REINHOLD ENVIRONMENTAL Ltd.

2016 NOx-Combustion-CCR Round Table Presentation

February 1 & 2, 2016, in Orlando, FL / Hosted by OUC

Groundwater Monitoring and Corrective Action

NOx-Combustion-CCR Round Table

February 1, 2016

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Senior Technical Leader
Electric Power Research Institute

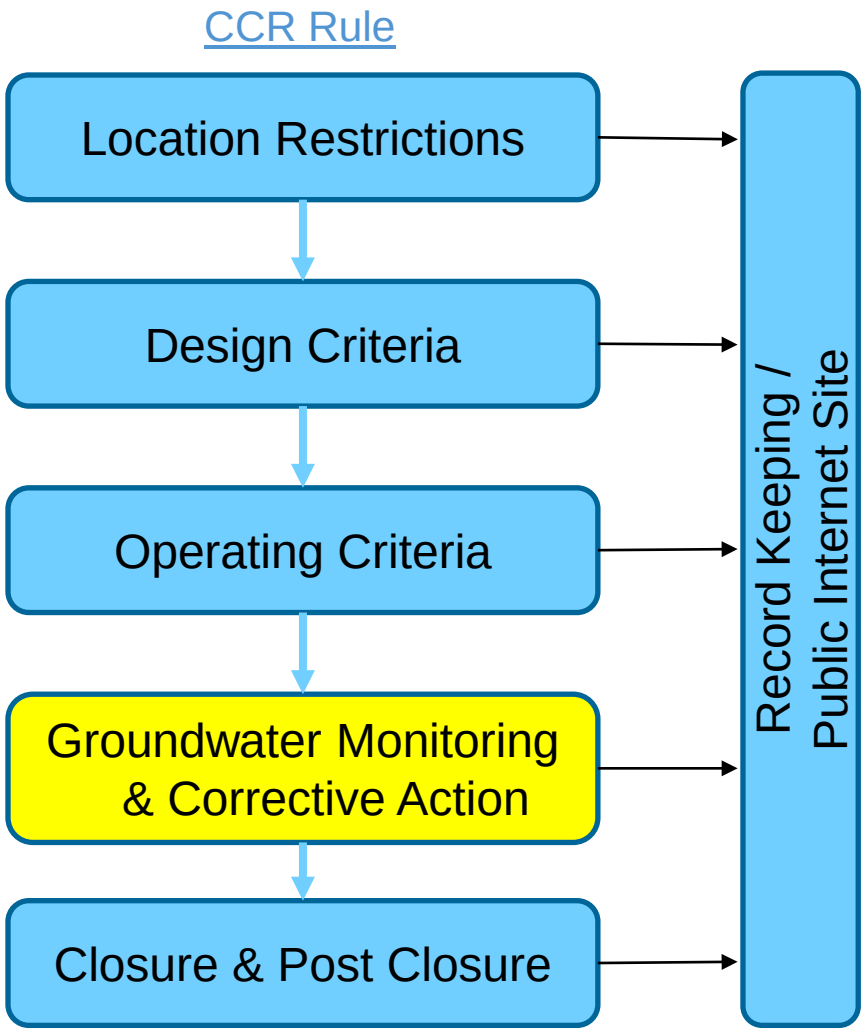
Topics

- Groundwater Monitoring
  - Overview
  - Drivers
  - Approach
  - Resources
- Corrective Action
  - Overview
  - Technologies applicable to CCR
  - Technology trends
  - Resources

Groundwater Monitoring

Groundwater Monitoring Overview

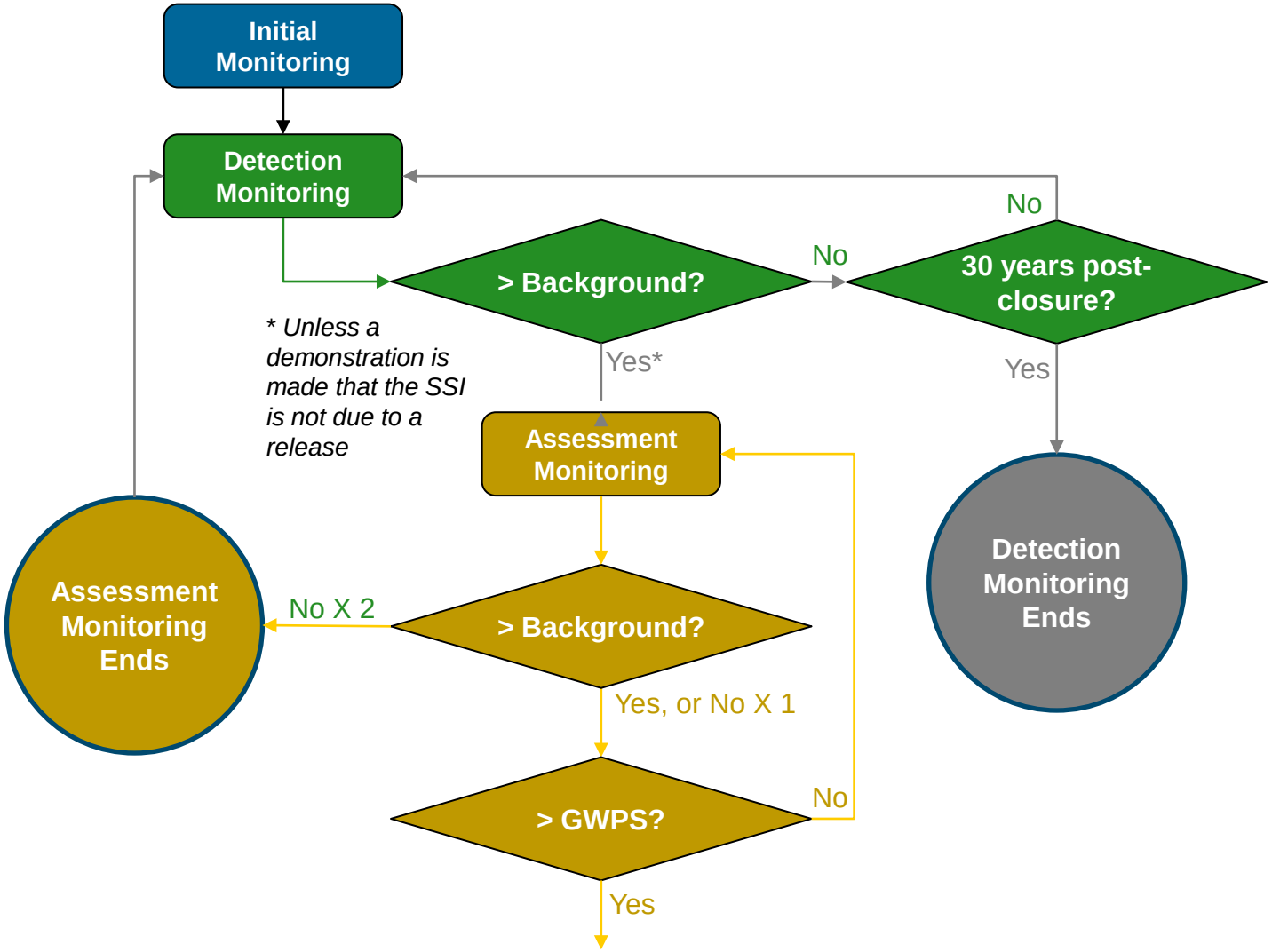
- Objective:
  - Determine whether or not there is a release to GW from the facility
- Approach:
  - Dependent on authority: CCR rule, state rules, or both
  - Characterize hydrogeology
  - Install groundwater monitoring system
  - Select monitoring parameters
  - Sampling and laboratory analysis
  - Statistical analysis
  - Reporting
- Potential actions if release detected:
  - Continued monitoring
  - Corrective action
  - Closure



Drivers

- Characterize hydrogeology
  - Site specific
  - State rules may specify minimum requirements
- Install groundwater monitoring system
  - Site specific
  - CCR rule and many state rules specify minimum requirements
- Select monitoring parameters
  - CCR rule specifies parameters
  - State rules may specify parameters, and/or may allow for site-specific considerations
- Sampling and laboratory analysis
  - Minimum requirements specified by rules
- Statistical analysis
  - Required for monitoring under CCR rule
  - Required by some, not all, states
- Reporting
  - Public under CCR rule
  - Typically to regulatory agency under state rule

Overview of Groundwater Monitoring Under the CCR Rule



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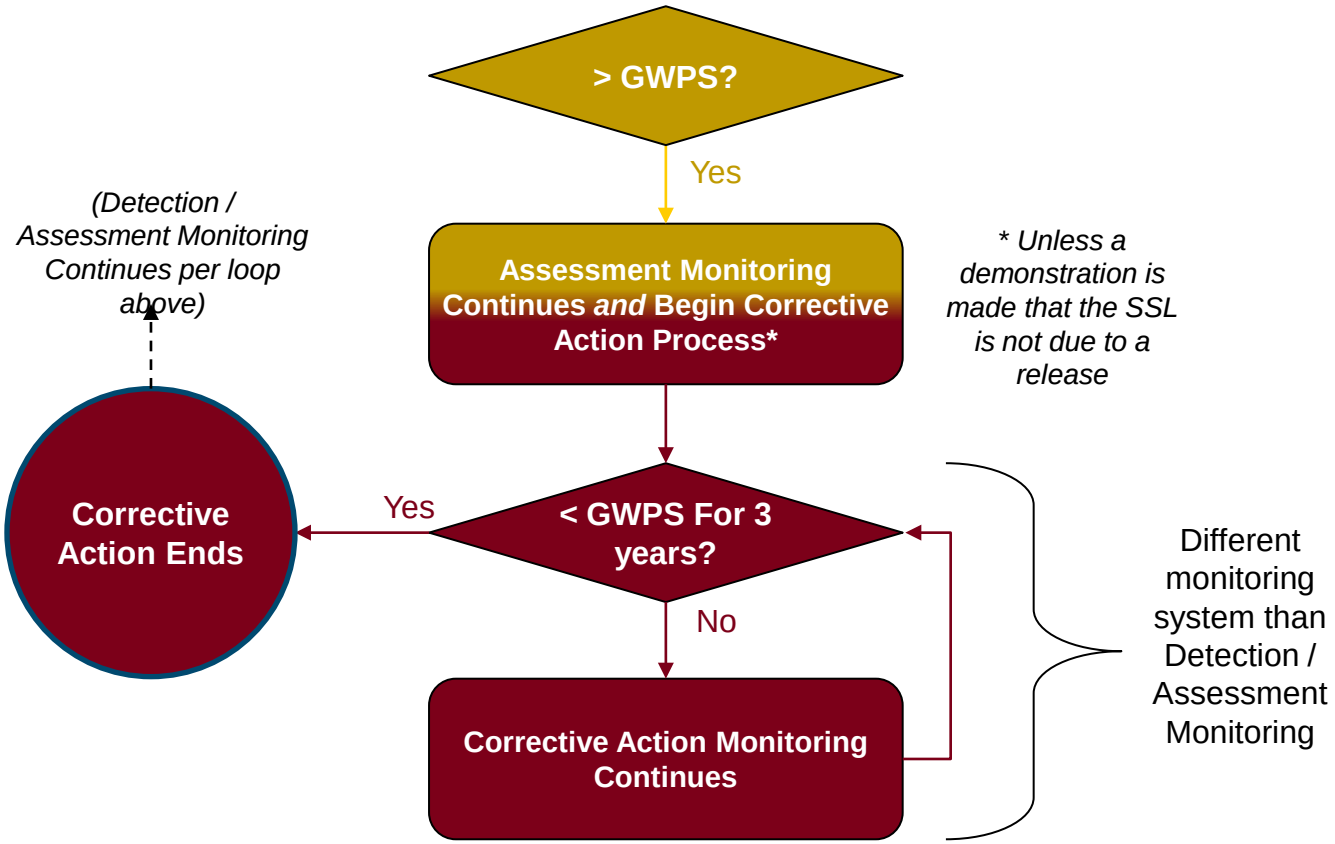
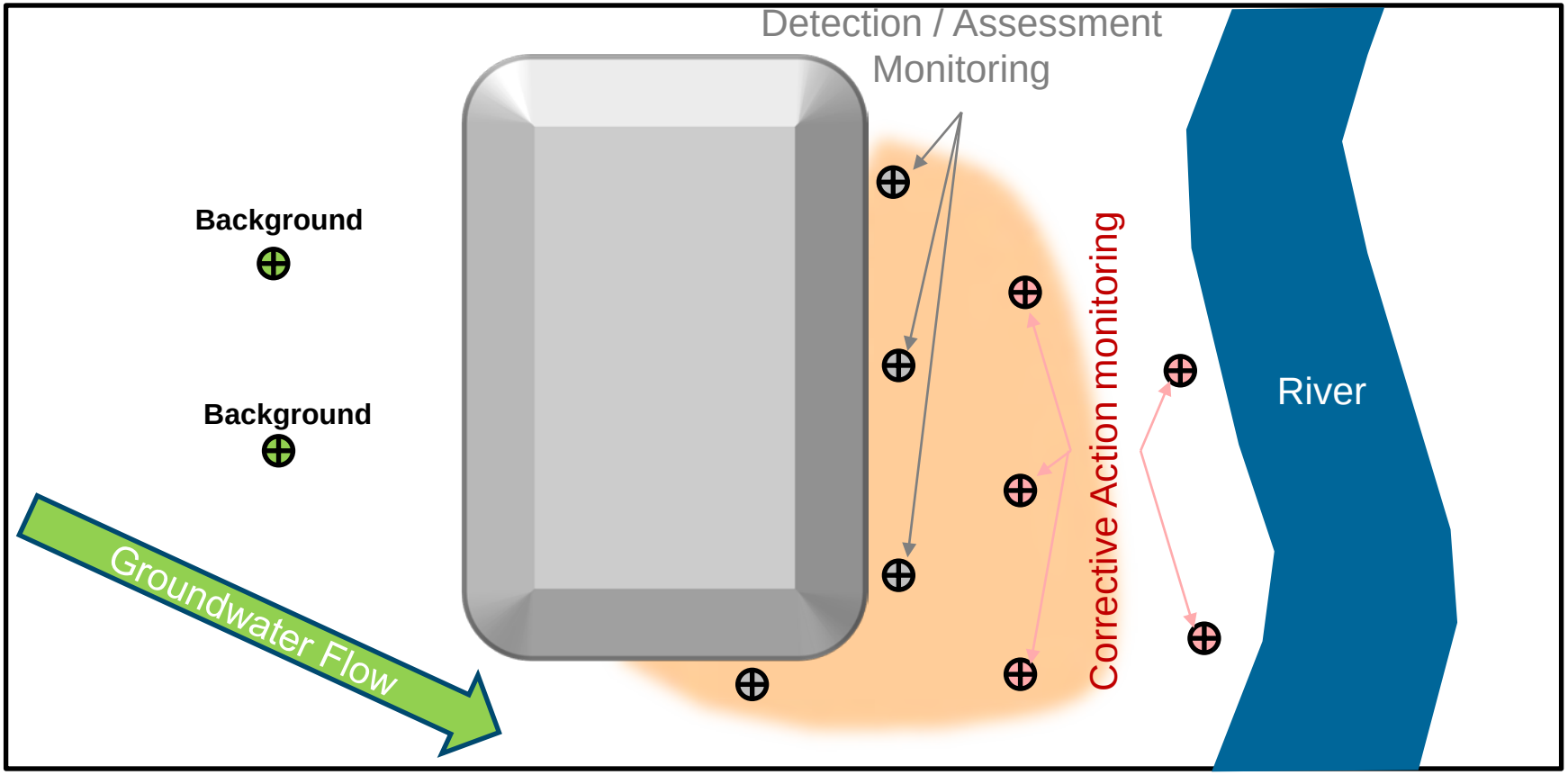
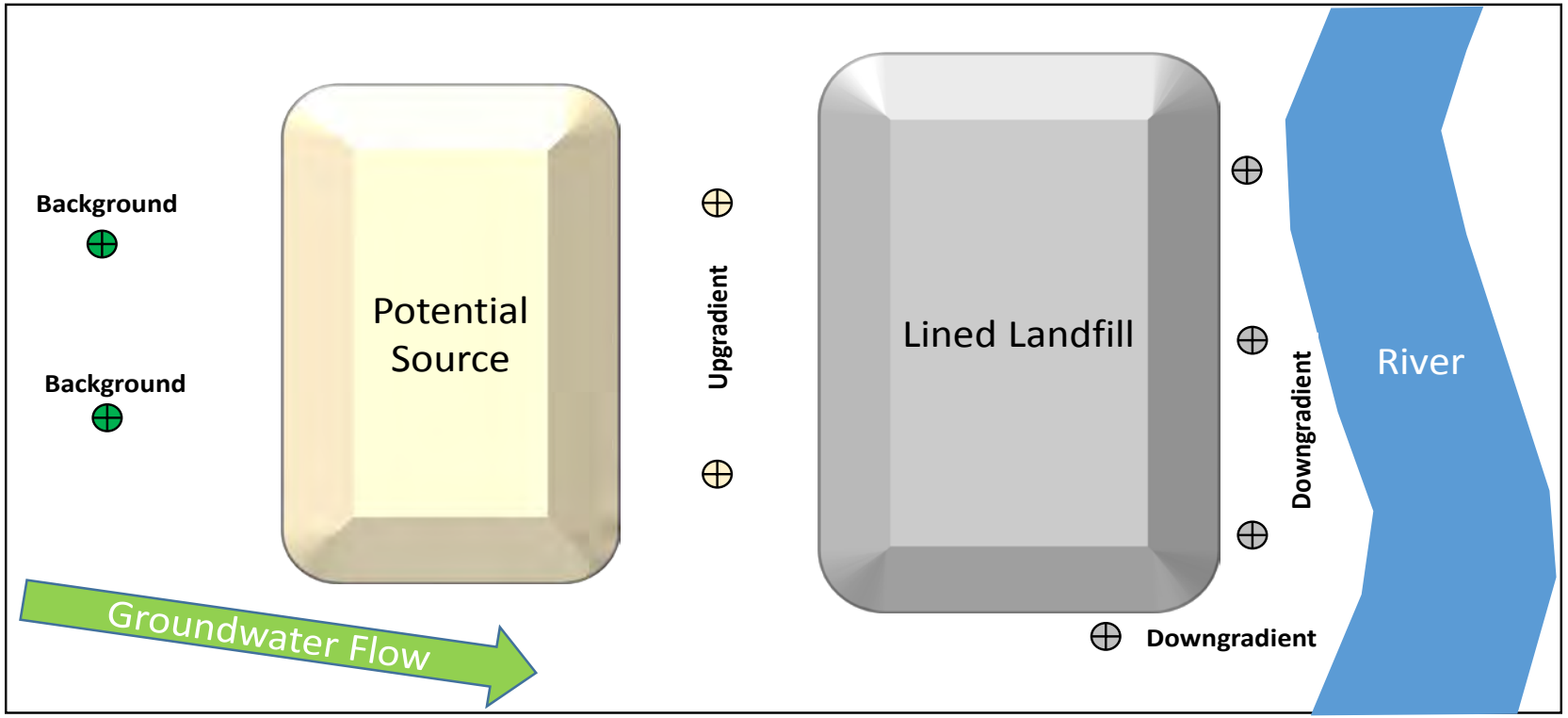
Overview of Groundwater Monitoring Under the CCR Rule (continued)



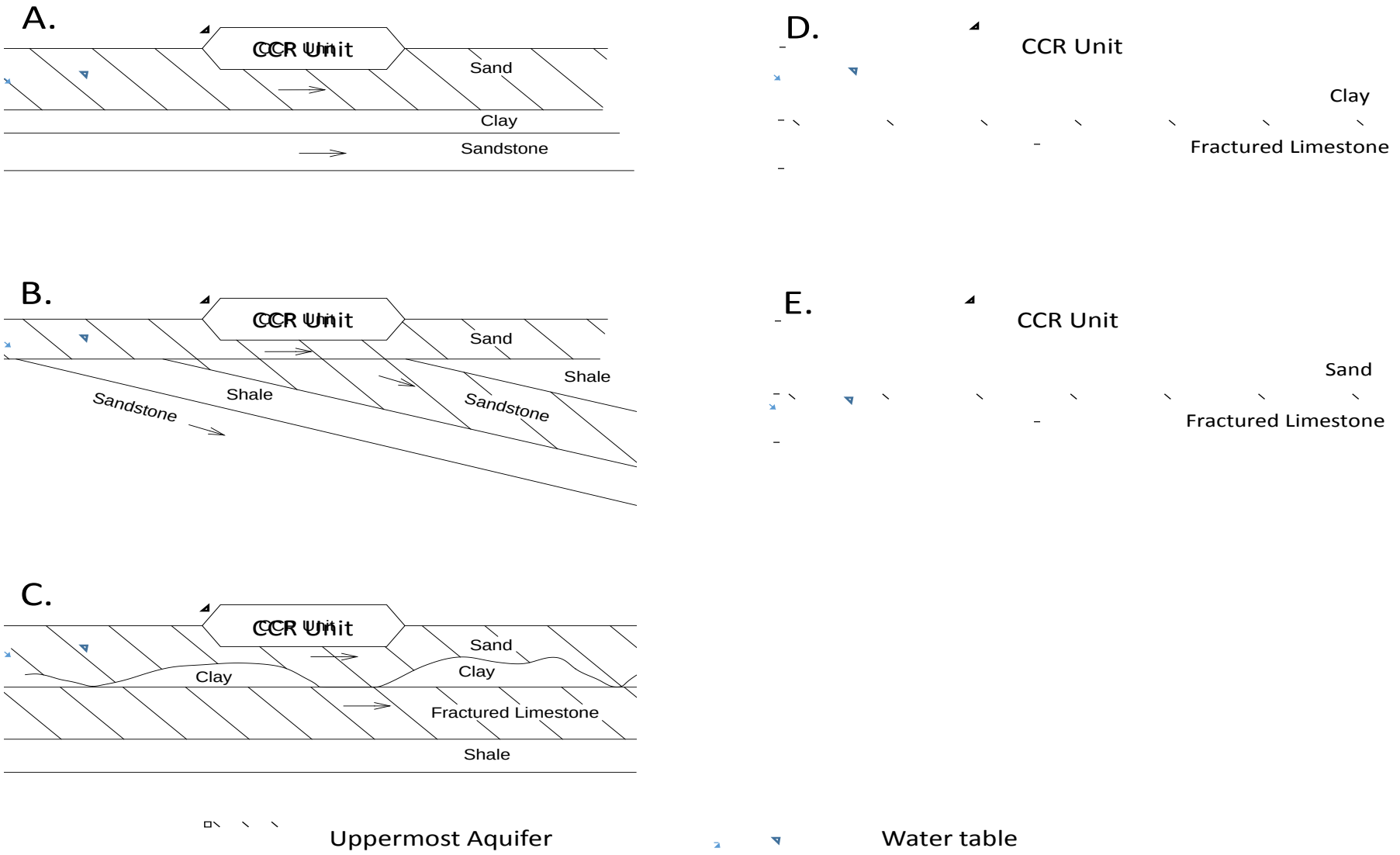
Groundwater Monitoring Systems



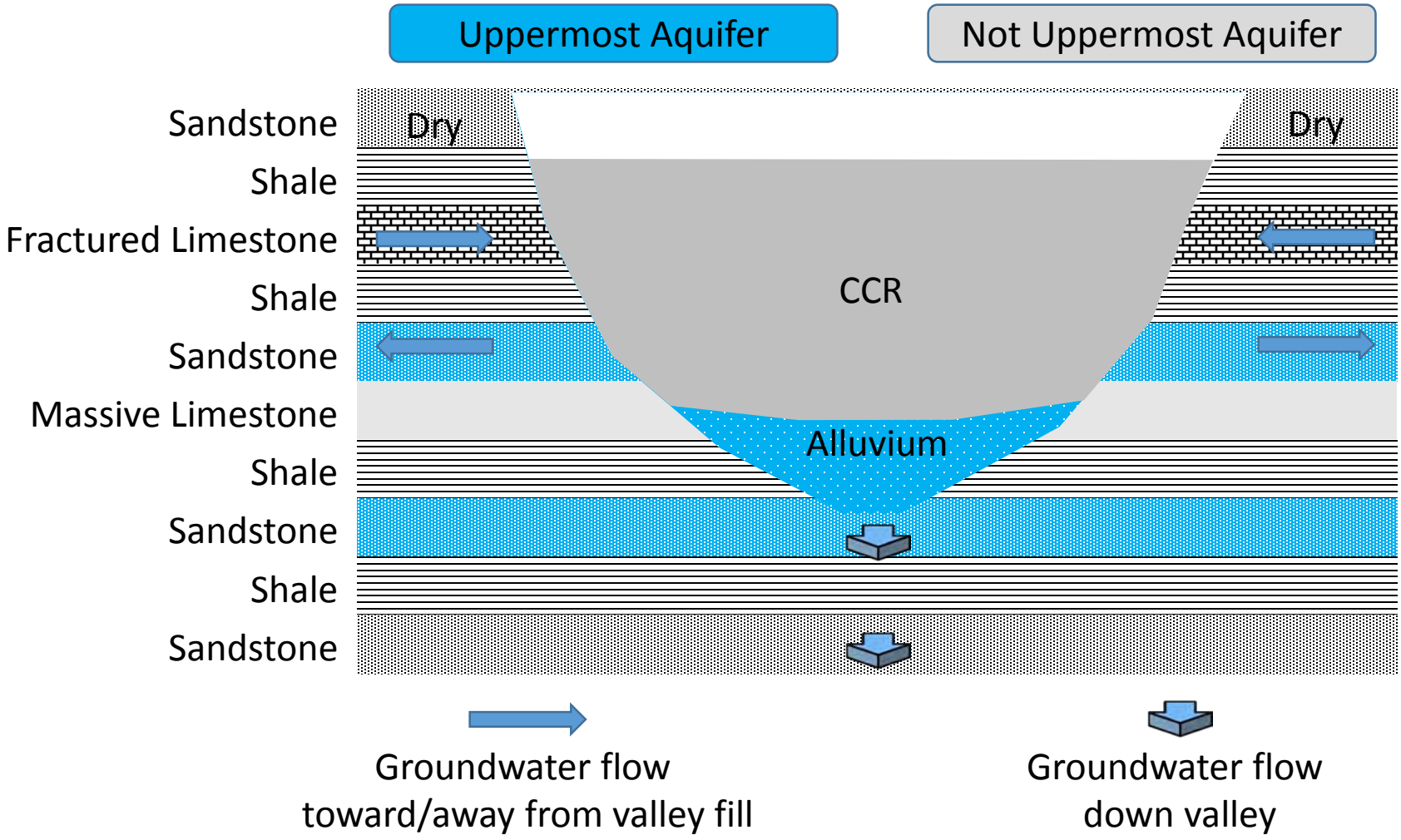
Groundwater Monitoring Systems



Groundwater Monitoring System: Uppermost Aquifer

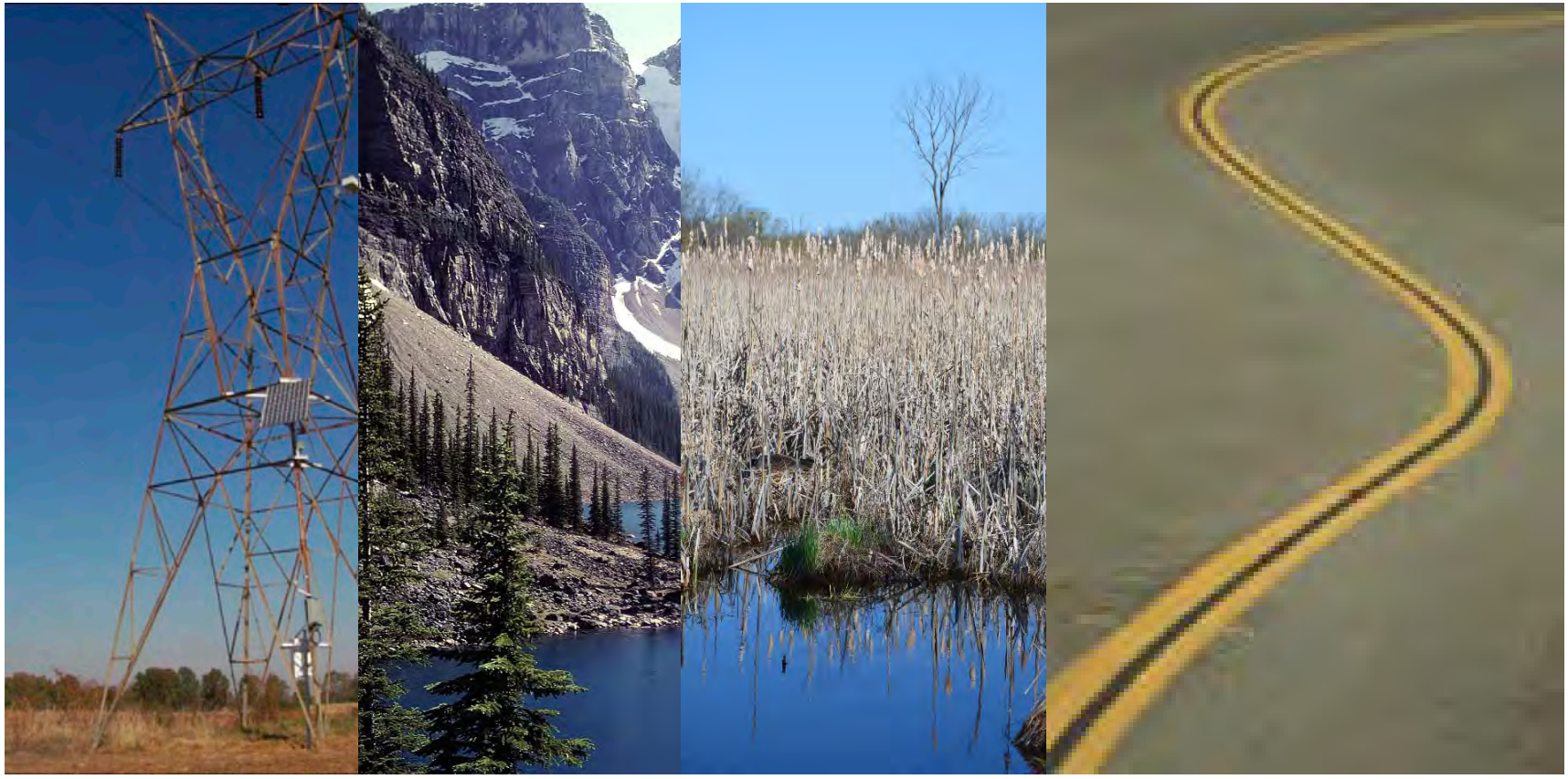


Groundwater Monitoring System: Uppermost Aquifer



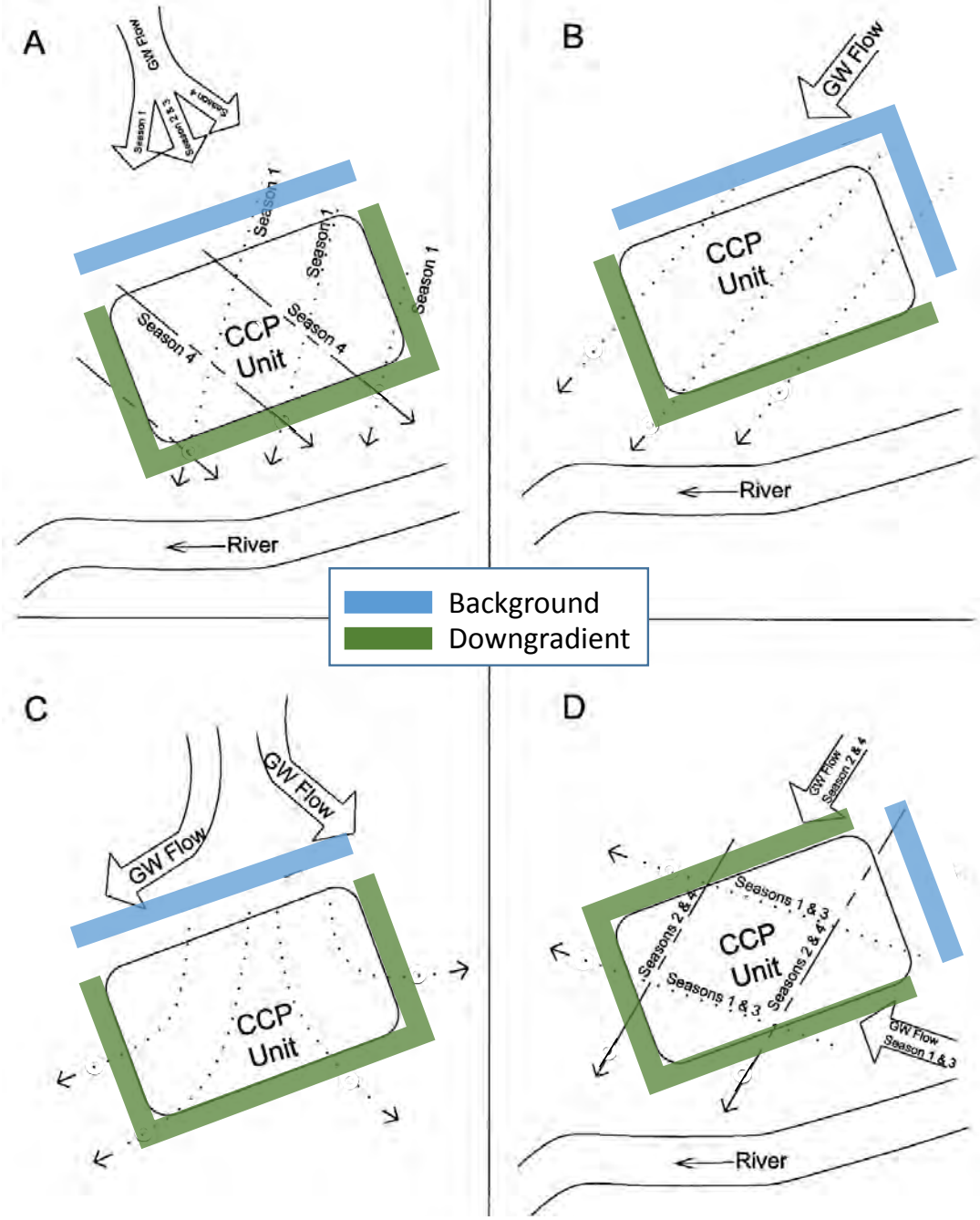
Groundwater Monitoring System: Compliance Boundary

- State rules: variable, including specific distances and/or performance standards
- CCR rule: “at the hydraulically downgradient perimeter (i.e., the edge) of the CCR unit or *at the closest practical distance from this location” (*80 FR 21400)

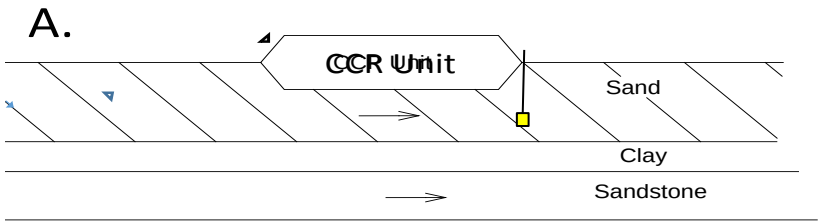


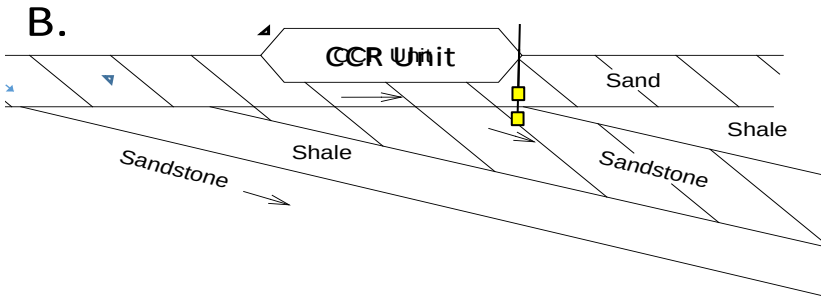
Groundwater Monitoring System: Well Placement

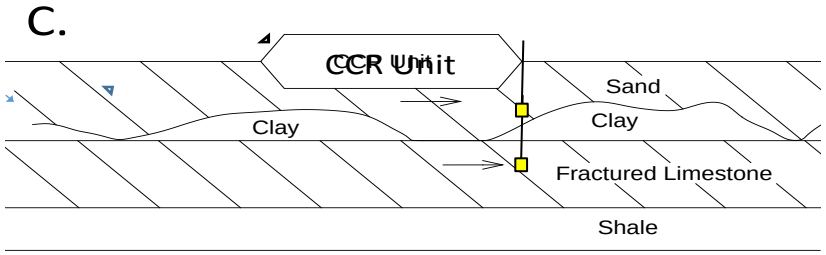
- Site-specific to account for hydrogeology and variations in flow direction
- At least 1 upgradient, more are usually beneficial
- At least 3 downgradient, most likely more than 3
- Challenges:
  - Identifying background monitoring locations representative of downgradient conditions
  - Determining appropriate spacing between wells
  - Determining appropriate vertical interval(s) to monitor in thick aquifers

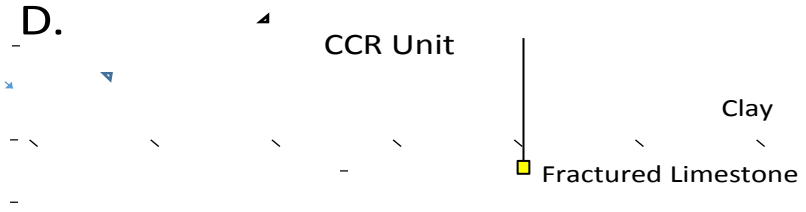


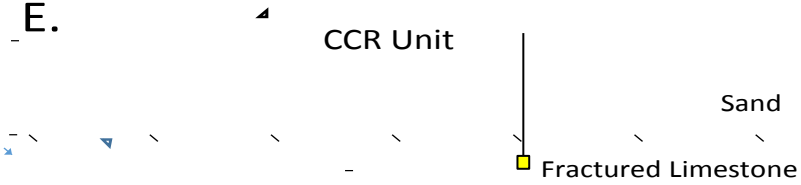
Groundwater Monitoring System: Monitoring Well Depth

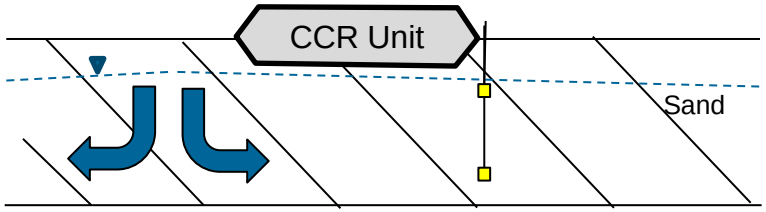












Uppermost Aquifer

Water table

Sampling and Laboratory Analysis

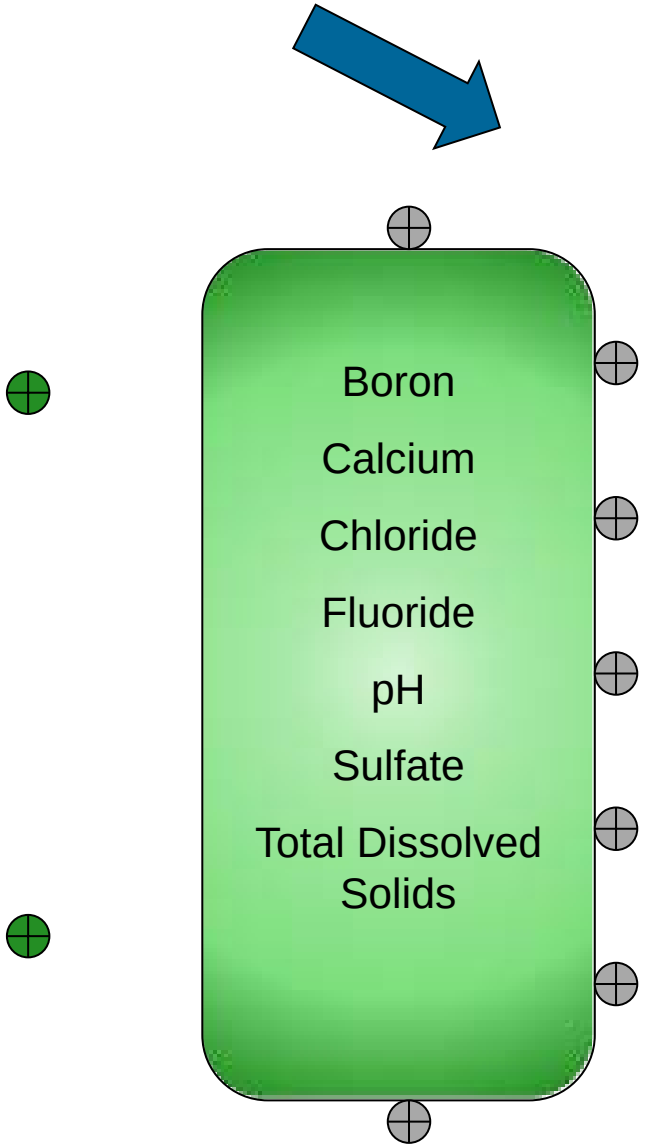
- Sampling and analysis plan
- Trained sample technicians
- Sample methods well established
- Qualified environmental laboratory
- Laboratory methods well established
- Challenges
  - Unfiltered samples required by CCR Rule and some state rules
  - Sampling from low-yield formations

Statistical Analysis

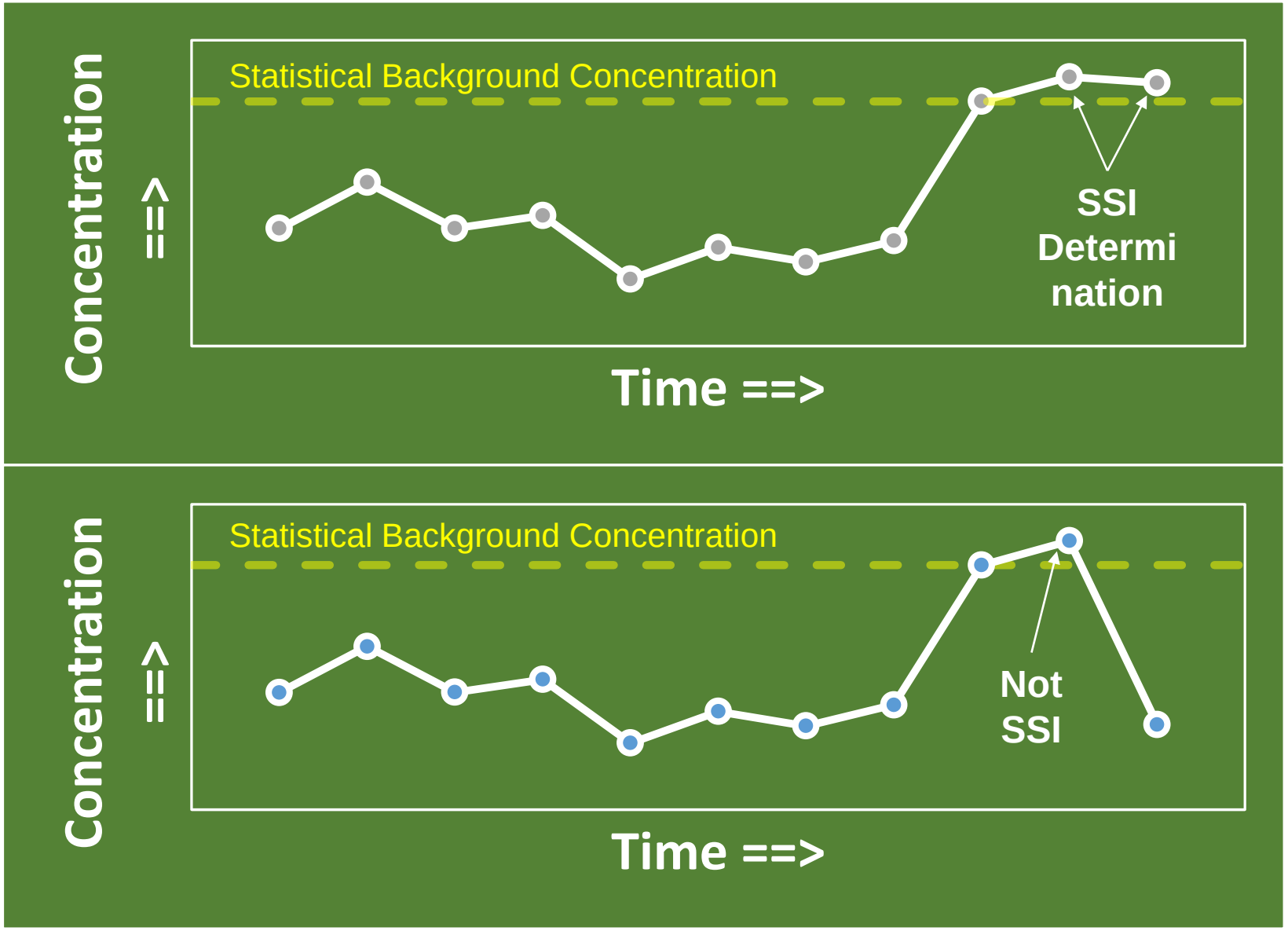
- Required under CCR rule, may be required by state programs
- CCR rule and state rules specify same statistical methods
- USEPA Unified Guidance provides information on which methods to use and how to calculate and apply
- Statistics used varies by monitoring phase (detection, assessment, corrective action), with some flexibility based on site-specific considerations
- CCR rule terminology:
  - Statistically significant increase (SSI): detection monitoring--when a downgradient concentration is statistically higher than background
  - Statistically significant level (SSL): assessment monitoring—when a downgradient concentration is statistically higher than the GWPS
  - Groundwater Protection Standard (GWPS): a threshold concentration, based on the chemical constituent's maximum contaminant level MCL), or background if higher than the MCL

Detection Monitoring

- Purpose: Early detection of a release
- Approach:
  - Monitor for relatively mobile indicator constituents
  - Compare to background
  - 30 years
- Outcome: If statistically significant increase (SSI) relative to background
  - Demonstrate exceedance not due to a release, or
  - Establish assessment monitoring program

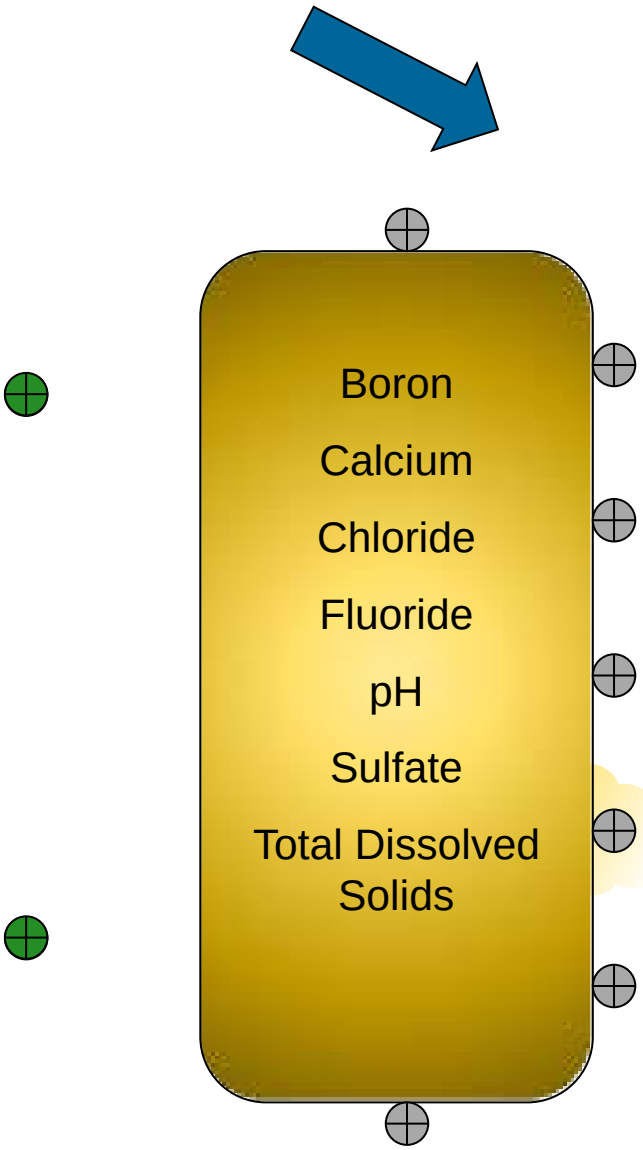


SSI Example

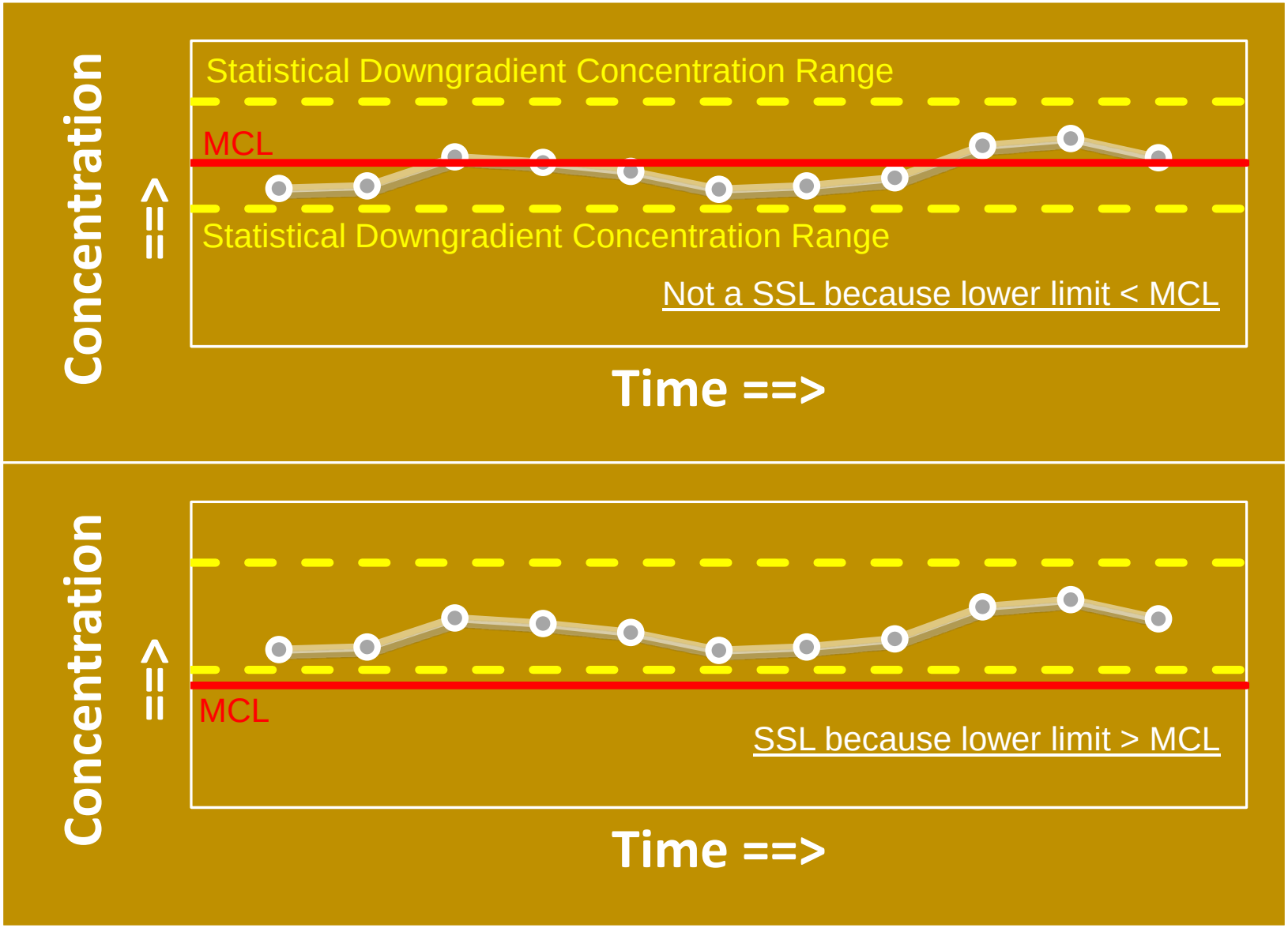


Assessment Monitoring

- Purpose: Determine if corrective action needed
- Approach:
  - Uses detection monitoring system
  - Monitor for larger list of constituents
  - Compare concentrations to MCL or background (GWPS)
- Outcome: If statistically significant level (SSL) relative to GWPS
  - Demonstrate an alternative cause, or
  - Initiate assessment of corrective action measures
  - Close or retrofit if facility is an unlined pond
- Post-closure continues as long as in Assessment monitoring

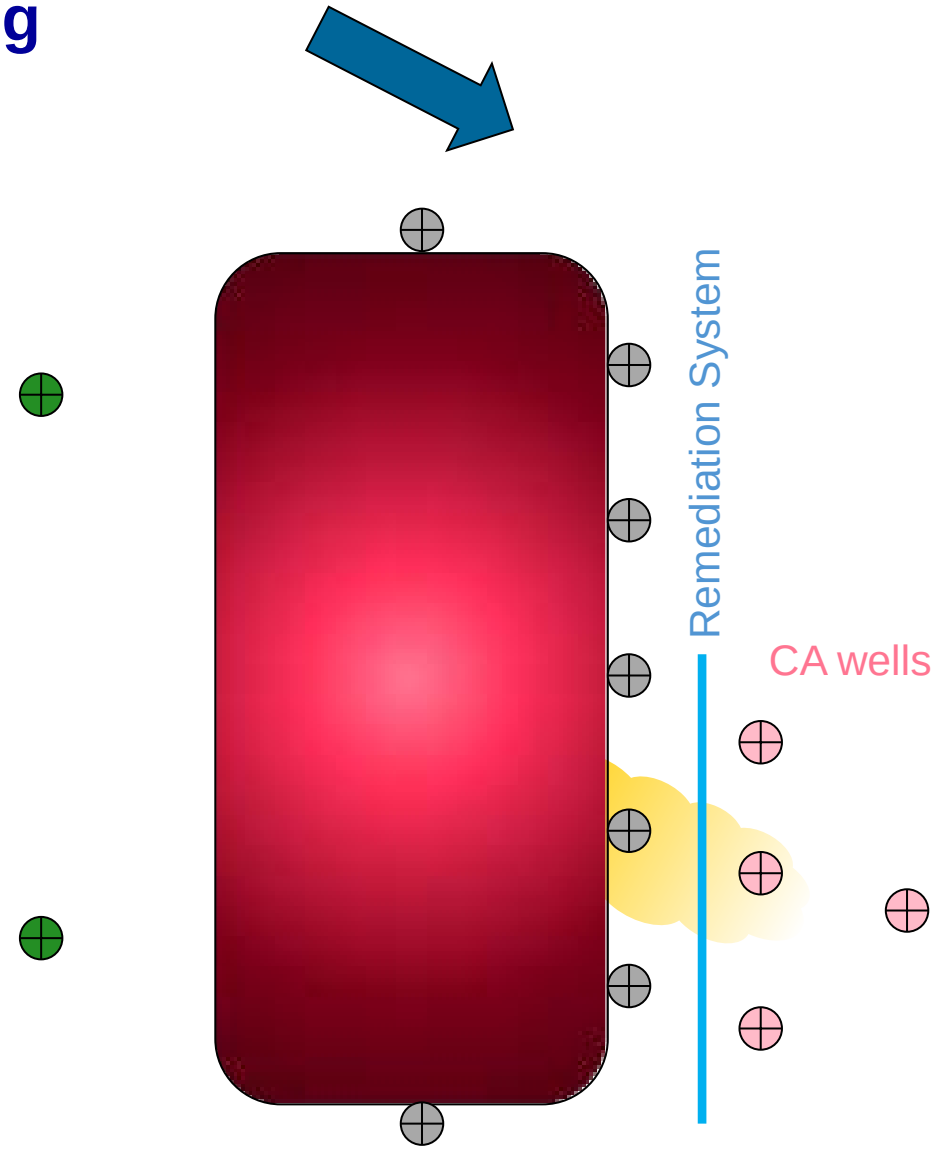


Statistically Significant Level Examples

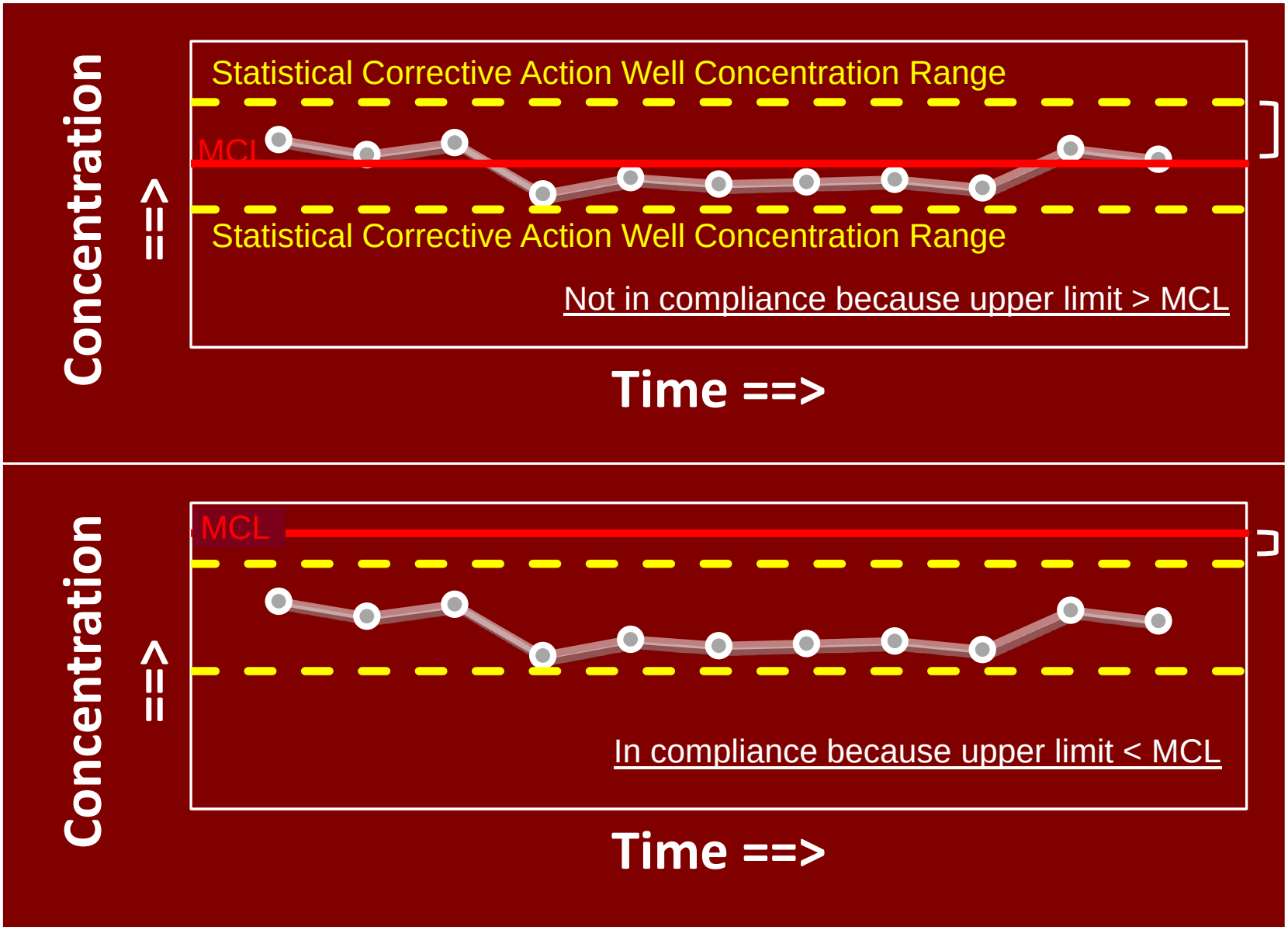


Corrective Action Monitoring

- Purpose:
  - Determine effectiveness of selected remedy
  - Determine if GWPS attained for Appendix IV parameters
- Approach:
  - Additional investigation / wells / monitoring
  - Monitor for Detection and Assessment monitoring constituents
- Outcomes:
  - Implement different corrective action if concentrations do not decrease
  - Return to assessment monitoring when GWPS attained in CA wells



Compliance Examples

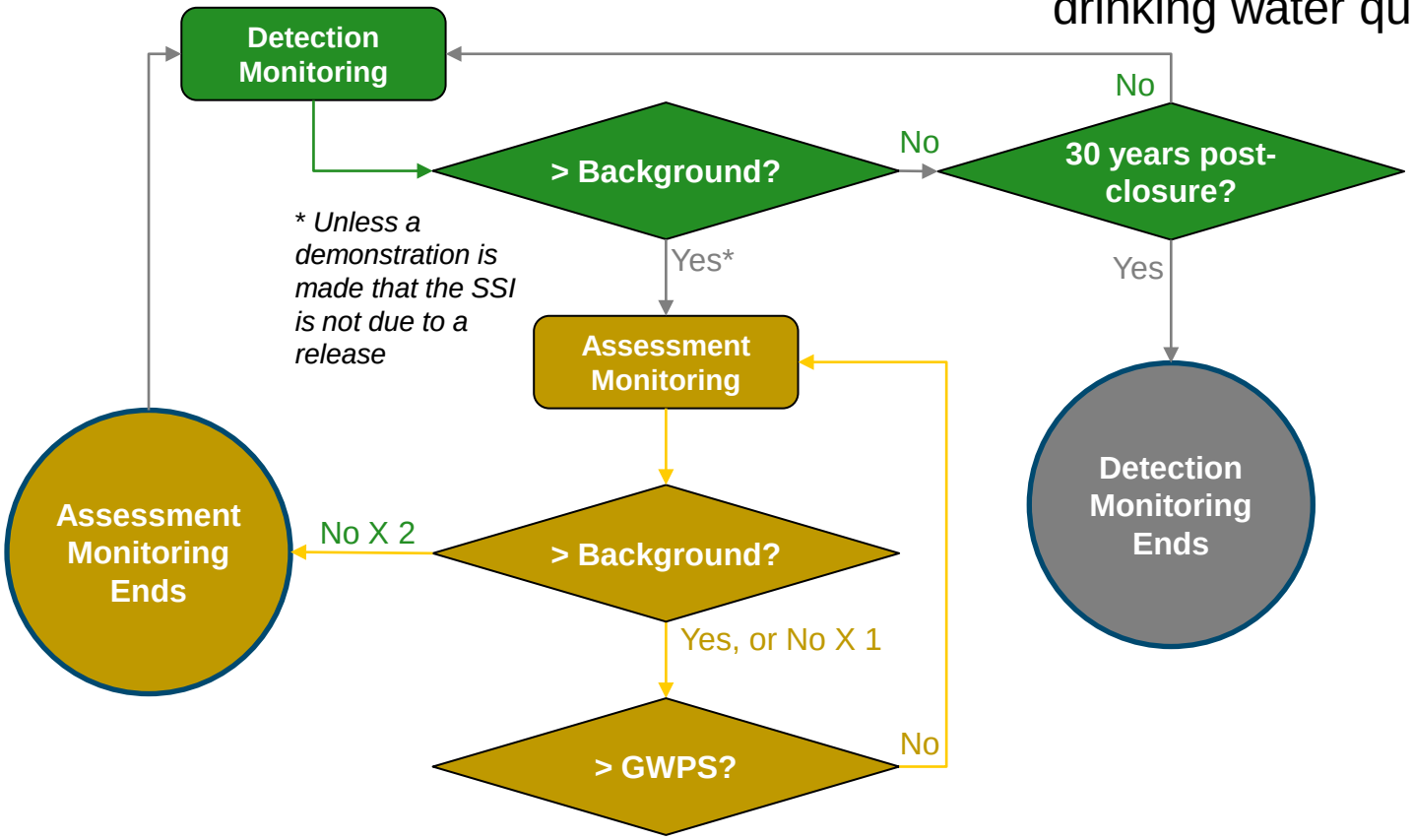


Reporting and Enforcement

- CCR Rule
  - Information reported to state and posted on public internet site
  - No approval process
  - Enforced by citizen lawsuits
- State Rule
  - Information reported to state
  - State approvals
  - Enforcement by state

Groundwater Monitoring End Point

- CCR Rule
  - 30 years post-closure AND
  - Not in assessment monitoring
- State rules
  - Varies by jurisdiction, often 30 years post closure and/or attainment of state groundwater or drinking water quality standards



Groundwater Monitoring Resources

- Groundwater monitoring under the CCR Rule (including statistical analysis)
  - EPRI, 2015. Groundwater Monitoring Guidance for the Coal Combustion Residuals Rule. EPRI Technical Report 3002006287
- Hydrogeologic Field Investigation and Monitoring Well Design/Installation
  - ASTM, numerous documents, e.g. D5092, D6286, D5979
  - Neilson, D.L. ed., 2005. Practical Handbook of Environmental Site Characterization and Ground-Water Monitoring, Second Edition, CRC Press.
  - USEPA, 1989. *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells*. EPA600/4-89/034.
  - USEPA, 1989. *RCRA Facility Investigation Guidance*. Interim Final, May 1989, EPA/530/SW-89-031.

Groundwater Monitoring Resources

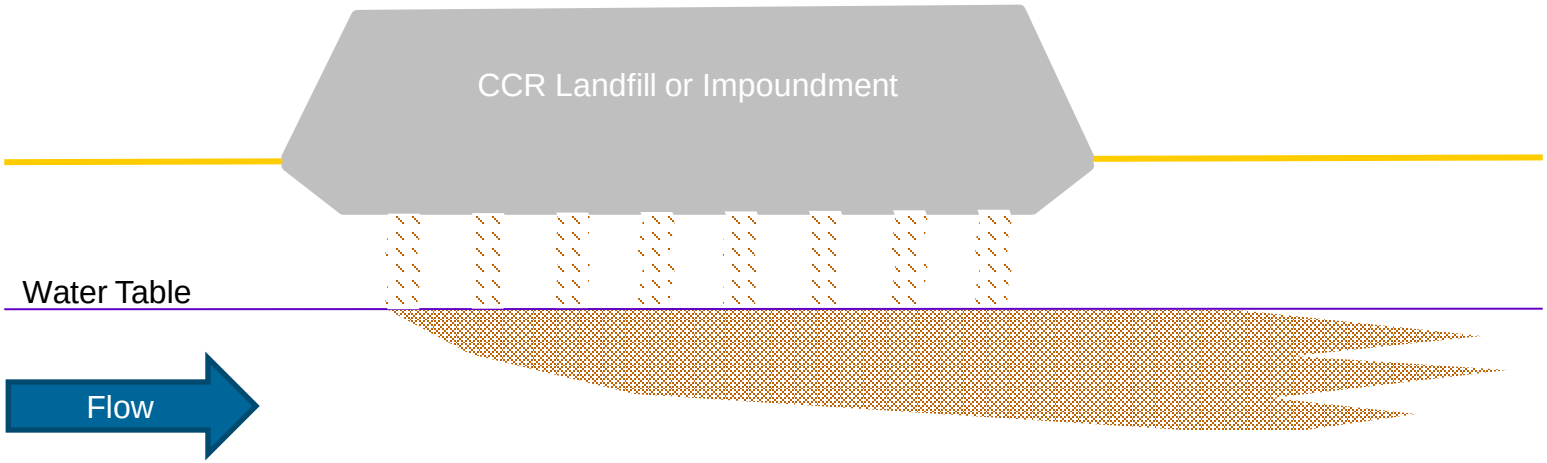
- Groundwater Sampling
  - ASTM, 2013. *ASTM D4448 - 01 Standard Guide for Sampling Ground-Water Monitoring Wells*. http://www.astm.org/Standards/D4448.htm
  - Barcelona, M.J., J.P. Gibb, J.A. Helfrich, and E.E. Garske, 1985. *Practical Guide for Ground-Water Sampling*. Illinois State Water Survey Contract Report 374.
  - USEPA, 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*
  - USGS. *National Field Manual for the Collection of Water-Quality Data (Continually Updated).* http://water.usgs.gov/owq/FieldManual/index.html
  - USGS. *National Water-Quality Assessment (NAWQA) Program Sampling Protocols* (multiple documents). http://water.usgs.gov/nawqa/protocols.html
- Statistical Analysis
  - USEPA, 2009. *Statistical Analysis of Groundwater Monitoring Data At RCRA Facilities: Unified Guidance.* EPA 530/R-09-007.

Corrective Action

Corrective Action Overview

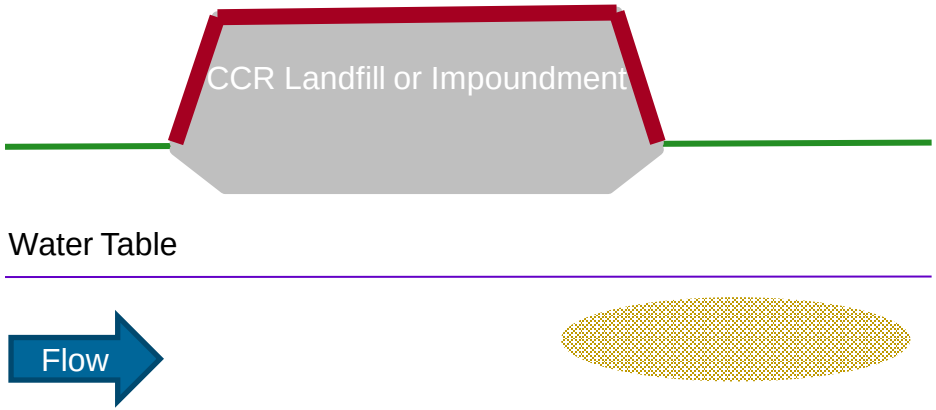
- Objective:
  - Mitigate environmental release from a facility
- Approach:
  - Characterize nature and extent of release
  - Engineering alternatives assessment to identify potential remedial actions, relative effectiveness, feasibility of implementation, time frames, and cost
  - Remedy selection, may include a public / stakeholder meeting
  - Detailed engineering design, may include bench and/or pilot testing
  - Construction / implementation
  - Documentation
  - Monitoring
- Drivers:
  - CCR rule: reduce groundwater concentrations to levels lower than GWPS
  - State rules: variable, some states allow risk-based approach

Technologies for CCR: Initial Condition



Technologies for CCR

Capping (source control)



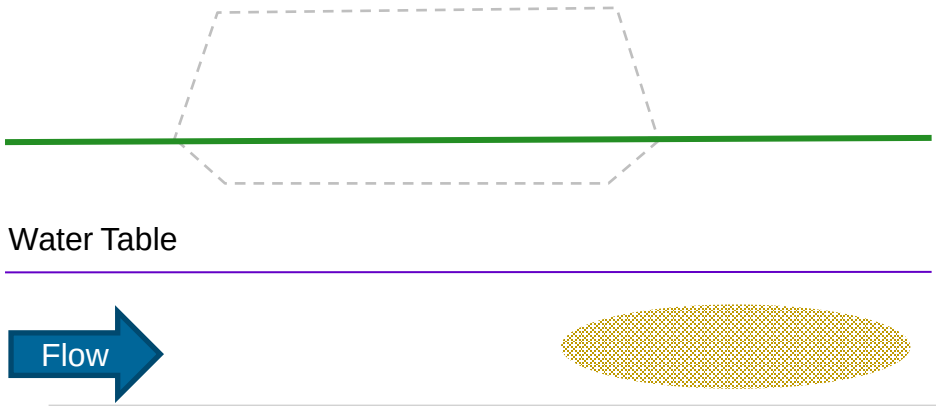
Advantages

- Ease of implementation
- Proven technology
- Low impact to community

Disadvantages

- Less effective if CCR below water table

Excavate and Remove (source control)



Advantages

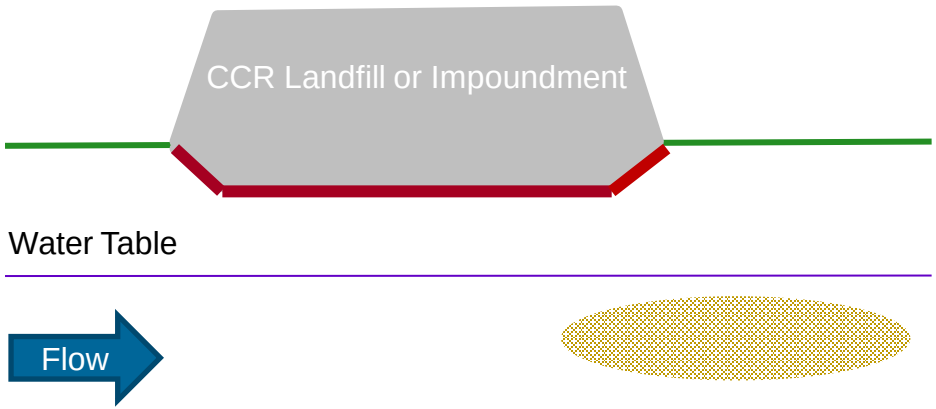
- No long-term maintenance
- Potentially removes CCR below water table

Disadvantages

- Impact to community
- Takes up landfill space elsewhere

Technologies for CCR

Retrofit with HDPE Liner (source control)



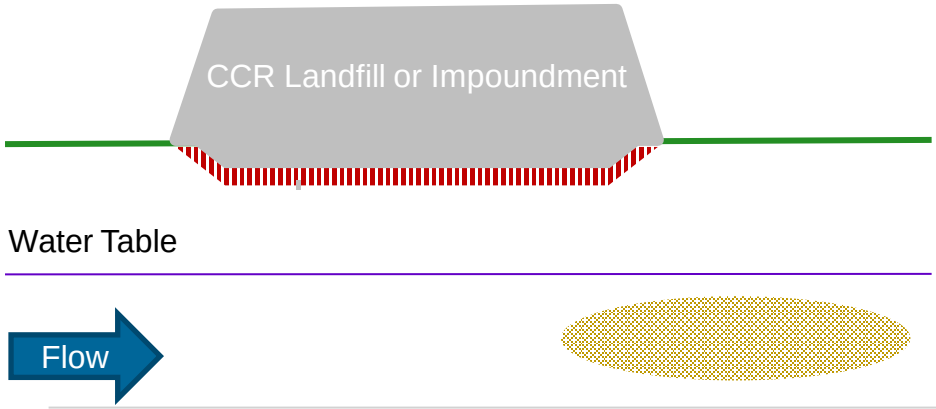
Advantages

- Facility can remain in operation
- Provides barrier between CCR and environment

Disadvantages

- Double handling of CCR
- Difficult implementation

In-Situ Liner Retrofit (source control)



Advantages

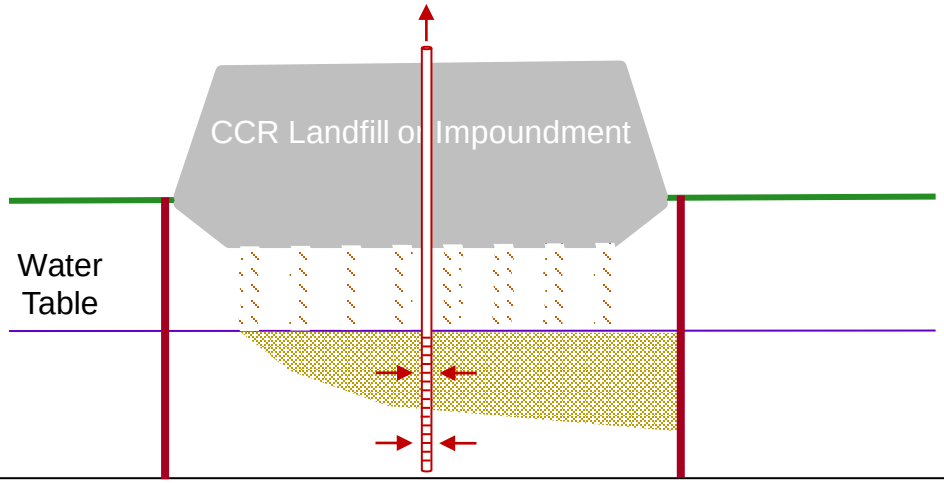
- Liner installed without excavating CCR
- Stabilizes CCR below water table
- Can improve structural properties of facility

Disadvantages

- Unproven at CCR facilities
- Would not qualify as a liner under the CCR rule (i.e., unlined pond still must close)

Technologies for CCR

Barrier Walls (source and hydraulic control)



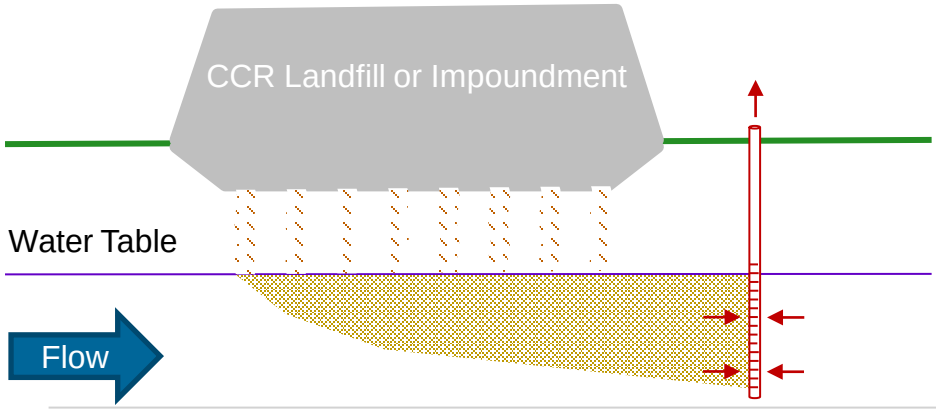
Advantages

- Facility can remain in operation
- Proven technology, within limitations
- Isolates groundwater beneath source, (i.e., contains all constituents in groundwater)

Disadvantages

- Long-term operation and maintenance

Pump and Treat (hydraulic control)



Advantages

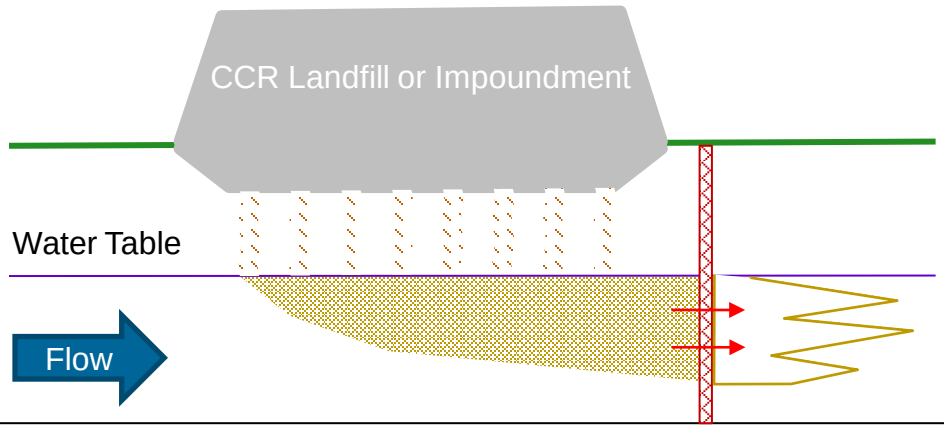
- Widely-used technology
- No depth limitation
- Mitigates all constituents in groundwater

Disadvantages

- Long remediation time (if not used with source control)
- Diminishing effectiveness over time

Technologies for CCR

Permeable Reactive Barrier (hydraulic control and in-situ treatment)



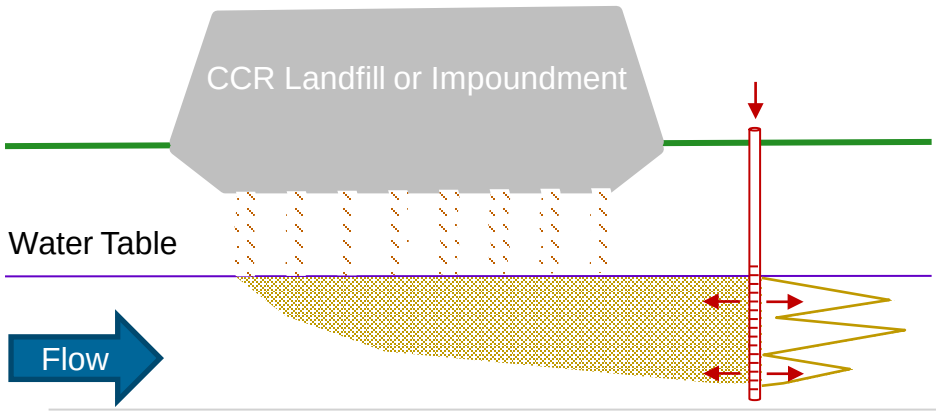
Advantages

- Passive technology
- Can be focused to specific treatment zone

Disadvantages

- Technology not proven for all CCR constituents
- PRB media replenishment

Geochemical Manipulation (in-situ treatment)



Advantages

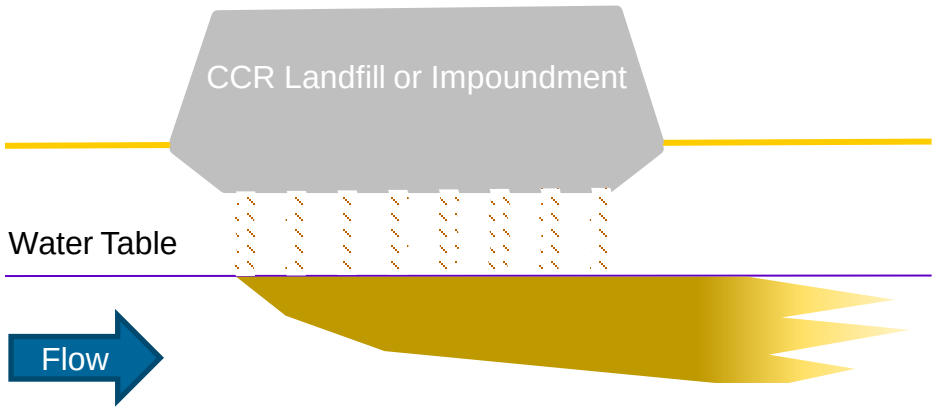
- Minimal site disruption
- Can be focused to specific treatment zone

Disadvantages

- Potential for reversibility if groundwater conditions change
- Unproven at CCR facilities

Technologies for CCR

Monitored Natural Attenuation (in-situ treatment)



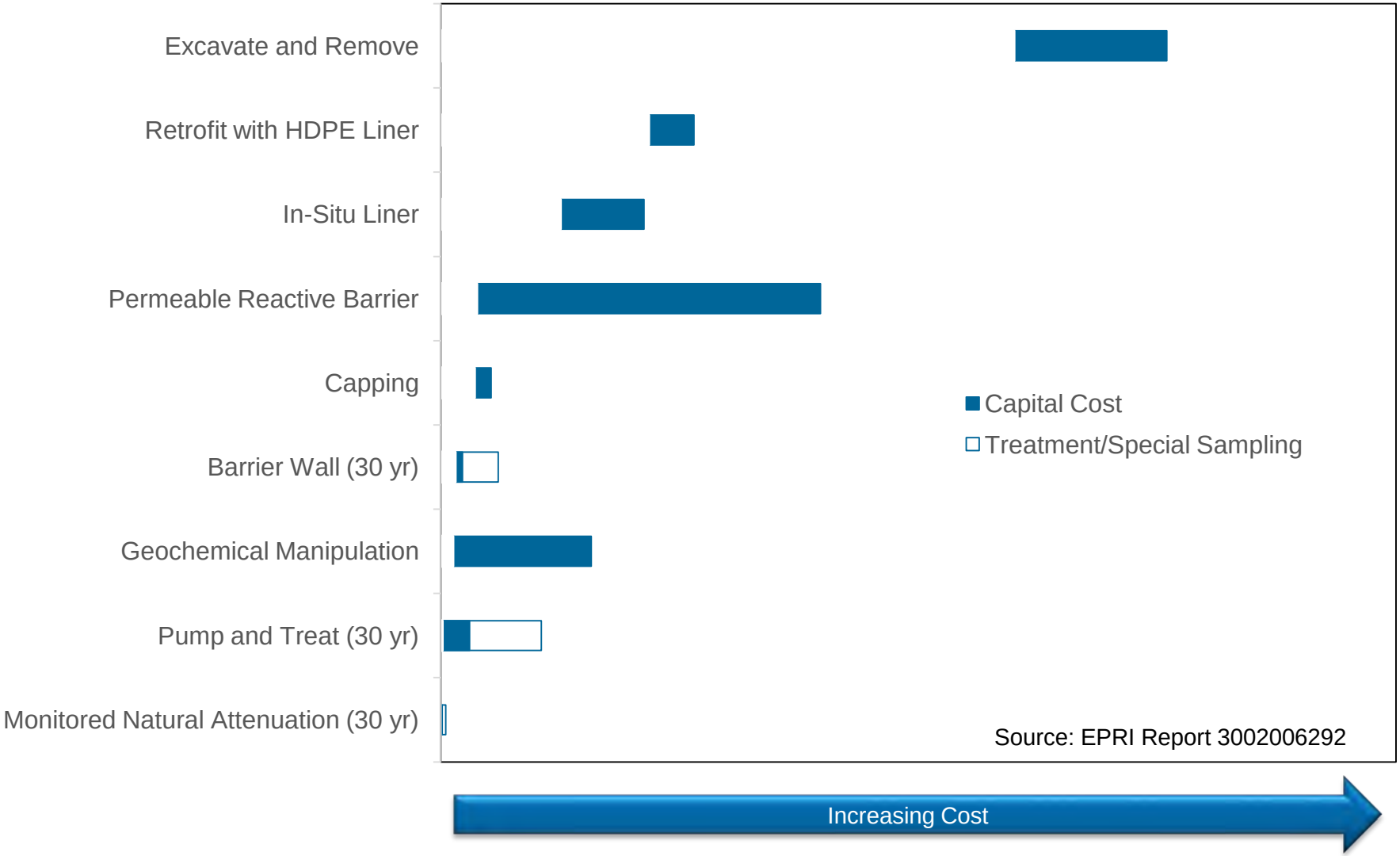
Advantages

- Passive technology
- Easily implemented

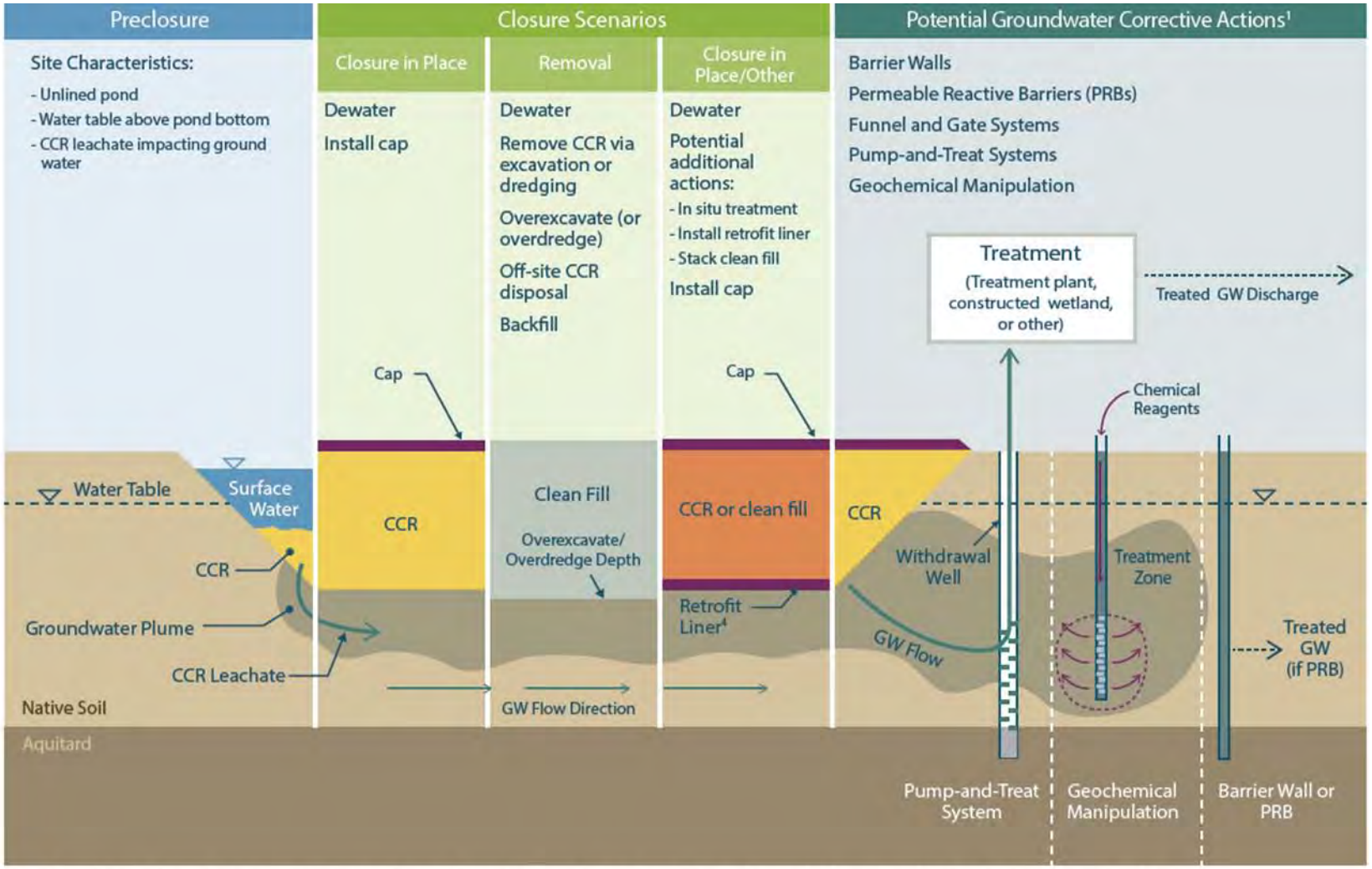
Disadvantages

- Long time frame to achieve remedial goals
- May not be effective if source control is not implemented

Estimated Relative Cost Ranges



Combined Corrective Action Technologies



Note 1: Several potential groundwater corrective actions are shown as alternatives. Depending on site conditions, only one technology or a combination of technologies may be selected.

Note 2: GW = Groundwater

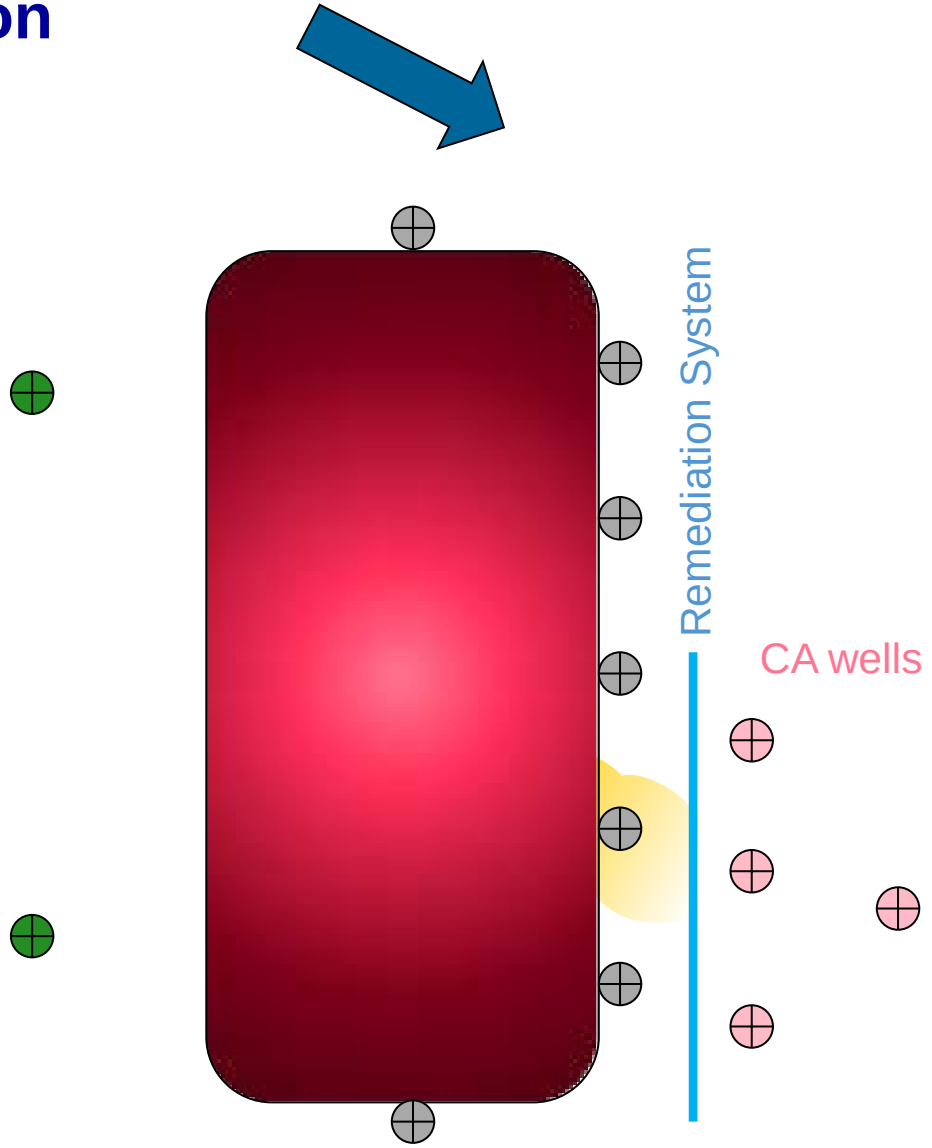
Note 3: CCR surface impoundments may be above or below grade

Note 4: Retrofit liner is a potential action if a pond or consolidated portion of a pond will continue to receive CCR

Source: EPRI Report 3002006292

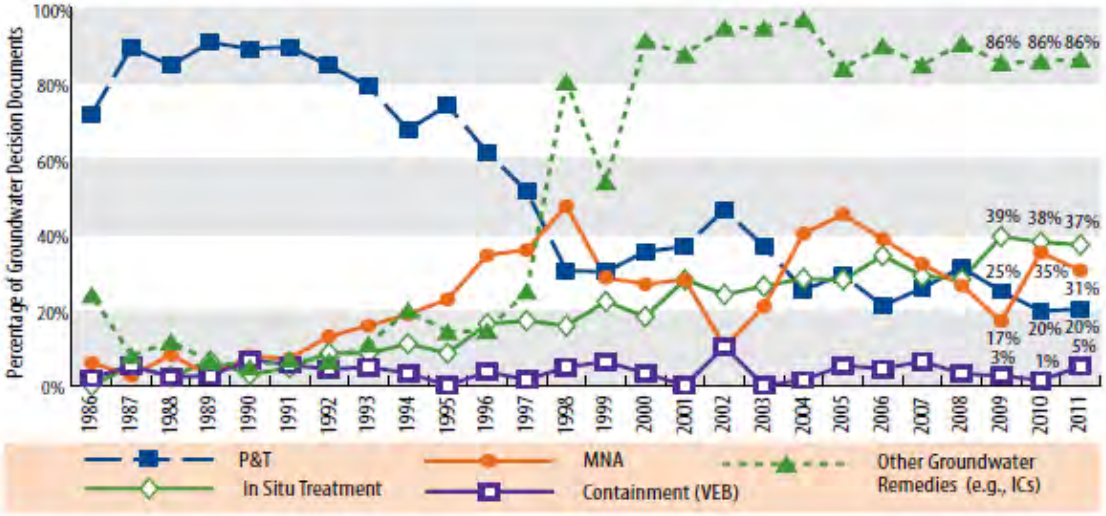
Corrective Action Completion

- CCR Rule
  - After the corrective action has been implemented, and
  - All monitoring wells in the corrective action monitoring system have concentrations statistically lower than the GWPS for three consecutive years.
- State Rule
  - Attainment of state approved remedial objectives

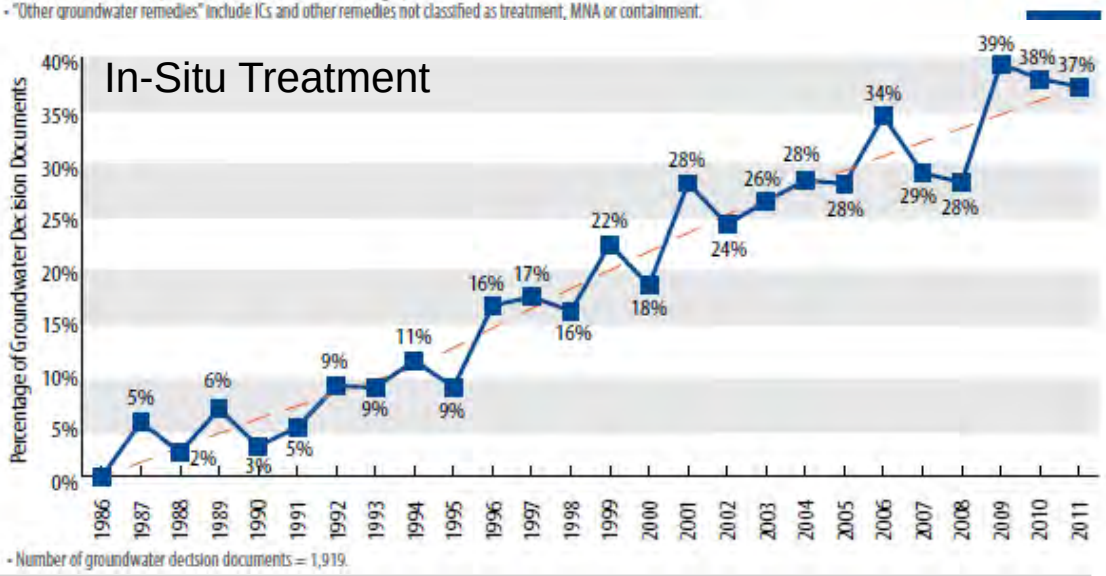


Technology Trends:
2014 Superfund Remedy Selection Summary (14th Ed.)

- 2009 – 2011, 459 Decisions
- Targets
  - Source control only 40%
  - Groundwater only 20%
  - Both 25%
- Groundwater Remediation
  - Primarily P&T (decreased), MNA (decreased), and in situ treatment (increased; bioremediation and chemical injection)
  - Usually include Institutional Controls (IC)
  - Containment rare



- Number of groundwater decision documents = 1,919.
- Decision documents may be included in more than one category.
- "Other groundwater remedies" include ICs and other remedies not classified as treatment, MNA or containment.



- Number of groundwater decision documents = 1,919.

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Corrective Action Resources

- USEPA Cleanup Science and Technology Website
  http://www.epa.gov/cleanups/cleanup-science-and-technology
- DOE Soil and Groundwater Remediation Website
  http://energy.gov/em/services/site-facility-restoration/soil-groundwater-remediation
- ITRC Publications
  http://www.itrcweb.org/Guidance
- EPRI Research Publications on Corrective Actions for CCRs
  - 1012584 Technologies Review (2006)
  - 1015551 PRB Media Lab Screening Treatability (2008)
  - 3002003769 In Situ Pilot for Arsenic (2014)
  - 3002003768 S/S Technology Review (2014)
  - 3002006285 Monitored Natural Attenuation (2015)
  - 3002006292 Corrective Action for Ash Ponds (2015)

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