



# Qualitative and Quantitative Evaluation of Long-Term Monitoring Programs

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LTMO

# Purpose and Overview

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- Purpose: Introduce Terminology and Lay Groundwork for Upcoming Detailed Discussion of Techniques
- Overview
  - Definitions
  - Information Needs
  - Considerations in Qualitative Reviews
  - Quantitative Optimization Approaches
  - Combining Qualitative and Quantitative Approaches
  - California Regulatory Considerations for Optimization of LTM Programs
  - Summary

# Definitions

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- Qualitative Evaluation: Use of Technical Expertise and Professional Judgment to Assess the LTM Program
- Quantitative Evaluation: Use Statistical and Numerical Analysis to Assess the LTM Program
- Temporal Analysis: Assess the Frequency of Sampling (May Contribute to Assessment of Network)
- Spatial Analysis: Assess the Network of Monitoring Points

# Needed Information

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- Information Required for LTMO Regardless of Approach
- Hydrogeology
  - Stratigraphy and Site Conceptual Model
  - Well Construction
- Monitoring Purpose
  - Cleanup Progress and Attainment of Cleanup Standards
  - Performance of Remedial Systems (e.g. Containment)
  - Release Detection

# Needed Information, Continued

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- Contaminants of Interest or Concern
- Cleanup Actions
  - May Affect Comparability of Data
  - Nature of Past Actions and Timing of Actions
  - Before and After Comparison
- Data Availability
  - Where to Find
  - Form (Electronic, Hard-Copy)

# Needed Information, Continued

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- Data Set Comparability
  - Spatial and Temporal Comparability
    - Multiple Organizations Contributing Data
    - Changes Over Time
  - Cleanup Impacts
  - Climatic/Hydrologic Changes: Drought, Pumping Changes
  - Differences or Changes in:
    - Sampling Techniques (e.g. Purge & Bail vs. Low-Flow)
    - Well Construction
    - Analytical Differences (e.g. Method, Dilution, Detection Limit)

# Considerations for Any Analysis

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- Analyst Needs to Understand Ground Water and Contaminant Flow Paths (now and future)
  - Rate and Direction of Advective Transport (in 3-D)
  - Mobility and Fate of Contaminants
- Conceptual Site Model
  - A CSM Includes: Nature and Extent of Site Contaminants and Their Fate and Paths to Reach Receptors, the Nature and Location of Possible Receptors, Effects of Current or Planned Remediation Activities, and Future Conditions (e.g., Land Use)
  - Verify the Project's Current CSM Consistent With the Data Recently Collected As Part of the LTM

# Considerations for Qualitative Analysis

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- Analyst Looks at Sampling Frequency/Location
  - Ground Water - Monitoring Wells, Extraction Wells
  - Surface Water, Air
  - Treatment Plant
- Consider Other Aspects
  - Analytical and Sampling Methods
  - Data Management and Visualization Approach
  - Project-Specific Public or Other Stakeholder Concerns



# Considerations for Qualitative Analysis, Continued

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- Temporal Analysis – Experienced Professional Makes Recommendation for Sampling Frequency Based on:
  - Frequency of Data Assessment by Project Team (How often does the team assess the data?)
  - Rate of Contaminant Migration (Generally Faster = More Frequent)
  - Rate / Nature of Contaminant Concentration Change
    - Concentration Trend Slope, Variability in Concentrations
  - Time to Take Action if Monitoring Indicates a Problem
  - Public Concerns / Regulatory Requirements

# Example Qualitative Logic for Optimization of Sampling Frequency

<i>Reasons for Increasing Sampling Frequency</i>	<i>Reasons for Decreasing Sampling Frequency</i>
Groundwater velocity is high	Groundwater velocity is low
Change in concentration would significantly alter a decision or course of action	Change in concentration would not significantly alter a decision or course of action
Well is close to source area or operating remedy	Well is farther from source area or operating remedy
Cannot predict if concentrations will change significantly over time	Concentrations are not expected to change significantly over time, or contaminant levels have met standards for some period of time

# Considerations for Qualitative Analysis, Continued

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- Spatial Analysis - Experienced Professional Makes Recommendation for Sampling Locations Based on:
  - Use of Well as Sentinel for Exposure Point
  - Past Well Performance (Goes Dry, Poor Construction)
  - Proximity to Other Wells in Same Aquifer
  - Proximity to the Known Plume Boundary
    - Near Source for Assessing Impact of Source Control
    - Near Leading Edge of Plume (Lateral & Vertical) to Assess Migration / Capture

# Considerations for Qualitative Analysis, Continued

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- Spatial Analysis, Continued
  - Compliance Point Well
  - Background Definition
  - Continuity for Wells with Long Sampling History
  - Identified Data Gaps

# Example Qualitative Logic for Optimization of Network

<i>Reasons for Retaining or Adding a Well</i>	<i>Reasons for Removing a Well From a Monitoring Network</i>
Well is needed to further characterize site, monitor concentration changes over time	Well provides spatially redundant information with a neighboring well (same constituents, short distance)
Well important for defining lateral or vertical extent of contaminants	Well has been dry for more than two years
Well is needed to monitor water quality at a compliance point or receptor exposure point	Contaminant concentrations are consistently below laboratory detection limits or cleanup goals
Well is important for defining background water quality	Well is completed in same water-bearing zone as nearby well(s)

# Quantitative LTMO Approaches

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- Application of Numerical and Statistical Techniques to Develop Recommendations for:
  - Sampling Frequency for Existing Wells/Points
  - Sampling Locations
  - Filling Data Gaps
- Provides Degree of Objectivity and Repeatability
- Requires Some Familiarity with Statistical Methods, Some Specialized Expertise

# Quantitative LTMO Approaches, Continued

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- Sample Frequency – Quantitative Temporal Analysis
  - Evaluate Nature and Strength of Statistical Trend
- Compute Measure of Variability, Periodicity
  - Rule-Based Decision Tree to Recommend Sampling Frequency Based on Trend, Variability, Average Concentration
  - Simulation Approach - Recommend Sampling Frequency Based on Observed and Projected Rate of Concentration Change

# Quantitative LTMO Approaches, Continued

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- Sample Network Optimization – Quantitative Spatial Analysis
  - Ranking Approaches
    - Use Geostatistical or Other Weighting Techniques to Evaluate the Contribution of Each Well to Plume Definition
    - Identify Areas of High Uncertainty
  - Simulation Approaches
    - Coupled Transport Simulations with Numerical Optimization Algorithms to Minimize Error in Plume Definition
    - Consider Additional Well Locations
  - Wells that Contribute Little are Candidates for Removal
  - Identify Areas for Additional Wells



# Combining Qualitative and Quantitative Approaches

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- Quantitative Results Must be Reviewed Qualitatively by Technical Staff for Appropriateness
  - Consider Site Hydrogeology
  - Address Stakeholder Needs
  - Consider Recent and Future Changes
    - Production and Land Use
    - Impacts of Climate, Other Factors
  - Qualitative Review May “Trump” Quantitative Results

# Combining Qualitative and Quantitative Approaches, Continued

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- May Perform Both Qualitative and Quantitative Methods, Use Rules to Adopt Specific Recommendations (e.g., Parsons Three-Tiered Approach)

# California Regulatory Considerations for Optimization of LTM Programs

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- *Article 6 Requirements (Cal. Code Regs, Title 22, Sec. 66264.90 et seq.)*
  - LTMO Only Applied to Facilities that:
    - Are Permitted
    - Are under a Corrective Action Mon. Program Or
    - Are in Detection Monitoring after a CAMP
  - Well Distribution:
    - Upgradient
    - At Point of Compliance
    - Within Plume
    - At Plume Perimeter

# California Regulatory Considerations for Optimization of LTM Programs, Continued

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- Analytical Parameters
  - COCs Unchanged by LTMO Process
  - Possibly Analyzed Less Frequently than Monitoring Parameters [Need to Clarify?]
- Sampling Frequency Must be Sufficient to Support Statistical Evaluation
- Other Prescriptive Requirements Still Apply
  - Refer to Monitoring Requirements for Permitted Hazardous Waste Facilities
  - [www.dtsc.ca.gov/PublicationsForms/HWMP\\_Guidance\\_Monitoring-Requirements.pdf](http://www.dtsc.ca.gov/PublicationsForms/HWMP_Guidance_Monitoring-Requirements.pdf)

# Summary

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- Provided Definitions of Qualitative and Quantitative LTMO
- Discussed Data Needs
- Explained General Considerations
- You Now Have Background for Detailed Discussions of LTMO Approaches