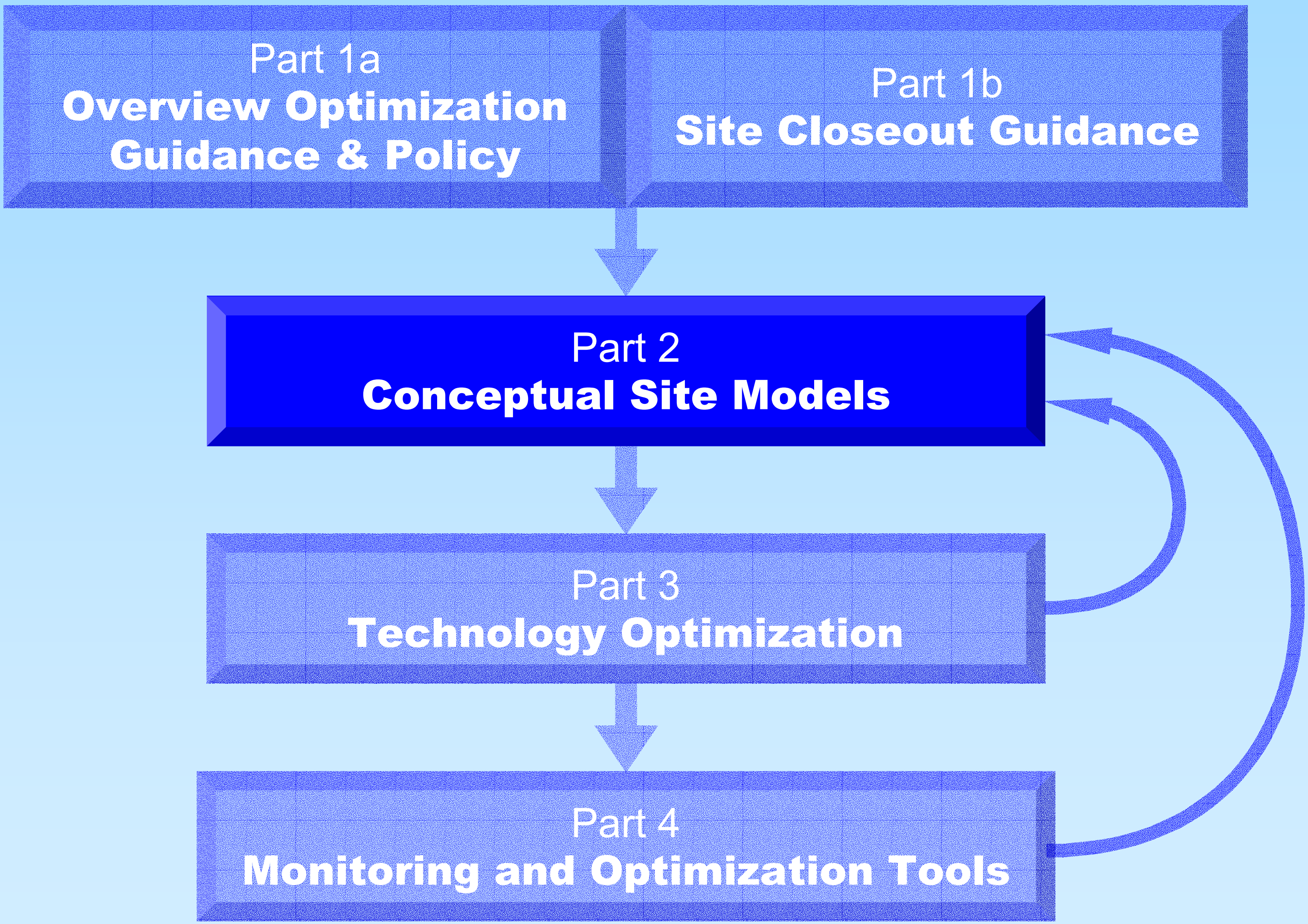
Part 2: Conceptual Site Models

J. Mark Nielsen, P.E.

Battelle Memorial Institute

RITS Spring 2004: Optimization of Remedial Actions



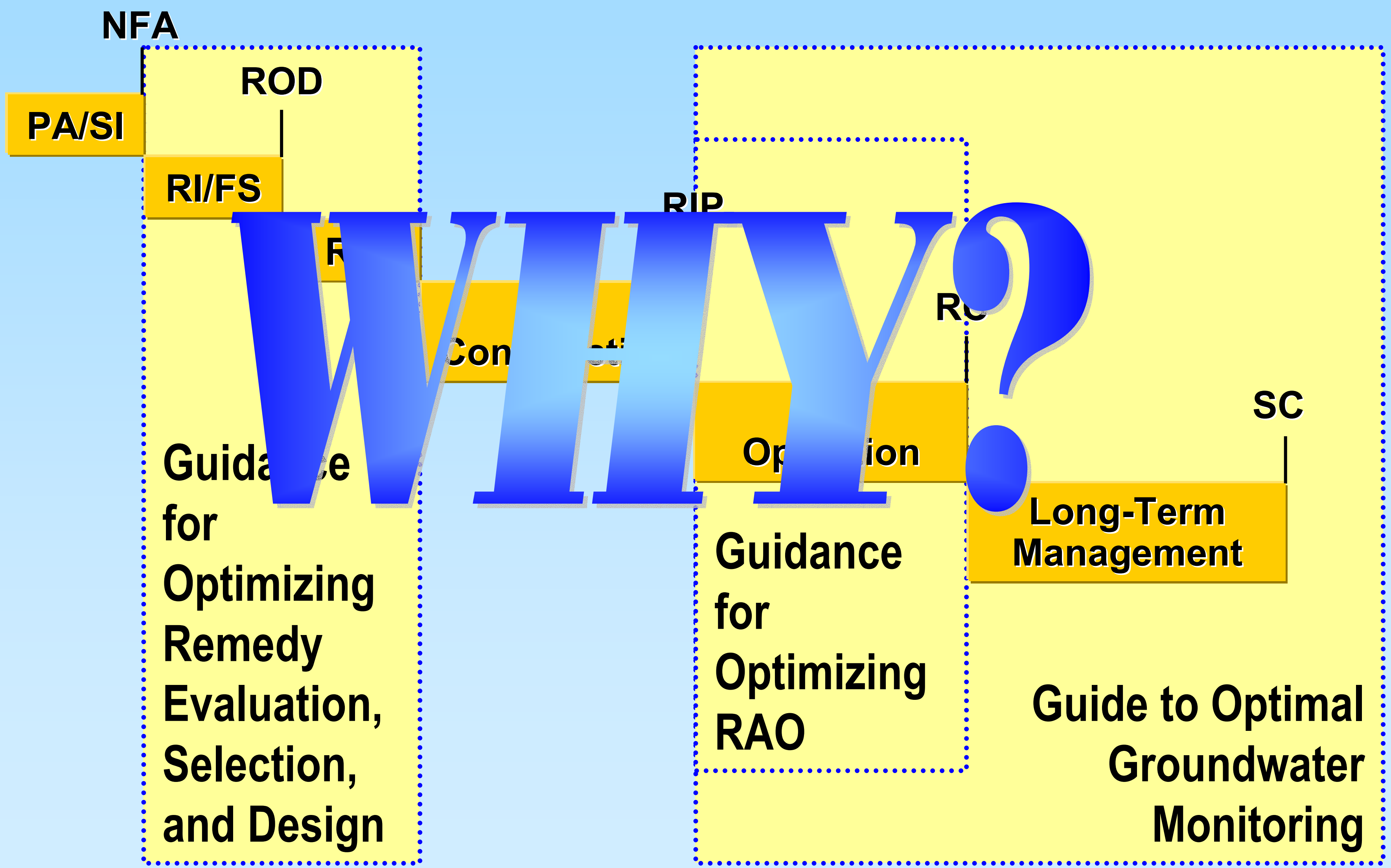
Presentation Focus

1. Importance of developing the CSM to establish a common understanding of project issues and goals
2. Use of the innovative approaches for developing a CSM, reducing costs and accelerating site closures
3. Role of a well developed & current CSM in the remedy optimization process to make educated decisions that reduce or eliminate the need for remediation expenditures

Presentation Overview

- Introduction
- CSM Development
- Triad
- CSM Development Case Study: NJ Superfund Site
- Role of the CSM in Focusing Remedial Goals
  - Remedial Action Objectives
  - Target Treatment Zones
  - Performance Objectives
- Remedial Goal Case Study: NJ Superfund Site
- Summary

Conceptual Site Models



Conceptual Site Models – Optimization Guidance

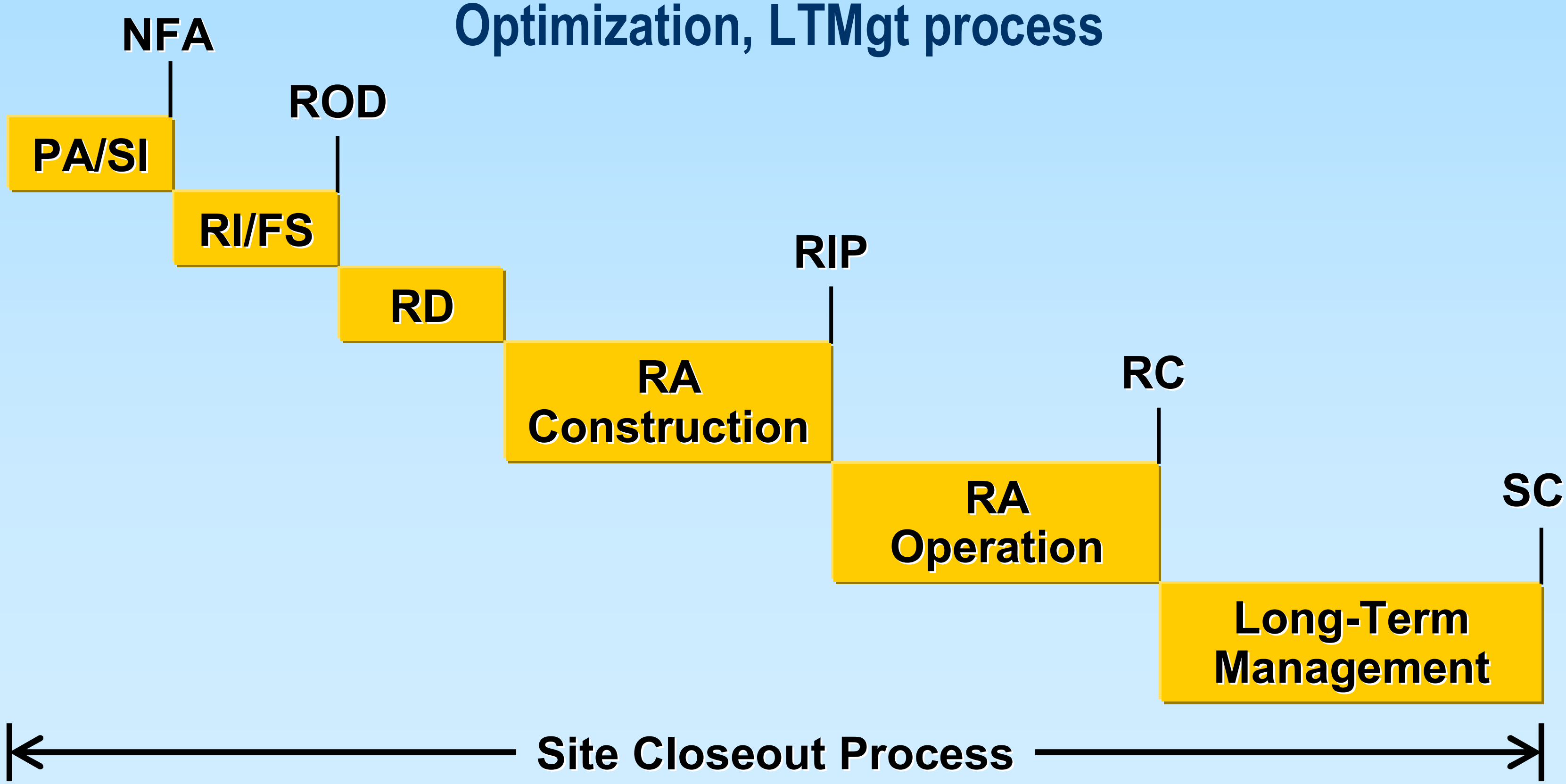
Guidance for Optimizing Remedy Evaluation, Selection, and Design, Interim-final due out in 2004 "Optimization Checklist"	Guidance for Optimizing Remedial Action Operation, Interim-Final, April 2001 "Optimization Process Steps"	Guidance for Optimal Groundwater Monitoring, January 2000 "Optimization Questionnaire"
√ **Conceptual Site Model [see Section 2.1]**	**Step 1: Review & Evaluate Remedial Action Objectives [see Section 3]**	**What is the Goal of the Monitoring Program? [see Section 2]**
√ **Remedial Action Objectives [see Section 2.2]**	Step 2: Evaluate Remediation Effectiveness [see Section 4]	**Where Should I Monitor? [see Section 3]**
√ **Target Treatment Zones [see Section 2.3]**	Step 3: Evaluate Cost Efficiency [see Section 5]	How Often Should I Monitor? [see Section 4]
√ Treatment Train [see Section 2.4]	**Step 4:Identify Remediation Alternatives [see Section 6]**	**What Contaminants Do I Need to Monitor For? [see Section 5]**
√ **Performance Objectives [see Section 2.5]**	Step 5: Develop & Prioritize Optimization Strategies [see Section 7]	How Should I Collect the Samples? [see Section 6]
√ **Optimization & Exist Strategy [see Section 2.6]**	Step 6: Prepare Optimization Report [see Section 8]	How Do I Evaluate & Present My Data? [see Section 7]
	Step 7: Implement Optimization Strategy [see Section 9]	**How Can I Ensure Regulatory Acceptance? [see Section 8]**

The Conceptual Site Model

- What is a CSM?
  - A written, graphical, or pictorial summary of site conditions
  - Used to support decisions for scoping site characterization, risk assessment, and remediation activities

When Should the CSM Be Prepared?

- Early in the IR process (develop as part of the RI Work Plan/RFI Work Plan)
- CSM should evolve during the IR process as data are collected
  - A common element throughout the Navy's RD, RAO Optimization, LTMgt process



Utility of the CSM

- Provides an overview of the “big picture”
- Guides critical decisions during the IR process
  - Types and locations of data to be collected
  - Criteria to be used to identify a “significant” release (in terms of risk to potential receptors)
  - Contaminants/media that warrant treatment and/or removal (i.e., to define Target Treatment Zones)
  - Remedial action objectives to achieve site closeout

Utility of the CSM (cont.)

Basis for Risk-Based Decision-Making

- Risk Assessment
  - The process of characterizing the nature and probability of adverse health effects of human exposure to environmental hazards. Risks need to be understood in advance of exposure.
- Risk Management
  - The process of evaluating and selecting among alternative regulatory actions.

Two Views on the Same Project

The project team and the community see things differently.

Gain Understanding and Buy-in from Stakeholders

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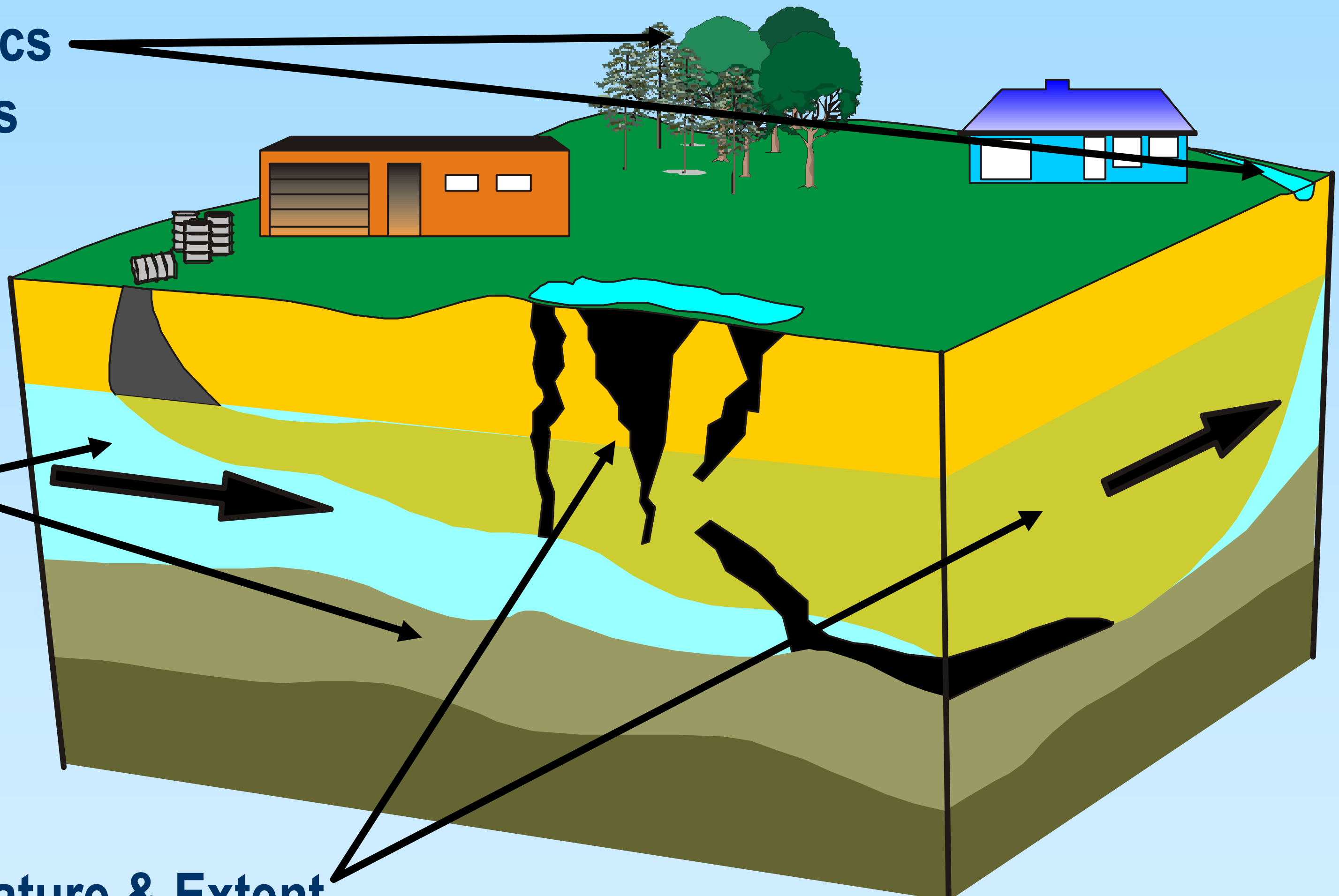
Key CSM Components

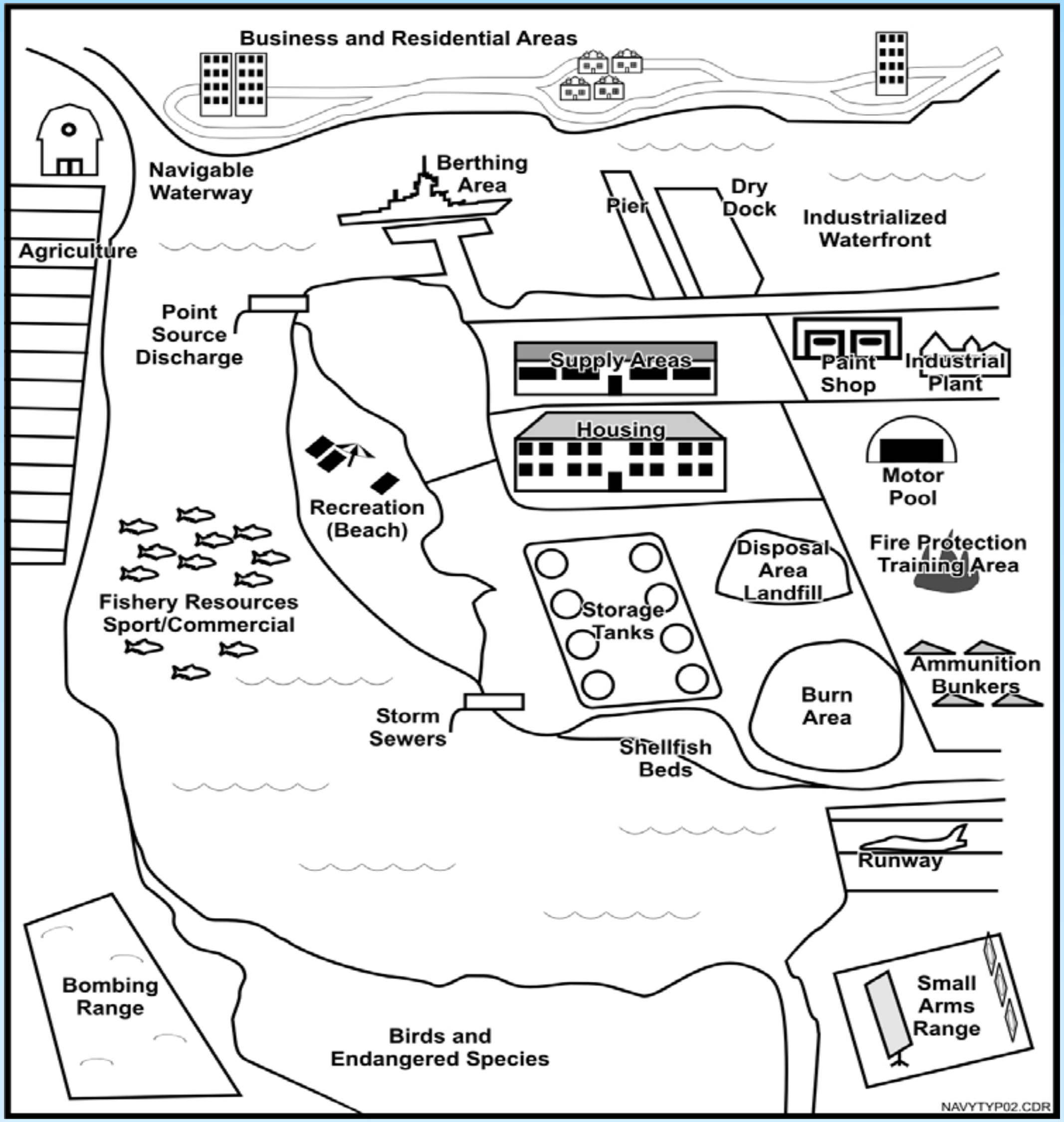
Site Characteristics & Receptors



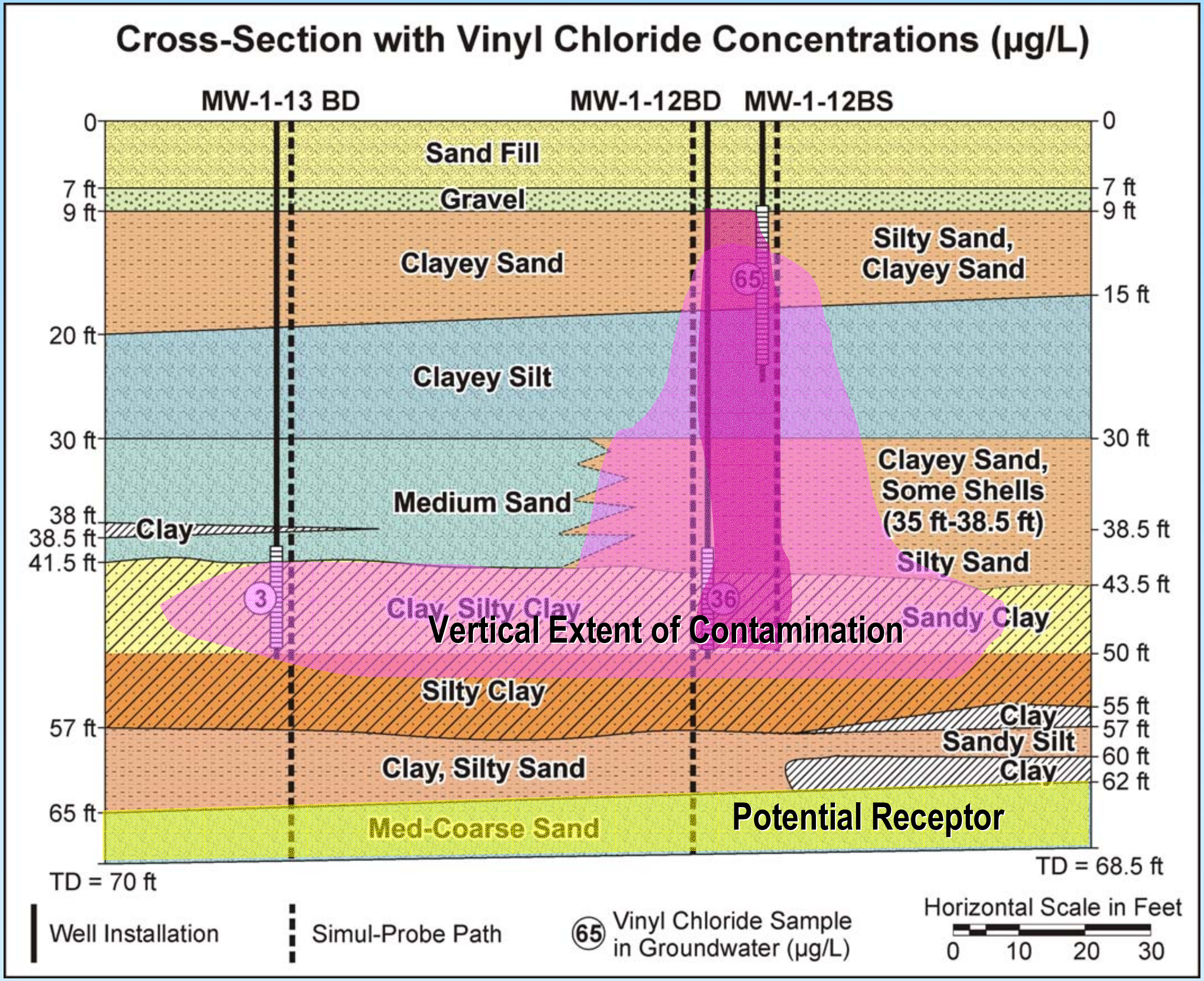
Geology & Hydrogeology

Contaminant Nature & Extent

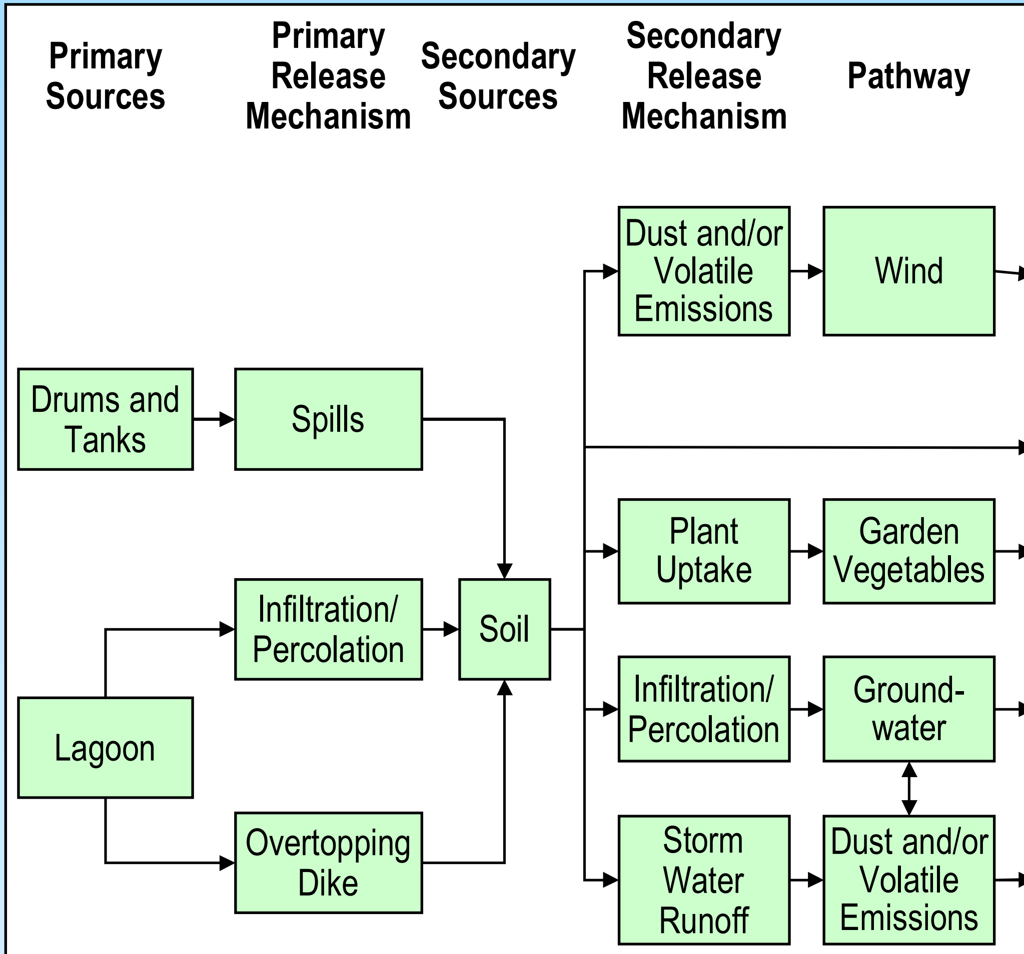
CSM Format: Schematic Highlights Characteristics of Site and Surrounding Area



CSM Format:
Cross-Section Highlights Geology & Hydrogeology



CSM Format: Source-Pathway-Receptor Matrix Presents Linkage between Sources and Receptors



Receptor

	Human		Biota	
Exposure Route	Area Residents	Site Trespassers	Terrestrial	Aquatic
Ingestion				
Inhalation	•	•	•	
Dermal Contact				
Ingestion	•	•	•	
Dermal Contact	•	•	•	
Ingestion	•			
Ingestion	•			
Inhalation	•			
Dermal Contact	•			
Ingestion	•	•	•	•
Inhalation				
Dermal Contact	•	•	•	•

(Source: U.S. EPA Soil Screening Guidance, 1996)

CSM Format: Tables Detail Potential Exposure Scenarios

Scenarios for Potential On-Facility Human Exposure					
Exposure Area & Exposure Point(s)	**Receptor Population**	**Exposure Route**	**Exposure Medium**	**Possible Currently**	**Possible in Future**
			On-Facility		
On-Facility	Routine Workers	ingestion and dermal contact	surface soil	No	Yes
		inhalation	particulates in air from surface soil	No	Yes
		inhalation	vapor released to ambient air from soil (surface and subsurface) and groundwater	No	Yes
		inhalation	vapor intrusion to indoor air from soil (surface and subsurface) and groundwater	Yes	Yes
	Trespassers	ingestion and dermal contact	surface soil	No	Yes
		inhalation	particulates in air from surface soil	No	Yes
		inhalation	vapor released to ambient air from soil (surface and subsurface) and groundwater	No	Yes
	Occasional Excavation/Maintenance Workers	ingestion, dermal contact and inhalation	surface and subsurface soil	Yes	Yes
		ingestion, dermal contact and inhalation	groundwater	Yes	Yes
		ingestion, dermal contact and inhalation	surface water (storm sewer system)	Yes	Yes

Building a CSM

- Begin with the End in Mind – what data are needed to identify contamination, remediation goals, and final cleanup verification
- Consider complete exposure pathways to establish data needs, for example:
  - Direct contact/drinking water/domestic use – water use survey
  - Groundwater discharge to surface water – is there a connection
  - Soil leaching to groundwater – vertical depth of contamination/depth to groundwater
- Consider key site characteristics, for example, hydrogeology:
  - Identify and target groundwater resource units
  - Characterize influence of artificial features (e.g., sewers & basements)
  - Establish flow direction early in process to minimize well installation
  - Collect data potentially needed for remedial measures (aquifer hydraulic parameters, MNA/geochemistry)

Building a CSM – Land Use Policy

- DON Policy: Relative to land use controls and institutional controls, the ROD shall:
  - Describe the risk(s) necessitating the remedy including LUCs;
  - Document risk exposure assumptions and reasonably anticipated land uses; and
  - Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications
- U.S. EPA Policy:
  - The assumption of future residential land use is not a requirement
  - Realistic future land use assumptions allow the baseline risk assessment and the feasibility study to focus on the development of practicable and cost-effective remedial alternatives

Building a CSM – Determination of Reasonably Anticipated Future On-Site Land Use

United Efforts Strengthen Cleanups – Partnering Makes a Difference

- Base Master Plans
- Community Land Use Resources
  - Current land use around site
  - Zoning laws and zoning maps
  - Comprehensive community master plans
  - Population growth patterns and projections
- Accessibility of site to existing infrastructure
- Institutional controls currently in place
- Proximity to urban, residential, commercial, industrial, agricultural, and recreational areas

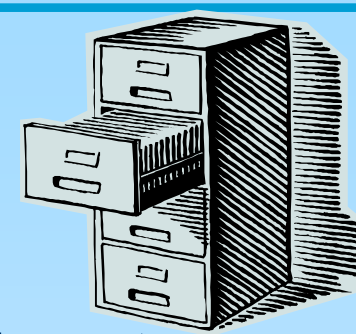
Building a CSM – Groundwater Use Policy

- U.S. EPA Expectations For Groundwater Remediation
  - Return usable groundwaters to their beneficial uses wherever practicable
  - Generally, drinking water standards should not be chosen as preliminary remediation goals (PRGs) for groundwaters that are not current or potential future sources of drinking water
  - In some cases, a longer time frame for achieving restoration cleanup levels [and] less aggressive remediation methods and/or more passive remediation approaches should be considered

Building a CSM – Determination of Reasonably Expected Future Groundwater Use

- Natural groundwater quality and historical use
- Current & reasonably expected future use of groundwater
- Consistency with future on-site and off-site land use
- Regulations governing installation and operation of community and private water supply wells
- State groundwater classification system and groundwater quality standards
- State and local wellhead protection plans

Building a CSM – Use of Existing Data



- Organize and analyze existing site data
  - Identify known sources of contamination
  - Identify affected media
  - Identify potential migration routes, exposure pathways and receptors
  - Identify Data Gaps

- Existing data considerations & DQOs
  - Why were the data collected?
  - Are the sampling locations & depths appropriate?
  - Is the analyte & methods list appropriate?
  - Have conditions changed since prior data were collected?
  - Are there sufficient data to obtain reliable estimates of “exposure concentrations”?

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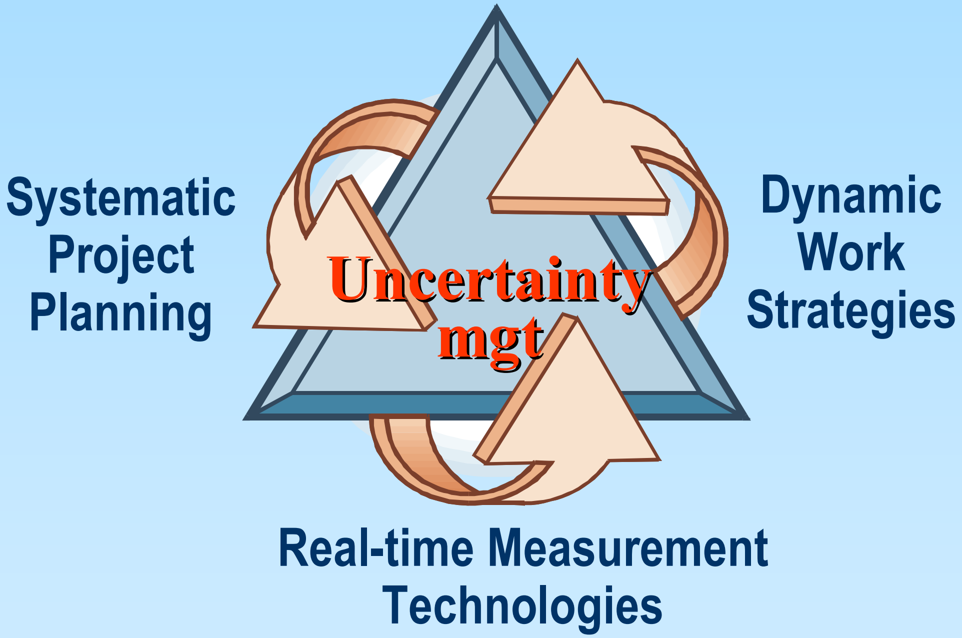
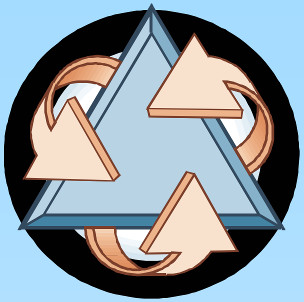
Building a CSM – Efficient Data Collection

- How do we efficiently gather data necessary to fill data gaps and develop an effective CSM?
- U.S. EPA Triad Approach
  - A streamlining strategy for managing decision uncertainty while reducing costs and accelerating site closures
  - Triad approach incorporates three elements:
    - Systematic Planning
    - Dynamic Work Strategies
    - Real-time Measurement Systems



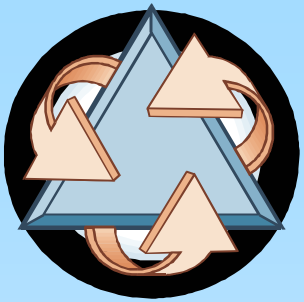
- DON's approach to optimization of ER process is generally consistent with U.S. EPA's Triad approach to streamlining characterization and remediation activities

Central Themes of Triad



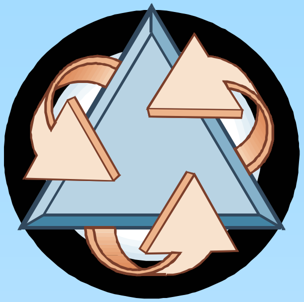
- Manage uncertainty
  - Establish clear project goals & decisions
  - Identify unknowns
  - Communicate
- Change paradigm to reduce cost & time
  - Utilize dynamic decision strategies
  - Promote use of real-time measurement technologies
- Broad applicability

Building a CSM – Efficient Data Collection



- Systematic Planning
  - Most important element of the Triad – systematic project planning
  - Form a comprehensive project team for the complete project
  - Establish clear objectives for work
  - Identify sources of uncertainty (incl. matrix heterogeneities)
  - Establish quality control program
- A key element of the Triad approach is the development of an accurate CSM to avoid inefficient use of resources
- Consider potential need for remedial actions at the earliest possible stage to provide for critical data collection

Building a CSM – Efficient Data Collection



- Dynamic Work Plans
  - Provide clear decision logic to enable field teams to change or modify site activities as required to achieve project objectives in the face of "field discoveries"
  - Designed as part of systematic planning so that on-site decisions can be made in real-time, most often through the application of field analytics.
  - Should result in faster, better more cost effective site characterization and cleanup.

Building a CSM – Efficient Data Collection

- **Real-Time Measurement and Interpretation**
  - Provides rapid feed-back of information needed for timely decision making
  - Within the Triad approach, "real-time" techniques are defined in terms of those sampling, analytical, and data review, interpretation, and management tools capable of meeting the needs of real-time decision-making.
  - Many advances have been made in the development of field-portable instrumentation, more efficient sample collection, and high density, *in situ* detection techniques
  - Requires clear understanding of QC requirements (e.g., data for CSM building/spatial delineation vs quantitative applications)

Collaborative Data Sets

Cheap screening analytical methods

↓

High spatial density

↓

Manages sampling uncertainty & builds the CSM

Costly definitive analytical methods

↓

Low DL + analyte specificity

↓

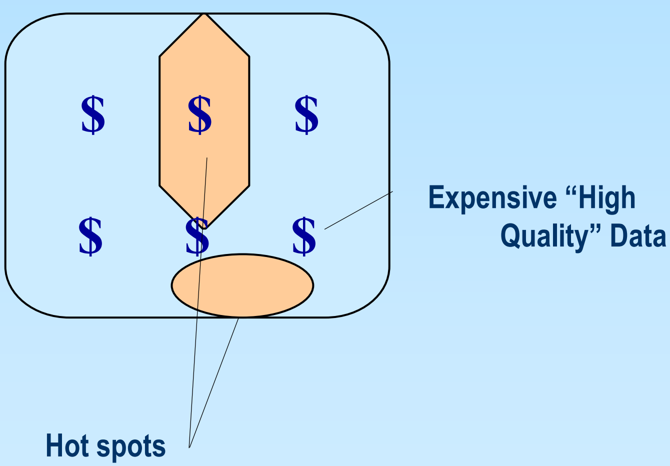
Manages any residual analytical uncertainty

Use collaboratively to manage both components of data uncertainty

Collaborative Data Sets – Example

Perfect analytical chemistry ≠ Data Quality

From this…



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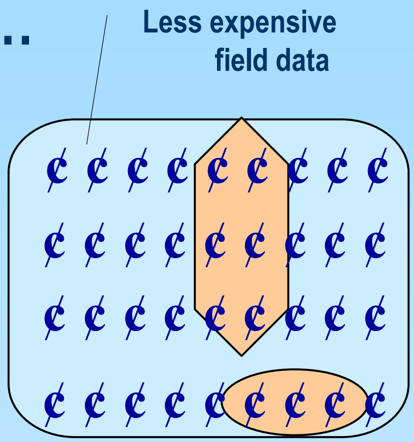

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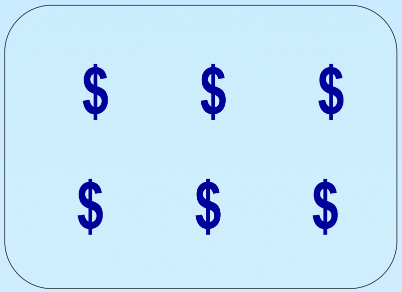
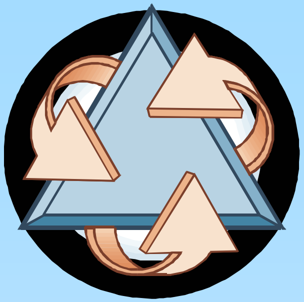


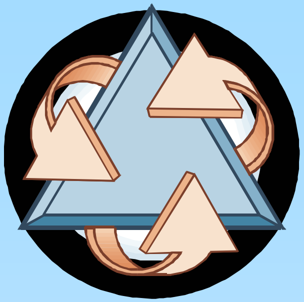
(based on U.S. EPA 2001)

Observations



- Reluctance to use Triad because of perceived uncertainty regarding regulatory acceptance
  - ITRC Triad guidance available
  - EPA SF guidance available for aspects of Triad
- Triad techniques require more strategic thinking than conventional approaches (i.e., decision logic, action levels for field instruments, interactive testing of CSM) <u>and</u> trust between responsible party and regulatory reviewer
- Triad approach complements Navy optimization strategy to reduce risk, cost, time and uncertainty

Summary



- Because of resistance to change, involve stakeholder community from the beginning of any project
- Importance of obtaining contaminant concentration data of known quality cannot be underestimated. However, exclusive focus on analytical quality alone disregards other equally important considerations.
- Changes in process:
  - Better initial determination of investigation objectives
  - Better use of CSMs during planning & project decision-making
  - Early agreement by all project team members and stakeholders on acceptable action concentrations
  - Use of techniques to evaluate data uncertainty (esp. sampling)
  - Real-time management & analysis of data

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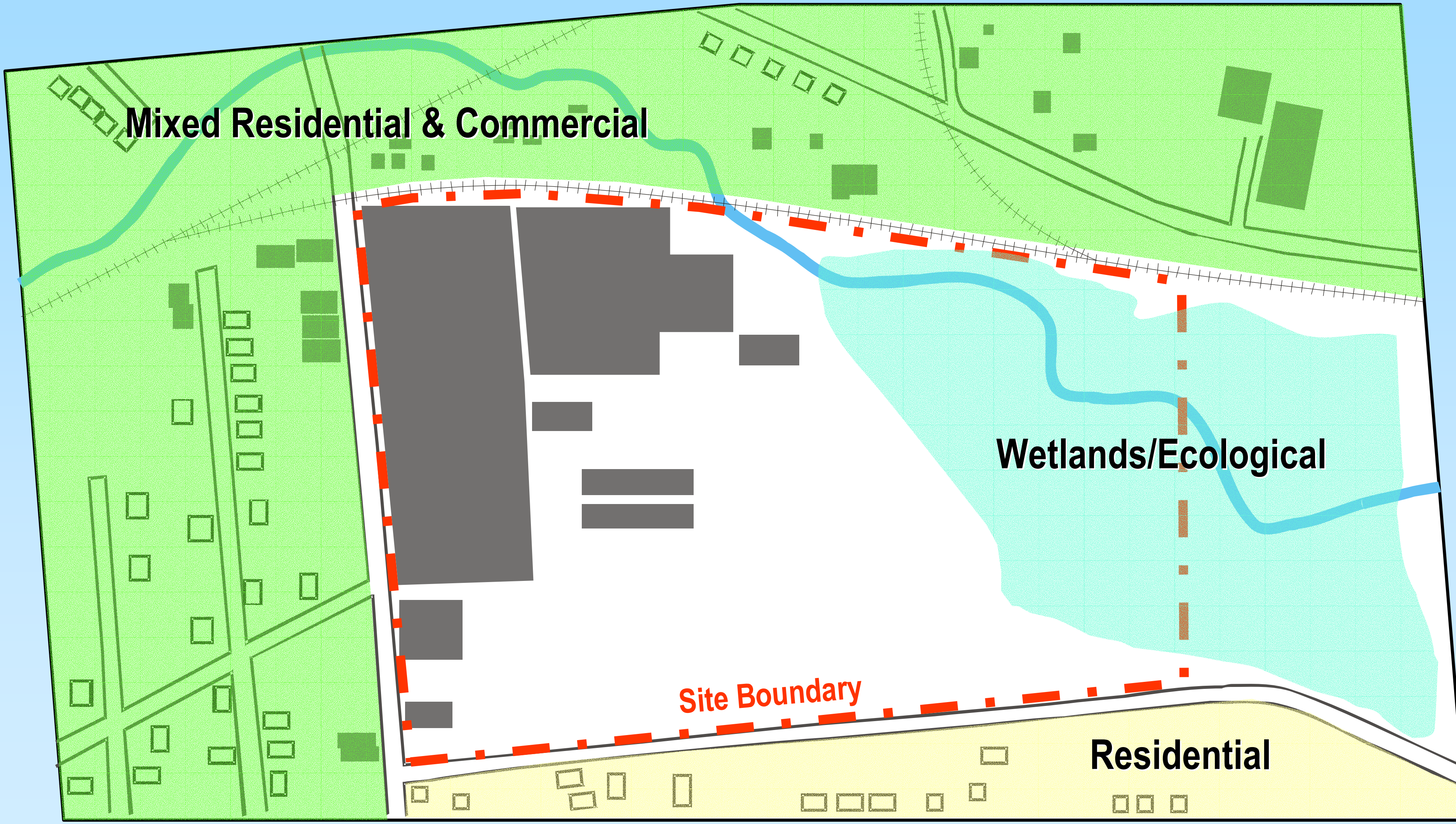
Case Study: New Jersey Superfund Site

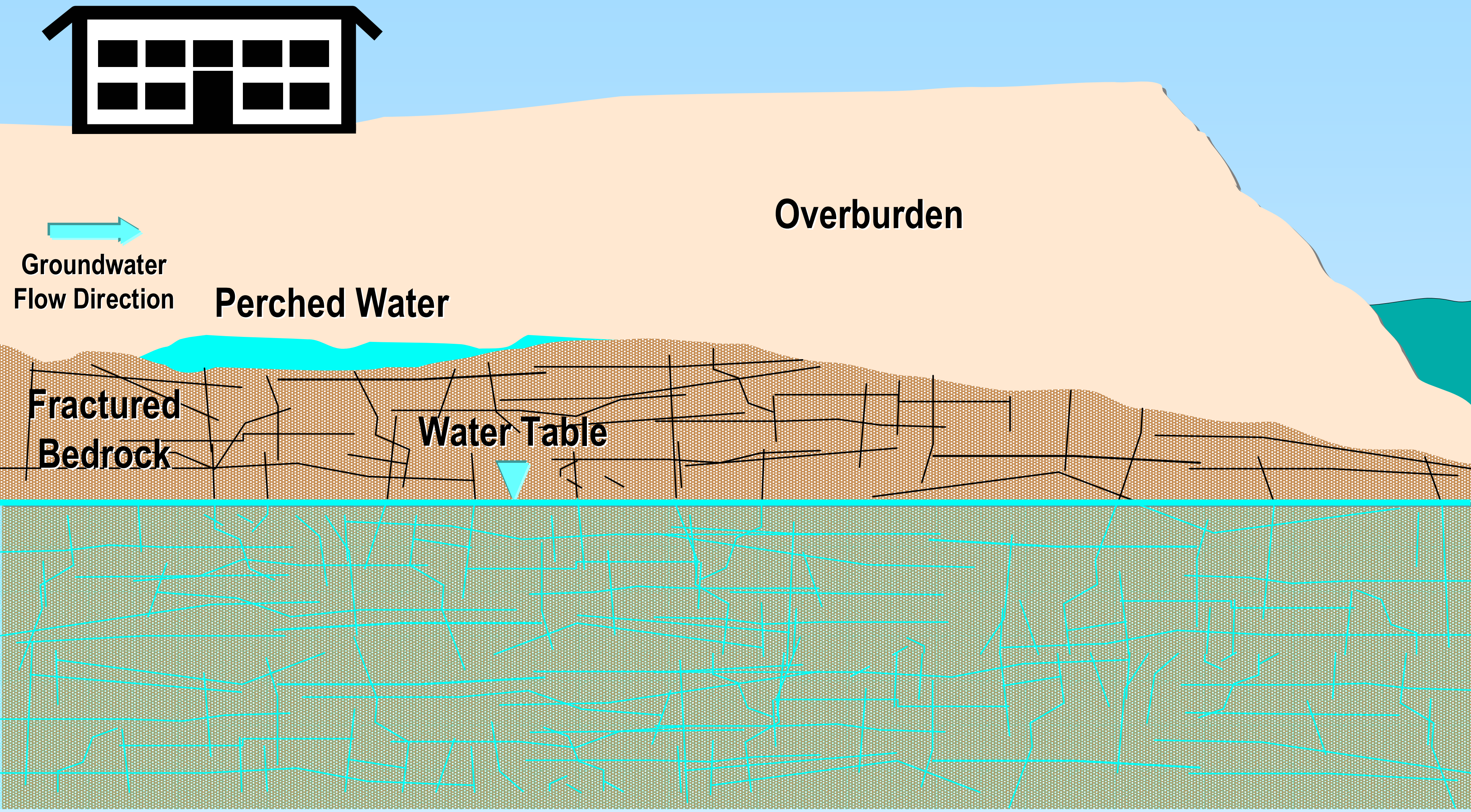
- Manufacturing facility located within the town center
  - 20+ acre property, with an approximately 50% developed portion
  - Originally developed in early 1900s
  - Surrounded by mixed residential/commercial properties on the end of the town's business district
- Site activities resulted in contamination of site soils, sediments, and groundwater
  - Contamination includes PCBs, semivolatile and volatile organic compounds, and metals
  - Buried debris was also encountered in the undeveloped portion of the property
- Characterized by the community as:
  - An under-used and blighted property that has never been a major source of tax revenue
  - Having the potential to provide useful and valuable land contributing to the public health, safety, and welfare

Aerial Photo

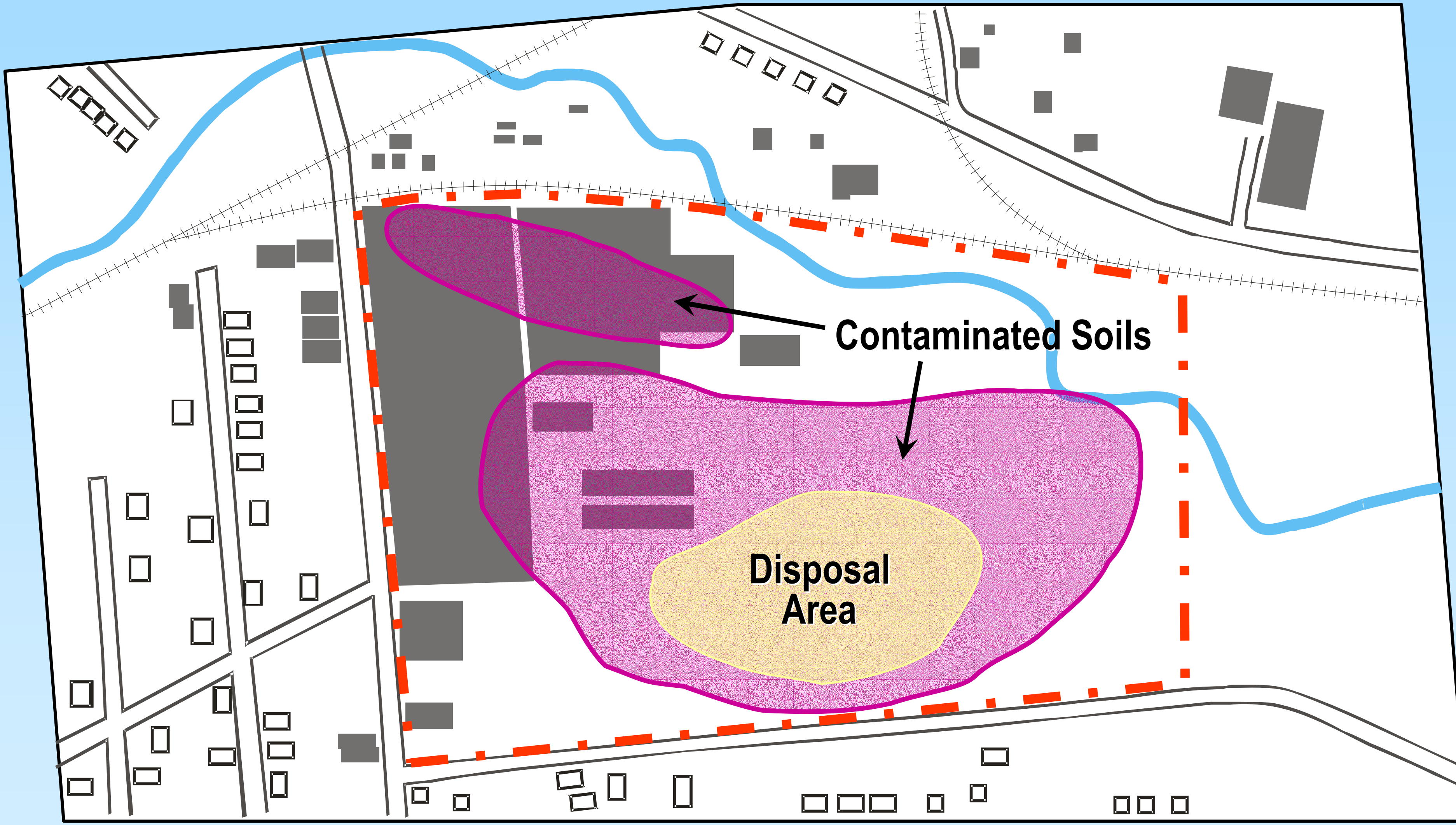
Site Plan


Mixed Residential & Commercial
Wetlands/Ecological
Site Boundary
Residential

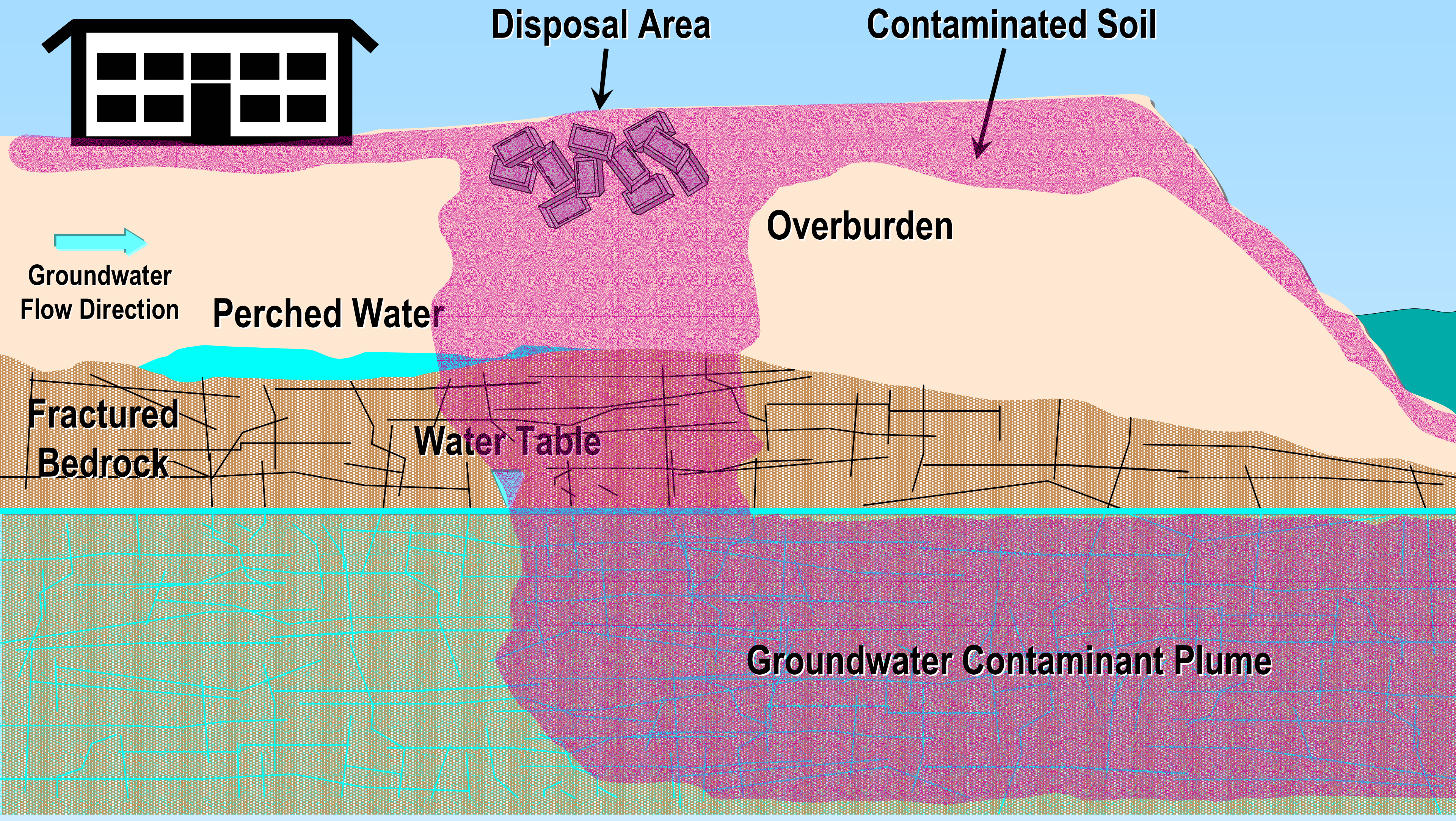
Cross-Section



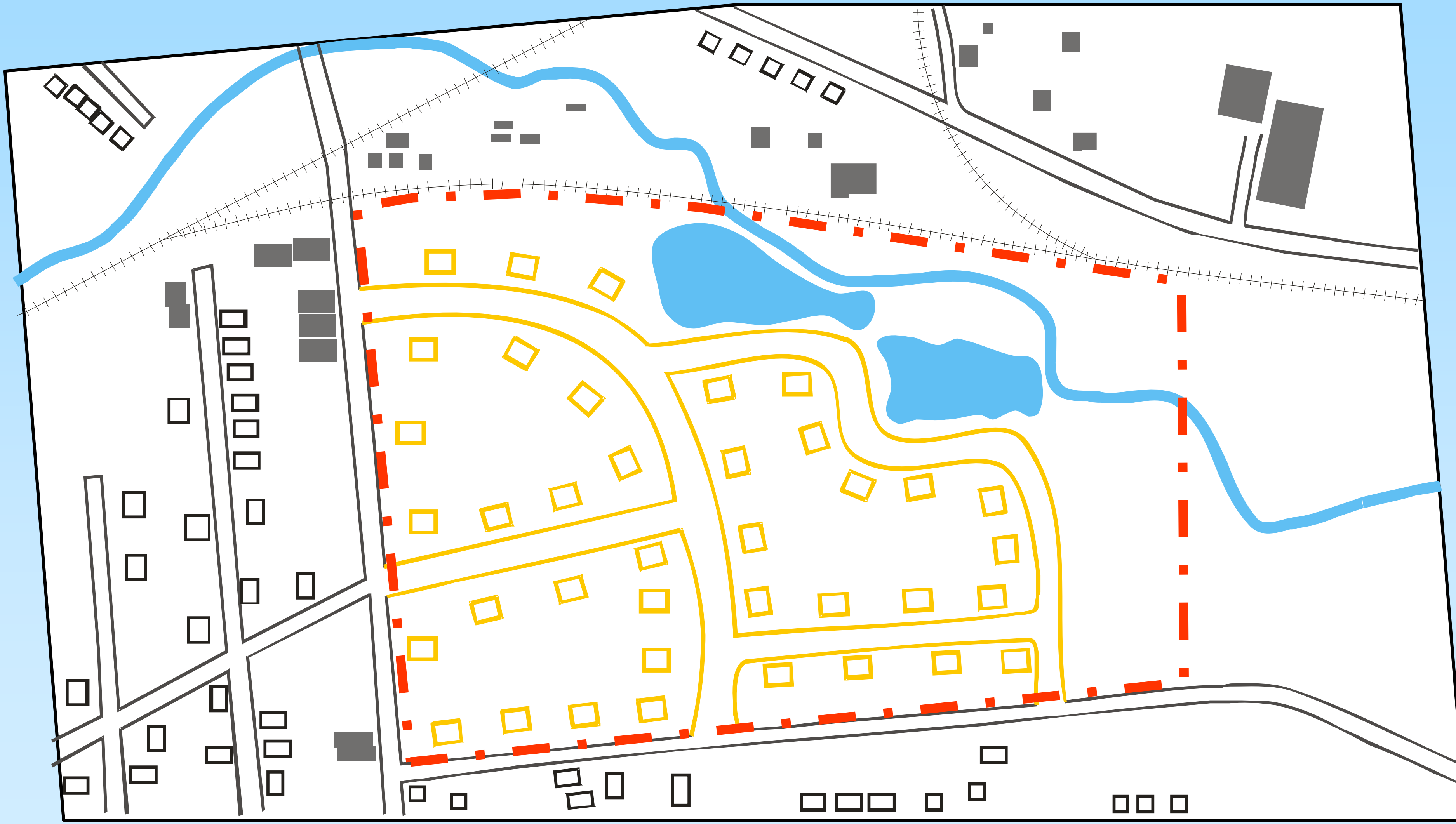
Soil Contaminant Distribution: Plan View



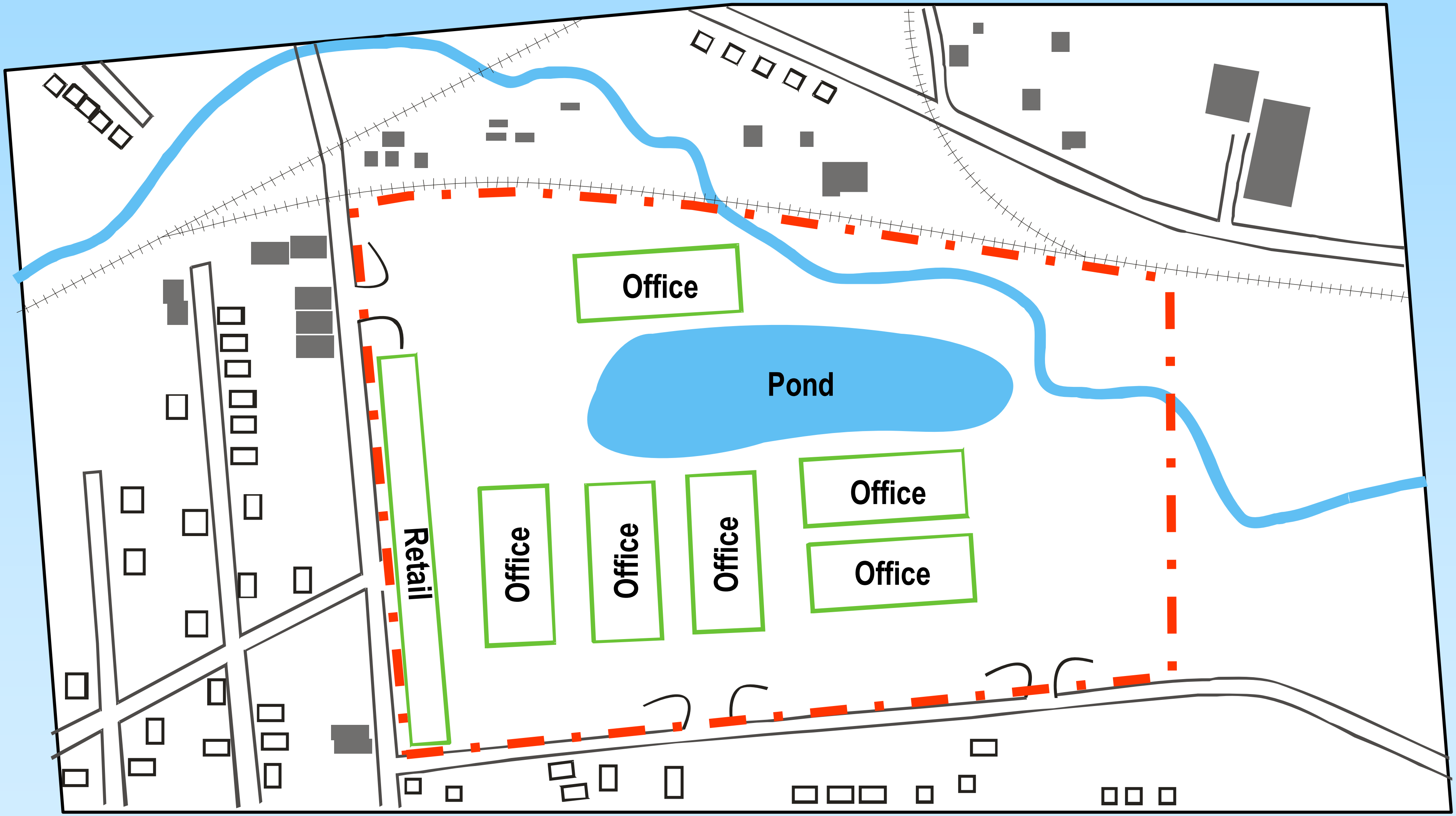
Soil Contaminant Distribution: Cross-Section



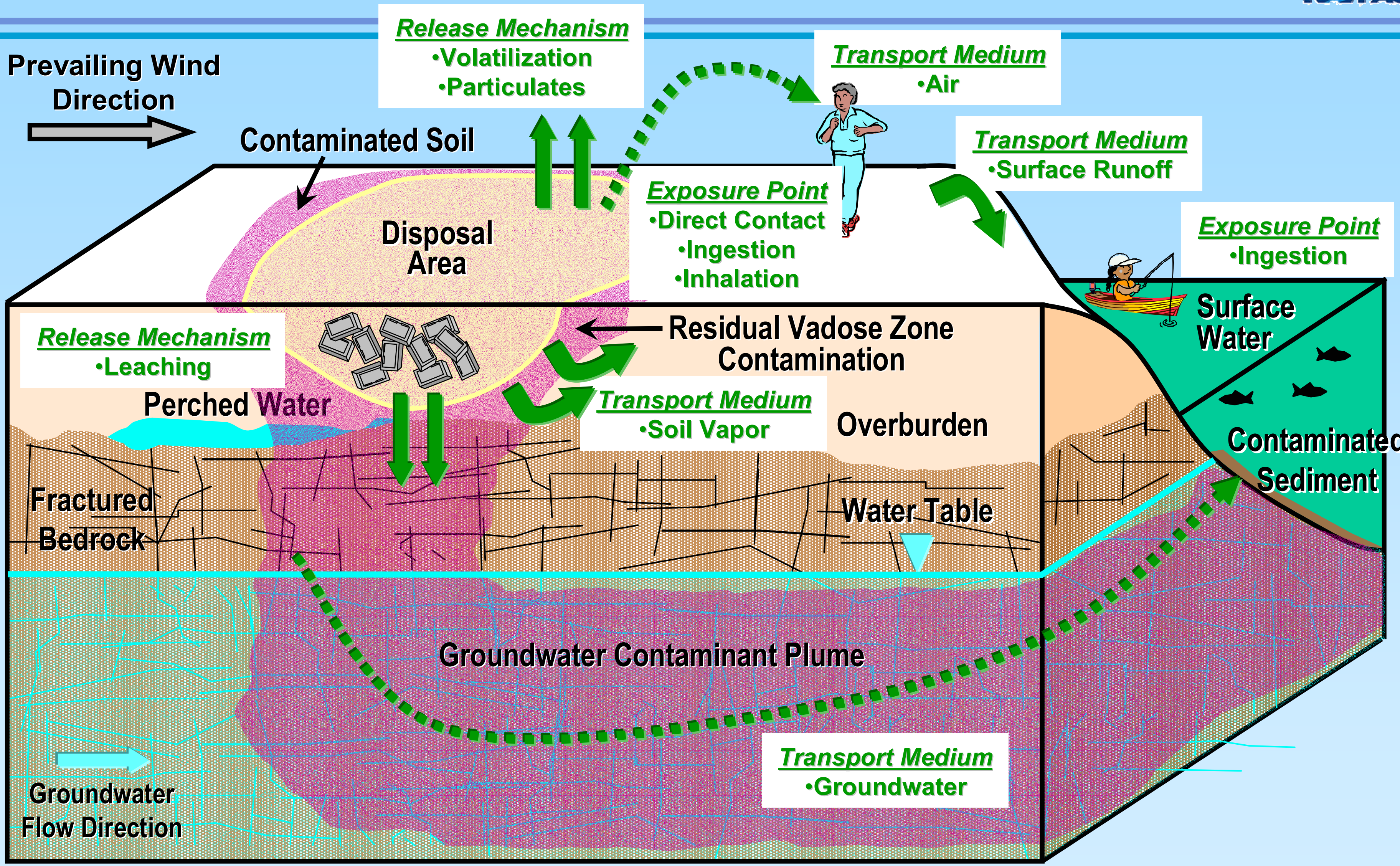
Site Redevelopment Planning: Residential



Site Redevelopment Planning: Commercial



CSM – Pathways Assessment



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Remedial Action Objectives (RAOs)

- RAOs are medium-specific or operable unit-specific goals for protecting human health and the environment. Account for:
  - Contaminant(s) of concern
  - Impacted media
  - Fate & transport characteristics
  - Exposure routes
  - Potential receptors
- Specify the contaminants and media of interest, exposure pathways, and PRGs that permit a range of treatment and containment alternatives to be developed.
- During Remedy Evaluation & Selection, RAOs should be developed as flexible goals rather than fixed numerical criteria

Target Treatment Zones

- During Remedy Evaluation & Selection, determine the volume or area of an impacted media at which the remedial action is determined to best apply
- Approach may be used to identify areas where different remedial strategies will be applied, for example
  - Aggressive source/mass recovery
  - Long-term plume containment
  - Downgradient MNA

Target Treatment Zones: Other Considerations

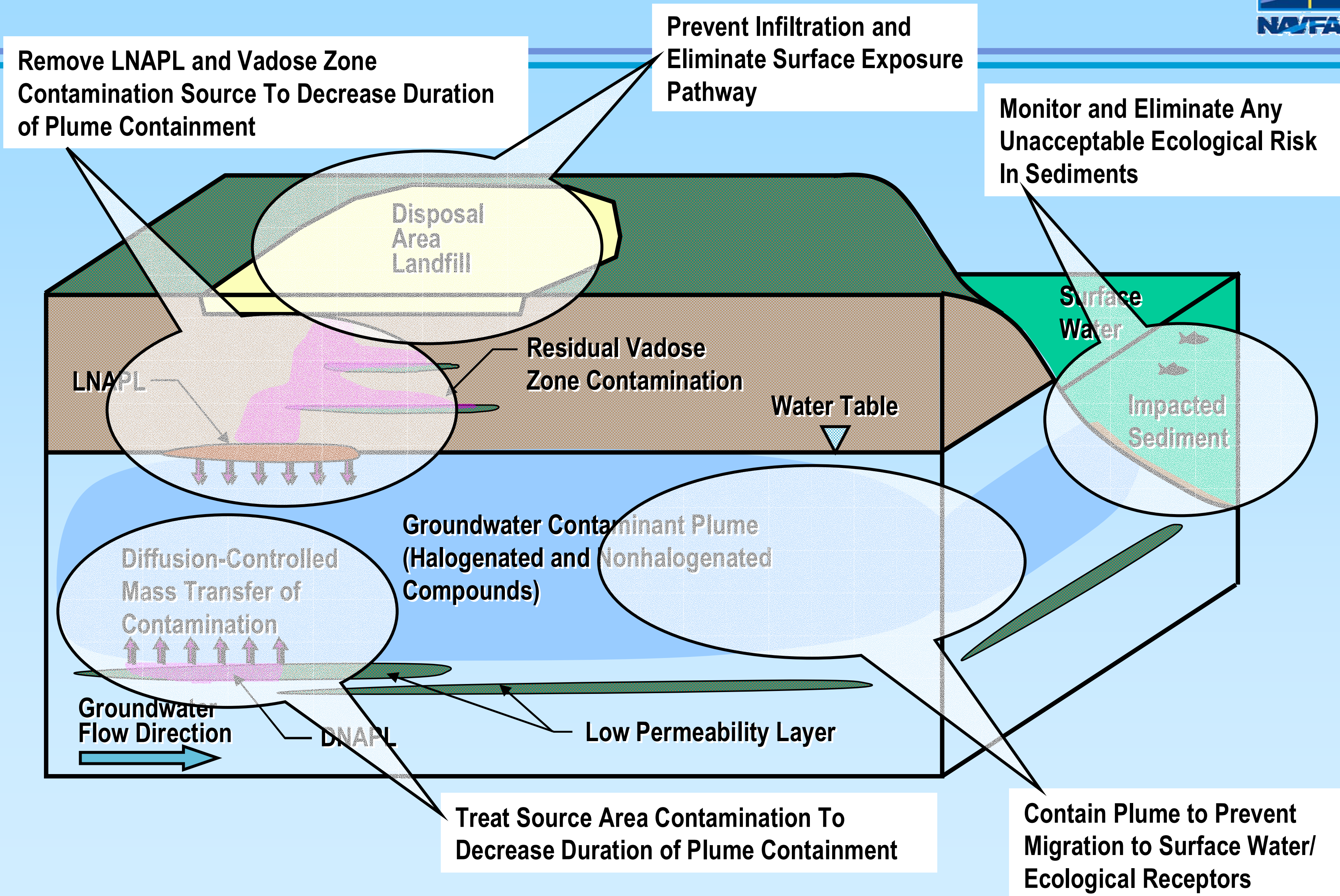
Source Containment Versus Treatment/Removal

- NCP specifies that the short-term risk associated with remedial alternatives be evaluated during the feasibility study; this includes risks to:
  - Neighboring populations (which include on-site workers not associated with remediation) and
  - On-site workers associated with remediation
- When "short-term risks outweigh potential long-term benefits ... achieving substantial reductions in toxicity, mobility, or volume may not be practicable or even desirable."

Performance Objectives

- During Remedy Evaluation & Selection, establish criteria to measure operational efficiency of each technology
- Performance Objectives ≠ Remedial Action Objectives
  - Define how RAOs will be achieved
  - Account for typical technology performance/limitations
  - Provide a trigger for changing technology

Remedial Action Objectives & Target Treatment Zones

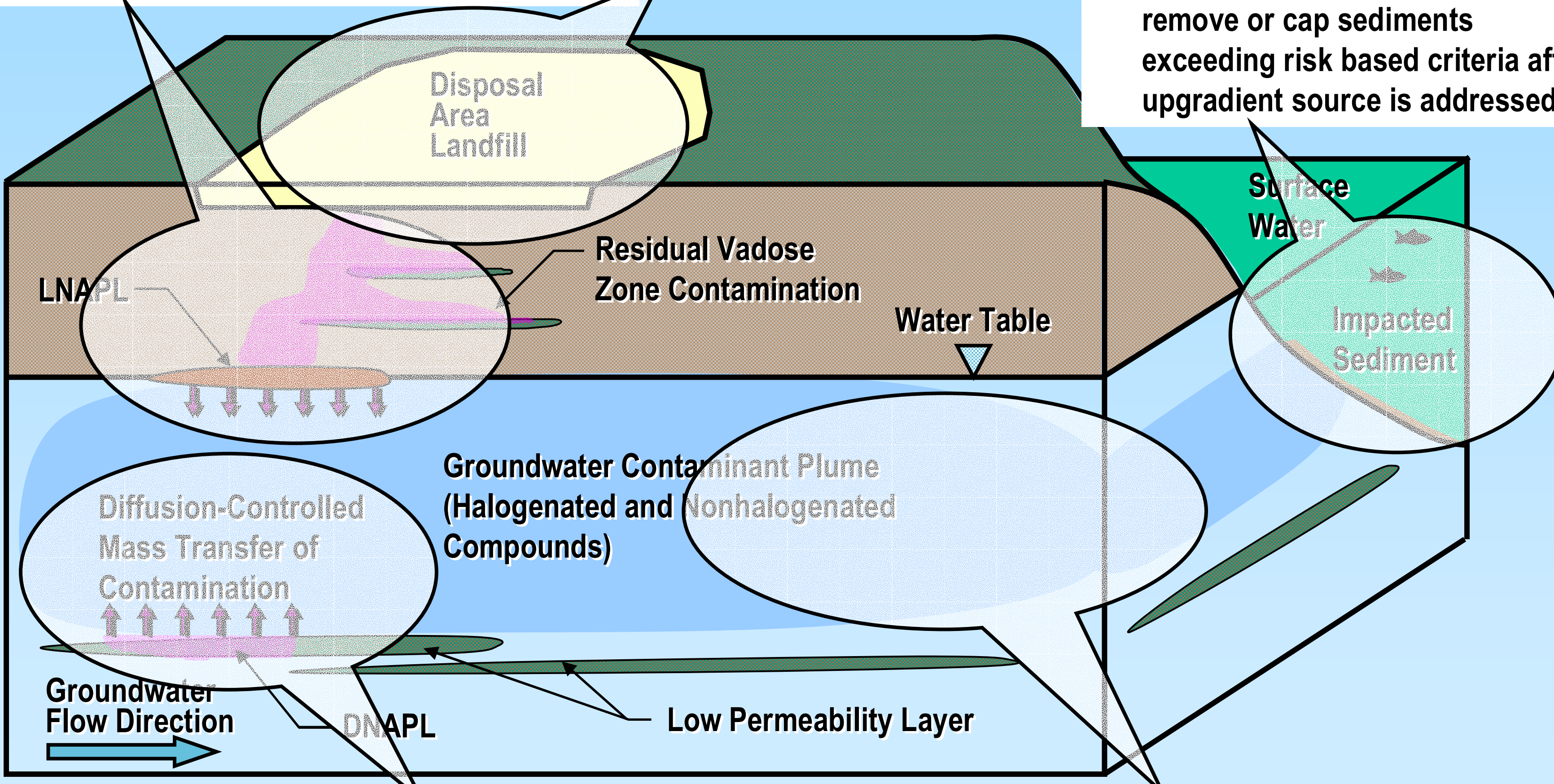


Performance Objectives

Performance Objectives:
1. Remove LNAPL to the extent practicable
2. Operate while cost effective by considering other components of treatment train and ability of MNA to reduce contaminant levels that are above risk-based levels at surface water

Performance Objectives:
1. Minimize infiltration of contaminants
2. Eliminate Surface Exposure

Performance Objectives:
1. Monitor for natural recovery. If natural recovery is ineffective, remove or cap sediments exceeding risk based criteria after upgradient source is addressed.

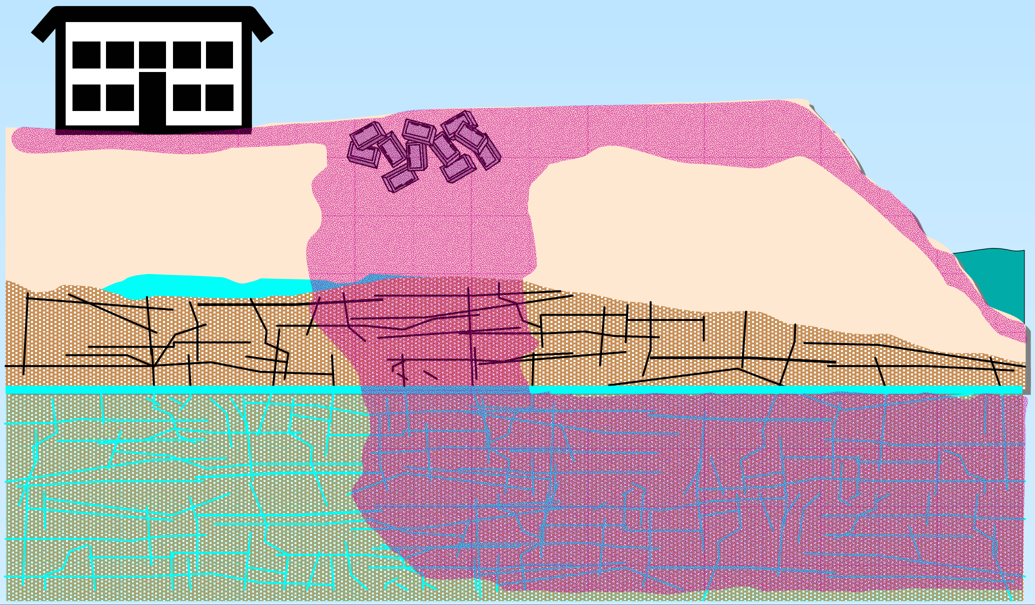


Performance Objectives:
1. Mass reduction in source area
2. Operate while cost effective

Performance Objectives:
1. Monitor and prevent migration of contaminants to surface water that are above risk-based levels

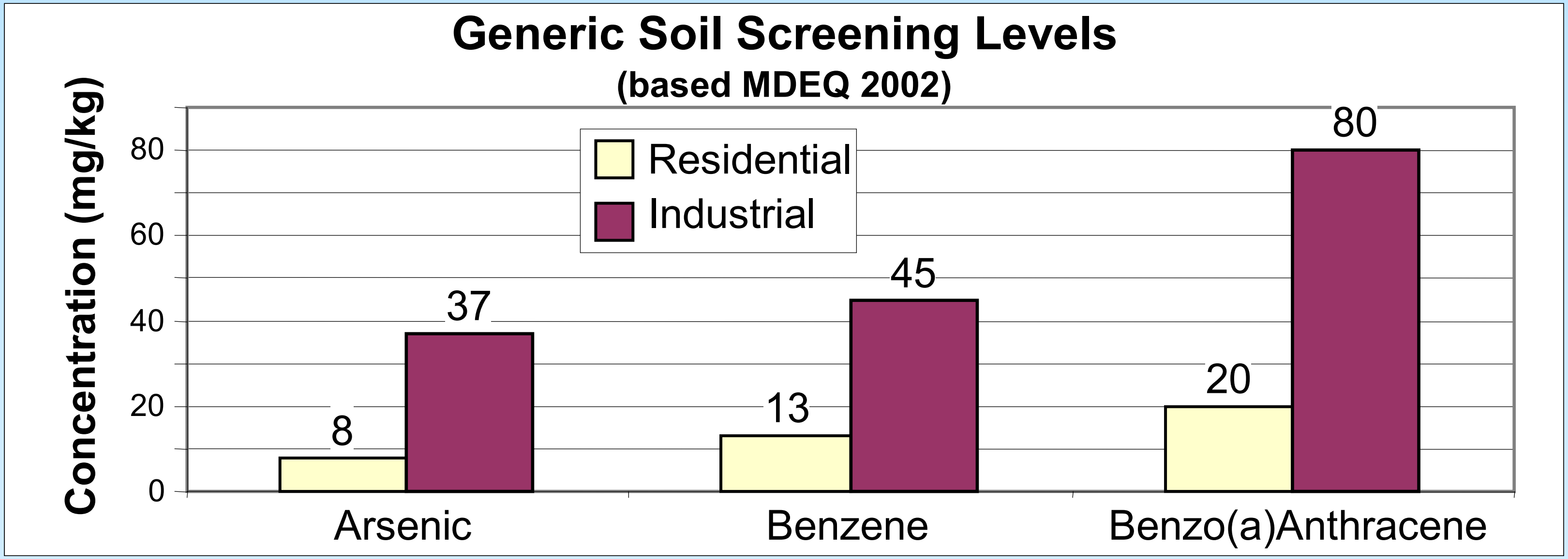
Remedial Action Objectives, Target Treatment Zones & Performance Objectives

- During Remedy Implementation and LTMtg, verify & update the RAOs, TTZs & POs
  - – Contaminants of concern
  - – Extent of contamination
  - – Exposure routes & receptors
  - – Cleanup goals for each contaminant & exposure route
  - – Change fate & transport warranting change in remedial technology



Key Assumptions Affecting Remedial Cost

- Land use assumptions
- Groundwater use assumptions
- Groundwater assumptions and relation to soil remedial action objectives
- Source containment versus treatment/removal



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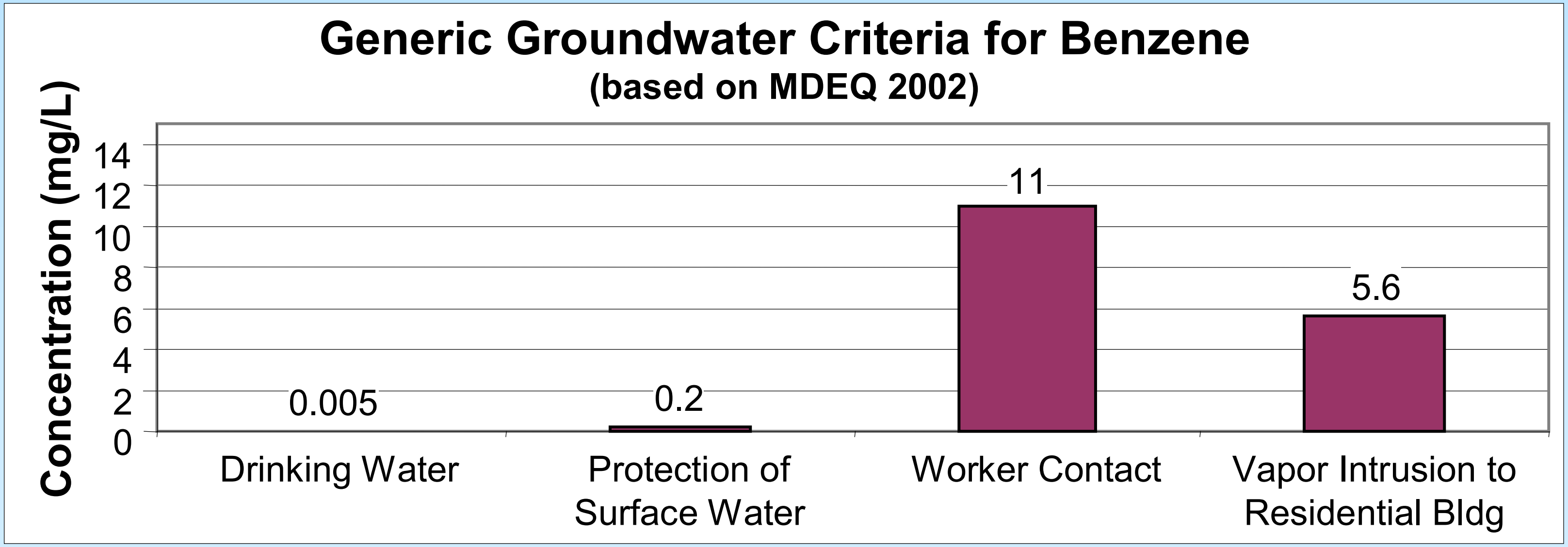

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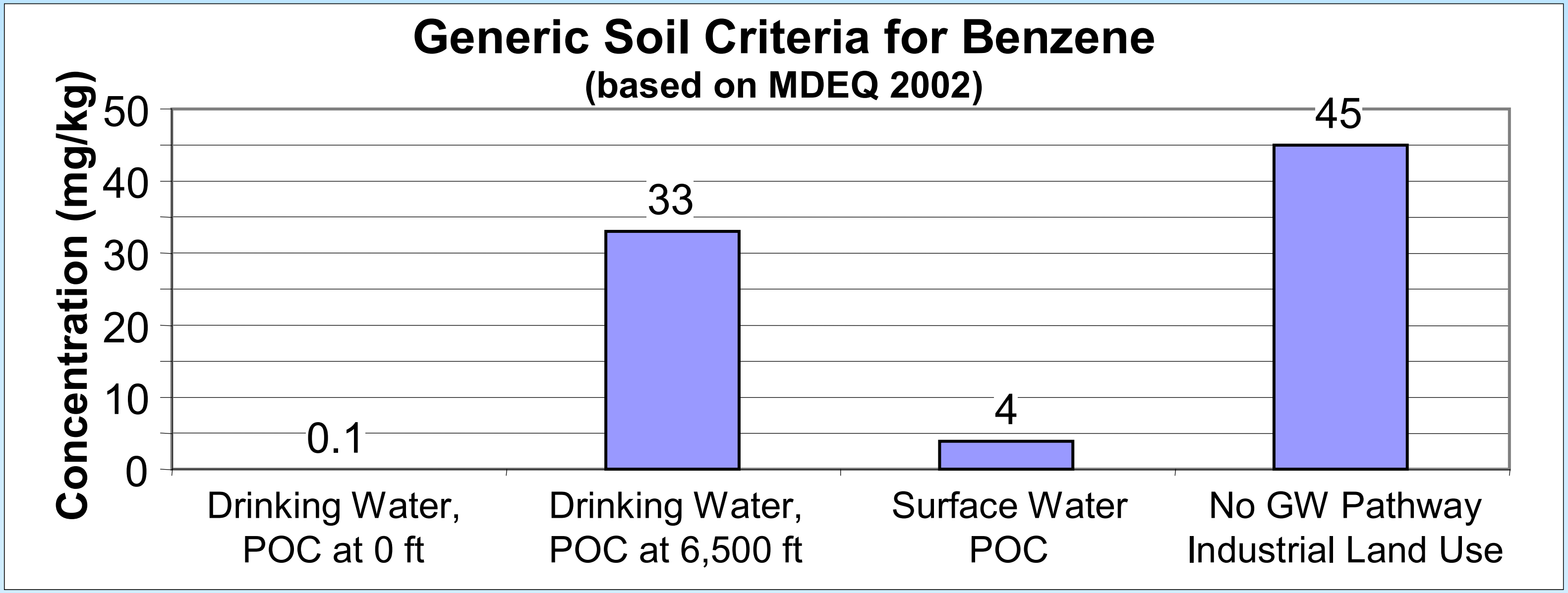

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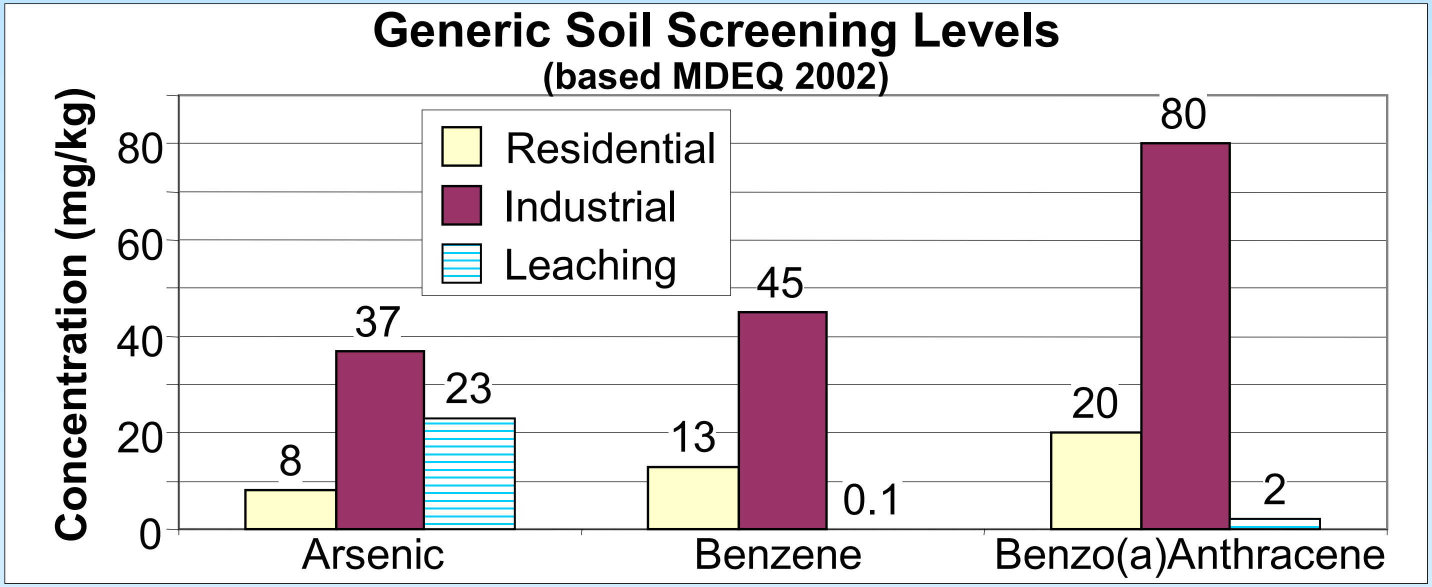

Key Assumptions Affecting Remedial Cost

- **Source containment versus treatment/removal – Assessment of Principal Threat**
  - "Source materials" include waste, contaminated soil, and pooled NAPL, but do not include groundwater.
  - Principal threat is generally considered those source materials that pose a potential risk several orders of magnitude greater than the risk level that is acceptable given realistic exposure scenarios

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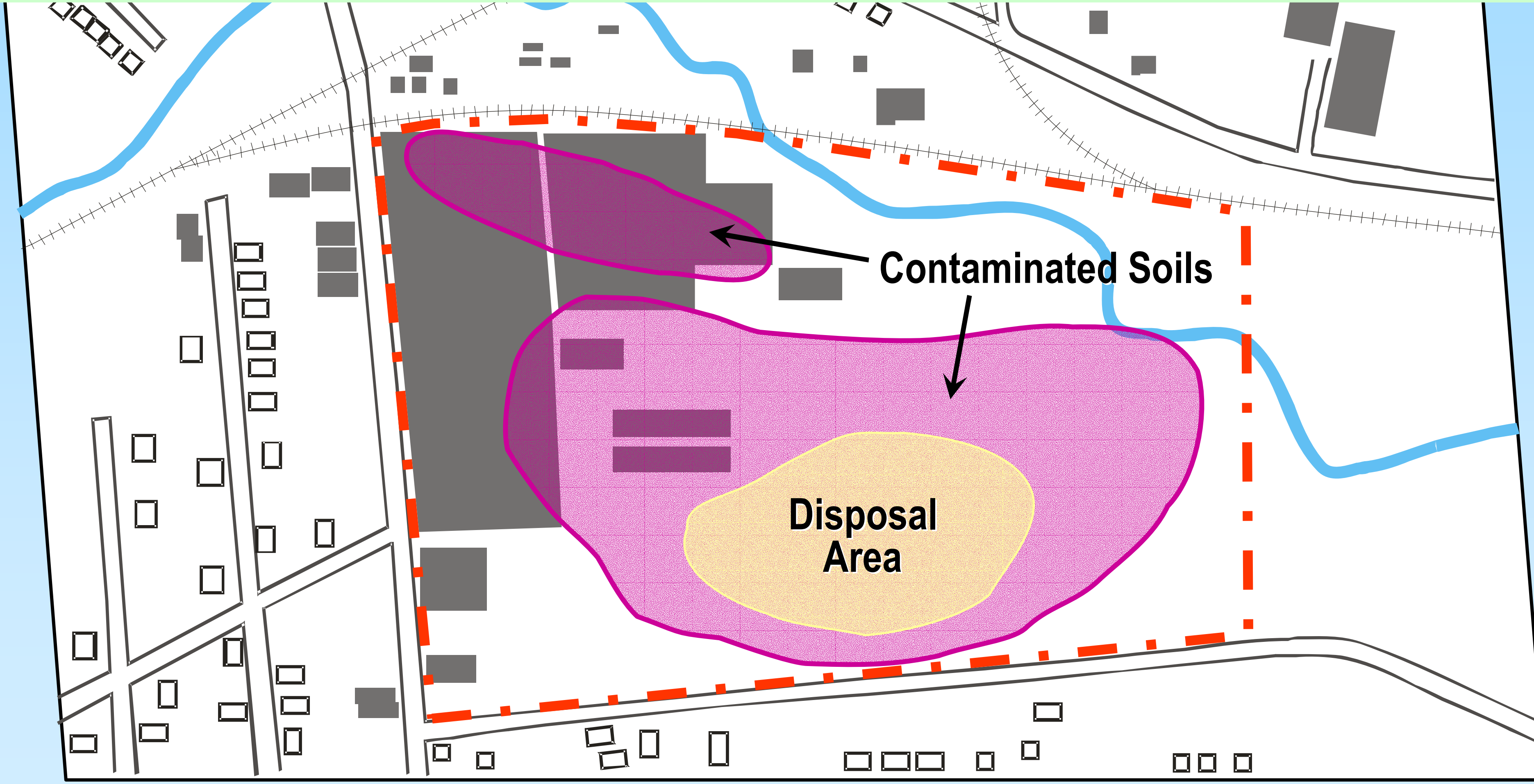
- CSM Development Case Study: NJ Superfund Site
- Role of the CSM in Focusing Remedial Goals
  - Remedial Action Objectives
  - Target Treatment Zones
  - Performance Objectives
- **Remedial Goal Case Study: NJ Superfund Site**
- Summary

Case Study: NJ Superfund Site

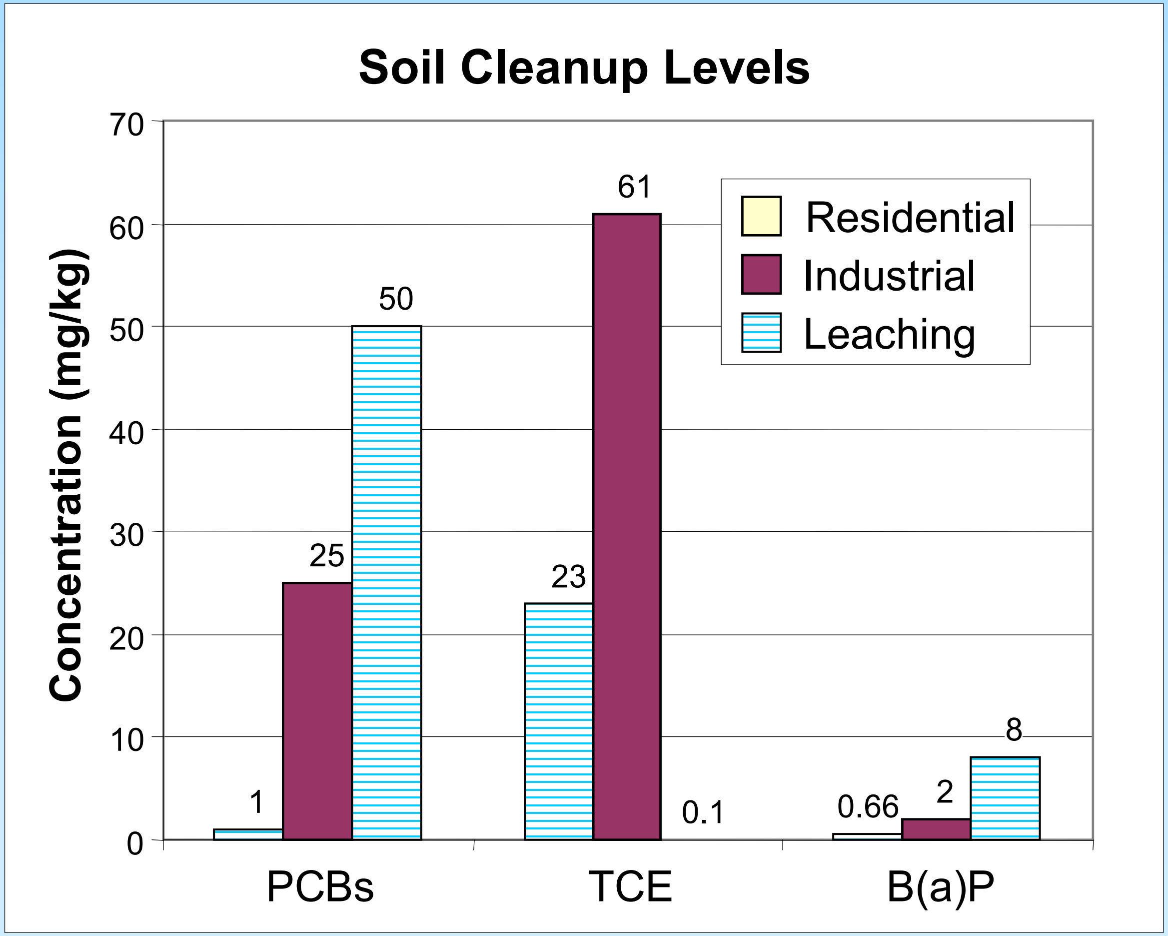
Contamination includes PCBs, semivolatile and volatile organic compounds, and metals exceeding criteria for protection of residential and industrial land use and protection of groundwater



Case Study: Cleanup Goals

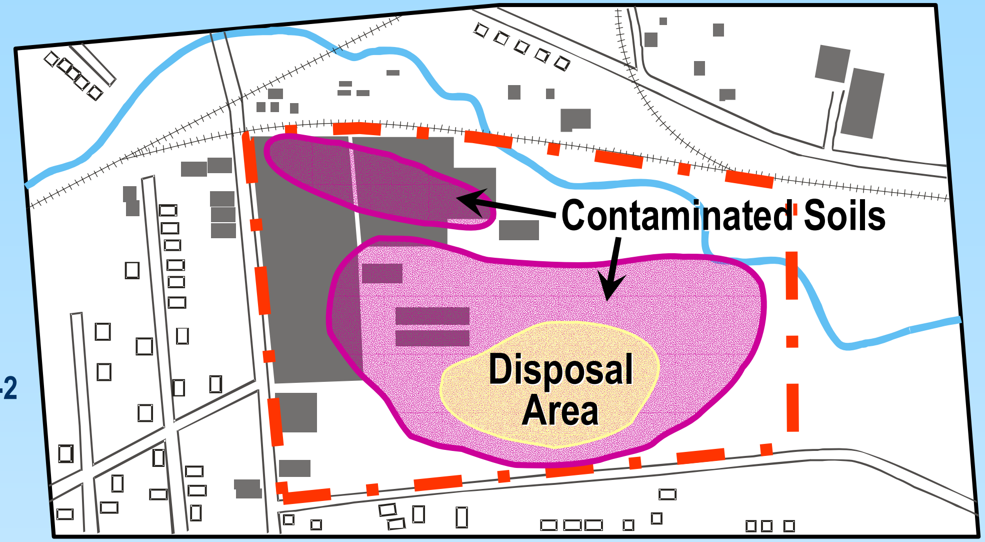
Cost to meet residential = $130+ million

Cost to meet industrial = $40+ million



Case Study: Preliminary Risk Estimates

- **Site-Wide**
  - Total cancer risk = $1x10^{-2}$
  - Total hazard index = 79
- **Fill Area**
  - Total cancer risk, Fill Area = $1x10^{-2}$
  - Total hazard index = 76
- **Non-Fill Area**
  - Total cancer risk, Fill Area = $5x10^{-5}$
  - Total hazard index = 2



Case Study: Remedial Alternatives for Soil

- **Sensitivity Analysis:**

  Alternative 1: Remove fill materials

  Alternative 2: Alt 1, plus removal of principal threat soil

  Alternative 3: Alt 2, plus removal of VOC soils exceeding impact to groundwater criteria

  Alternative 4: Alt 3, plus additional PCB soils >500 mg/kg

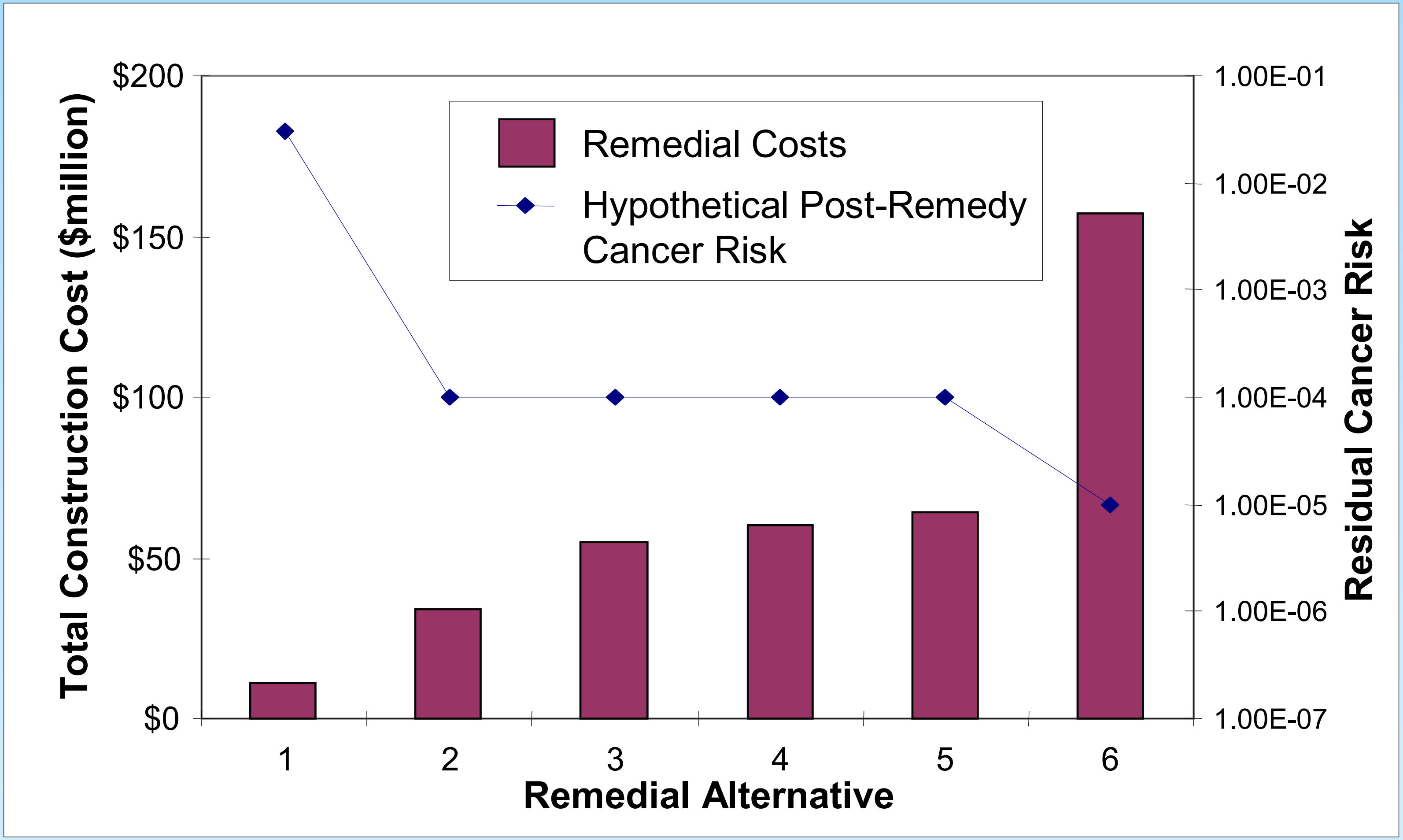
  Alternative 5: Alt 4, plus other misc. debris

  Alternative 6: U.S. EPA's alternative based on removal of all soils having concentrations above generic cleanup criteria calculated at target cancer risk level of 10^{-6} and hazard index of 1

(Source: PENDING Authorization)

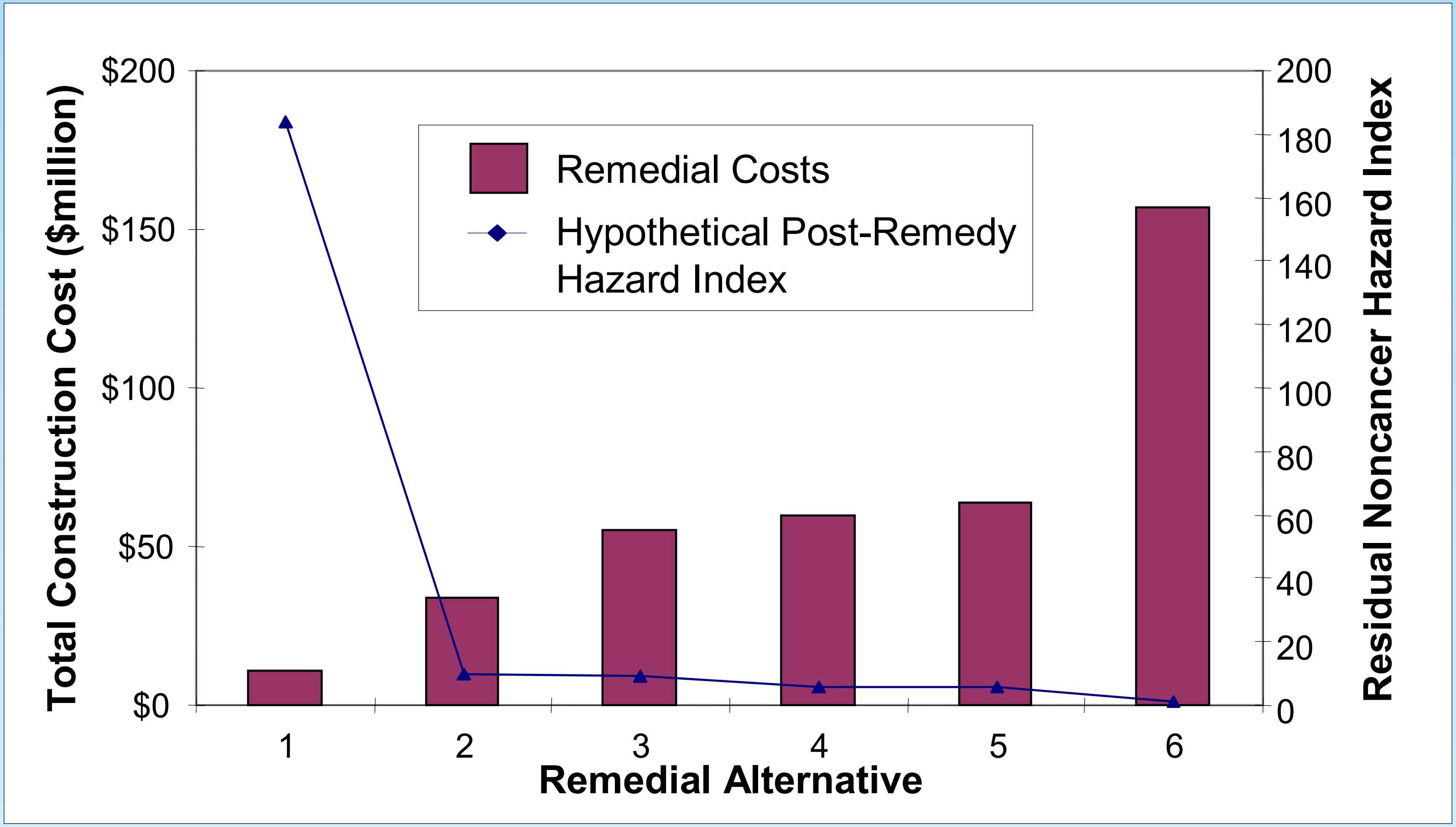
Case Study: Cancer Risk Reduction

- **Alternate 2 represents most cost-effective solution for cancer risk reduction**



Case Study: Noncancer HI Reduction

- **Alternate 2 represents most cost-effective solution for noncancer risk reduction**



Case Study Solution???

- Given a Superfund Site
  - Center of town
  - Neighboring residential areas
  - Groundwater well fields in the vicinity
  - Contaminated soil & groundwater and on-site disposal area
- What is a reasonable solution?

No Peeking!

Case Study Solution – Current Strategy

- Current strategy:
  - Partner with local government & redeveloper to select site reuse plan
  - Integrate remedial components with site redevelopment plan
- Preliminary redevelopment plans include,
  - Mixed neighborhood retail, flexible commercial space, mini-storage, and dedicated open space with ties to existing downtown business district
- Redevelopment plans benefit the local community
  - Increases tax revenues
  - Increases property value
  - Improves aesthetic quality of the borough
  - Enhances ongoing revitalization of downtown business district

Case Study Solution – Current Strategy (cont.)

- Maintain commitment to protection of human health and the environment during redevelopment and into the future
  - High volume of low level threat material – select principal threat removal for fill area
  - Redevelopment requires “hardscape” capping over majority of site – select a containment remedy

- **Achieves acceptable risk reduction**

- **Estimated remedy cost = $20-$30 million**

Presentation Overview

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Summary

1. Develop the CSM early in the IR process

2. The CSM should evolve during the IR process as data are collected

3. The CSM should focus definition of remedial goals & provide decision framework for optimizing remedy

Summary (cont.)

1. Develop the CSM early in the IR process
   - A CSM provides an overview of the "big picture" and is an important tool used for organizing site information, identifying data gaps, and assisting all stakeholders with project decision-making
2. The CSM should evolve during the IR process as data are collected
   - Use an iterative process of data collection and hypothesis testing to build a CSM and focus subsequent data gathering
   - Update during the RA phase as new information is collected, site conditions change and/or long-term objectives are redefined
3. The CSM should focus definition of remedial goals & provide decision framework for optimizing remedy
   - Overall IR Program goal is protection of human health & the environment, and to support the mission
   - Groundwater use assumptions often drive the scope and cost of investigation and remediation of both groundwater and soil
   - Higher cost to achieve "unrestricted use" does not always achieve lower overall risk

Case Study Lessons Learned

- Actively partner with interested parties:
  - U.S. EPA and state agencies
  - Local government & community
  - Business leaders
  - Developers
- Integrate reuse plans into the site cleanup planning
- Maintain commitment to protection of human health and the environment during redevelopment and into the future
- Encourage building on successes at similar sites

Navy Case Studies

- **Streamlined Characterization & Decision Making:**
  - Naval Air Facility, Adak, AK (source: Guidance for Optimizing Remedy Evaluation, Selection, and Design. December 2003 [interim final])
- **Target Treatment Zones:**
  - Naval Weapons Station, Charleston, SC (source: Guidance for Optimizing Remedy Evaluation, Selection, and Design. December 2003 [interim final])
- **Land Use Planning & Community Involvement:**
  - Mare Island Naval Shipyard (http://www.navfac.navy.mil/brc/about/accomp.htm)
  - Fleet and Industrial Supply Center, Oakland, CA (http://www.navfac.navy.mil/brc/about/accomp.htm)