Planning Treatment Trains and Concurrent Remedies
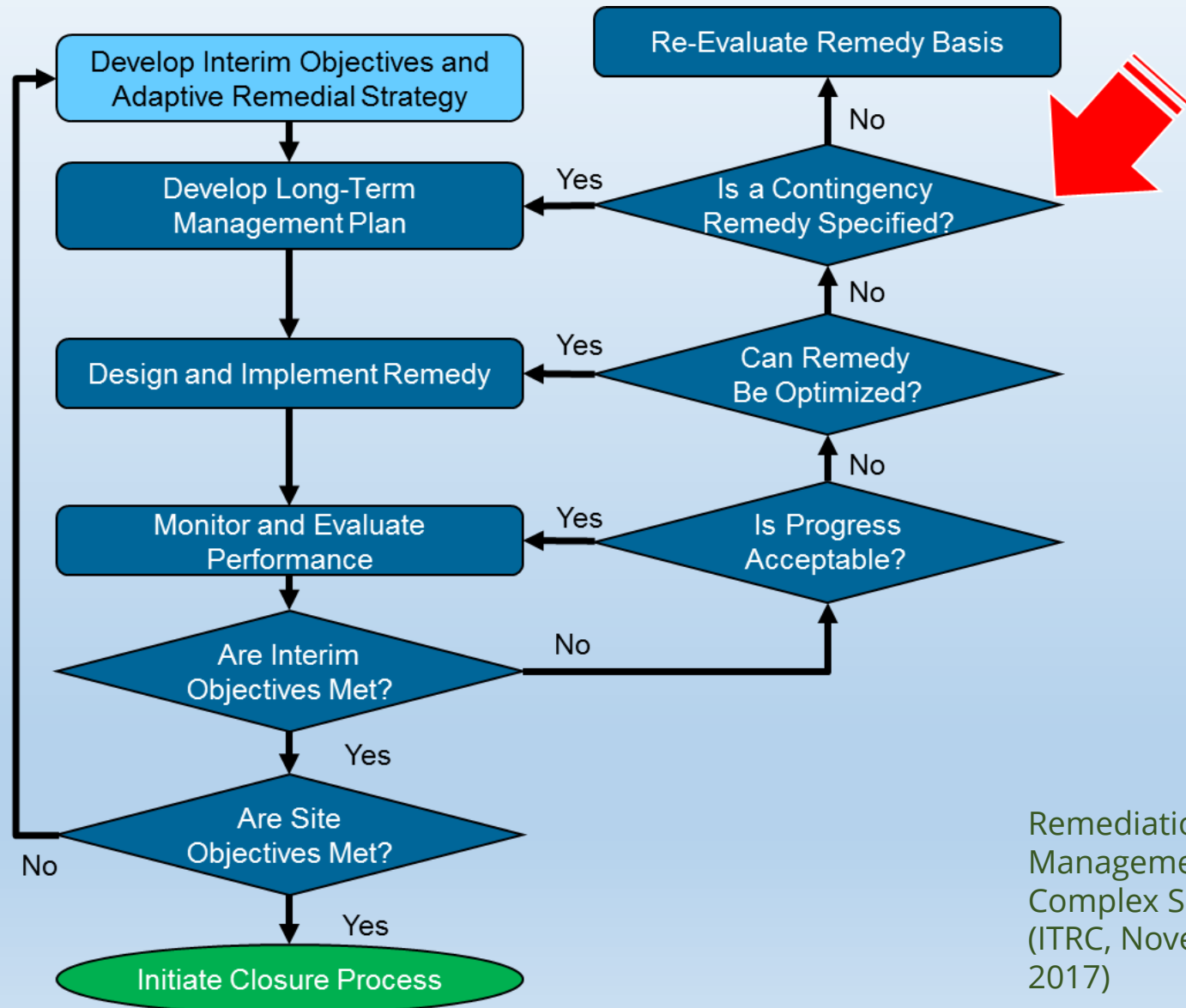

Failing to plan is planning to waste a lot of _____ (fill in the blank).

"CAP to Closure"

- Does your agency require one?
- What does this mean?
- Do you usually reach closure in one try?
- Is the CAP* ever updated?
  - How (and how often) are modifications made?
  - How are costs reconciled?
- How do you judge remedial progress?

*CAP = Corrective Action Plan

Adaptive Site Management

Remediation Management of Complex Sites (ITRC, November 2017)

21 Technology "Tools"

1. Excavation
2. Skimming
3. Vacuum enhanced skimming (LNAPL & vapor)
4. Total liquid extraction (LNAPL & water)
5. Multi-phase extraction (LNAPL, water, & vapor)
6. Water/hot water flooding
7. Surfactant-enhanced subsurface remediation
8. Cosolvent flushing
9. Steam injection
10. Electrical resistance heating
11. Air sparging / soil vapor extraction (AS/SVE)
12. In-situ chemical oxidation
13. Natural source zone depletion (NSZD)
14. Physical or hydraulic containment (including PRBs)
15. In-situ soil mixing (stabilization)
16. Thermal conduction heating
17. In-situ smoldering
18. Biosparging / bioventing
19. Enhanced anaerobic biodegradation
20. Activated carbon
21. Phytotechnology

LNAPL Site Management: LCSM Evolution, Decision Process, and Remedial Technologies (ITRC, March 2018)

Not Included in Technology Tables

1) Manual Bailing

2) Periodic or Short-term Vacuum Truck Events

3) Passive Skimmers

4) Absorbent Socks

WHY NOT?

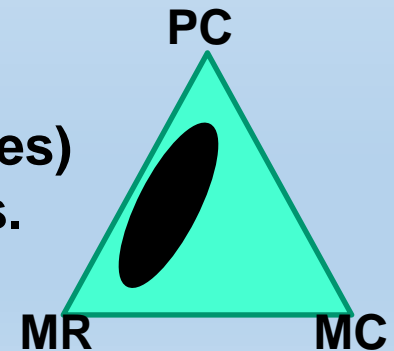The mass recoverable is insignificant compared to the whole
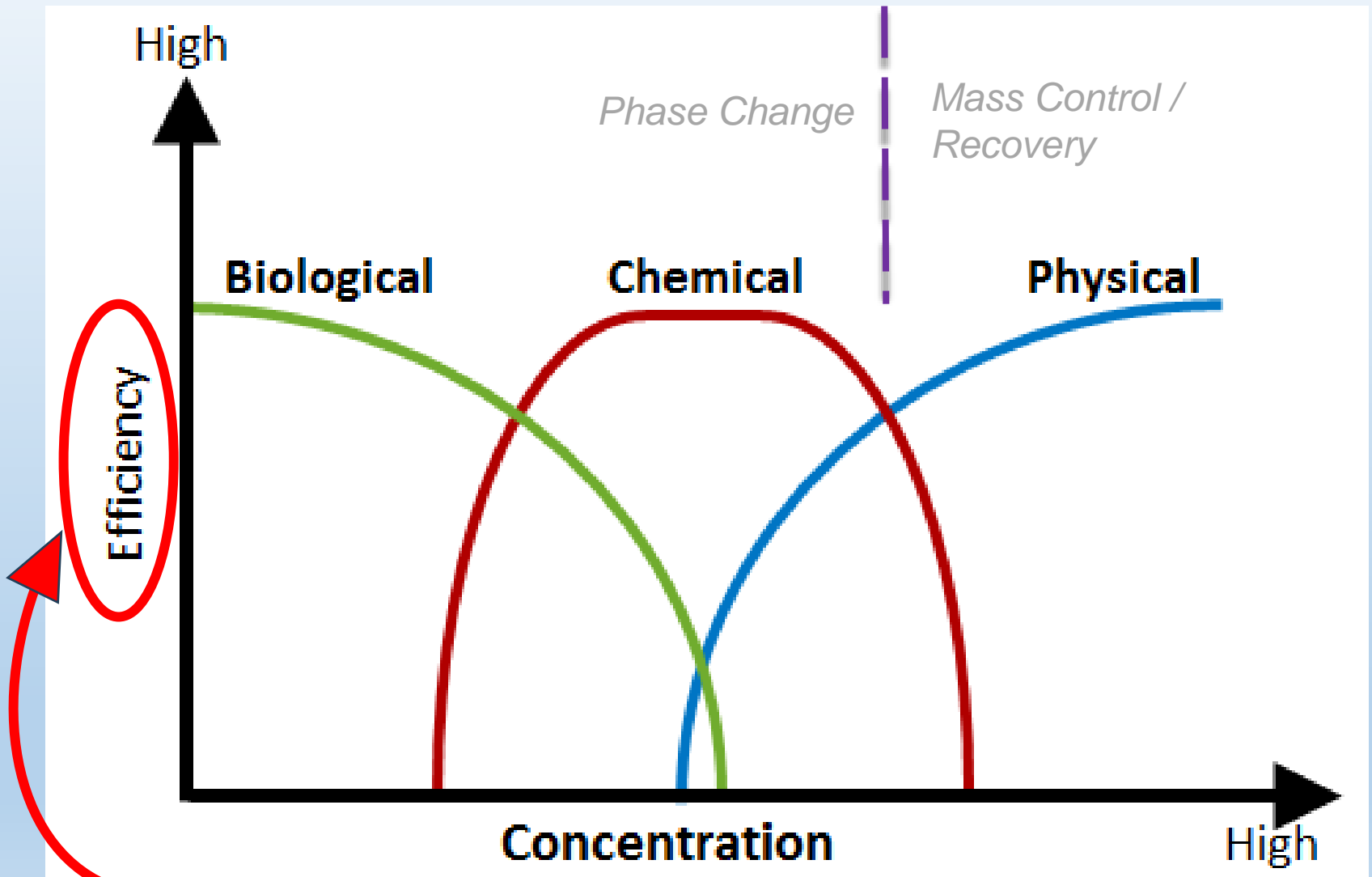
(*but it may be required by regulation*)

LNAPL Remedial Technology Groups

- **Mass Control** - Contain LNAPL at a defined boundary

- **Mass Recovery** - Remove LNAPL mass to limit migration

- **Phase Change** - Abate unacceptable COCs

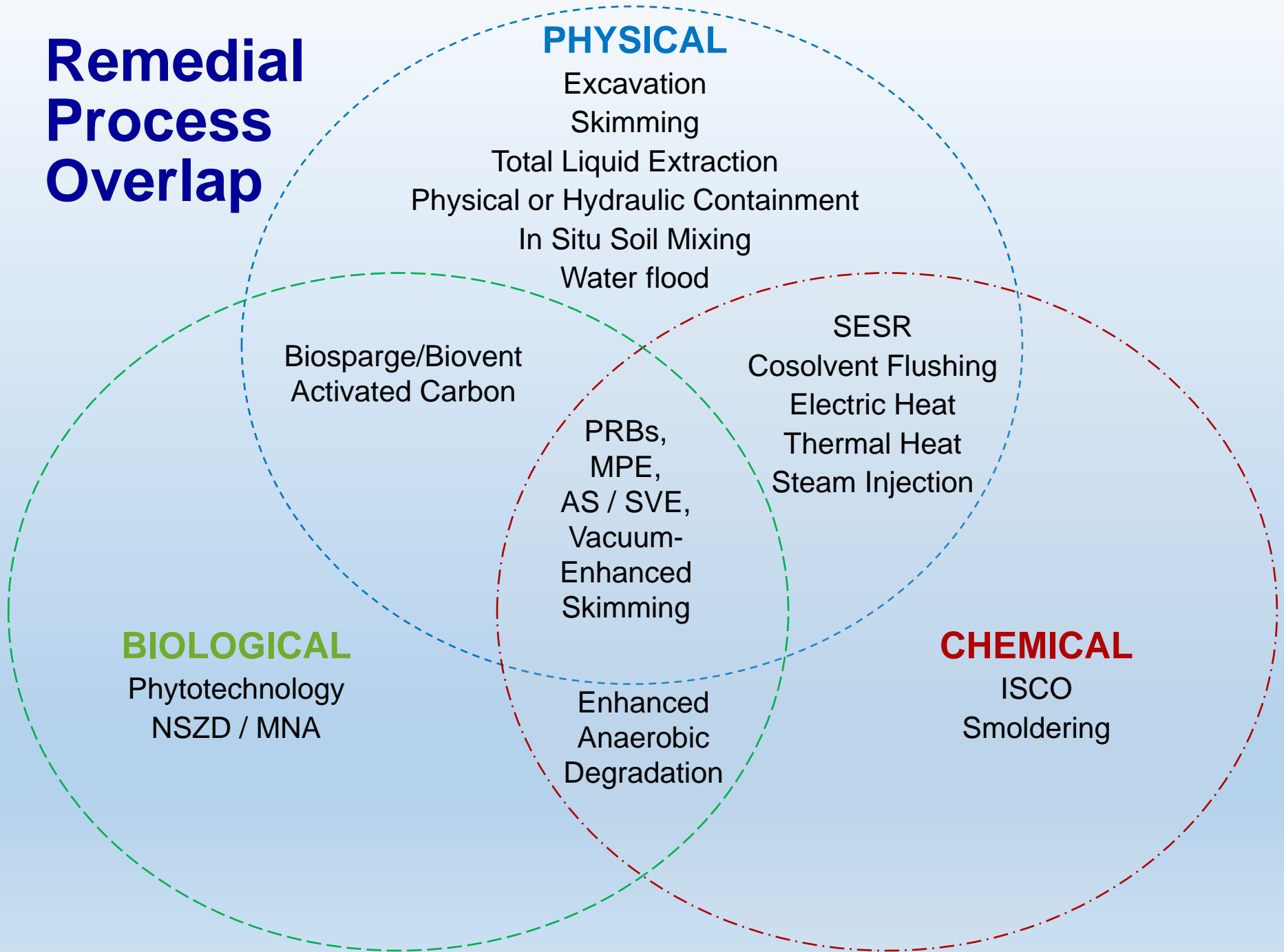**Technologies (i.e. processes) sometimes overlap groups.**

PC

MR   MC

Processes

Remedial Process Overlap

PHYSICAL
Excavation
Skimming
Total Liquid Extraction
Physical or Hydraulic Containment
In Situ Soil Mixing
Water flood

Biosparge/Biovent
Activated Carbon

SESR
Cosolvent Flushing
Electric Heat
Thermal Heat
Steam Injection

PRBs,
MPE,
AS / SVE,
Vacuum-
Enhanced
Skimming

BIOLOGICAL
Phytotechnology
NSZD / MNA

Enhanced
Anaerobic
Degradation

CHEMICAL
ISCO
Smoldering

Technically Achievable

Examples Include:

Remedial Mechanism

1. LNAPL Recoverability

2. Volatilization
   - AS
   - SVE

3. Injection
   - ISCO
   - Carbon

4. Biodegradation
   - Biovent / Biosparge
   - NSZD/MNA

Technically Achievable Limit

LNAPL Transmissivity
(0.1 to 0.8 ft^2/day)

Vapor Pressure (> ~1 kPa at 15° C)
PID emissions stable (<xxx ppm)

Soil texture limits delivery of
oxidant / other media

Rate of degradation won't achieve
goal in timeframe

"Treatment Train"
(Consecutive Remedies)

- <u>PLANNING</u> to use multiple remedial technologies *in sequence* to achieve closure

- Sequence remedial technologies based on contaminant concerns and remedial objectives

  1. Start with a primary technology (excavation?) tailored for higher contaminant mass

  2. Continue with a 2nd treatment technology (ISCO?) and possibly a 3rd polishing step (CBI?) for remaining contaminant mass

Treatment Trains

Bad

▶ Unplanned, lack SMART objectives, no or poor metrics for transition, milestones and endpoints uncertain

▶ "Throwing" more technologies at the problem

Good

▶ When planned with SMART objectives; metrics for progress / transitions; milestones and endpoints defined
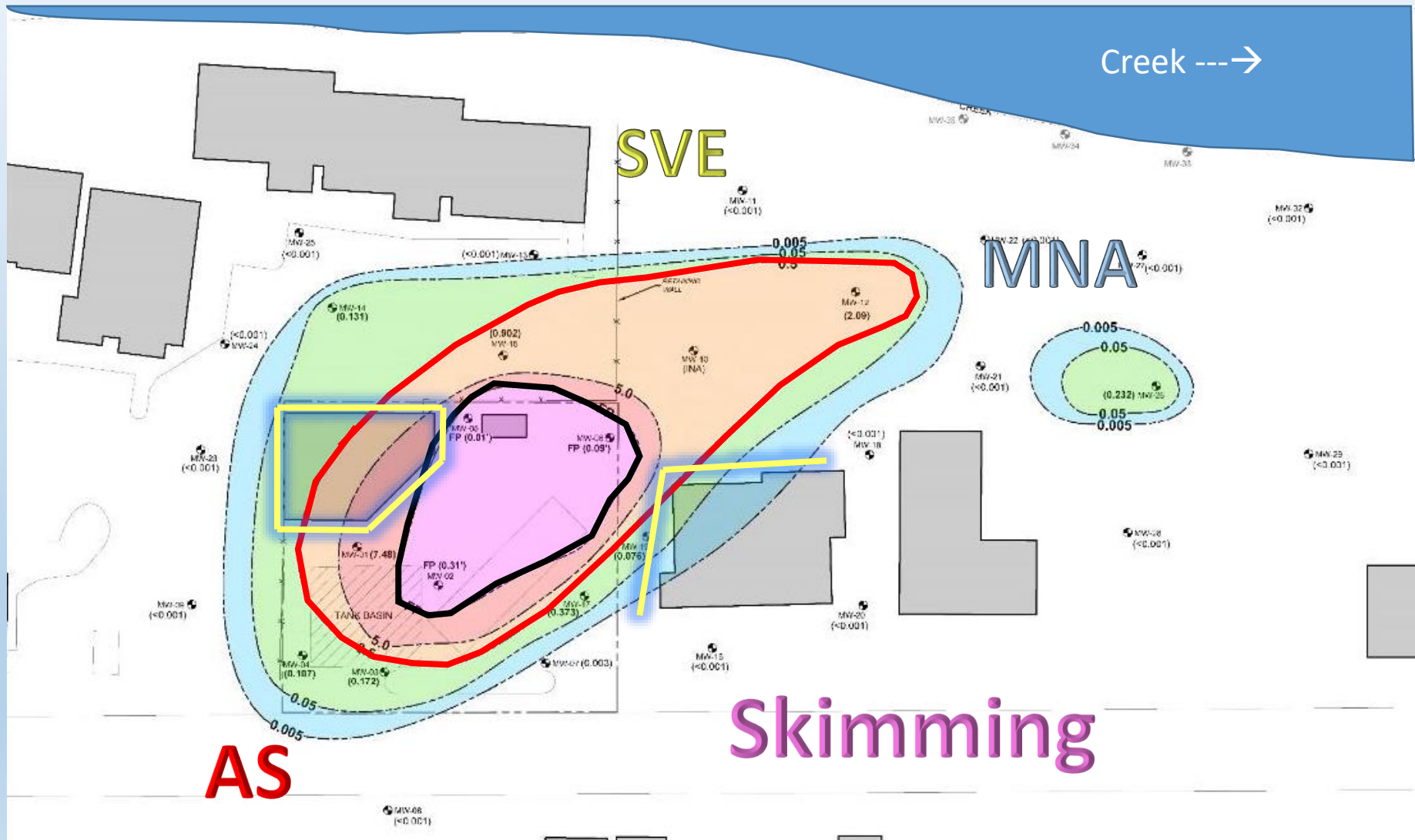
▶ Orderly implementation!

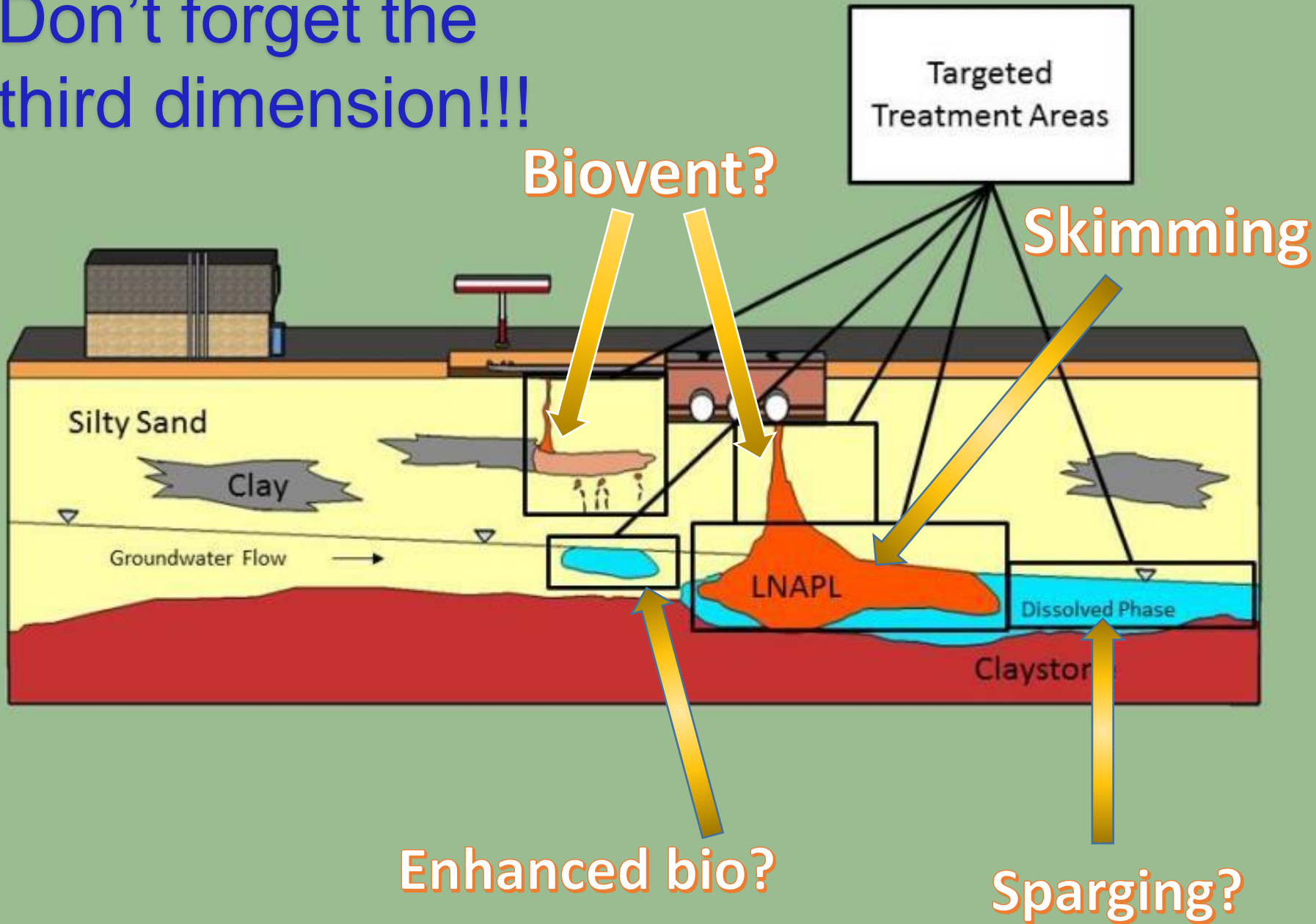**Key question to ask:**

THEN what will you do?

Concurrent Remedies

- Using multiple technologies on a site at the same time, in *different target zones* due to differing contaminant concentrations

  - Use primary technologies in the source area (e.g. excavation).

  - Use secondary or tertiary technologies on <u>periphery</u> of contaminated area, and in deeper zones.

- Still rely on SMART performance metrics to measure remedial progress

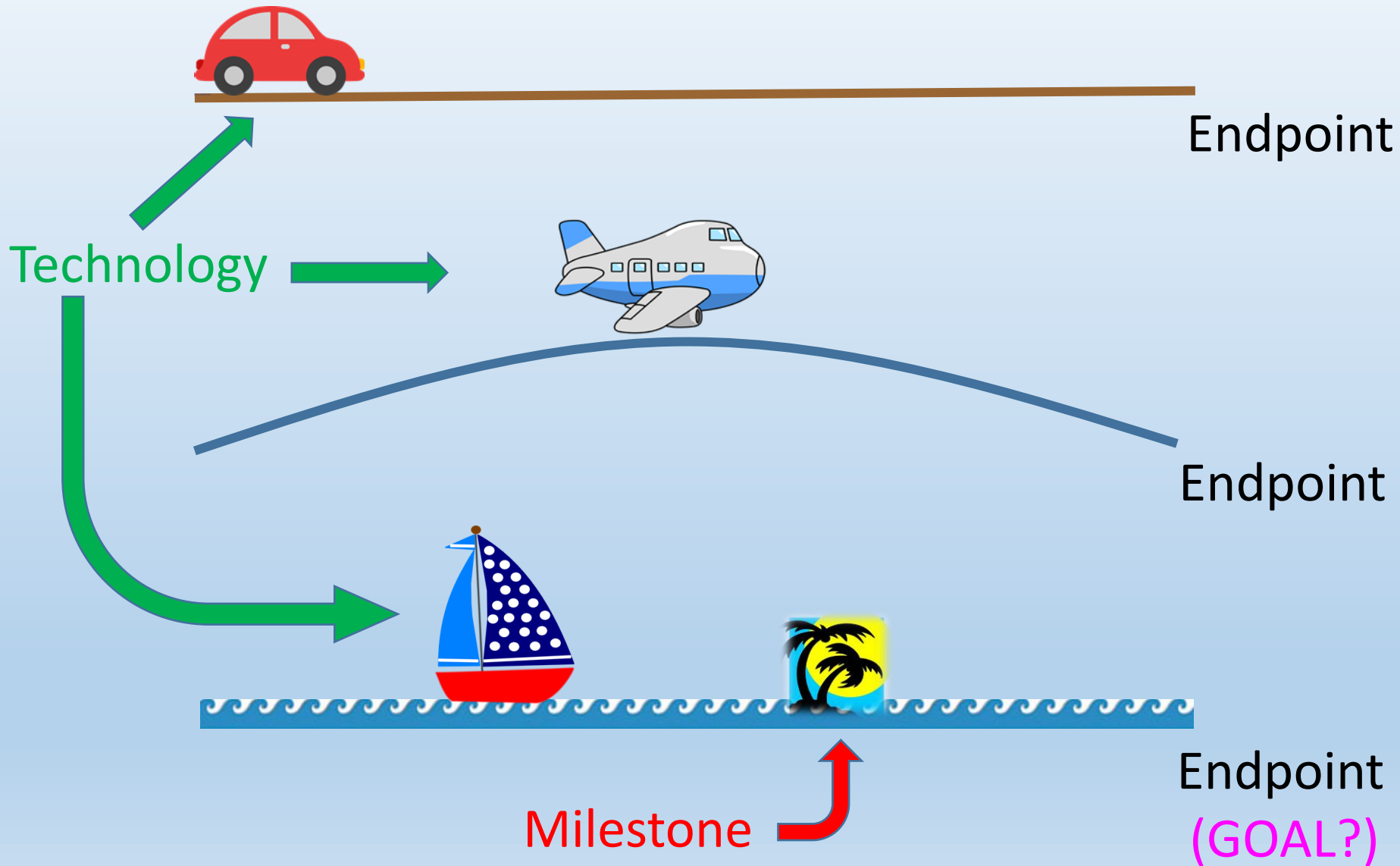# Example: Treatment Areas

Don't forget the
third dimension!!!

Targeted Treatment Areas

Biovent?

Skimming

Silty Sand

Clay

Groundwater Flow

LNAPL

Dissolved Phase

Claystor

Enhanced bio?

Sparging?

"My Vacation"

Technology

Endpoint

Endpoint

Milestone

Endpoint
(GOAL?)

THE 'ART' IN *SMART*?

- **S**pecific - Targeted treatment area and technology-specific endpoints are clearly stated

- **M**easurable – Performance metrics that demonstrate progress towards the endpoint

- **A**greed Upon – Concerns, goals, objectives, treatment areas, metrics, endpoints

- **R**ealistic – Demonstrated ability to achieve objective

- **T**ime-Based – Target date of remedial endpoint being achieved

Performance Metrics

Measurable characteristics that track the progress of a *selected technology* to achieve a remedial objective and abate a contaminant concern

ASK: What conditions do you expect to change as you remediate the site? And how quickly?

Performance Metrics

- Technology-specific!

- Track progress toward endpoint

- Verify that remedy is being implemented
  effectively

- Allow for mid-course corrections

- Allow for CSM updates
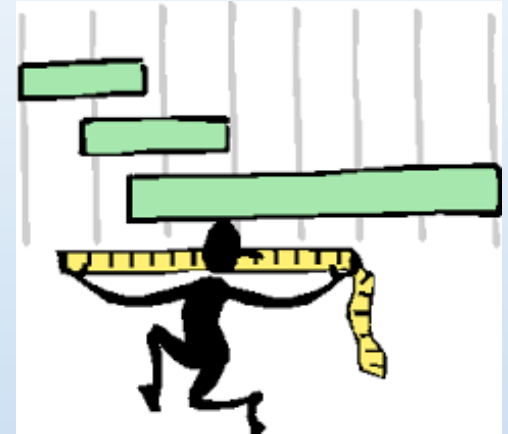
Performance Metrics Examples
(What you can measure)

- AS/SVE – Concentrations in emission samples (e.g. PID, benzene, CO_2, CH_4)

- ISCO - Data to evaluate distribution of an in-situ application (e.g. pH, ORP, DO, SO_4^{-2})

- SVE - Interim or final soil confirmation samples

- MNA – Organic/ inorganic/ biological samples
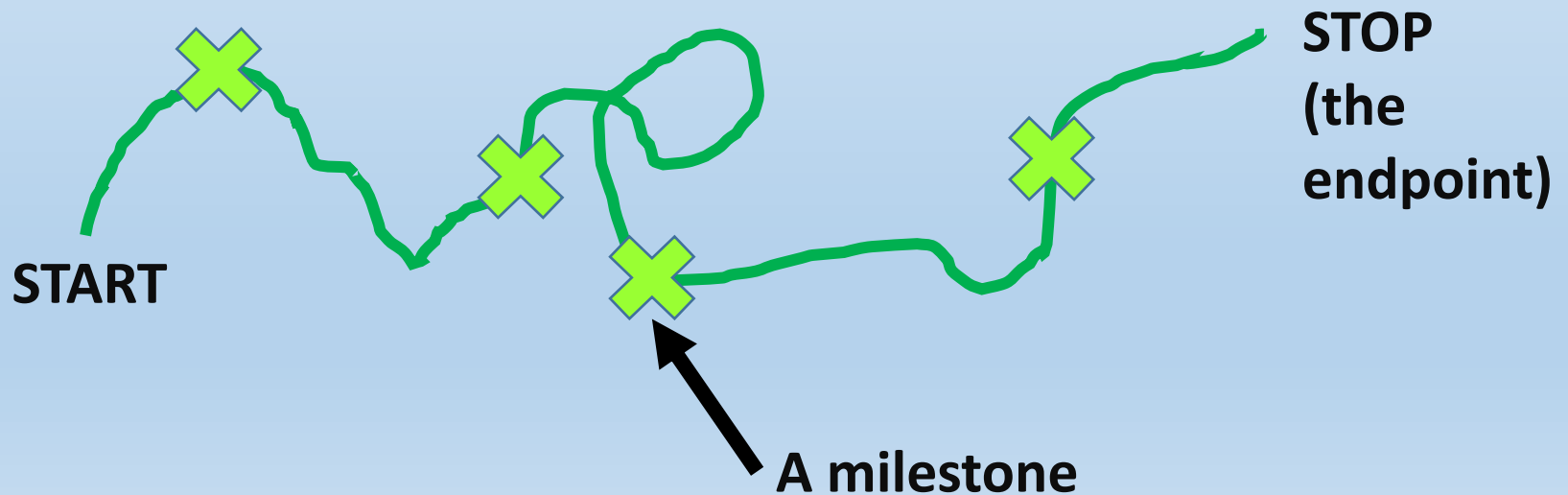
All of these parameters require a timeframe

Performance implies progress.
Progress occurs at a RATE.

- *When* will you measure?
- How *frequently* will you measure?

At what rate is progress insufficient?

Remedial Milestones
(Interim Objectives)

Points to evaluate progress towards a remediation technology endpoint

(a schedule)

START

STOP (the endpoint)

A milestone

Remedial Milestone Examples

- LNAPL reduction = 10% of volume estimate per quarter / per month

- Emissions decrease 25% per quarter / per month

- Dissolved phase concentrations remediated to 25%, 50%, 75% of endpoint (with timeframe)
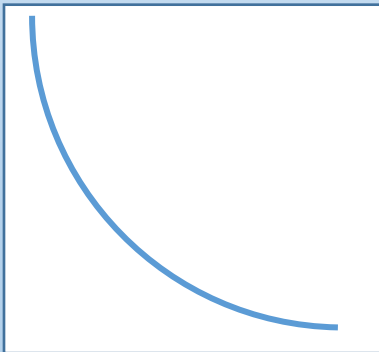
Remember!
Declines are exponential, not linear
(90% of the result takes 10% of the time?)

Endpoints

- Also technology-specific!
- Defined as:

1. Practicable limit of the technology reached, or

2. LNAPL concern has been addressed.

The technology's endpoint may not be your site goal!