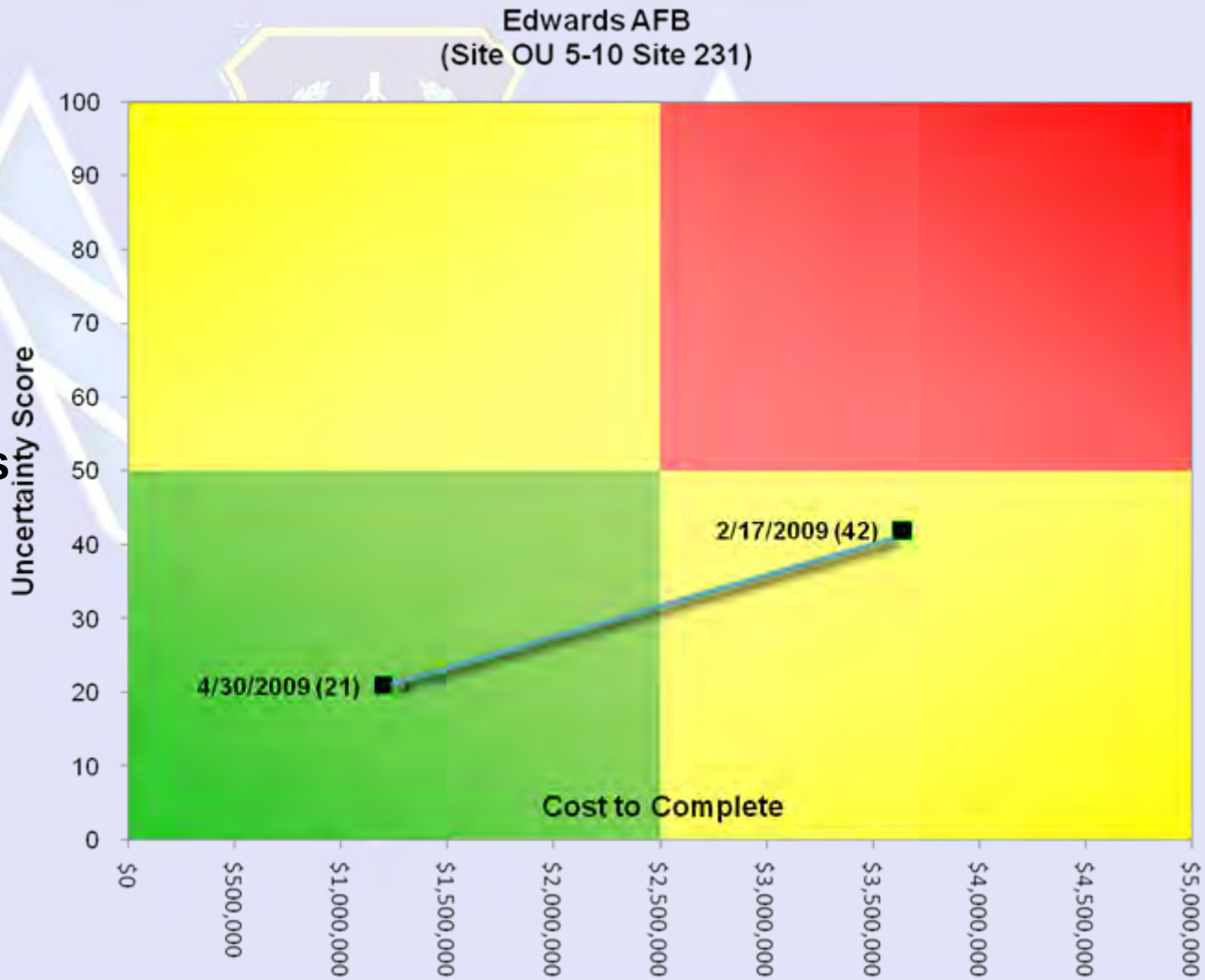






Uncertainty Analysis Tool

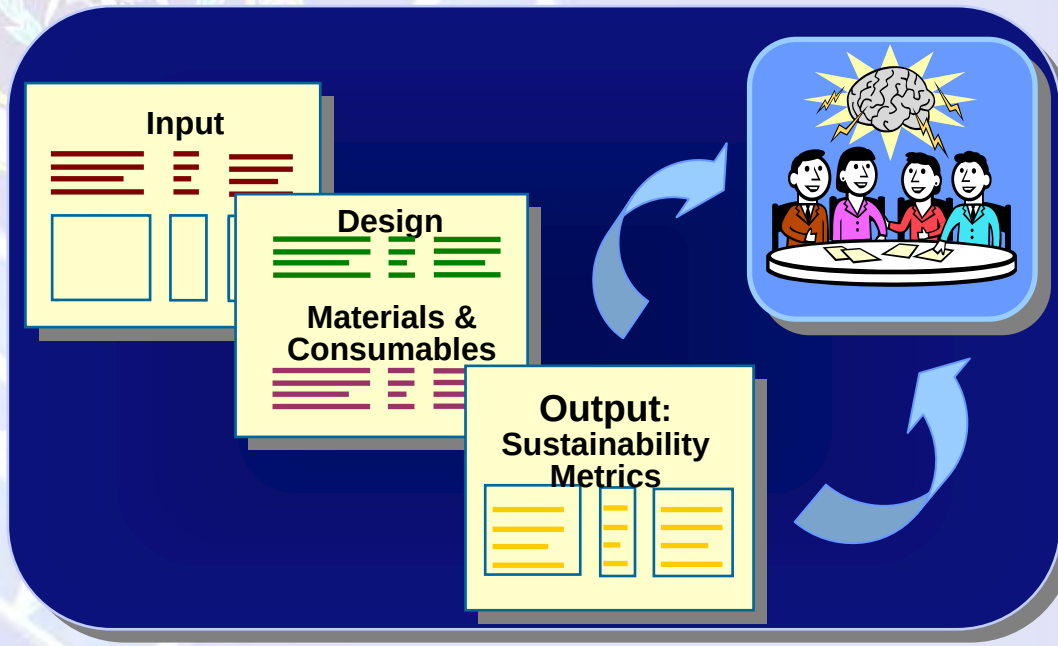
- A series of questions
- Site-specific information
- Estimates based on ERP-O team recommendations
- Real reduction after reasonable time of implementation



SRT

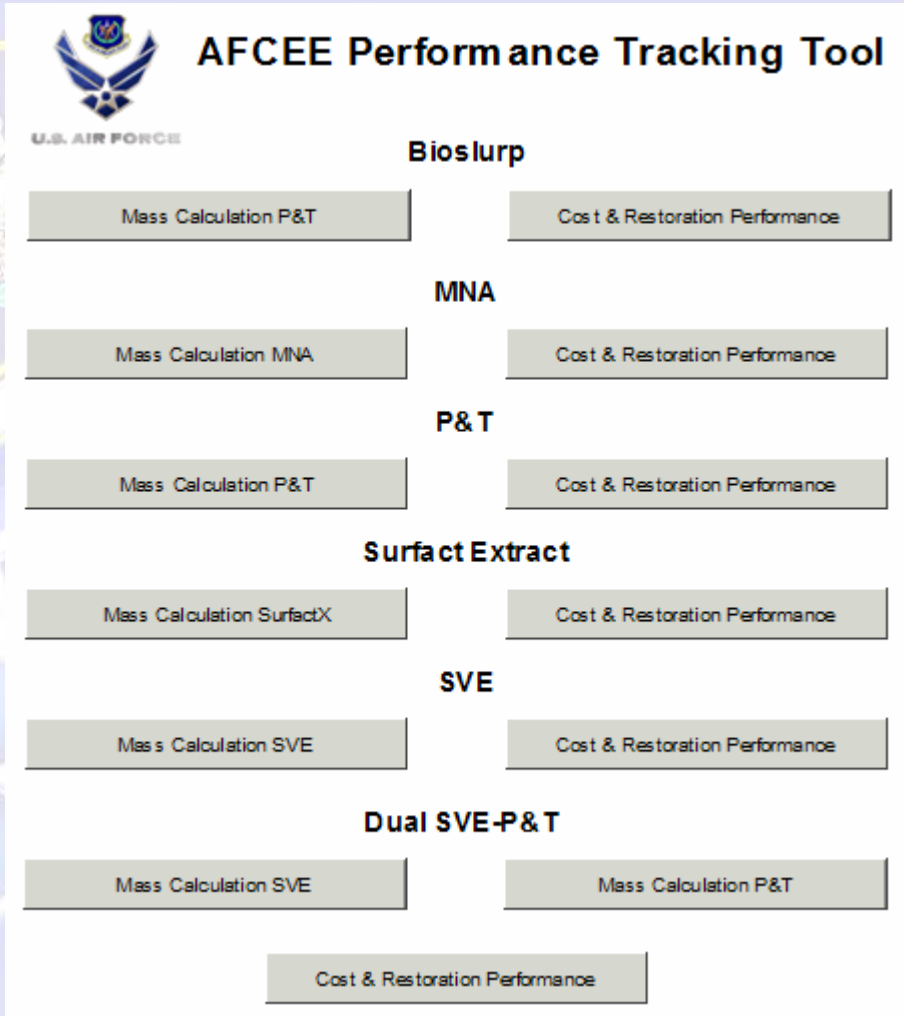
Which site at which facility

- SRT estimates sustainable metrics for specific technologies
  - ✓ Excavation
  - ✓ SVE
  - ✓ P&T
  - ✓ Enhanced Bioremed
- Sustainable metrics developed
  - ✓ CO_2
  - ✓ Energy Consumed
  - ✓ Technology Cost
  - ✓ Safety/Accident Risk



Performance Tracking Tool

- Track Remedy's Performance and Cost
  - ✓ Projected vs. actual for contaminant reduction
  - ✓ Projected cost vs. actual
- Normalized output for easy comparisons
- Six Technologies
  - ✓ Bioslurping
  - ✓ MNA
  - ✓ P&T
  - ✓ Surfactant Extraction
  - ✓ SVE
  - ✓ Dual – SVE & P&T

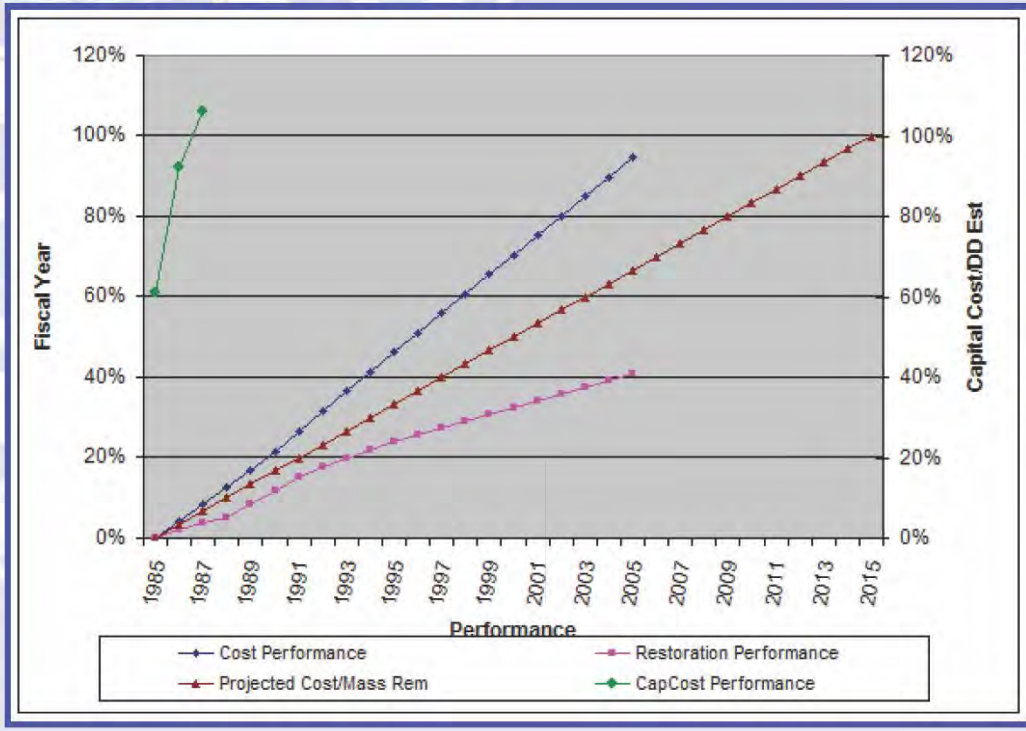


PTT

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%	



➢ Track Recommendations (ERP-O Phase IV)

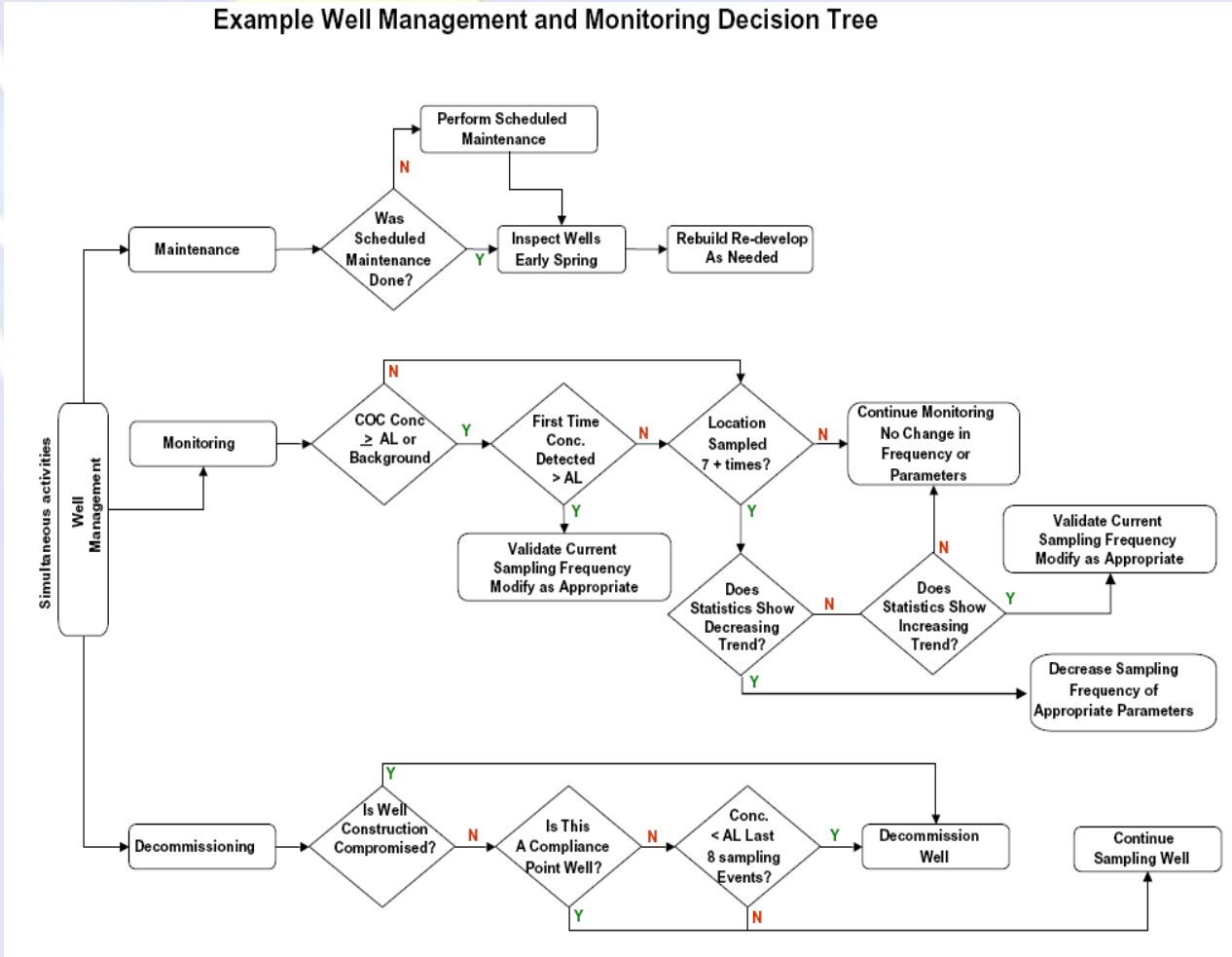
- ➢ Phase II, III
- ➢ Track
  - ✓ Implementation
  - ✓ Risk reduction
  - ✓ RC Acceleration
  - ✓ Total Investment
  - ✓ Cost avoidance
  - ✓ ROI

	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; MW20-2S and SV08 areas; OU 4, MW-12B; OU 10 MW-11S)	Basewide/Program Wide	RKutaman	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 risk	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

Monitoring Decision Logic

- Purpose of each well?
- CoC trends
- Statistical analysis
- Rational recommendations



Monitoring Decision Logic

Well ID	Current Sampling Frequency	Well purpose (e.g., water level only, background, compliance monitoring, analog well, plume monitoring, etc.)	Target Analytes/Method (e.g., 8260B, MNA, field parameters, etc.)	If Sample results in historic record and most recent result ug/L) B, TCE, PCA)	Qualitative Concentration Trends Most Wells Decreasing in Plume	Potentially spatially redundant or unnecessary	Recommend statistical temporal trend analysis?	Recommendation for future monitoring (e.g., frequency, analyte list, sampling method, removal)	Rationale for recommendation	Comment
AP-374	semi-annual	sentry	VOCs by 8260B	21, ND, ND	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Down gradient of sentry well AP4019	All non detects since inception (21 sampling rounds)
AP-401	semi-annual	PM	VOCs by 8260B	19, 17, 1.3	Stable	AP4017 & AP4525	No	NO (Abandon)	Plume stability is confirmed	Only TCE remains above MCLs after 19 rounds of sampling
AP-401	semi-annual	PM	VOCs by 8260B	18, 1200, 280	Decreasing/Stable		No	YES (5 yr, TCE & PCA only)	Main plume monitoring well	Principal indicator of progress towards RAOs
AP-401	semi-annual	sentry	VOCs by 8260B	18, ND, ND	Decreasing/Stable		No	YES (5 yr, TCE & PCA only)	To monitor plume stability and behavior	Sentry well to ensure the plume stability
AP-434	semi-annual	sentry	VOCs by 8260B	7, 15, nd	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Plume is stable	Sentry well has a well upgradient to monitor AP4525
AP-434	semi-annual	sentry	VOCs by 8260B	7, nd, nd	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Plume stability is confirmed	No detections of CoCs for over five years of sampling
AP-435	semi-annual	sentry	VOCs by 8260B	7, nd, nd	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Plume stability is confirmed	TCE, PCE ND for ten years
AP-452	semi-annual	PM	VOCs by 8260B	5, 600, 120	Decreasing/Stable		No	YES (5 yr, TCE & PCA only)	Plume monitoring	Principal indicator of progress towards RAOs
AP-455	semi-annual	PM	VOCs by 8260B	3, 19, 120	Decreasing/Stable	Spatially redundant with AP4017 & AP4525	No	NO (Abandon)	Plume is stable	TCE can be monitored from the wells AP4017 & AP4525
AP-524	semi-annual	sentry	VOCs by 8260B	1, nd, nd	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Plume stability is confirmed	No detections of CoCs
AP-374	semi-annual	PM	VOCs by 8260B	14, 56, 9	Decreasing/Stable	Spatially redundant with AP4017 & AP4525	No	NO (Abandon)	Up gradient of sentry monitoring well AP3747	All COCs below action levels except for TCE & PCA
AP-374	semi-annual	side gradient	VOCs by 8260B	17, 29, 25	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Up gradient of sentry monitoring well AP3748	All COCs below action levels except for TCE & PCA
AP-37	semi-annual	sentry	VOCs by 8260B	16, 250, 2.5	Decreasing/Stable		No	YES (5 yr, TCE & PCA only)	Monitoring/Sentry well	Sentry well to ensure the plume stability
AP-374	semi-annual	way upgradient	VOCs by 8260B	18, ND, ND	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Upgradient clean well	
AP-398	semi-annual	Upgradient	VOCs by 8260B	14, 9.8, 2.5	Decreasing/Stable	Unnecessary	No	YES (5 yr, TCE & PCA only)	Plume stability is confirmed	No/low detections since 2000
AP-398	semi-annual	sentry	VOCs by 8260B	18, ND, ND	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Plume stability is confirmed	No detections since 2000
AP-398	semi-annual	PM	VOCs by 8260B	17, 2100, 720	Decreasing/Stable	Spatially redundant with AP4017 & AP4525	No	NO (Abandon)	Plume is stable	Wells on either side AP3989 and AP4519 will suffice
AP-398	semi-annual	PM	VOCs by 8260B	17, 350, 53	Decreasing/Stable	Spatially redundant with AP4017 & AP4525	No	NO (Abandon)	Plume stability is confirmed	Other wells in the main plume area will continue to monitor
AP-398	semi-annual	PM	VOCs by 8260B	16, 250, 27	Decreasing/Stable	Spatially redundant with AP4017 & AP4525	No	NO (Abandon)	Plume is stable	Other wells in the main plume area will continue to monitor
AP-39	semi-annual	PM	VOCs by 8260B	18, 920, 200	Decreasing/Stable		No	YES (5 yr, TCE & PCA only)	To monitor plume stability and behavior	TCE and PCA can be monitored in this well to make future cleanup complete decision
AP-435	semi-annual	sentry	VOCs by 8260B	7, nd, nd	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Down gradient clean well	No detections since 2000
AP-435	semi-annual	Upgradient		7, 210, 62	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Plume stability is confirmed	Upgradient well
AP-435	semi-annual	Upgradient		7, nd, nd	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Upgradient clean well	No detections ever
AP-451	semi-annual	side gradient		15, ND, ND	Decreasing/Stable	Unnecessary	No	NO (Abandon)	Side gradient clean well	No detections ever
AP-45	semi-annual	PM		6, 1000, 350	Decreasing/Stable		No	YES (5 yr, TCE & PCA only)	Main plume monitoring well	TCE and PCA can be monitored in this well to make future cleanup complete decision
AP-455	semi-annual	PM		3, 1000, 330	Decreasing/Stable	Spatially redundant with AP4017 & AP4525	No	NO (Abandon)	Plume stability is confirmed	Other wells in the main plume area will continue to monitor

ERP-O Supporting Agencies

- **ITRC - Interstate Technology Regulatory Council**
  - ✓ **ITRC Team Members become Advocates for the Process**
- **USGS – US Geological Survey**
  - ✓ **Support CSM and fate and transport model oversight**
- **USACE – US Army Corp of Engineers**
  - ✓ **Additional DoD Technical Expertise**

ITRC RRM and GSR Teams

- ITRC - Interstate Technology Regulatory Council
- AFCEE is providing in-kind support to several ITRC teams including Remediation Risk Management (RRM) and Green & Sustainable Remediation (GSR) Teams
- AFCEE Funds and Supports ITRC RPO Team Members to Participate on ERP-O Reviews

ITRC RRM & GSR Team Products

- RPO Products on www.itrcweb.org
  - ✓ RPO and PBEM Technical Guidance Documents
  - ✓ RPO related Fact Sheets
  - ✓ RPO and PBEM Internet-based Trainings
- ITRC RRM Team Products
  - ✓ Technical & Regulatory Guidance Document (Fall ’09)
  - ✓ Internet-based Training on RRM (Early 2010)
- ITRC GSR Team Products
  - ✓ Status summary of GSR practices
  - ✓ State survey of GSR practices
  - ✓ Technical and Regulatory Guidance Document (2010)
  - ✓ Internet-based Training on GSR (2011)

Incorporating Sustainable and Green Practices into ERP-O

- **AFCEE PBM Guidance document is being developed to reflect ERP-O Strategies and sustainable remediation**
  - ✓ **PBRM a green/sustainable process is also being revised**
  - ✓ **PBM, ERP-O, IPO, RPO, PBRM all have a common goal**
    - **Sustainable, green, & cost effective RIP by 2012**
    - **Accelerate clean closure**
- **Investigation Processes**
  - ✓ **Use more sustainable approaches for characterization**
  - ✓ **Use Triad with a green perspective**
- **Land Use and Institutional Controls**
  - ✓ **Developing sustainable strategies with the active participation from stakeholders**

Integrity - Service - Excellence