Performance Monitoring of MNA Remedies in Ground Water

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Conference on Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization

June 15-17, 2004

Dallas, Texas

Performance Monitoring of MNA Remedies For VOCs In Ground Water

EPA United States Environmental Protection Agency

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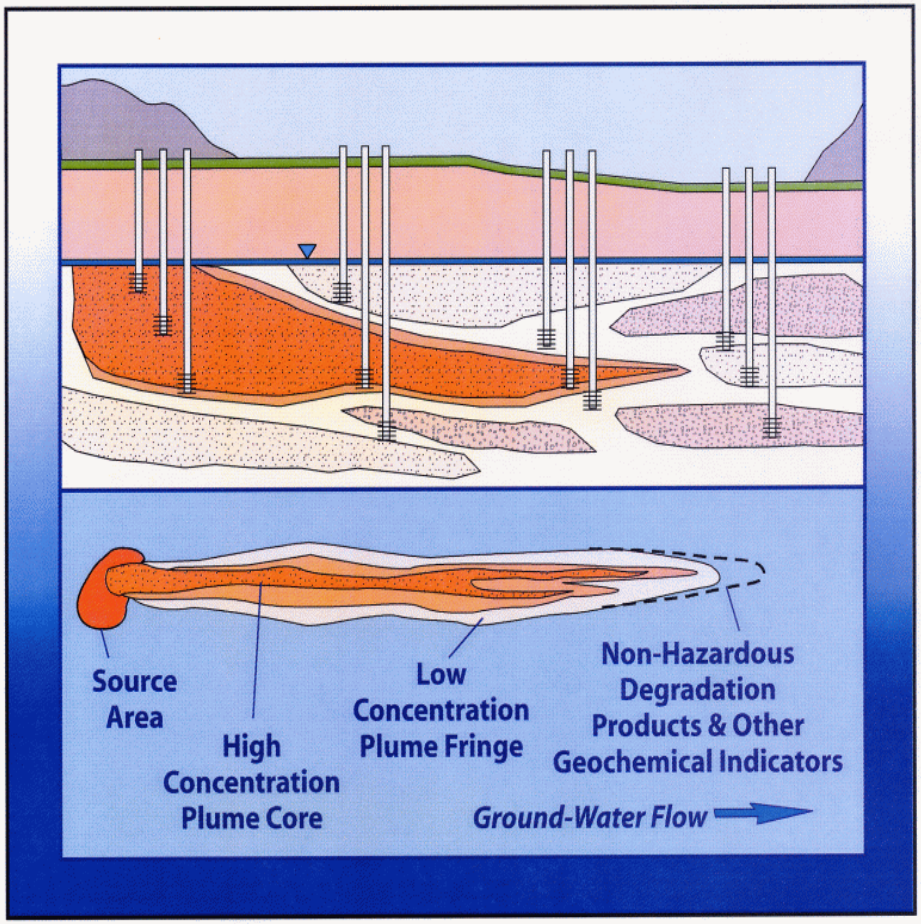

Authors

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Introduction

- This document has been developed to be used during the preparation and review of long-term monitoring plans for sites where MNA has been selected.
- A technical framework for monitoring program development is presented.
- Technical issues discussed include monitoring parameters, locations and monitoring frequencies.
- The scope is limited to VOCs in porous media.

Performance Monitoring Objectives

- OSWER Directive 9200.4-17P (1999) provides 8 specific objectives.

- This document discusses technical aspects of monitoring systems typically necessary to meet these and similar objectives.

Objectives for Performance Monitoring

1. Demonstrate that natural attenuation is occurring according to expectations
2. Detect changes in environmental conditions that may reduce the efficacy of any of the natural attenuation processes
3. Identify any potentially toxic and/or mobile transformation products

Objectives for Performance Monitoring

4. Verify that the plume(s) is not expanding downgradient, laterally or vertically.
5. Verify no unacceptable impact to downgradient receptors.
6. Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy.

Objectives for Performance Monitoring

7. Demonstrate the efficacy of institutional controls that were put into place to protect potential receptors, and
8. Verify attainment of remediation objectives.

Objectives of Performance Monitoring

This information will be used to evaluate the dynamic behavior of the plume over time including:

- Changes in three-dimensional plume boundaries,
- Changes in the geochemical setting that may be indicative of changes affecting rate and extent of natural attenuation and
- Contaminant mass and/or concentration reduction

Objectives of Performance Monitoring

Plume behavior can then be evaluated to determine the effectiveness of the MNA remedy, the adequacy of the monitoring program, and the adequacy of the conceptual site model.

On this basis decisions may be made for subsequent phases of site operations, such as:

Objectives of Performance Monitoring

- Continue the performance monitoring program without change,
- Modify the performance monitoring program,
- Modify the institutional controls,
- Implement a contingency or alternative remedy, or
- Terminate performance monitoring

Develop Site Specific Objectives and Criteria

Site specific performance monitoring goals are derived from site specific objectives (restoration) and site specific risk based endpoint concentrations (MCLs).

Site Specific Objectives

Common remedial objectives include lack of plume expansion and contaminant reduction to established limits. Examples of performance criteria for monitoring such objectives include:

- Ability to detect a given contaminant at a given concentration at a specified location,
- Ability to detect a specified decrease in concentrations throughout the site within a specified time-frame

Steps in the Establishment of Data Quality Objectives (modified from U.S. EPA, 2000a)

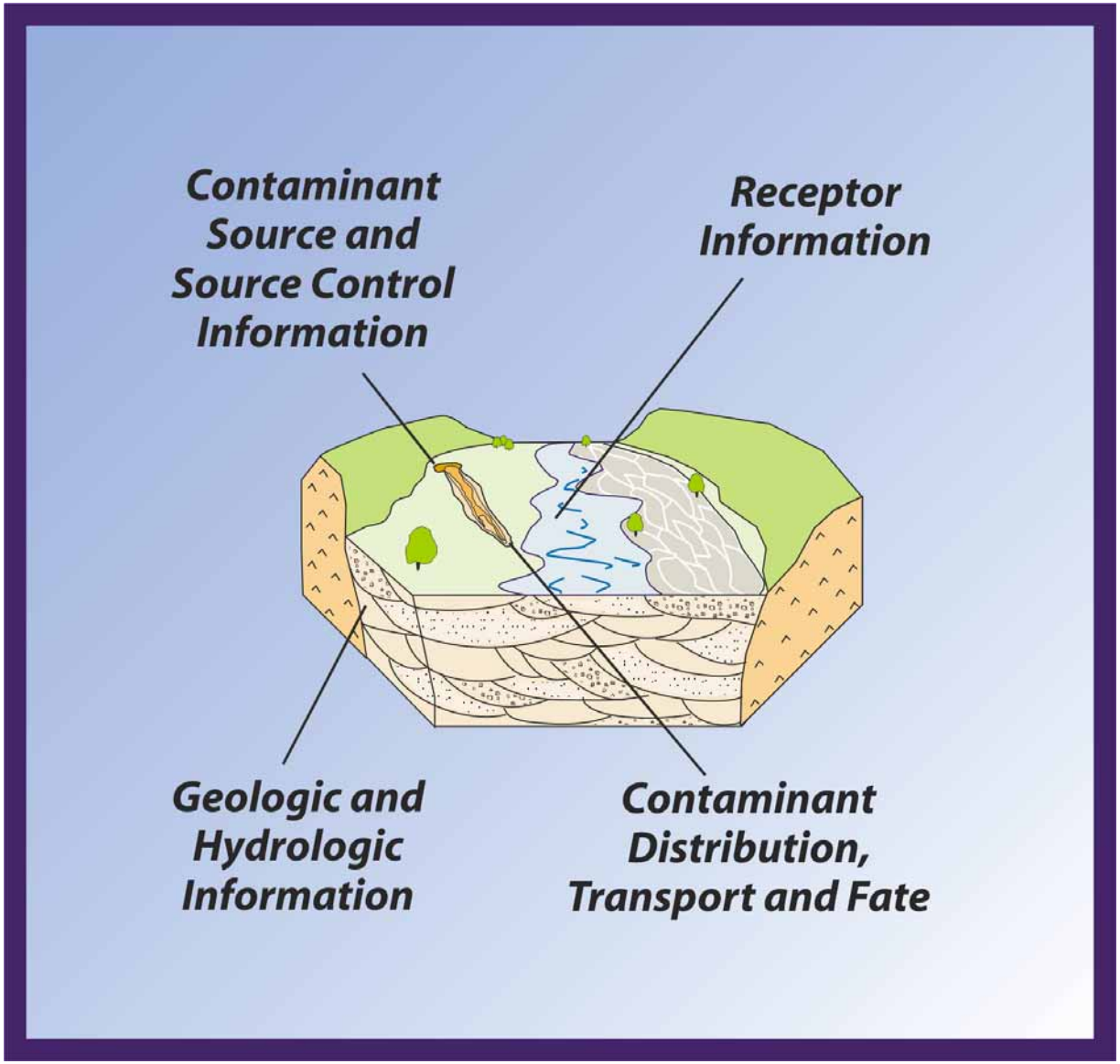
MNA Conceptual Site Model

"..the site-specific qualitative and quantitative description of the migration and fate of contaminants with respect to possible receptors and the geologic, hydrologic, biologic, geochemical, and anthropogenic factors that control contaminant distribution."

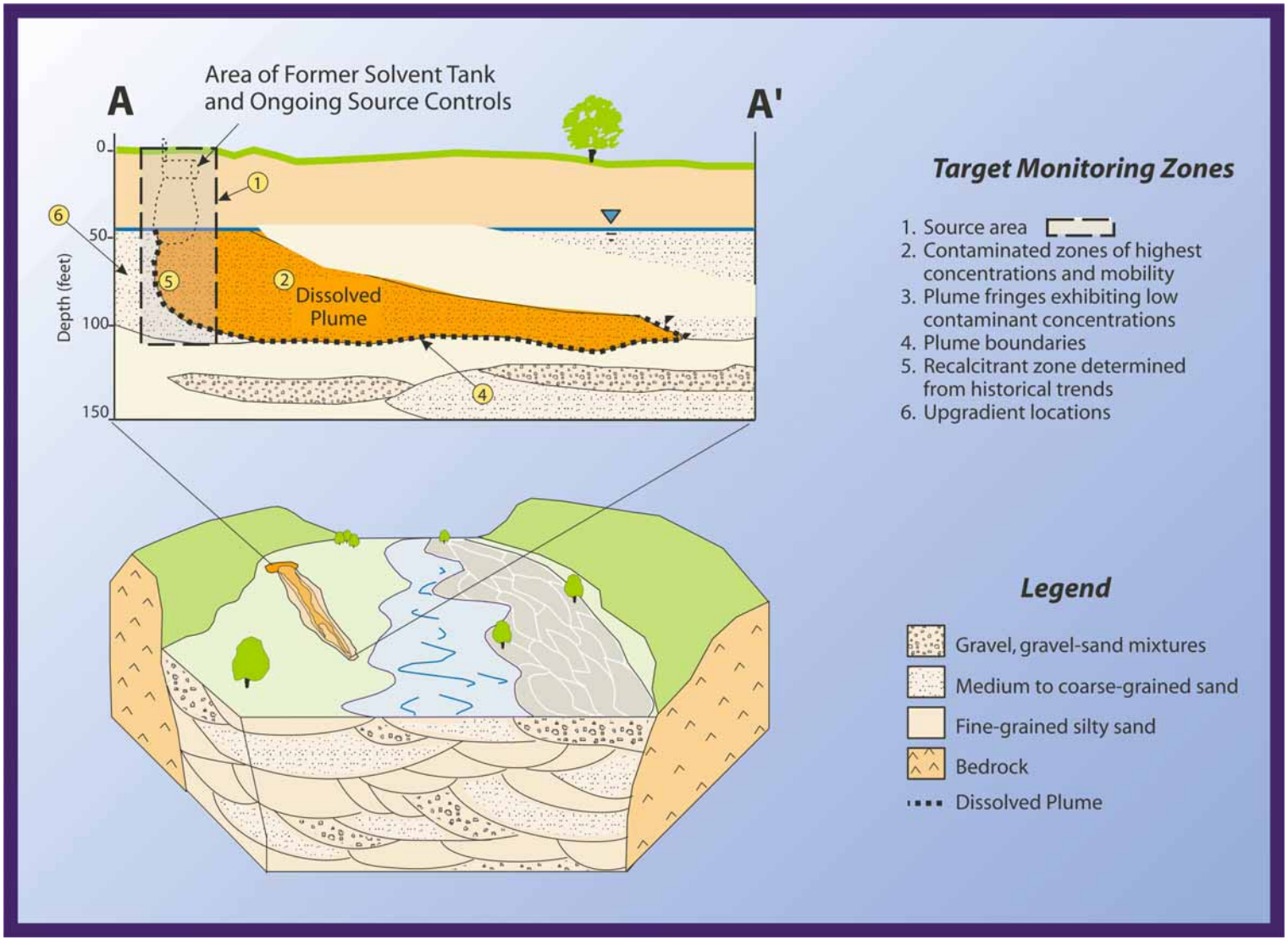
Site Conceptual Model

..expresses an understanding of the site structure, processes, and factors that affect plume development and behavior..

..built on assumptions and hypotheses that have been evaluated using site-specific data, and is continually reevaluated as new data are developed..



Elements of a Conceptual Site Model for Monitored Natural Attenuation



Geologic Block Diagram and Cross Section Depicting a Stream Environment in which Sediments Have Accumulated as Valley Fill

Monitoring Network Design

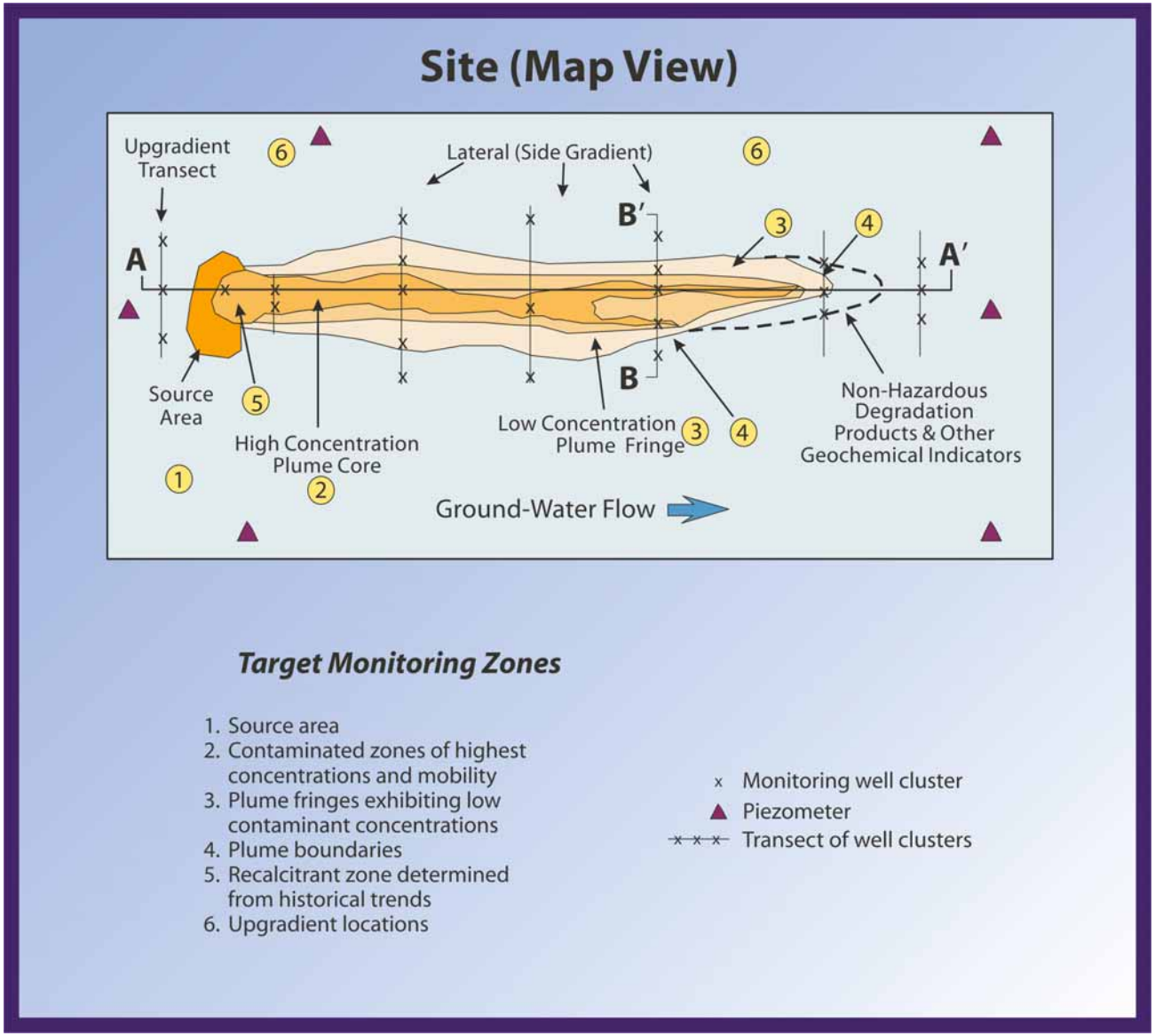
- May be different than the network established during earlier phases of site characterization, feasibility studies, or interim actions.
- The number and locations of existing wells may not be well suited for MNA performance monitoring.
- The network should be designed to provide data to demonstrate attainment of all the remedial action objectives MNA

Monitoring Network Design

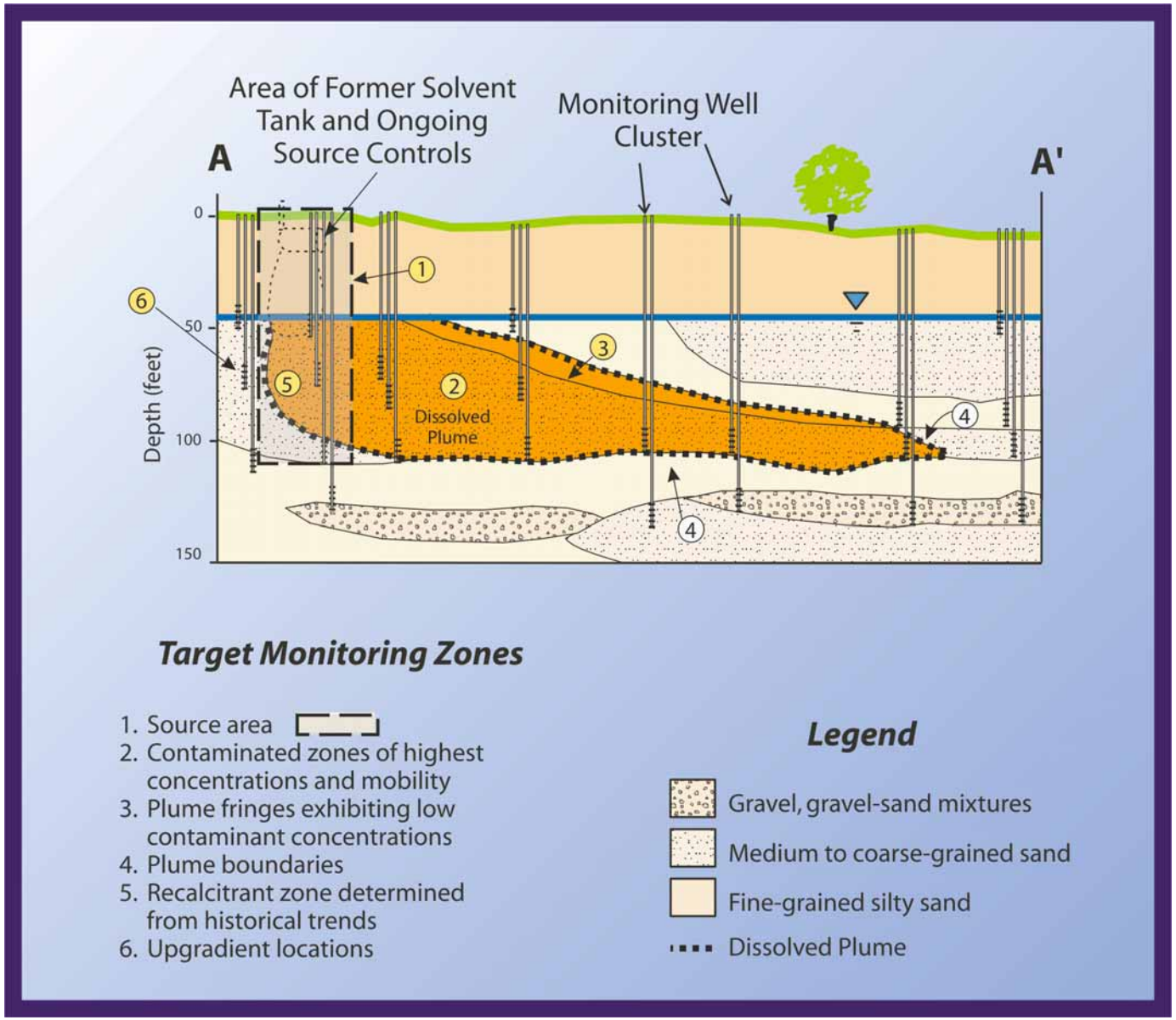
- The density of sampling points depends on geology, hydrology, 3-D spatial scales, temporal scale, and desired level of confidence.
- Plumes often vary in concentration in transverse and horizontal cross sections.

Monitoring Network Design

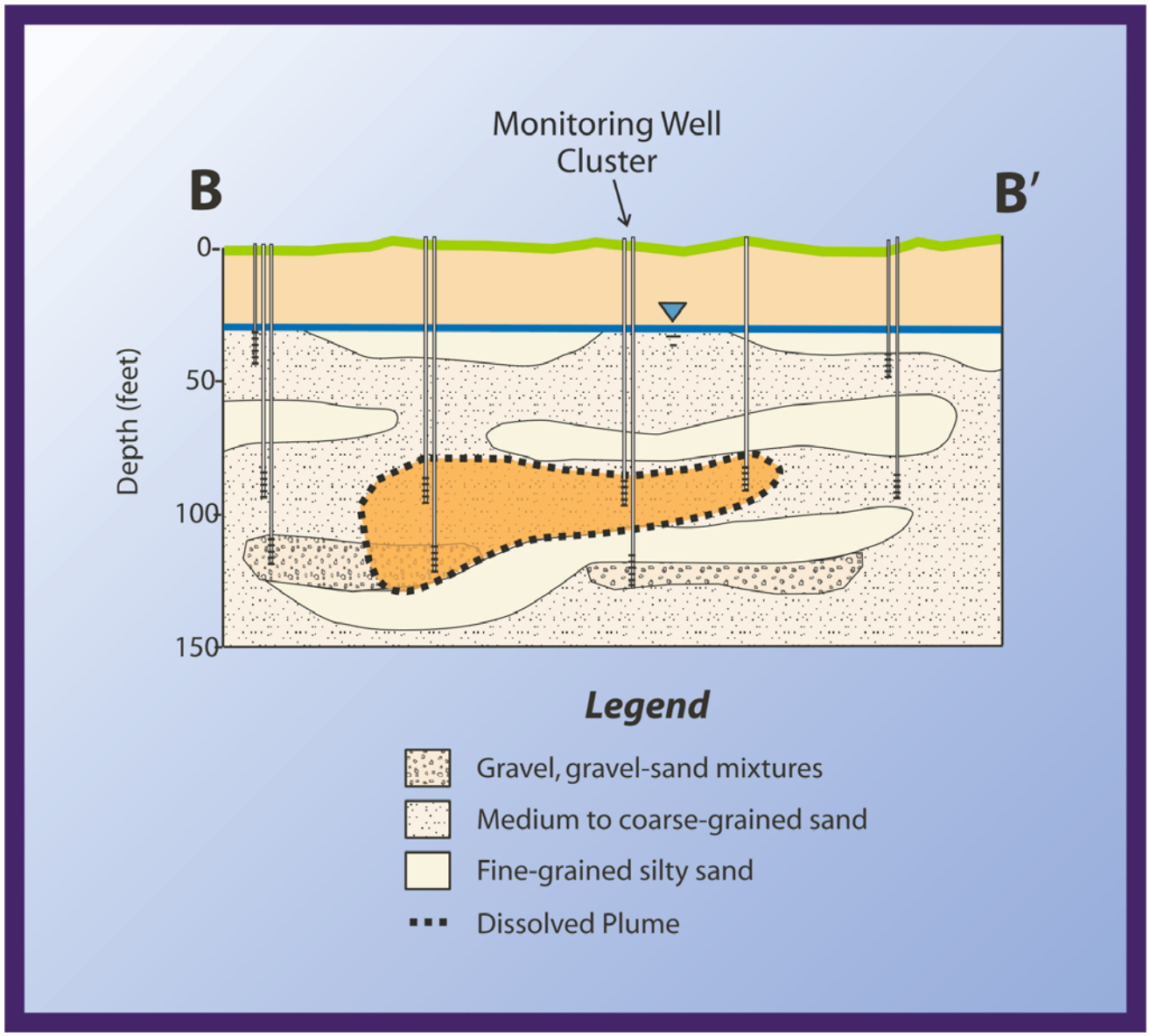
- Clustered monitoring points in transects across and through the plume, perpendicular to the direction of ground water flow can be used.



Example of a Network Design for Performance Monitoring



Cross Section A-A' through Monitoring Network in General Direction of Ground-Water Flow



Cross Section B-B’ through Monitoring Network Perpendicular to Ground-Water Flow

Monitoring Frequency

…affects the ability to:

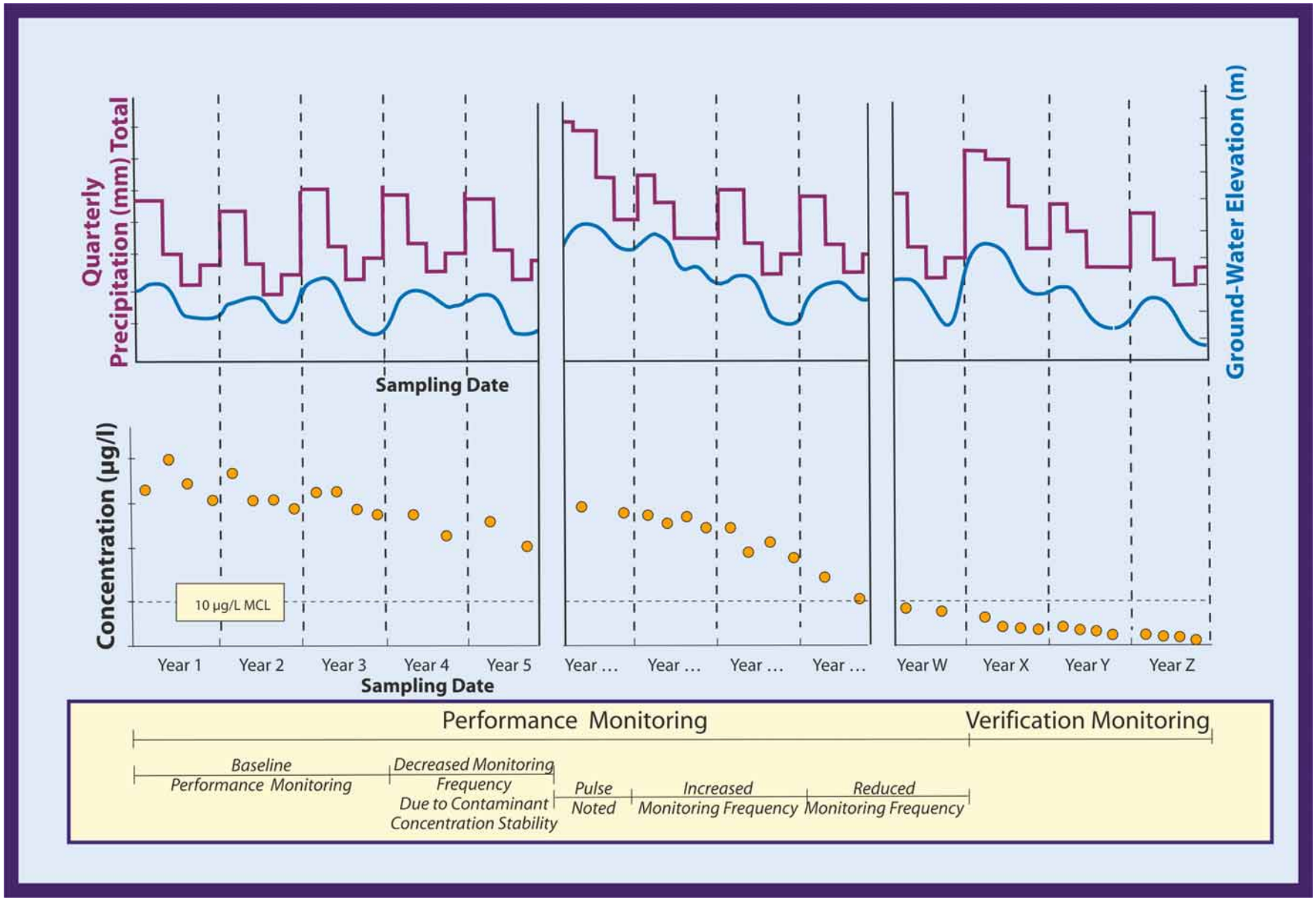
- Provide timely warning of impact to receptors,
- Detect contaminant releases that warn of possible plume expansion
- Detect changes in plume size, shape
- Determine temporal variability of data

Monitoring Frequency

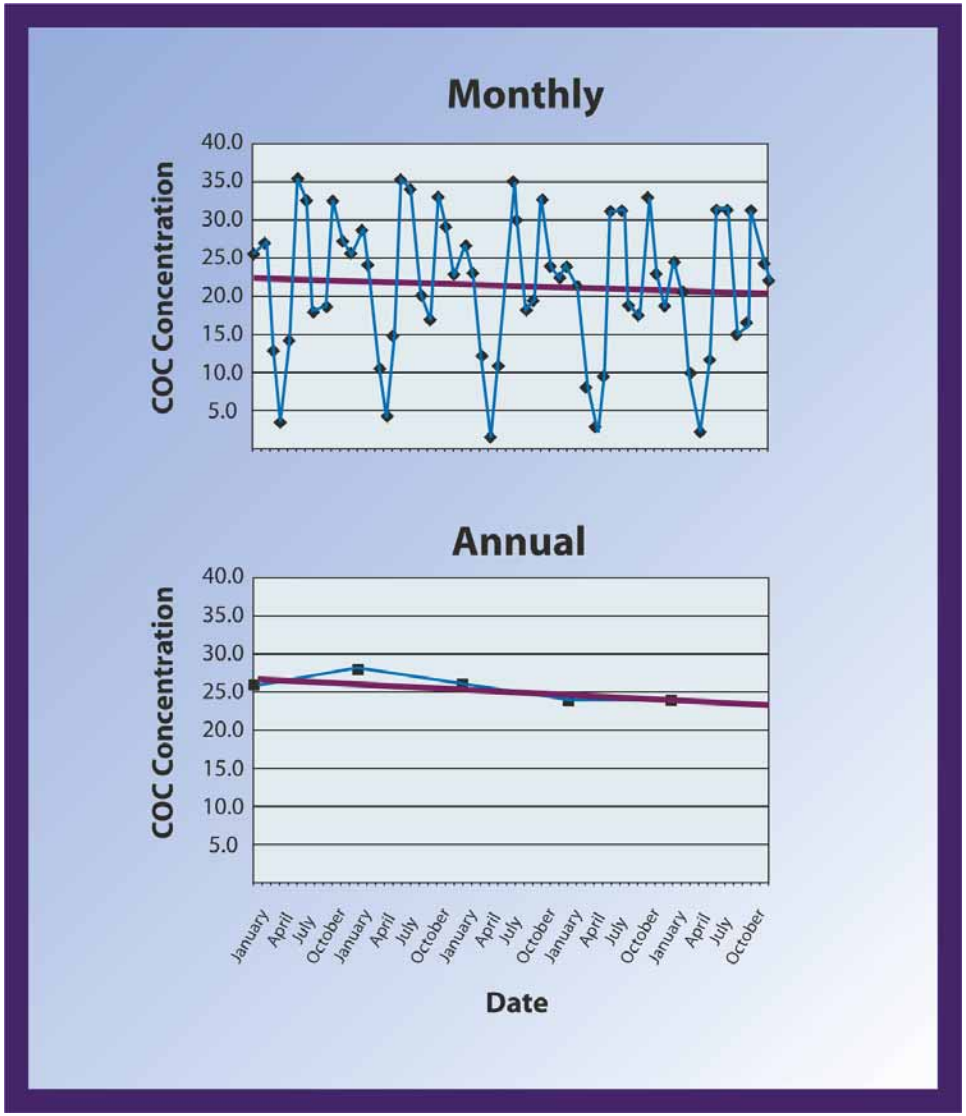
- Detect changes in geochemistry that warn of changes in attenuation, and
- Yield data necessary to reliably evaluate progress toward contaminant reduction objectives

Monitoring Frequency

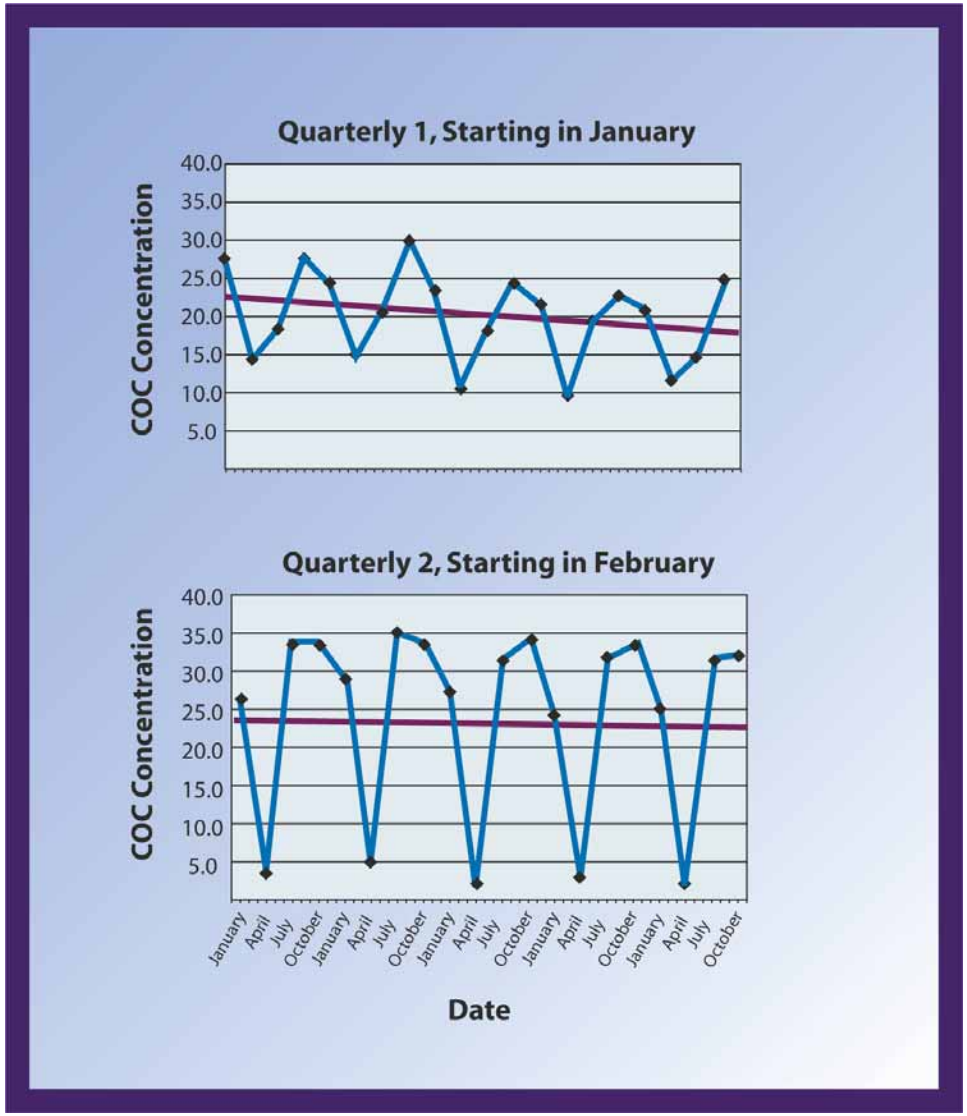
- Several years of monitoring data are typically necessary for estimation of site variability and expected rates of changes in ground water flow, contaminant concentrations, and geochemistry.
- Increases and decreases in monitoring frequency may occur several times over the life of the remedy in response to changes in site conditions and monitoring needs.



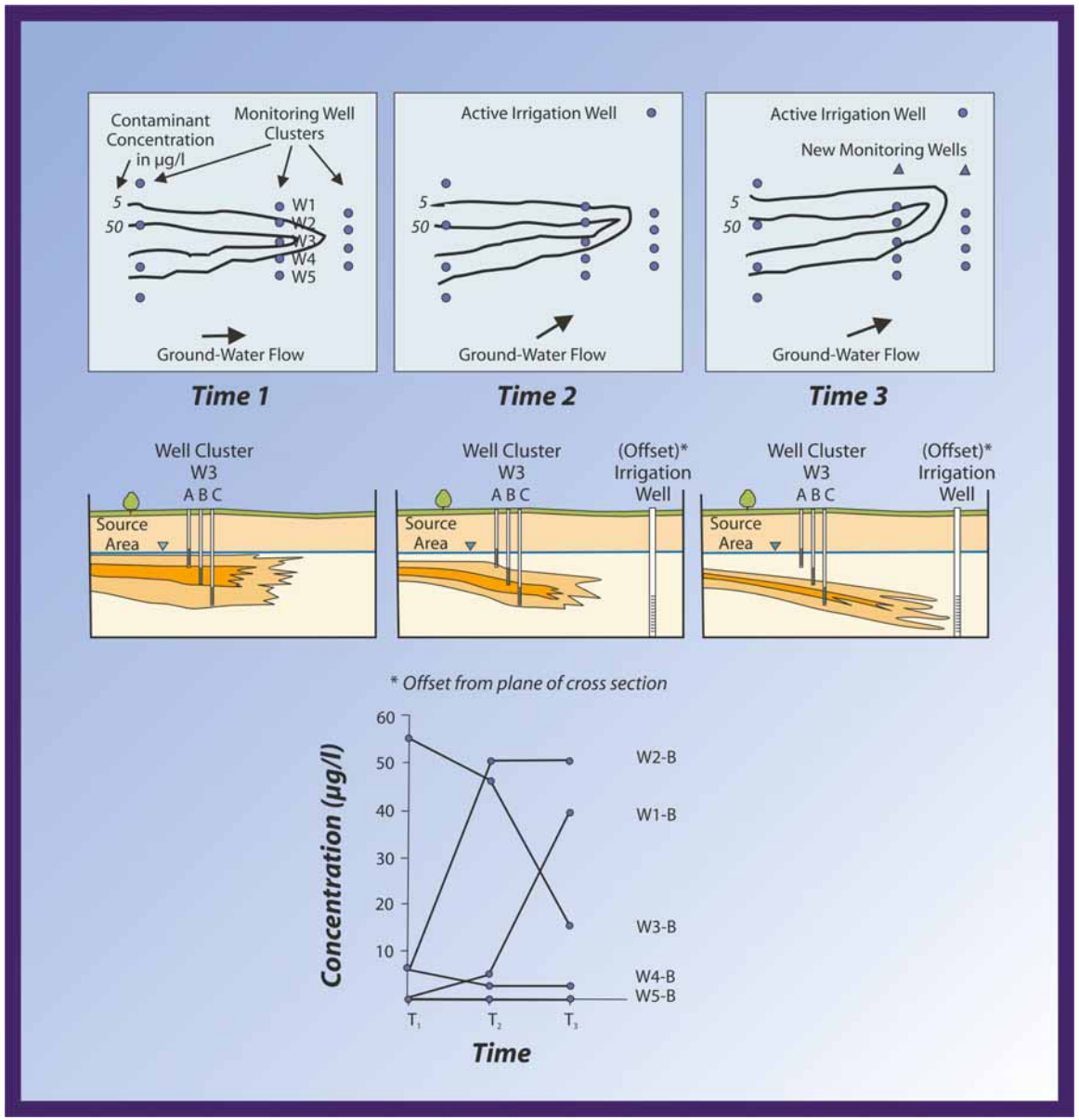
Examples of Possible Changes in Monitoring Frequency Over the Monitoring Life Cycle



Monitoring Frequency Effects on Sampling Data Collection and Interpretation (Monthly/Annual)



Monitoring Frequency Effects on Sampling Data Collection and Interpretation (Quarterly)



Potential Effects of Changes in Ground-Water Flow Direction on Temporal Trends in Contaminant Concentrations

Estimation of Contaminant Mass Reduction

- Data from transects may be used to estimate contaminant flux within the plume, and mass loss along the plume axis.
- These transects provide 3-D cross sections of contaminant distribution.
- If used with hydrogeologic data, contaminant mass flux through each cross section can be calculated.

Analysis of Performance Monitoring Data

Data interpretation involves 4 basic steps of the data quality assessment (DQA) process:

1. Placing the data in context of time, location, sampling and analytical methods,
2. Preliminary assessment of the data with basic statistical measures, and graphs, charts, maps, time-series plots, and cross-sections,

Analysis of Performance Monitoring Data

3. Applying appropriate statistical tests to detect changes, trends, and assess attainment of goals, and
4. Making Decisions based on the data.

Analysis of Performance Monitoring Data

Particular changes of interest include:

- Changes in ground water flow rates or directions that indicate contaminants may move farther downgradient, laterally or vertically into previously unimpacted areas,
- Changes in contaminant concentrations within the plume, may indicate new releases or changes in attenuation rates,

Analysis of Performance Monitoring Data

- Detection of contaminants outside the known plume or other compliance boundaries,
- Changes in geochemistry that may indicate changes in attenuation rates, such as changes in availability of electron donors and acceptors, changes in ORP, other geochemical indicators, or changes in sorption characteristics.

Reporting

- The guidance provides a discussion and presents examples of what should be in a monitoring plan and what should be in a monitoring report.

Where you can find it

On the web at:

http://www.epa.gov/ada/publications.html