Environmental Molecular Diagnostics: New Technical and Regulatory Guidance from the Interstate Technology & Regulatory Council

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ITRC EMD Team Leader

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Overview

- Who is the ITRC EMD Team?
- What have we done?
- What are EMDs?
- What are examples of EMDs?
- How can EMDs be used in making environmental management decisions?

WHO IS THE ITRC EMD TEAM?

ITRC (www.itrcweb.org) – Shaping the Future of Regulatory Acceptance

- Host organization
- Network
  - State regulators
    - All 50 states, PR, DC
  - Federal partners

DOE DOD EPA

  - ITRC Industry Affiliates Program
  - Academia
  - Community stakeholders

- Wide variety of topics
  - Technologies
  - Approaches
  - Contaminants
  - Sites
- Products
  - Technical and regulatory guidance documents
  - Internet-based and classroom training

EMD Team Members

State Regulators and Federal Personnel

- NJDEP
- Alaska DEC
- California DTSC
- California RWCQB
- Georgia EPD
- MI MCSWMA
- PADEP
- SCDHEC
- USEPA
- AFCEE
- DOE
- SERDP/ESTCP
- U.S. Navy

Stakeholder and Academic Representatives

- PM Strauss & Associates
- North Carolina State University
- University of Oklahoma
- University of Tennessee
- University of Tulsa
- West Virginia University

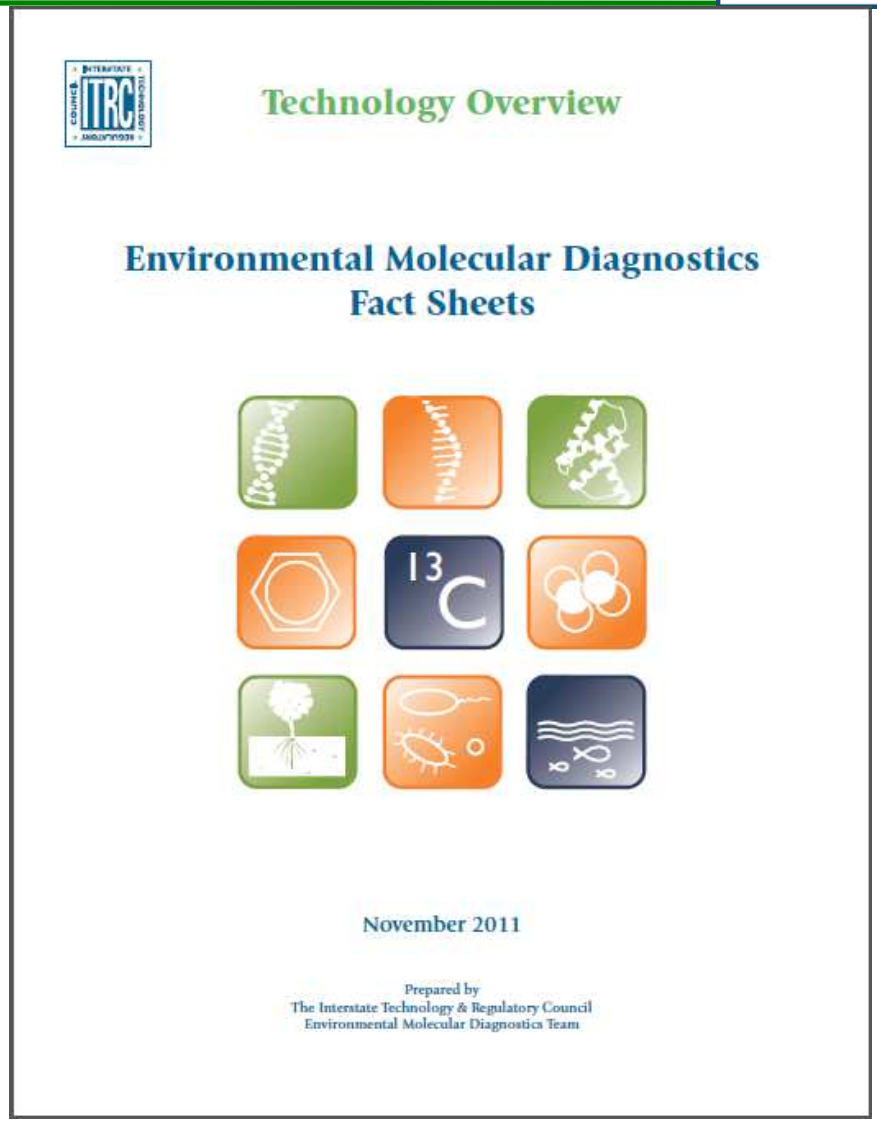
Industry Representatives

- AECOM Environment
- Anchor QEA
- ARCADIS
- Battelle Memorial Institute
- BP
- Brown and Caldwell
- CDM Smith
- Duncklee and Dunham
- DuPont
- Cardno Entrix
- Engineering and Land Planning Associates
- ENVIRON
- Geosyntec Consultants
- Haley & Aldrich
- Kleinfelder
- Microbial Insights
- Microseeps
- Sage Risk Solutions
- Treadwell Rollo
- Zymax

WHAT HAVE WE DONE?

Fact Sheets

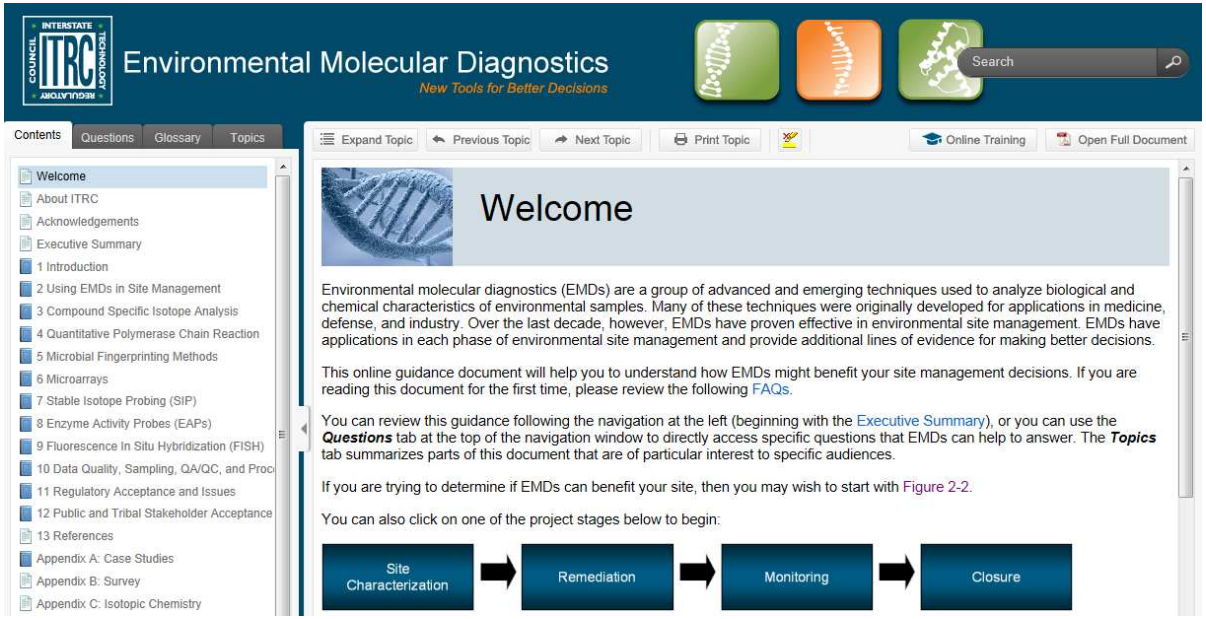
- November 2011
- Application of EMDs
- Technology descriptions
- Advantages and limitations
- Sampling protocols
- QA/QC



http://www.itrcweb.org/Guidance/ListDocuments?topicID=33&subTopicID=14

TechReg Guidance Document

- April 2013
- Web-based
- Technology detail
- Case studies
- Decision framework
- Data quality considerations
- Regulatory and stakeholder acceptance
- State survey results
- Background appendices

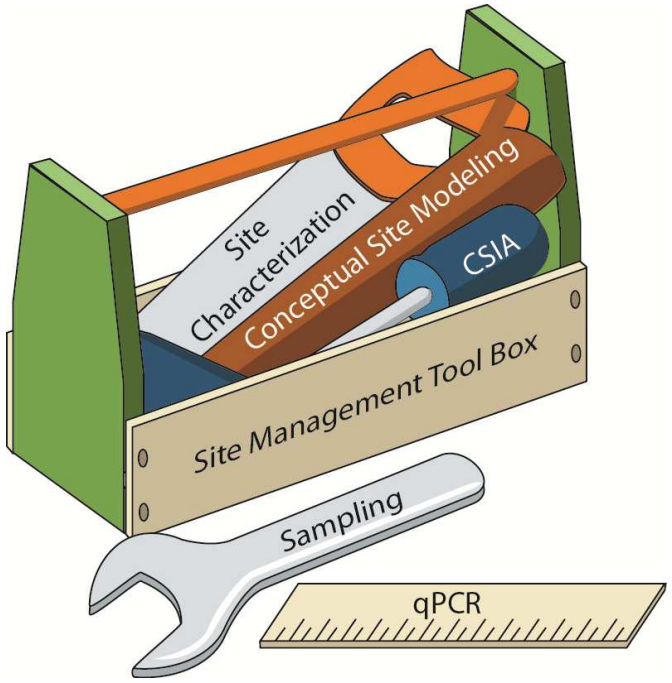


http://www.itrcweb.org/emd-2/

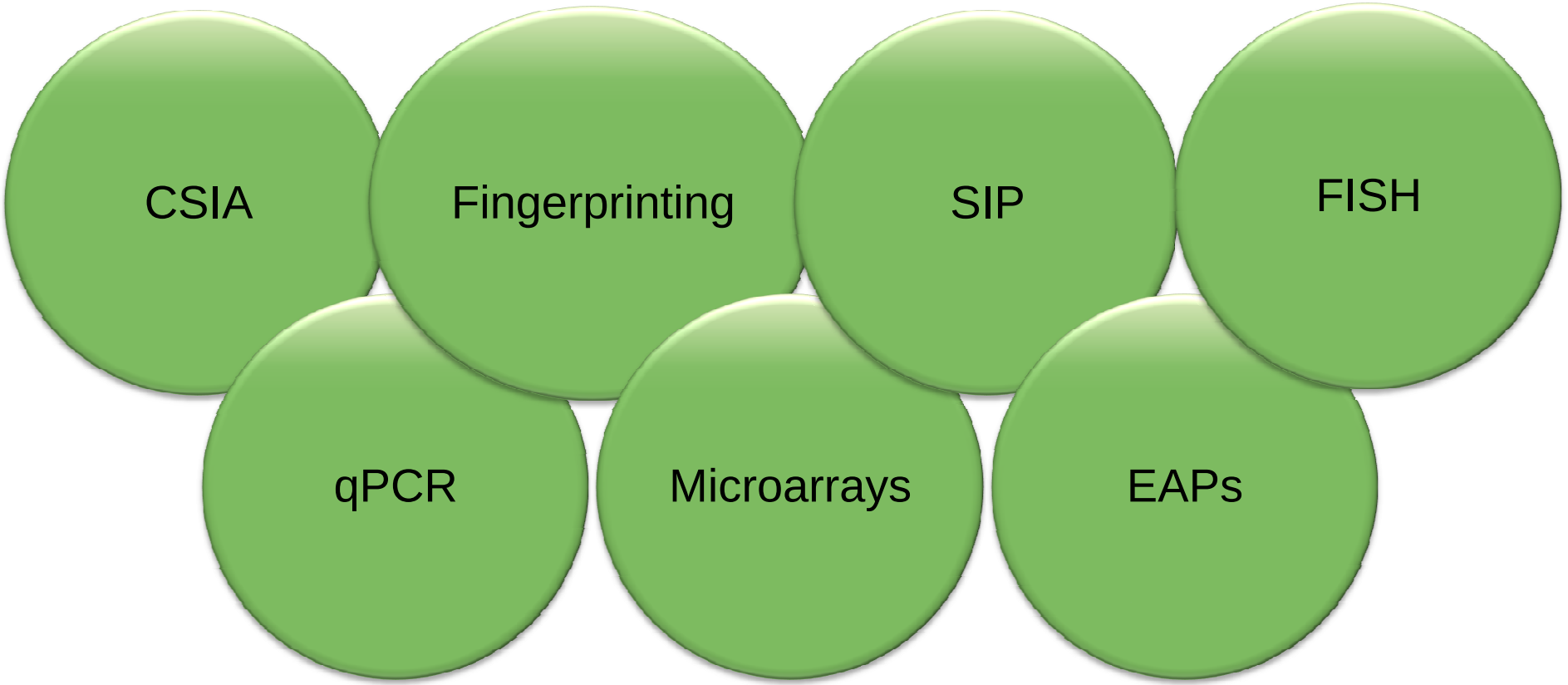
WHAT ARE EMDS?

What are EMDs?

- Group of analytical techniques
  - Used to analyze biological and chemical characteristics of soil, sediment, and water samples
- Developed for medicine
  - Adapted for environmental site management
- Two major categories
  - Chemical techniques
  - Molecular biological techniques (MBTs)



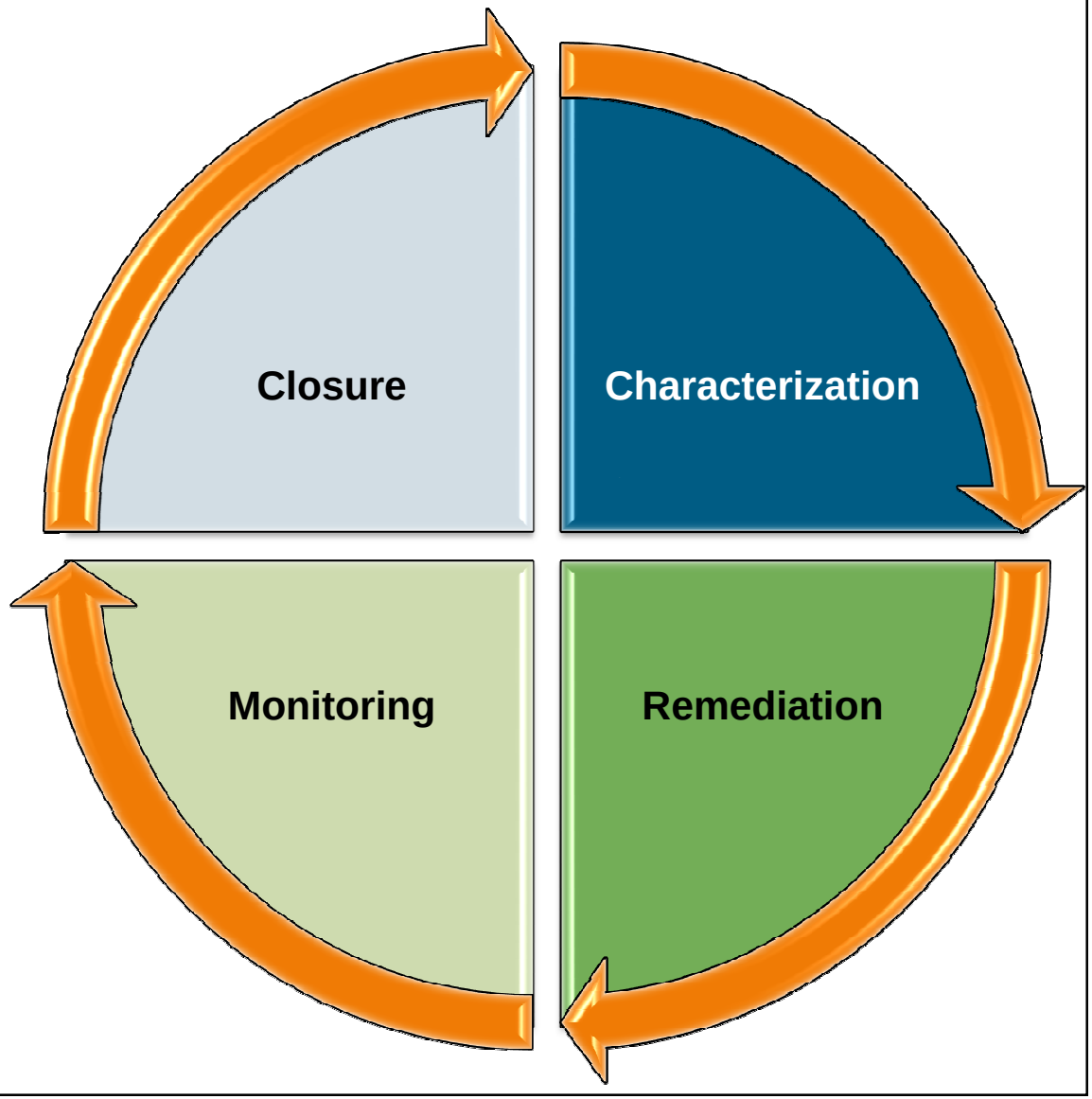
EMD Techniques



HOW CAN THEY BE USED TO MAKE ENVIRONMENTAL MANAGEMENT DECISIONS?

Big Picture

- Applicable to each project phase
- Conventional data
  - Chemical
  - Geochemical
- EMDs complement conventional data, not replace it



Generic Case Study

- Chemical concentrations
  - Chlorinated solvent release to groundwater
  - Transformation of PCE to cDCE
- Geochemical concentrations
  - Anaerobic conditions conducive to biodegradation
  - Very low organic carbon
- Remedial alternatives
  - Natural attenuation (requires microbes and donor)
  - Biostimulation (requires microbes, provides donor)
  - Bioaugmentation (provides both microbes and donor)

Do we have the right microbes?

Decision Framework

- TechReg document provides decision framework
  - Identify when EMDs can complement conventional data
  - Decide which EMD will provide desired information

Identify project status → Identify if EMDs could be useful → Ask the right question → Narrow down the options → Select an EMD

Figure 2-2

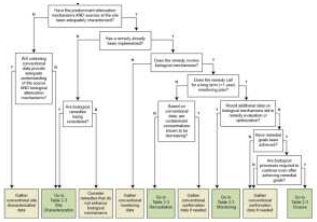


Figure 2-2

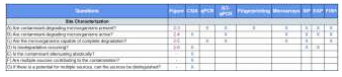
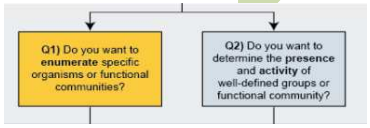
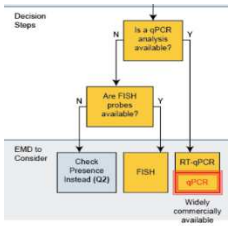


Table 2-3





Figures 2-3 to 2-9

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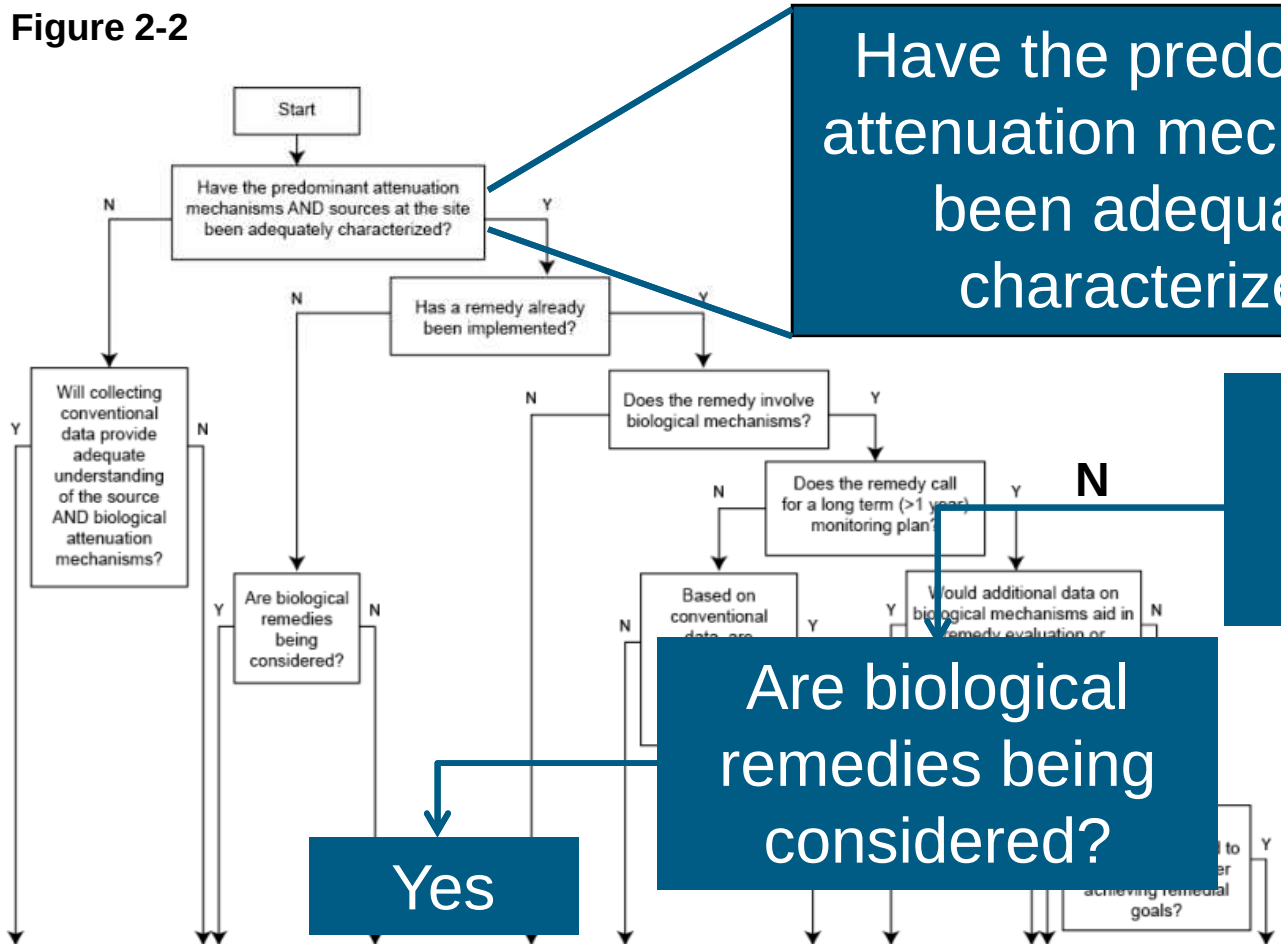
Identify project status

Figure 2-2



Have the predominant attenuation mechanisms been adequately characterized?

Y

Has a remedy already been selected?

N

Are biological remedies being considered?

Yes

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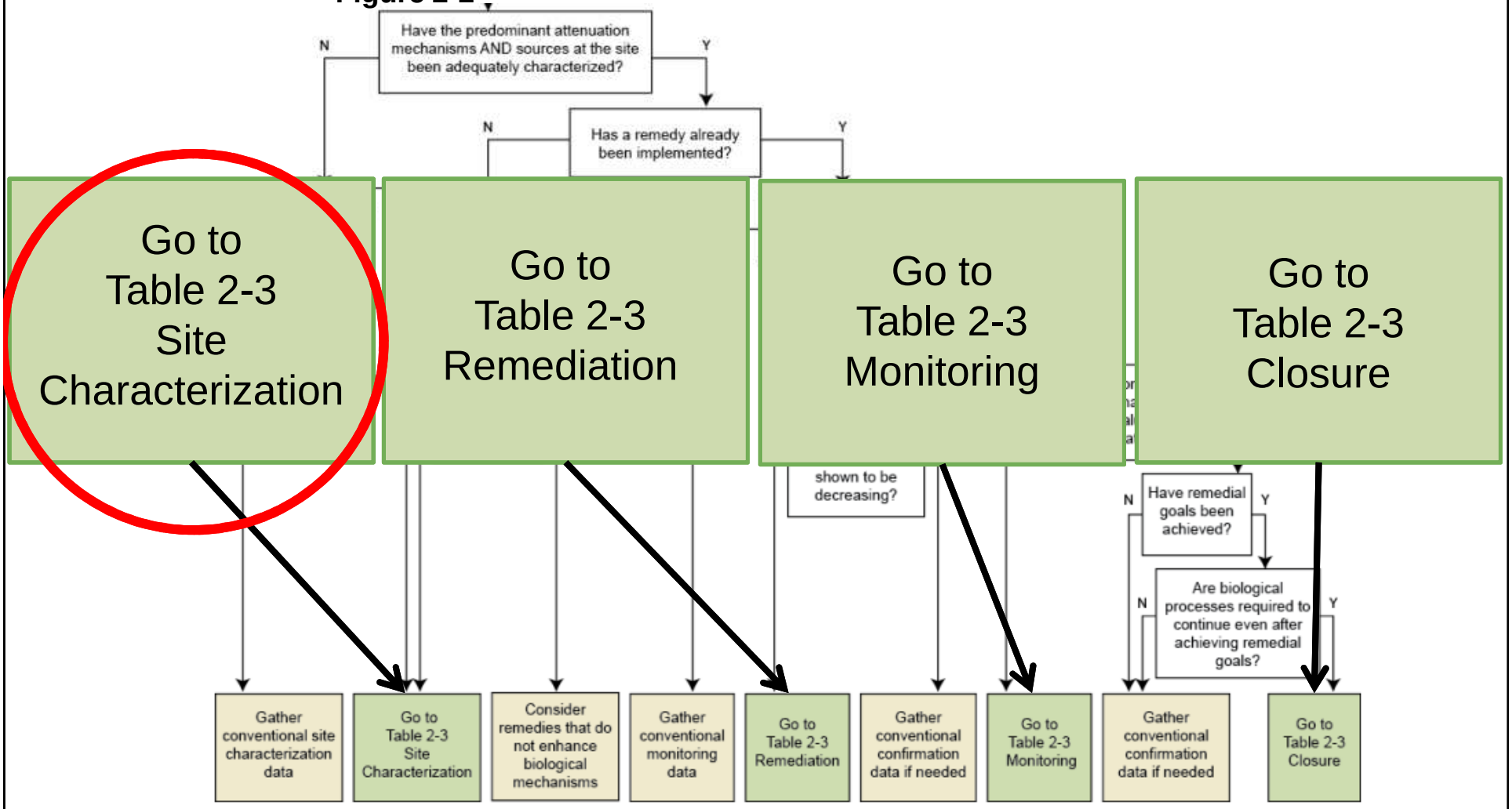
Identify if EMDs could be useful

Figure 2-2



Ask the right question

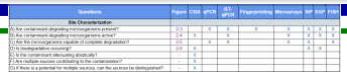


Table 2-3

PCE ⟶ TCE ⟶ cDCE ⟶ VC ⟶ Ethene

Questions	Figure	CSIA	qPCR	RT-qPCR	Fingerprinting	Microarrays	SIP	EAP	FISH
Site Characterization									
A) Are contaminant-degrading microorganisms present?	2-3		X	X	X	X	X	X	X
B) Are contaminant-degrading microorganisms active?	2-4	X		X		X	X	X	X
C) Are the microorganisms capable of complete degradation?	2-5		X	X		X	X		X
D) Is biodegradation occurring?	2-6	X					X	X	
E) Is the contaminant attenuating abiotically?	-	X							
F) Are multiple sources contributing to the contamination?	-	X							
G) If there is a potential for multiple sources, can the sources be distinguished?	-	X							

C) Are the microorganisms capable of complete degradation?

Ask the right question

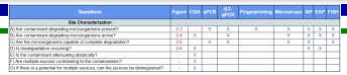


Table 2-3

Potential EMDs that could help answer the question

Questions	Figure	CSIA	qPCR	RT-qPCR	Fingerprinting	Microarrays	SIP	EAP	FISH
Site Characterization									
A) Are contaminant-degrading microorganisms present?	2-3		X	X	X	X	X	X	X
B) Are contaminant-degrading microorganisms active?	2-4	X		X		X	X	X	X
C) Are the microorganisms capable of complete degradation?	2-5		X	X		X	X		X
D) Is biodegradation occurring?	2-6	X					X	X	
E) Is the contaminant attenuating abiotically?	-	X							
F) Are multiple sources contributing to the contamination?	-	X							
G) If there is a potential for multiple sources, can the sources be distinguished?	-	X							

Use Figure 2-5 to narrow down the options

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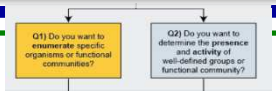
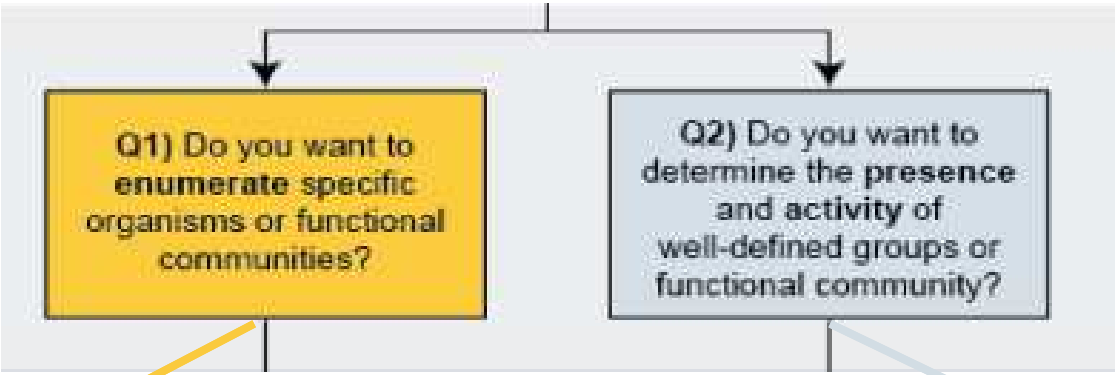
Narrow down the options



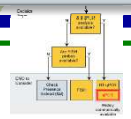
Figures 2-3 to 2-9



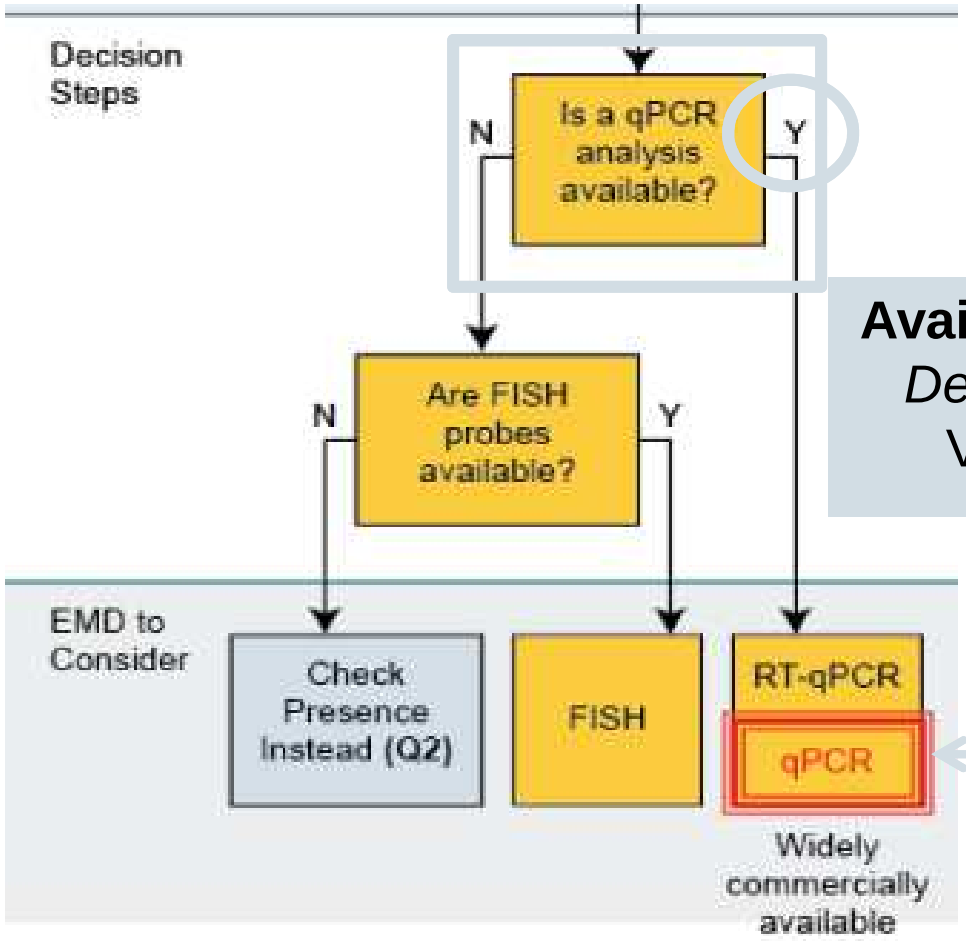
Adequate number of microbes known to completely degrade PCE indicate a biostimulation is appropriate; otherwise bioaugmentation is necessary

Sufficient activity of microbes known to completely degrade PCE would likely correlate to chemical concentrations of VC

Select an EMD



Figures 2-3 to 2-9



Available Analyses:
Dehalococcoides VC reductase

Then What?

- Learn about the EMDs
  - How is it done?
  - How do I interpret the data?
  - What QA/QC should I consider?
  - What are the practical application considerations?
- See examples of application of EMDs
  - Concise, focused examples
  - Larger case studies
- Review background materials
  - Microbiology
  - Isotope chemistry

Summary

- EMDs complement conventional data
  - Provide unique information
  - Assist in making effective management decisions
- Decision framework
  - Identify when to use EMDs
  - Decide which EMD to use
- Visit the ITRC EMD website

  http://www.itrcweb.org/emd-2/
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  - 609-984-3910

QUESTIONS?