

Attainment Monitoring and Planning for Site Closure


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Performance Monitoring for Optimization of In Situ Remediation Technologies
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Attainment Monitoring

- ▼ Background
- ▼ EPA Guidance and Tools for Demonstrating Attainment
- ▼ Case Study: Fort Ord
- ▼ Monitoring Strategies for Attainment Demonstrations



Background: Monitoring Framework


- ▼ Site Characterization
 - Sampling provides basis for remedy design
- ▼ Remedy Performance
 - Demonstrate remedy performs as designed
- ▼ Remedy Effectiveness
 - Demonstrate remedy is reducing concentrations, mass, containing plume and progress to attainment
- ▼ Attainment Monitoring ★
 - Demonstrate that remedy has attained cleanup goals
 - Move to passive or MNA remedy
 - Site closure



EPA Guidance

- ▼ May 2014- OSWER 9355.0-129: *The Guidance for Evaluating Completion of Groundwater Restoration Remedial Actions*
- ▼ July 2014 OSWER 9283.1 46: *Groundwater Statistics Tool User's Guide* and *Excel Spreadsheet Tool* download at:


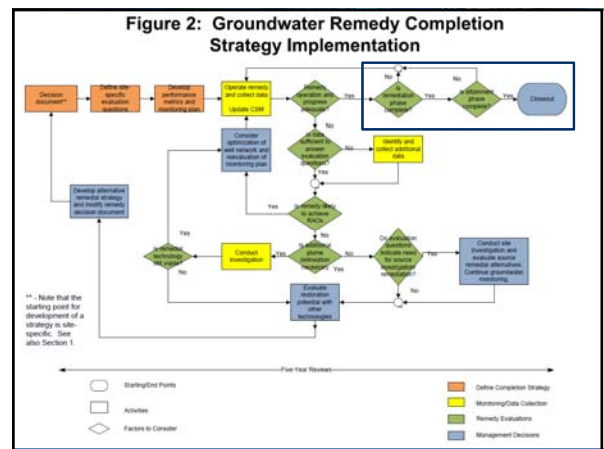
http://www2.epa.gov/sites/production/files/2015-11/qw_stats_tool_08112014.final_xlsm



Site Completion

Groundwater restoration remedial actions should generally be considered complete when **well-specific monitoring data**, provide a **scientific basis** to conclude that the groundwater has met and will continue to meet **cleanup levels** for all COCs in the future, in accordance with the decision document.

Groundwater Remedy Completion Strategy: OSWER 9200.2-144





EPA Guidance: Framework

Two Phases of Monitoring


- Remediation Monitoring – results compared to remedy performance expectations
- Attainment – results compared to remedial goals, background or non-detect

Key Point: The decision point or trigger between the two monitoring phases is not always obvious



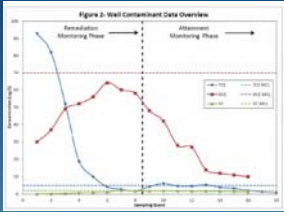
EPA Guidance: Framework

- The Remediation Phase of monitoring is complete when:
 - All remaining wells/COCs below remedial goals (mostly)
 - Post-Remediation “Steady State” (not defined) is demonstrated Pre-approval by regulatory agency
- Transition from Remediation to Attainment
 - Minimum of 4 data points
 - “Visual” review all results ND or < MCLs statistical review may not be necessary to begin Attainment Monitoring

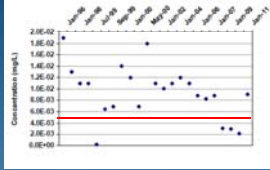



EPA Guidance: Reality Check

Ideal



Real






EPA Guidance: Framework


Transition from Remediation to Attainment Monitoring

- Statistical Review if “visual” review inconclusive
- Mean Test
 - 95% Upper Confidence Limit (UCL) – if < MCL, begin Attainment Monitoring phase
- Trend Test
 - 95% UCL on a trend line (Theil-Sen)
 - 95% UCL < MCL
 - Trend ‘not increasing’



EPA Guidance: Framework

- Attainment Monitoring Phase
 - Minimum of 8 data points
 - Two Lines of Evidence
 - “Visual” All data ND or < MCL
 - Mean test to demonstrate GW at or below cleanup goal
 - Trend test to support conclusion of future attainment
- Request regulator for ‘Completion’ status



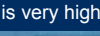
EPA Excel Tool

Situation	Decision	Criteria
Attainment	Has action level been attained?	Time-dependent UCL < Action level AND Trend is not increasing AND Time-independent UCL < Action level
Site Cleanup	Is site cleaned up?	Time-independent UCL < Action level

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    graph TD
      A[Data Entry] --> B[Outlier Test]
      B --> C[Normality Test]
      C --> D[Trend Tests and Time-Dependent UCL]
      D --> E[Time-independent UCL and Summary]
    
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Key Point: The statistical standard set by EPA tool is very high.



EPA Excel Tool

Groundwater Statistics Tool
Data Input worksheet

Site Name	Former Fort Ord	Concentration (background)	Data	Detected? (Yes or No)
Operating Unit (OU)	OU 1	1.1	Yes	Yes
Type of Evaluation	Attainment	1.4	Yes	Yes
Date of Evaluation	1/20/2016	8.1	Yes	Yes
Person performing analysis		10	Yes	Yes
Chemical of Concern	TCE	10	Yes	Yes
Well Name/Number	MX-OU1-E1A	26	Yes	Yes
Date	3/13/2012	38.3	Yes	Yes
Concentration Units	micrograms/liter	38.3	Yes	Yes
Confidence Level Desired	95%	35	Yes	Yes
Change Level	5	3.25	Yes	Yes
Source of cleanup level (e.g. MCL)	MCL	6.2	Yes	Yes
at risk based concentration		5.95	Yes	Yes
Risk of Future Outlier Rejection	1%	5.4	Yes	Yes
Maximum Trend Error for Well Month		5.55	Yes	Yes
Significant figures to use	3	6.20	Yes	Yes
		4.4	Yes	Yes
		4.33	Yes	Yes
		4.26	Yes	Yes
		3.7	Yes	Yes
		3.40	Yes	Yes

Data Review

Question	Yes	Recommendations
Are all necessary data fields entered, and in proper format?	Yes	None
Are at least 4 data points present for statistical analysis?	Yes	None
Are detection levels for constituents a maximum detected value?	Yes	None
Are all data within their data levels?	Yes	None

Next Step: Check for Outliers

Attainment for In Situ Remedies

- Why don't I have an example of attainment demonstrations at In Situ Remediation Sites?
 - Poor site characterization
 - Remedy not installed in correct location
 - Failure to identify primary source(s)
 - Source under building
 - Fractured bedrock
 - Back diffusion - remedy did not address low K zones, long-term, low level discharge

Attainment for In Situ Remedies

- Why don't I have an example of attainment demonstrations at In Situ Remediation Sites?
 - Remedy failure - formation plugged, incomplete treatment etc.
 - Monitoring wells - premature or wrong wells P&A
 - Concentration variability - data do not meet statistical standards

Attainment Case Study: Fort Ord, California PBR

- Client: US Army Corps
- Location: Former Fort Ord, California, EPA R10
 - OU-1 former fire training area
 - TCE is the only COC remaining above cleanup goal
 - P&T remedy, sandy aquifer
 - PBR Contract - size of plume was larger than portrayed in site characterization documents

Optimized Exit Strategy

Well No.	RIP Pumping Rates (gpm)	PBMO™ Optimized Pumping Rates (gpm)
62	0.0	0.9
60	1.4	0.1
66	12.3	1.2
10	21.2	1.4
87	7.3	1.3
46	0.0	1.7
85	14.3	3.4
71	0.0	0.7
Total:	56.5	10.7

Use of groundwater model and formal mathematical optimization using PBMO

Time to Attainment of Goals

Time to think about monitoring to demonstrate attainment

Ft. Ord Monitoring Framework

- Remedy performance data collected 2006 through 2014
- 2014 Data showed no exceedance of MCLs for TCE
- P&T terminated in October 2014
- Agreement with stakeholders that 2014 data sufficient to trigger attainment monitoring phase
- 8 Attainment monitoring locations - along the main axis of plume
- 4 Samples collected in 2015 for Attainment Demonstration
- Well and COC-specific statistical evaluation
 - No exceedance of MCL at any of the 8 wells during Attainment phase
 - 4 wells with statistically *Decreasing* trends
 - No wells have *Increasing* trend

Qualitative Considerations

- ▼ Complete CSM
 - ▼ Aquifer parameters understood
 - ▼ No significant data gaps
 - ▼ No complete human or ecological exposure pathways
- ▼ Weight of Evidence
 - ▼ Historical sampling results below MCLs for wells not in Attainment program
 - ▼ Documented history of P&T remedy optimization success
 - ▼ Sampling plan included PFOS/PFOA even though not specified in the ROD
 - ▼ Good relationship between stakeholders

Fort Ord – Closure Letter

Receipt of Site Closure Letter from P&A and State Regulators

CPAR Rating

Project Title: FT Ord OUI GWTP Operations and GWM

Evaluation Area	Pass Rating	Rating
Quality	N/A	Exceptional
Schedule	N/A	Exceptional
Cost Control	N/A	Exceptional
Management	N/A	Exceptional

Attainment: Reality Check

- ▼ Most sites will not meet all standards for all wells and COCs for either 'visual' or statistical methods – *Do not despair*
- ▼ "Guidance is not set in stone"
- ▼ Discretion of regulatory agency
- ▼ Pursue "weight of evidence" approach

Recommendations

- ▼ Identify monitoring wells that reliably demonstrate remedy performance
 - Screened in relevant interval
 - Located on GW flow lines
 - Data show low variance
 - Have a long sampling history
 - Have not been adversely affected by remedial action
 - Do not P&A

Recommendations

- ▼ Data Sufficiency
 - If site has reduced monitoring frequency insufficient data for demonstration?
 - Think about increasing frequency prior to attainment demonstration reduce impact of outliers or variability
 - Think about re-sampling as done for Detection Monitoring programs

Recommendations

- ▼ For wells close to cleanup goals after each sampling event
 - Mann-Kendall Statistical Trend – document *Decreasing* or *Stable* trends
 - Calculate 95% UCL on recent results – compare with MCLs
 - Review all outliers for laboratory or sampling errors



Recommendations

- ▼ Communicate with regulators and stakeholders – early in the process
 - Confirm consensus on CSM
 - Articulate remedy performance metrics
 - Cultivate ‘culture of optimization’
 - Outline exit strategy and requirements for site closure