

REINHOLD ENVIRONMENTAL Ltd.



**2019 REINHOLD Round Table
Presentation**

June 24 & 25, 2019, in Birmingham, Alabama / Hosted by Southern Company

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GOLDER

Advanced Engineering Solutions for Environmental Protection in CCR Closures

2019 REINHOLD / PCUG Conference
June 24-27, 2019 Birmingham, AL

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AGENDA

Safety Share

Technical Considerations for Closure of CCR Units

Sampling & Testing of CCR Units

Engineering Options to Enhance GW Performance

Options Assessment & Decision Making Tools

Beneficial Use Characterization and Planning

Importance of Water Management in CCR Projects – Case Studies

Q&A

Safety Share

Safety Share

GOLDER SAFETY SHARE – CCR POND ACCESS SAFETY

- Golder Safety Share – CCR Pond Access Safety

Golder takes pride in sharing our approaches and experience in dealing with the unique challenges and safety risks working in and over ash. Our professionals have prepared multiple publications focused on CCR safety aspects.



CCR Pond Construction Access Evaluation, Monitoring, and Proofing Methods

World of Coal Ash 2017
May 11, 2017

Gregory Hebler, PhD, PE
Grant Martin, EIT

Stability Evaluation and Monitoring During Staged Construction of Fly Ash Closure Projects

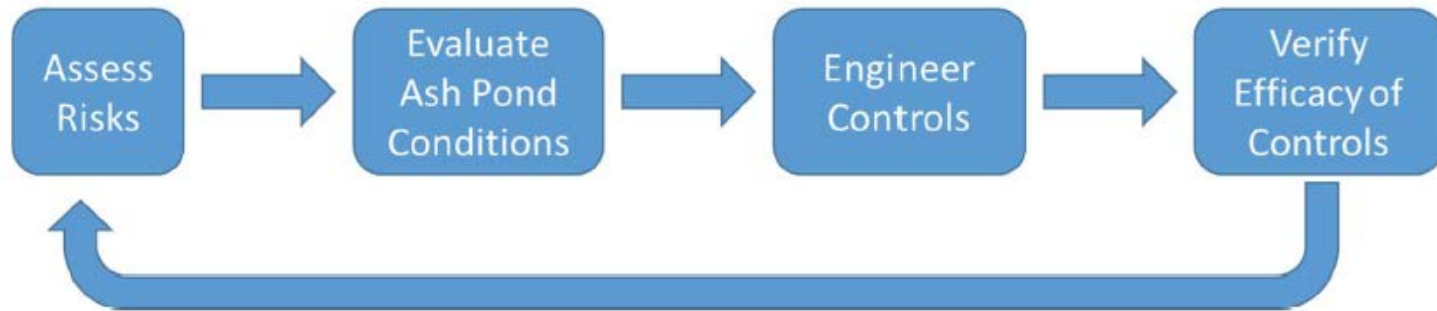
ACAA – World of Coal Ash 2017
10 May, 2017

Gregory Hebler, PhD, PE
Chris Hardin, PE
Tony Simmonds



Safety Share

FRAMEWORK FOR MITIGATION OF RISKS



CCR Pond Construction Access Evaluation, Monitoring, and Proofing Methods

World of Coal Ash 2017 - May 11, 2017

Gregory Hebler, PhD, PE; Grant Martin, EIT

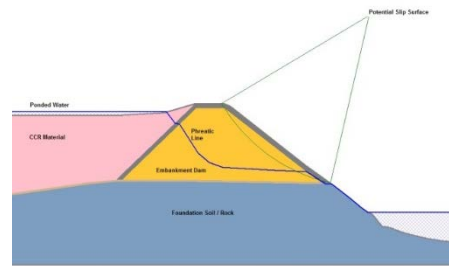
Technical Considerations for Closure of CCR Units

Technical Considerations for CCR Closures

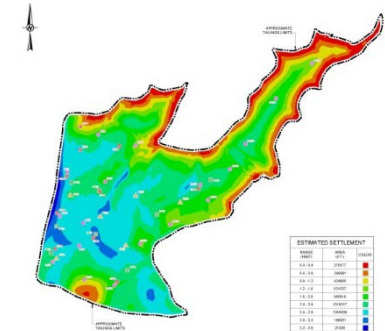
Material Characterization



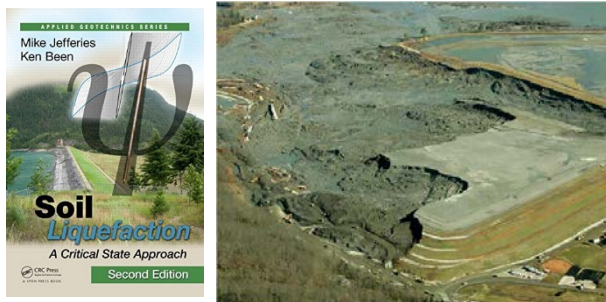
Stability Evaluations



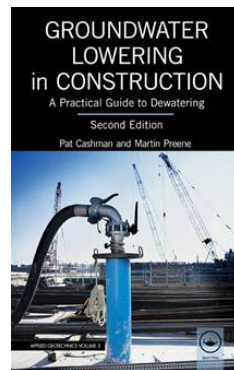
Settlement & Capping



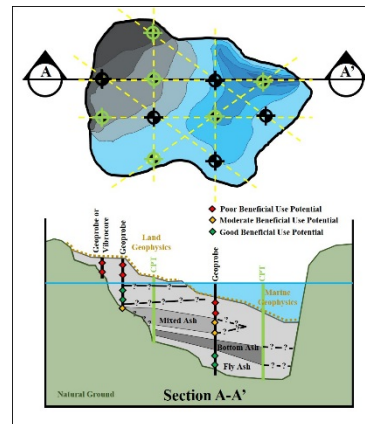
Liquefaction Potential



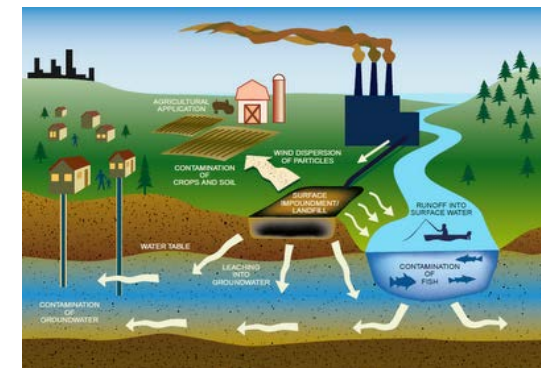
DeWatering



Future Harvesting



Env Protection



Engineering Design Drivers for CCR Closures

Water Levels and Control are Keys to Design and Performance of these Systems

Sluiced and Uncompacted Materials can show significant strength when dried but retain risk of return to low strengths and liquefaction / flow susceptibility if saturated and containment is lost

Obtain Enough Data to Evaluate PFMs, Potential Critical Interim Conditions, Future Harvesting Potential, Geochemical Evaluations, etc.

Economic & Risk Trade offs Between: Material and Placement Controls & Engineering and Monitoring Controls.

Sampling & Testing of CCR Units



GOLDER

CCR Distinctives

Soil-like

**Traditional correlations
don't always apply**

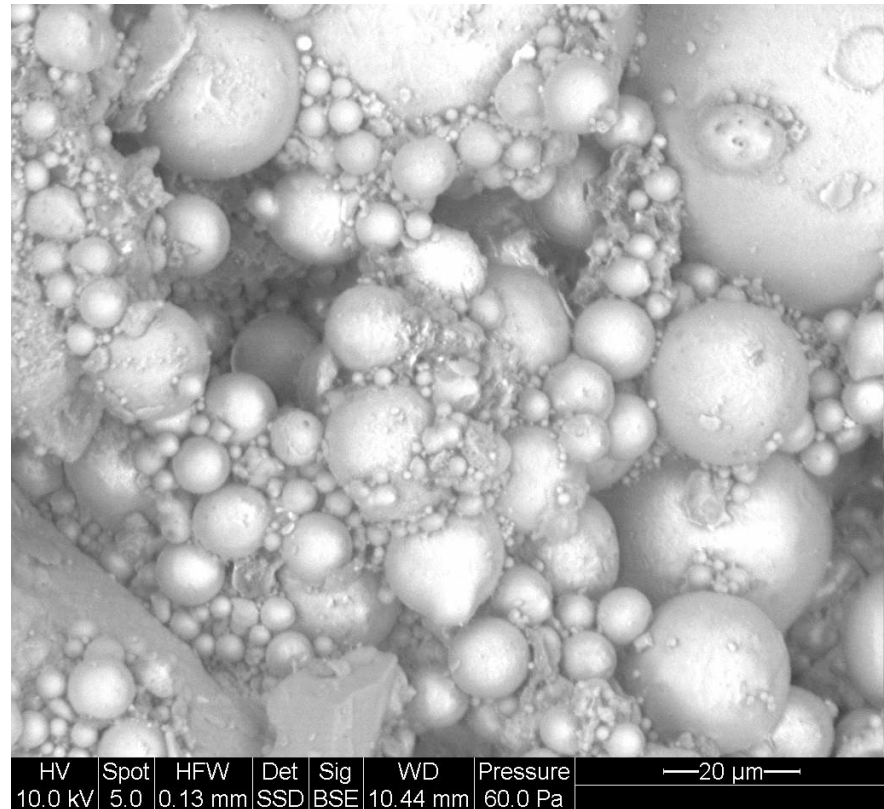
Spherical particles

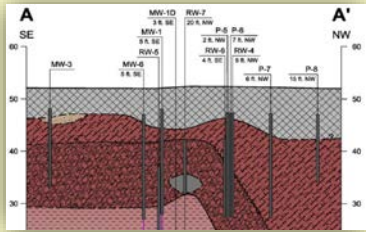
Small size, but relatively
high permeability

Light weight

Can be lightly / heavily
cemented

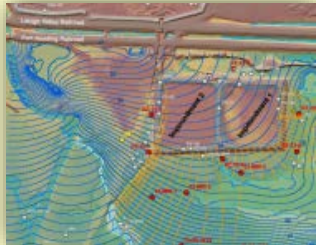
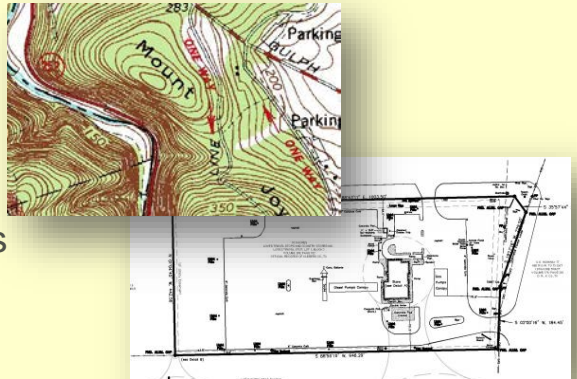
Highly erodible





Regional references
 Borehole logs
 Cross-sections
 Structural contours
 Fractures/faults
 Site mapping

Site maps
 Well locations
 Utilities
 Topography
 As-built drawings



Hydrogeology

Hydro testing
 Water levels/contours
 Regional references
 GW modeling

**Cultural/
 Survey**



Chemistry

Sampling results
 Tables/graphs
 Contours
 Cross-sections



**Conceptual
 Site Model**

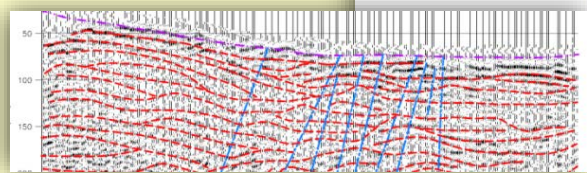
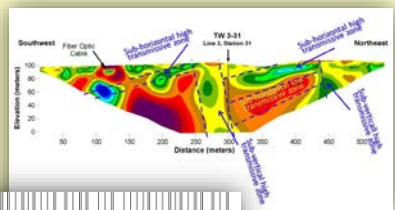
Site History

Historical maps Photos
 Sanborn maps Records
 Aerial images
 Past operations



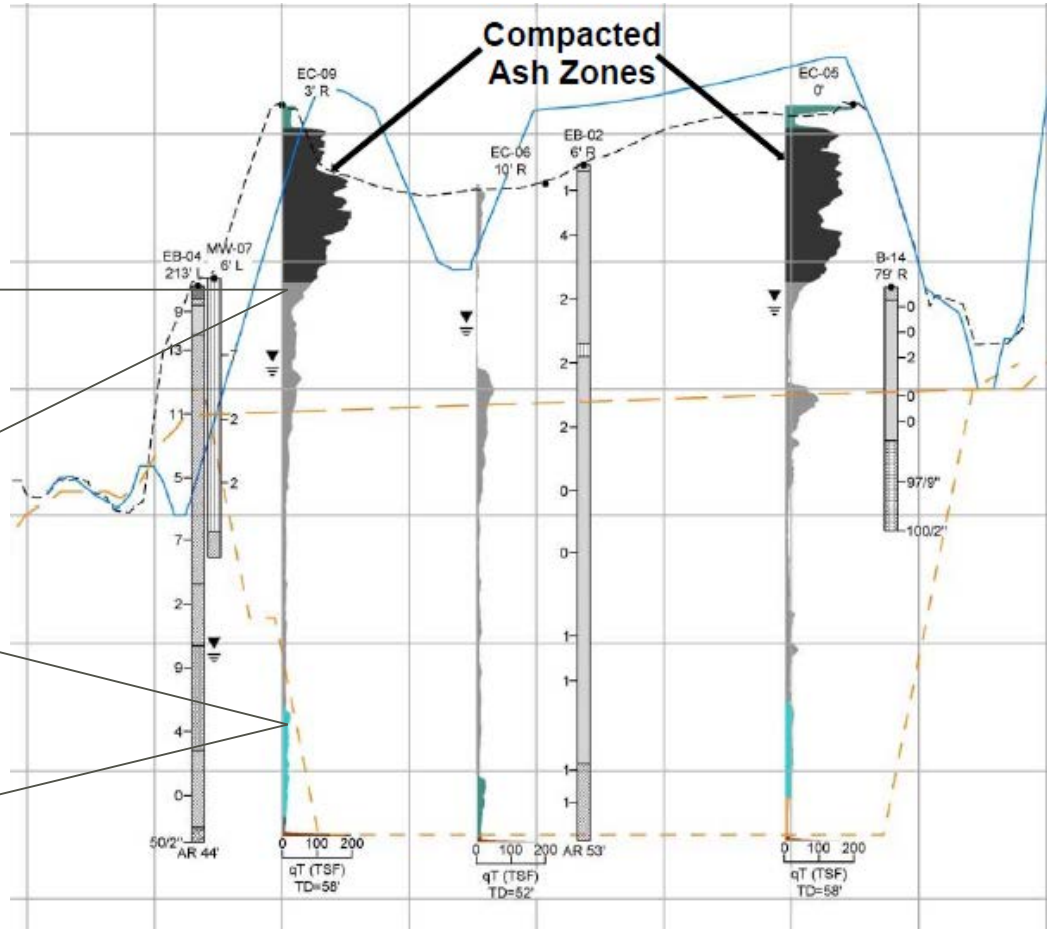
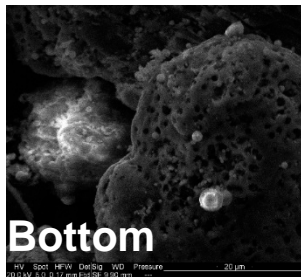
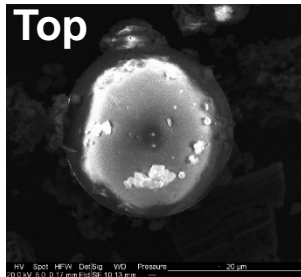
Geophysics

Maps/logs
 Testing results
 Cross-sections
 Surface/DH



CCR Distinctives – Aging & Diagenesis

SEM Images



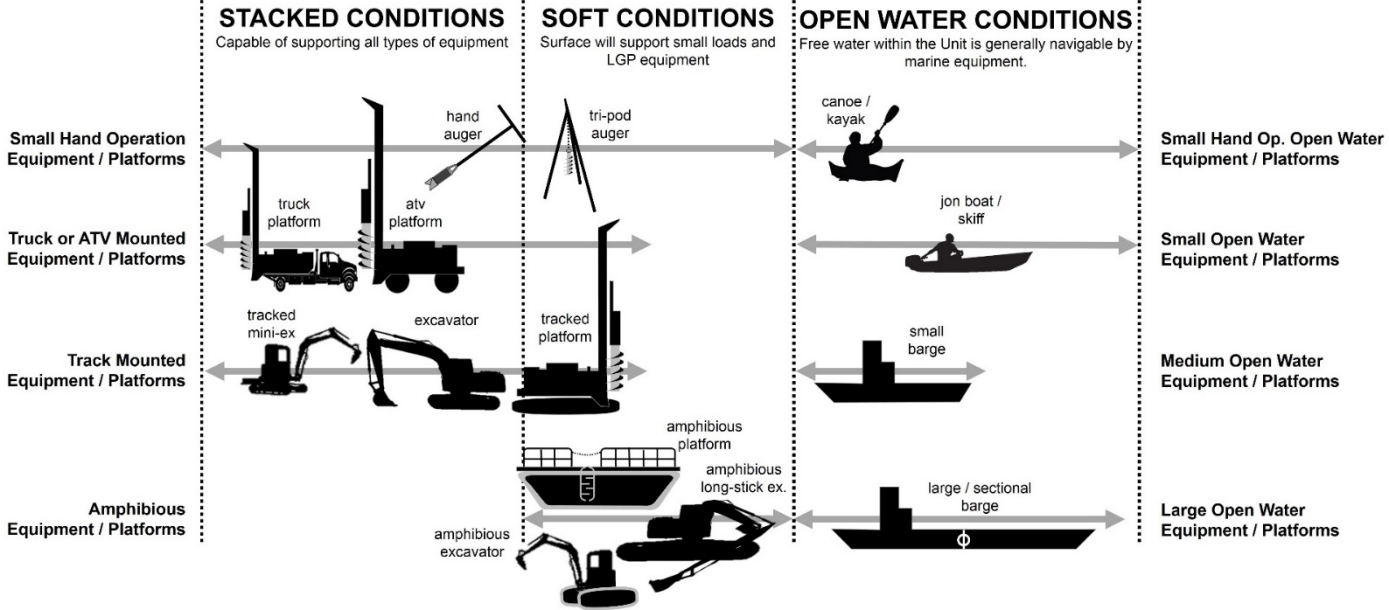
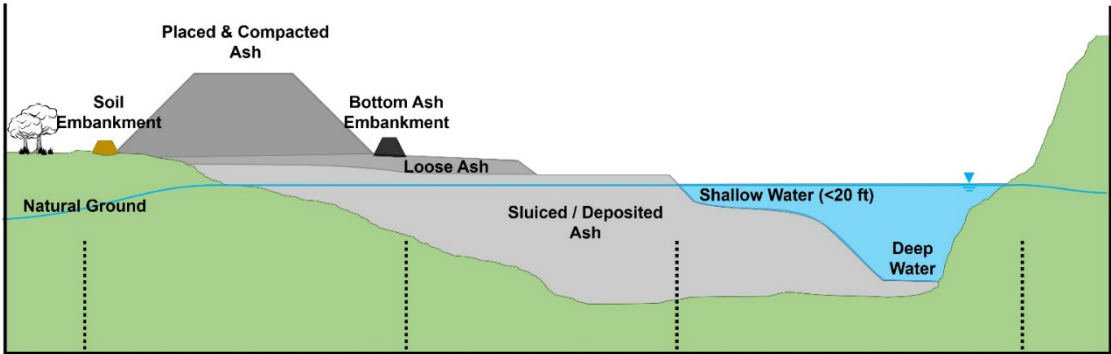
CCR Sampling – Operational History Considerations

Conditions often vary often short distances based on current and historic operations



CCR Sampling Field Explorations

Range of Site Conditions

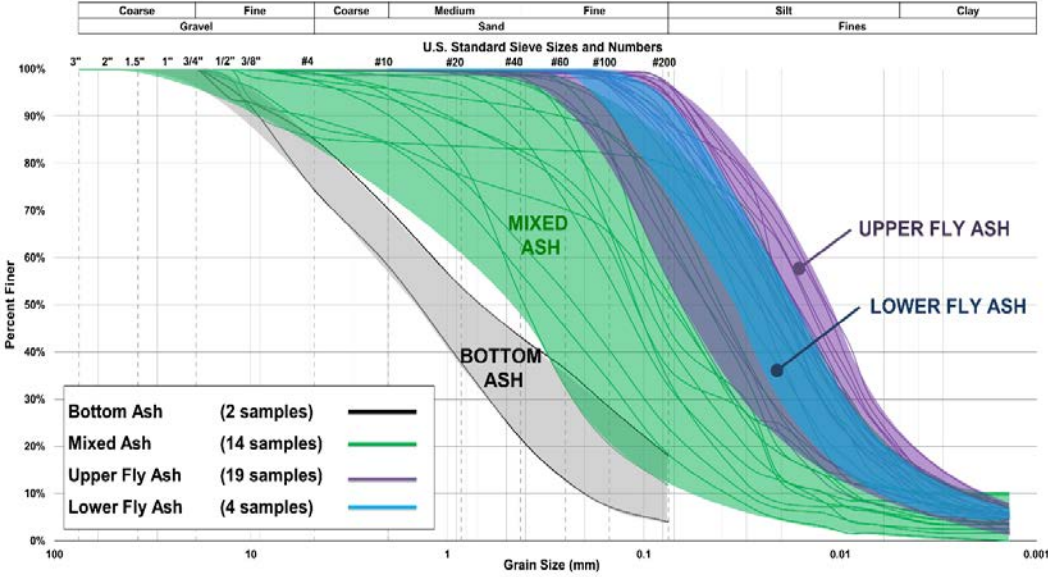


CCR Sampling – Material and Deposition Considerations

Bottom Ash Stringers / Lenses



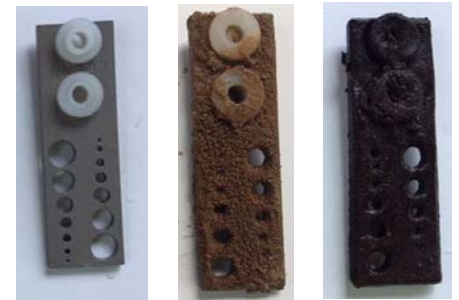
CCR Layering



CCR Sampling – GW Constituents & Geochemistry



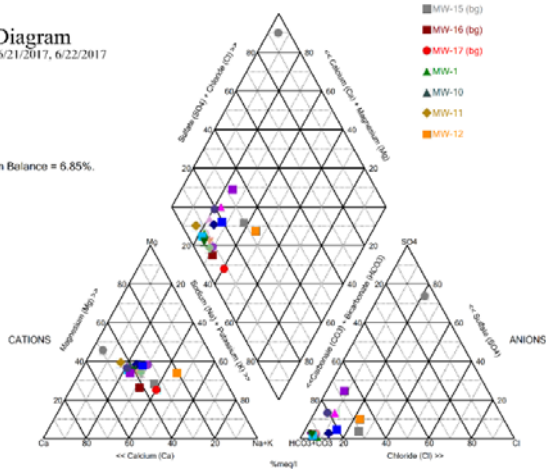
Sanitas® v.9.5.32 n/a. UG



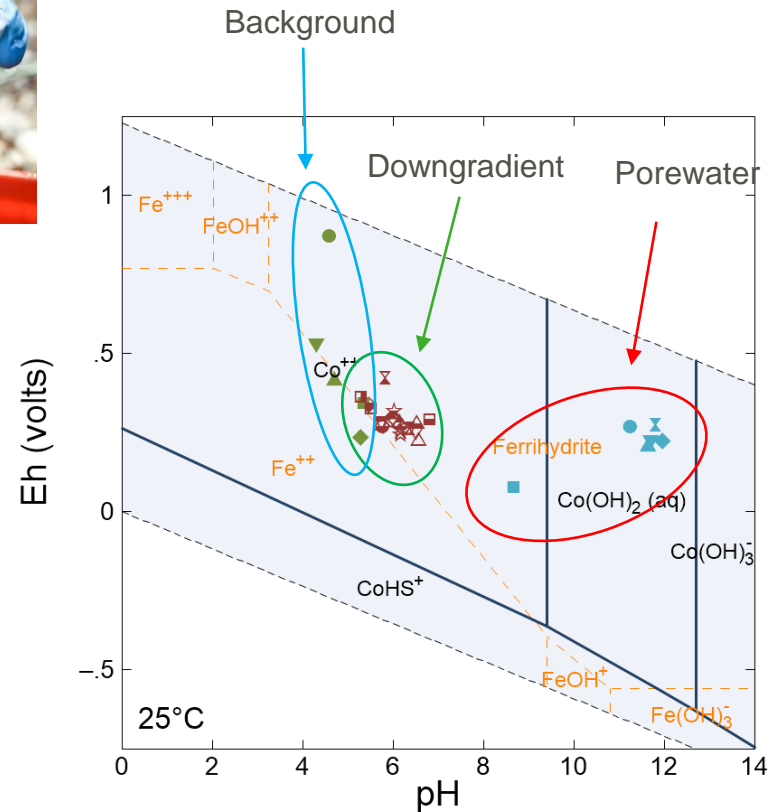
Piper Diagram

6/20/2017, 6/21/2017, 6/22/2017

Cation-Anion Balance = 6.85%.



Analysis Run 8/17/2017 1:20 PM View: Stiff Piper Plots



A full suite of chemical data can be used in reactive transport modeling

ANALYTICAL TESTS

Groundwater

Cations	Potential COIs/Metals	Possible Redox Indicators
Sodium	Arsenic	Fe(II)/Fe(III)
Potassium	Antimony	Mn(III)/Mn(V)
Magnesium	Barium	Se(IV)/Se(VI)
Calcium	Boron → <i>isotopes</i>	As(III)/As(V)
	Cadmium	
	Chromium	
Anions	Cobalt	Other
Sulfate	Lead	Field pH
Chloride	Molybdenum	Redox potential
Fluoride	Selenium	(<i>caution</i>)
Nitrate	Strontium → <i>isotopes</i>	Temperature
Nitrite	Thallium	TDS
Phosphate	Vanadium	SC
Alkalinity		

Solids (bedrock, overburden, potential source materials)

Near-total metal extractions

Iron
Aluminum
COIs

Sequential extraction

Iron
Aluminum
COIs

Mineralogy

Rietveld XRD → QEMSCAN
SEM

Leaching tests

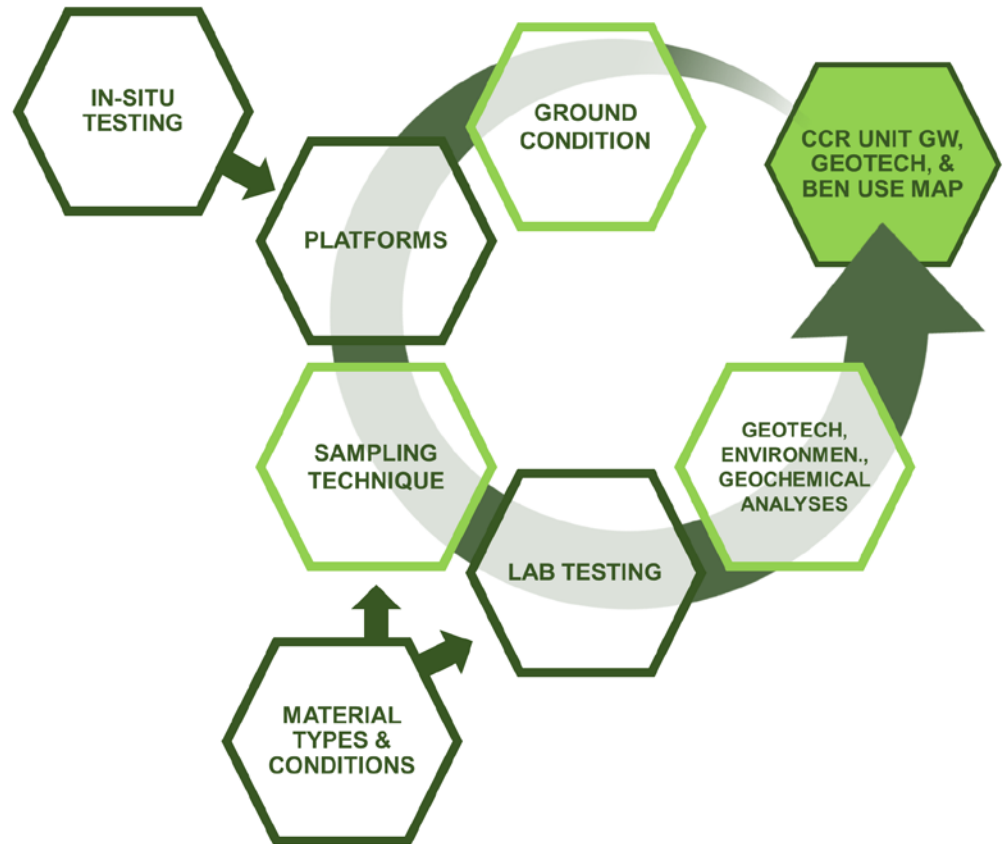
SPLP → LEAF

Grain size

Sampling & Testing Take-Aways

CCR Sampling and Testing can require multiple and non-traditional methods

Look to combine data collection investigations for geotechnical, beneficial use, groundwater monitoring, and geochemical evaluations



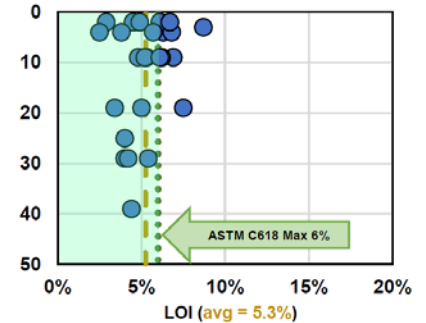
Beneficial Use Characterization and Planning

Beneficial Reuse Characterization

Evaluate the CCR Resource

- Quantity – Develop Volumetric Estimates / Models by Material Type
 - Resource Map the CCR Unit
- **Quality of CRR for reuse**
 - Material Variability Vertically and Laterally
 - Disturbed samples typically fine for Beneficial Use Evaluations
- **Application / Use Options Evaluations (→ Concrete, → Fill, → other)**
- **Define the Market, Transportation, and Other Conditions**

Loss on Ignition (LOI) Variation with Depth



Is Beneficiation Required ?

- What kind (Carbon control, drying, material separation, thermal, etc.)
- Constraints on use opportunities

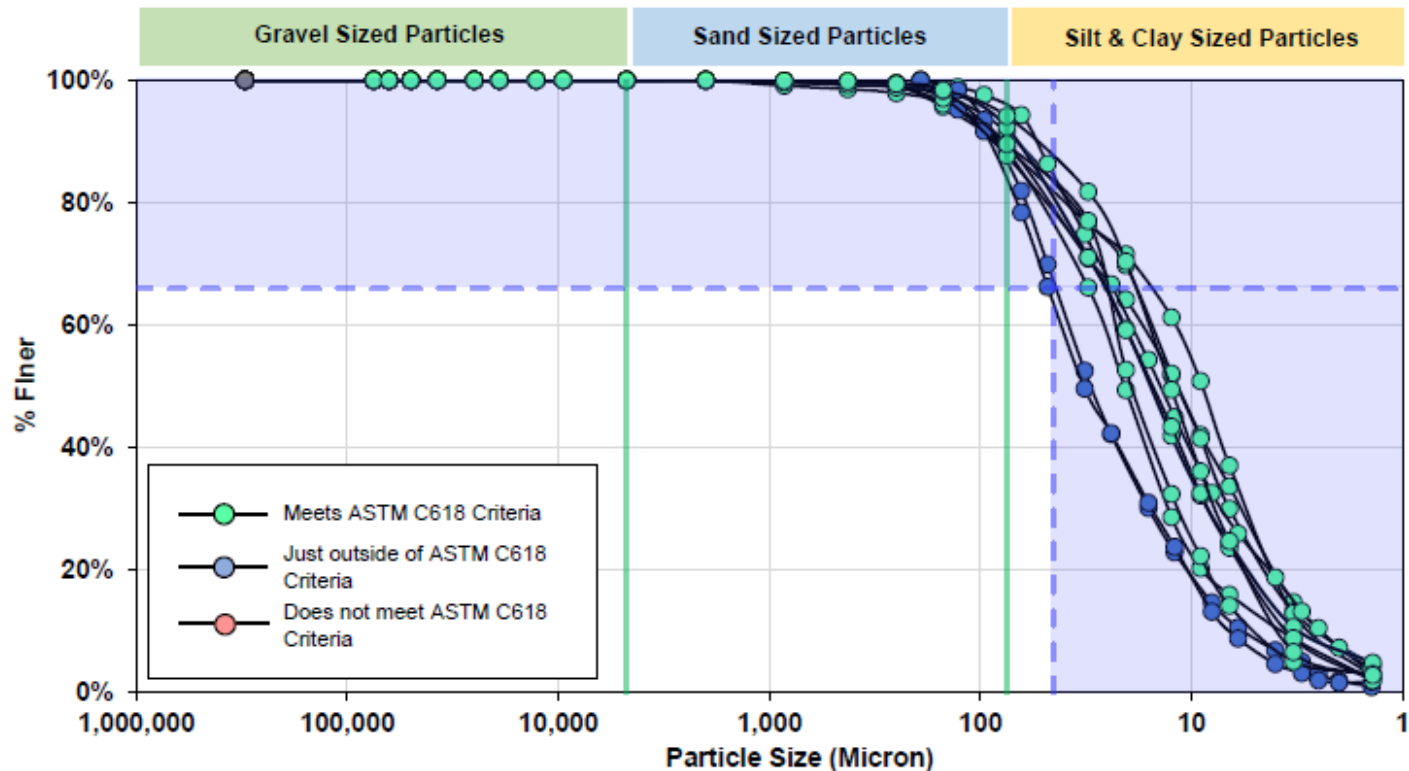
Leverage operations, construction activities, and other investigation programs to systematically obtain samples for beneficial use characterization.

Can closure be situated / staged to improve potential future harvesting?

Beneficial Use Resource Evaluations

CCR Unit Beneficial Use Data

COAL ASH PARTICLE SIZE DISTRIBUTION CURVES

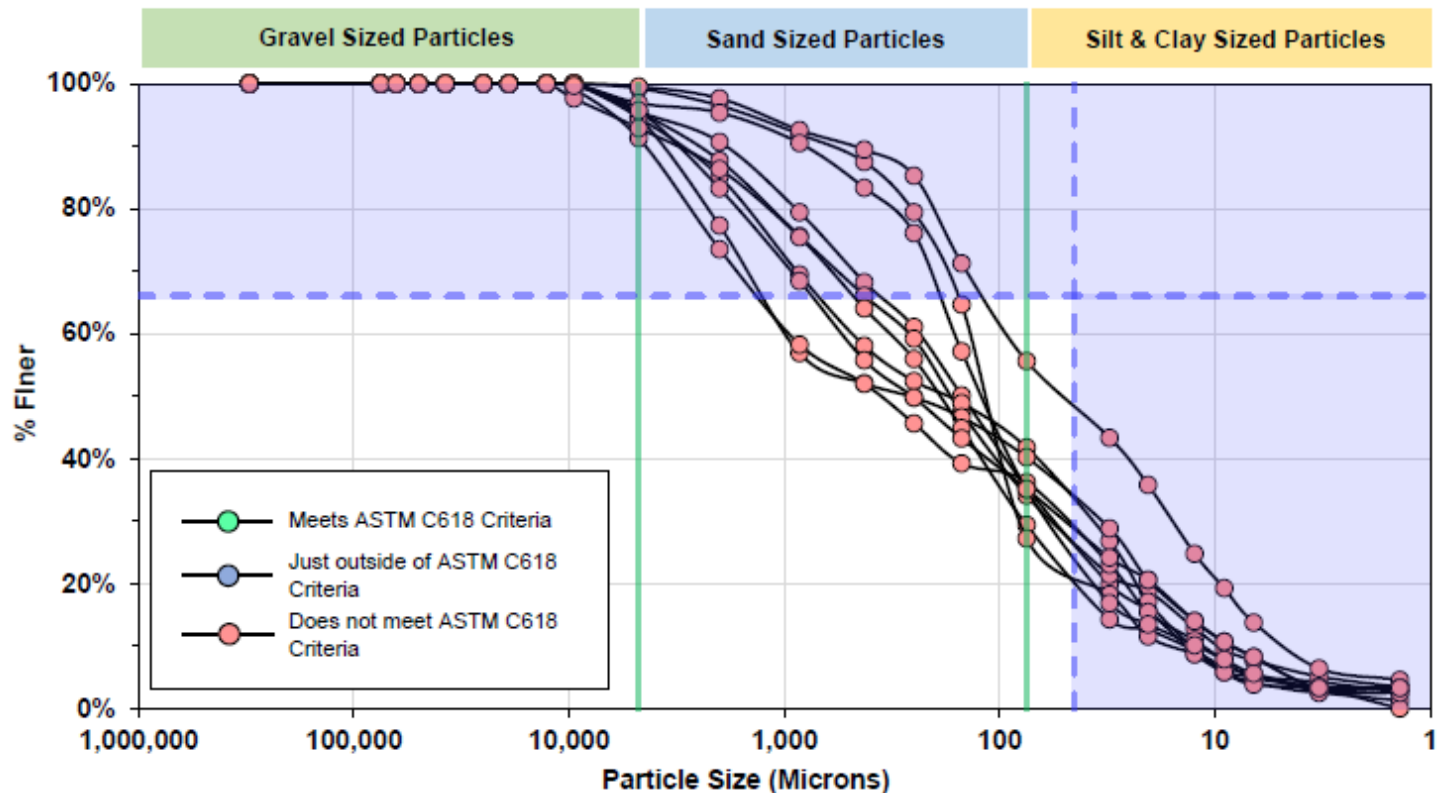


Note: (1) Dashed blue lines show the ASTM C618 maximum criteria for Fineness, i.e. a minimum of 66% by mass of the sample should be finer than 45 microns. (2) The blue zone represents the allowable region of the PSD plot that is within the ASTM requirement for fineness. If any portion of the PSD plot is outside the blue zone, the sample does not meet the ATSM fineness criteria. (3) The green lines delineate the particle size transitions from gravel to sand size, and from sand to silt and clay sized particles.

Beneficial Use Resource Evaluations

CCR Unit Beneficial Use Data

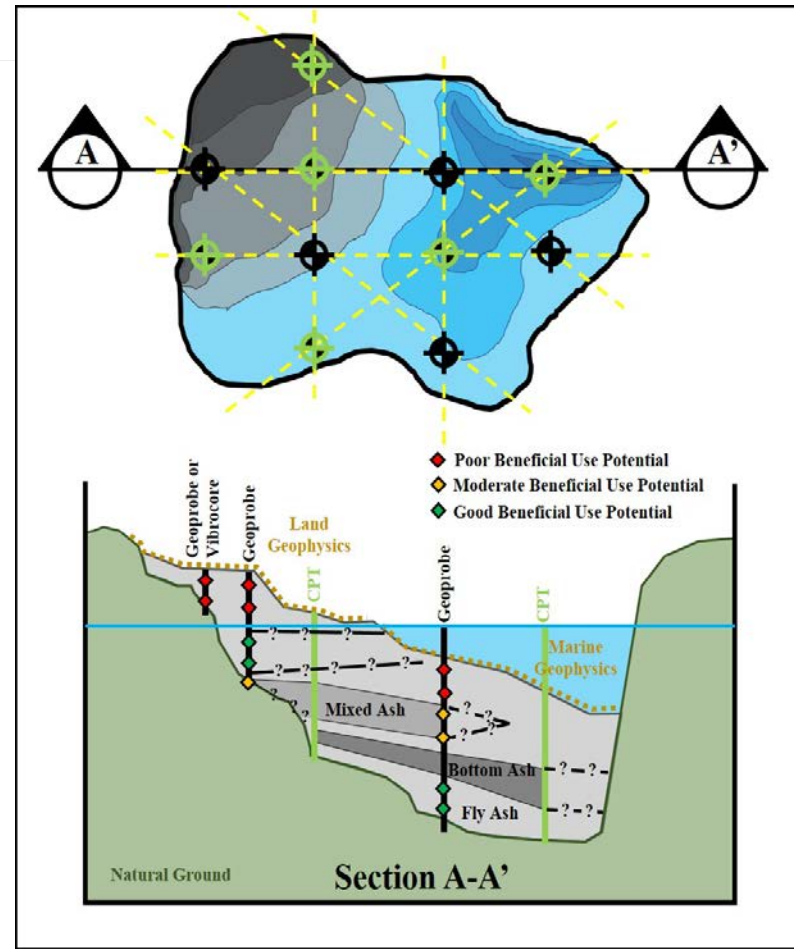
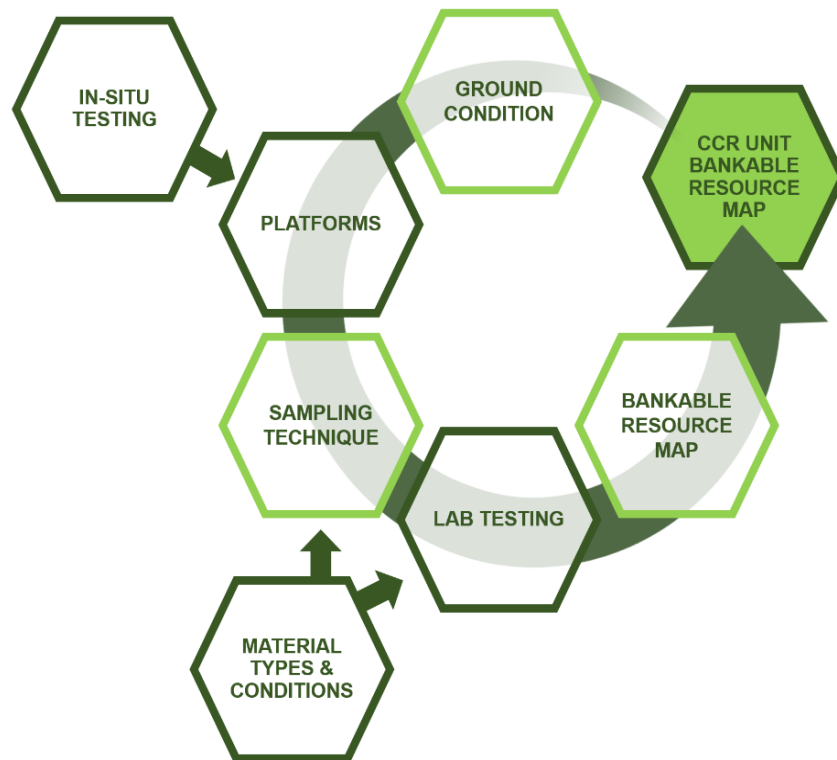
COAL ASH PARTICLE SIZE DISTRIBUTION CURVES



Note: (1) Dashed blue lines show the ASTM C618 maximum criteria for Fineness, i.e. a minimum of 66% by mass of the sample should be finer than 45 microns. (2) The blue zone represents the allowable region of the PSD plot that is within the ASTM requirement for fineness. If any portion of the PSD plot is outside the blue zone, the sample does not meet the ATSM fineness criteria. (3) The green lines delineate the particle size transitions from gravel to sand size, and from sand to silt and clay sized particles.

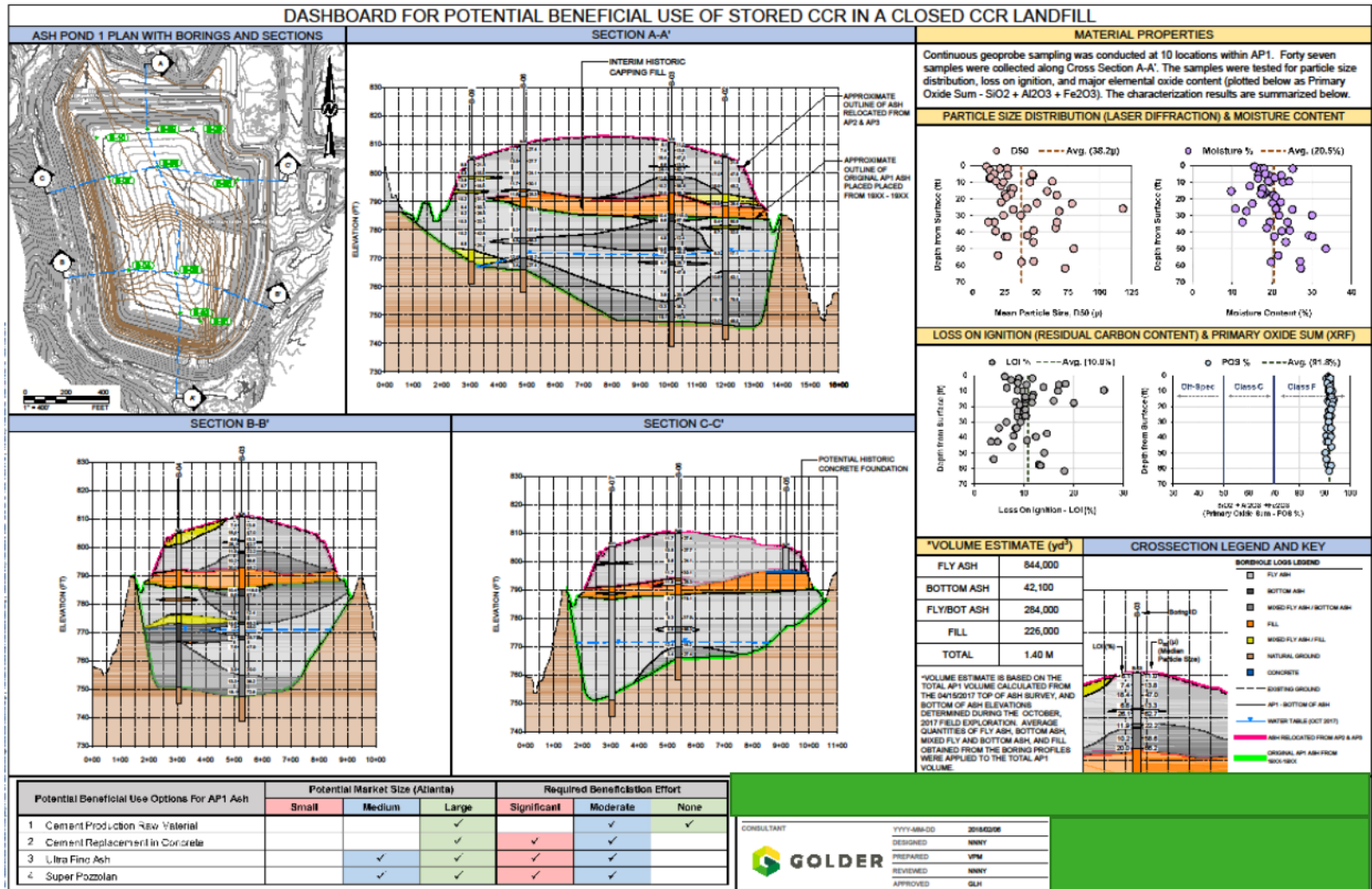
Beneficial Use Evaluations

EPRI Report – 3002013740 Under Program 78



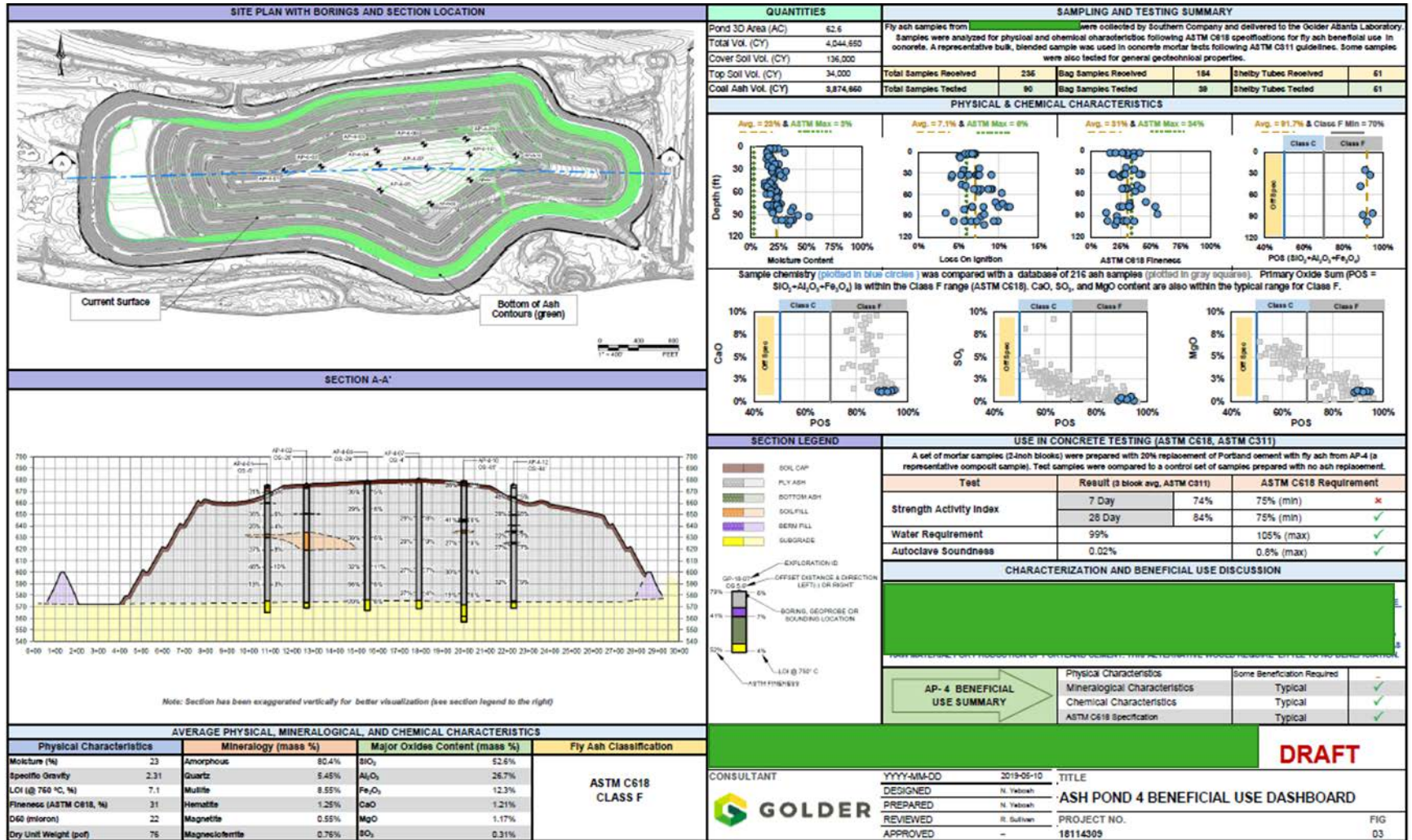
Beneficial Use Resource Evaluations

CCR Unit Beneficial Use Dashboards



Beneficial Use Resource Evaluations

CCR Unit Beneficial Use Dashboards

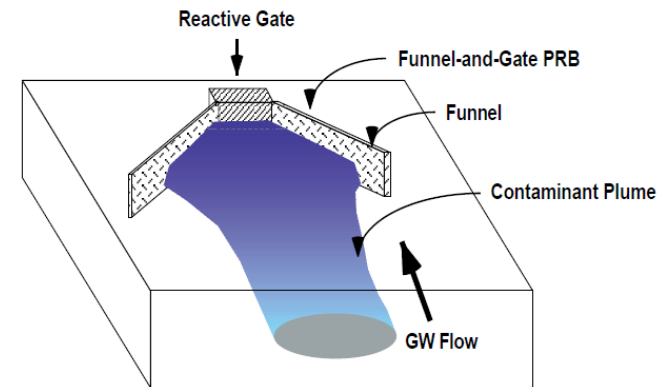
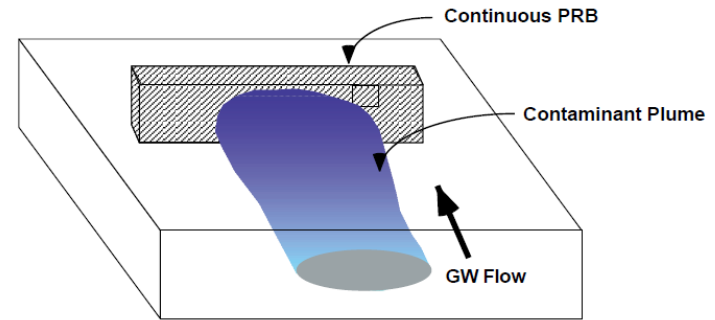


Engineering Options to Enhance GW Performance

Assessment of GW Corrective Measures

POTENTIAL ACTIONS

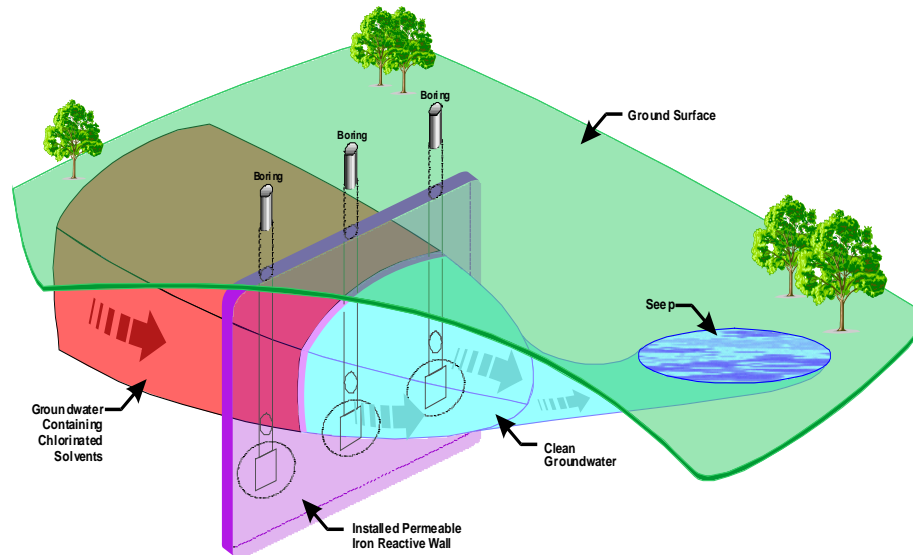
- Monitored natural attenuation (MNA)
- Barrier walls
- Grouting
- In-situ stabilization
- Hydraulic containment
- Permeable reactive barriers
- Subaqueous reactive cap
- Geochemical manipulations
- Phytoremediation



Permeable Reaction Barriers

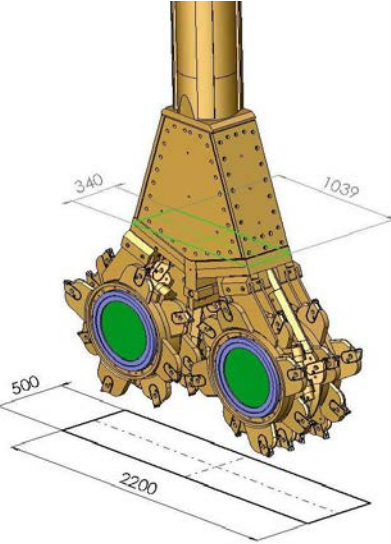
EXAMPLE

- Pressure Injection Panels
- Slurry Construction
- Shored Excavation



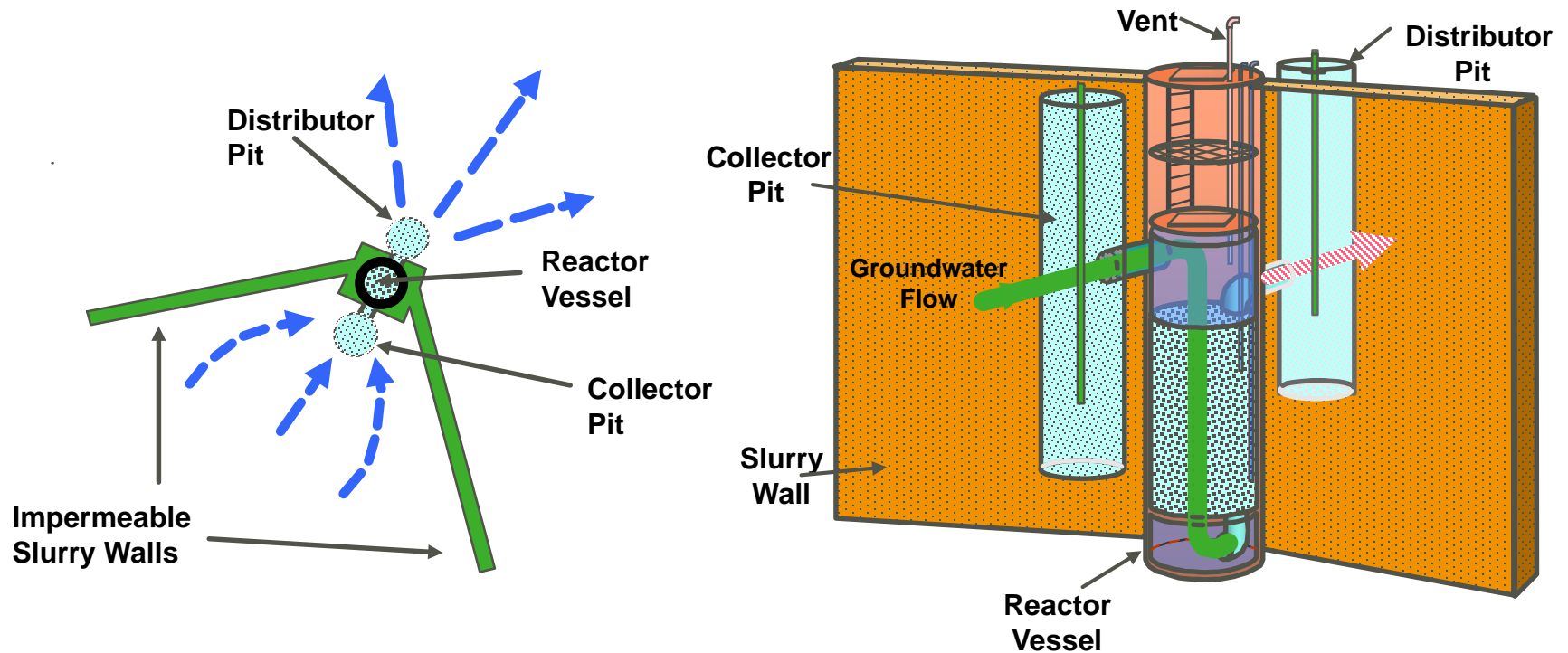
GW Cut Off Barriers

RANGE OF CONSTRUCTION TECHNIQUES

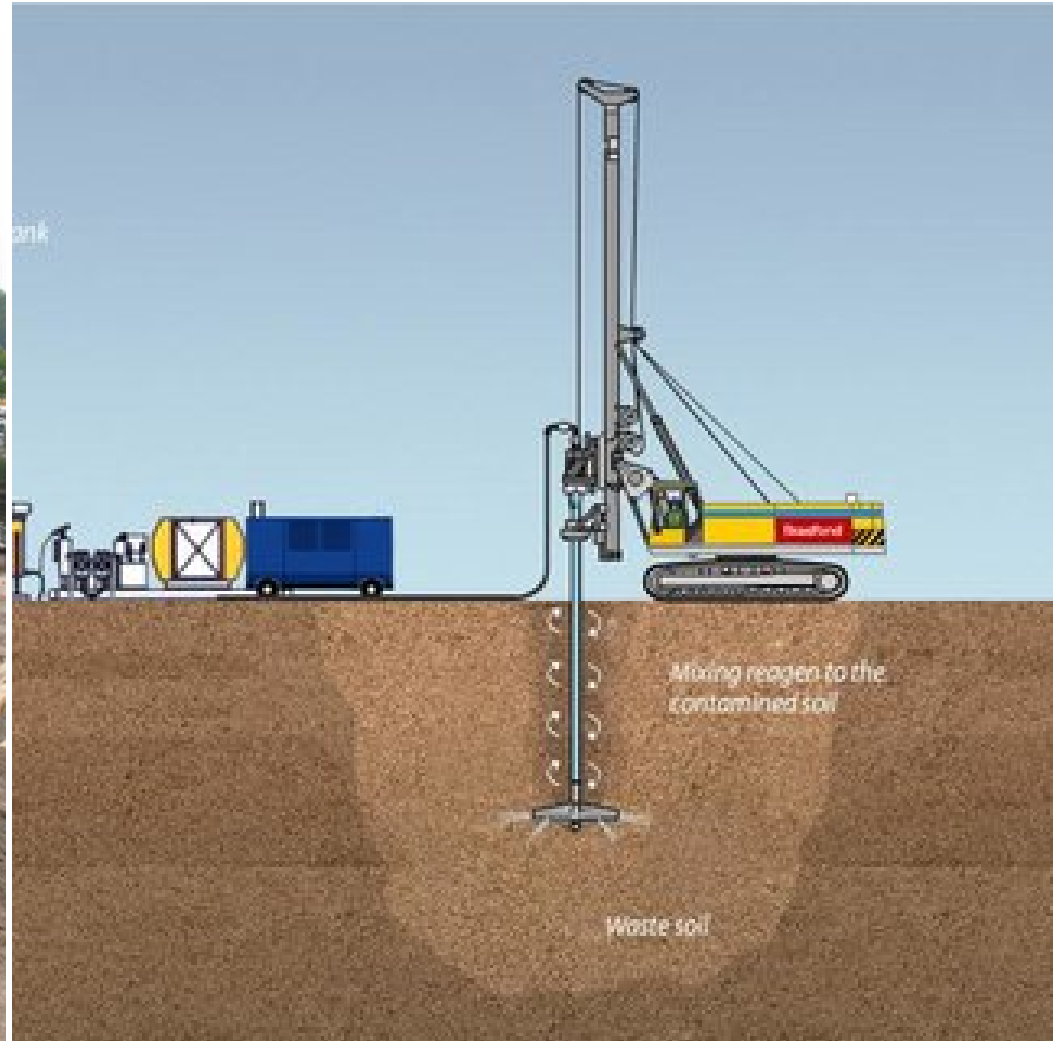


Funnel and Gate with Permeable Reaction Vessel

EXAMPLE



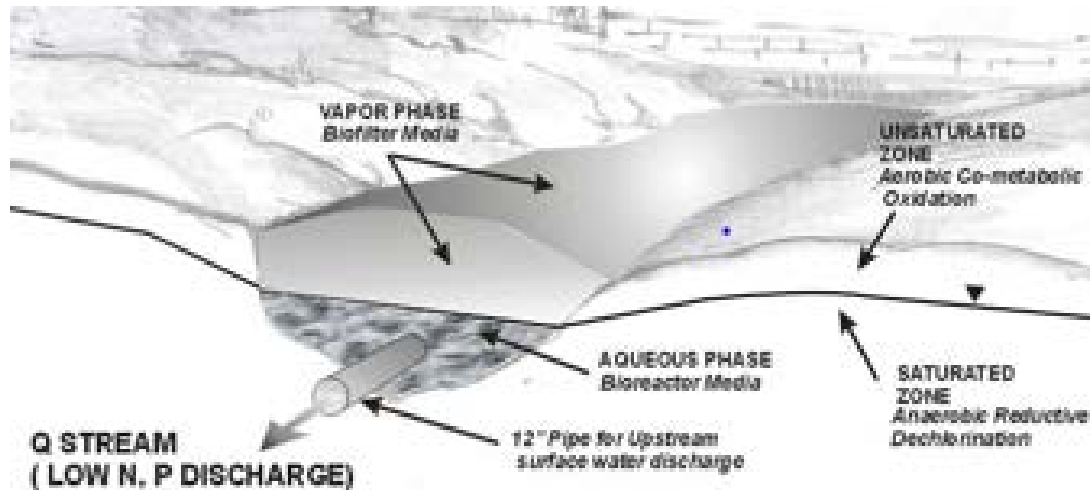
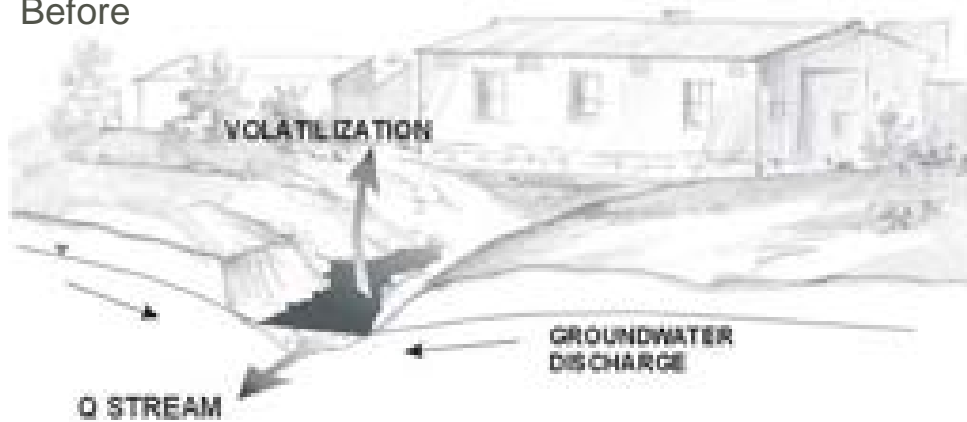
In-Situ Stabilization



Permeable Reaction Channel

EXAMPLE

Before



As-built
Tailrace Bio-Reactor

Computational approaches

METHODS

Mechanistic adsorption models:

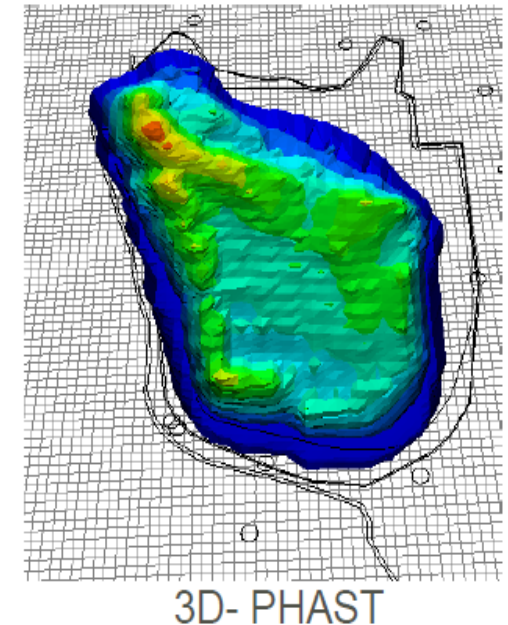
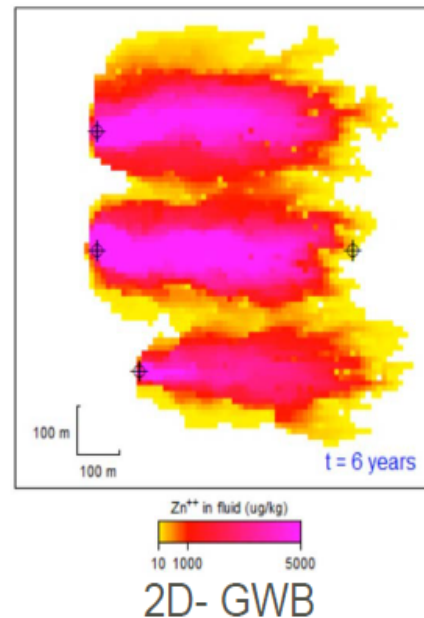
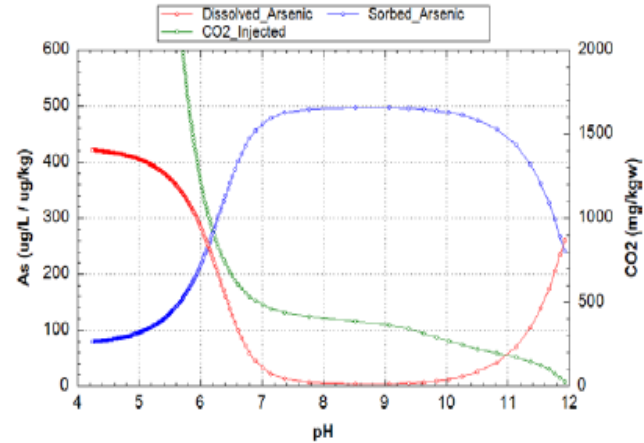
- Diffuse Double Layer Model (DDLDM)
 - Iron, aluminum, manganese
 - Organic, inorganic carbon
- Constant Capacitance Model (CCM)
- Charge Distribution Multi-Site (CD-MUSIC)

DDLDM methods:

- Metal extractions/sequential extractions
- Primary/secondary phases

Examples of computational codes:

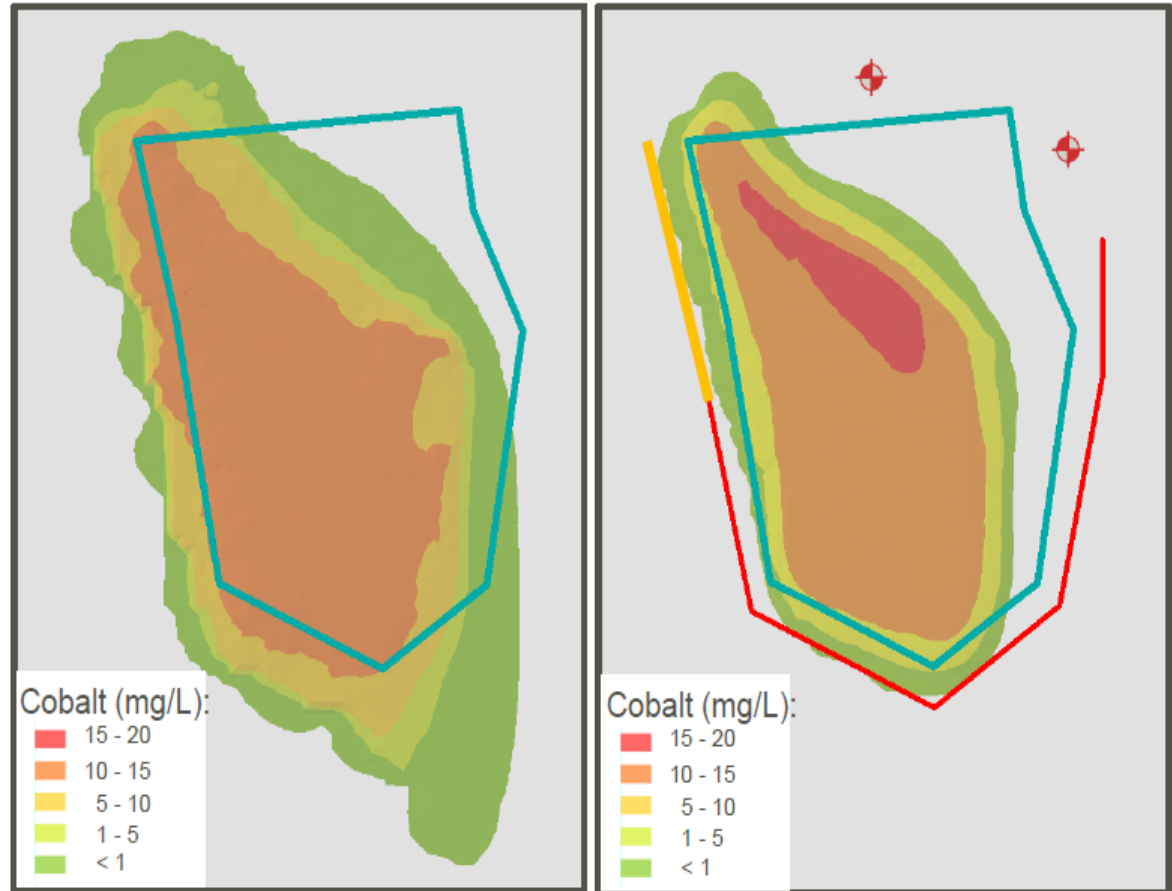
- Geochemist's Workbench
- USGS PHREEQC
- USGS PHAST
- FEFLOW with PiChem



Results- Barrier wall with pumping wells

MODELING ENHANCED MNA

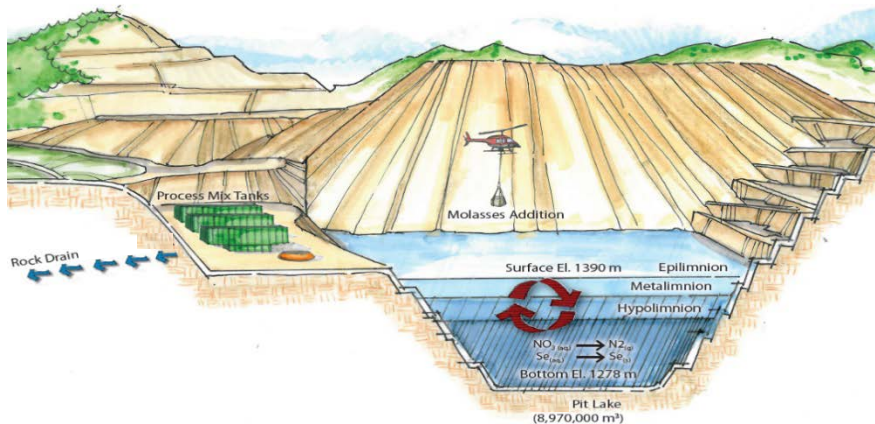
- With addition of the barrier wall and hydraulic control, constituents met their target levels in <5 years
- Mounding behind the wall was relieved by hydraulic control wells and pumping rates were optimized
- Adjustments to the barrier wall optimized plume retention and direction
- Barrier wall depth could be used to also direct plume movement



Selenium Treatment – Mine Pit Case Study

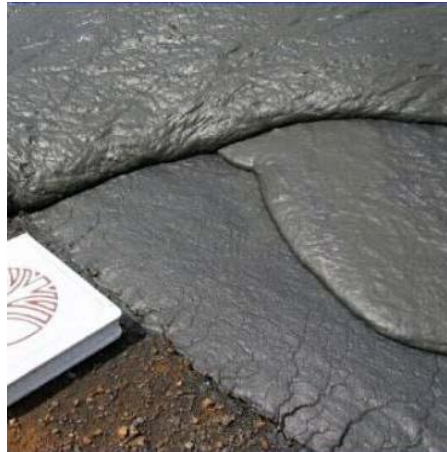
APPLICATION

- Molasses application into pit lake to assist in selenium reduction
- Selenium: 67 ppb to 15 ppb over a 2-year period



Paste Technology & Encapsulation

What is “Paste”?



- Is simply dewatered material (generally tailings or other mineral wastes i.e. ash) that is an engineered mixture of solids and water
- Possesses a yield stress
- Produces a measurable slump and has a maximum slump of ~10 inches
- Has a homogenous appearance i.e. no segregating of coarse to fine particles

What is “Paste”?



- Is normally free standing when deposited
- Has low or no critical flow velocity
- Uses pumps or gravity to move through a pipeline
- Exhibits plug flow characteristics
- Exhibits little to no water bleed and is generally non-segregating at any stage of transport or placement



Paste Technology Applications for CCR

Paste → Material Thickening and Handling Process

- Some Sites Have Advantages for Wet vs Dry Handling
- Ability to Scale Up / Down to Match Handling Operations
- Production and Safety Advantages at Some Sites
 - Can be Operated 24/7 – Safe Working at Night
 - Paste Operations Less Impacted by Weather than Trucking / Conventional Methods
 - Can Significantly Reduce Post Deposition Handling Needs – Significantly Reduces Need for Access / Personnel on Ash
 - Largely Eliminates Dusting of Ash Surfaces / Deposits

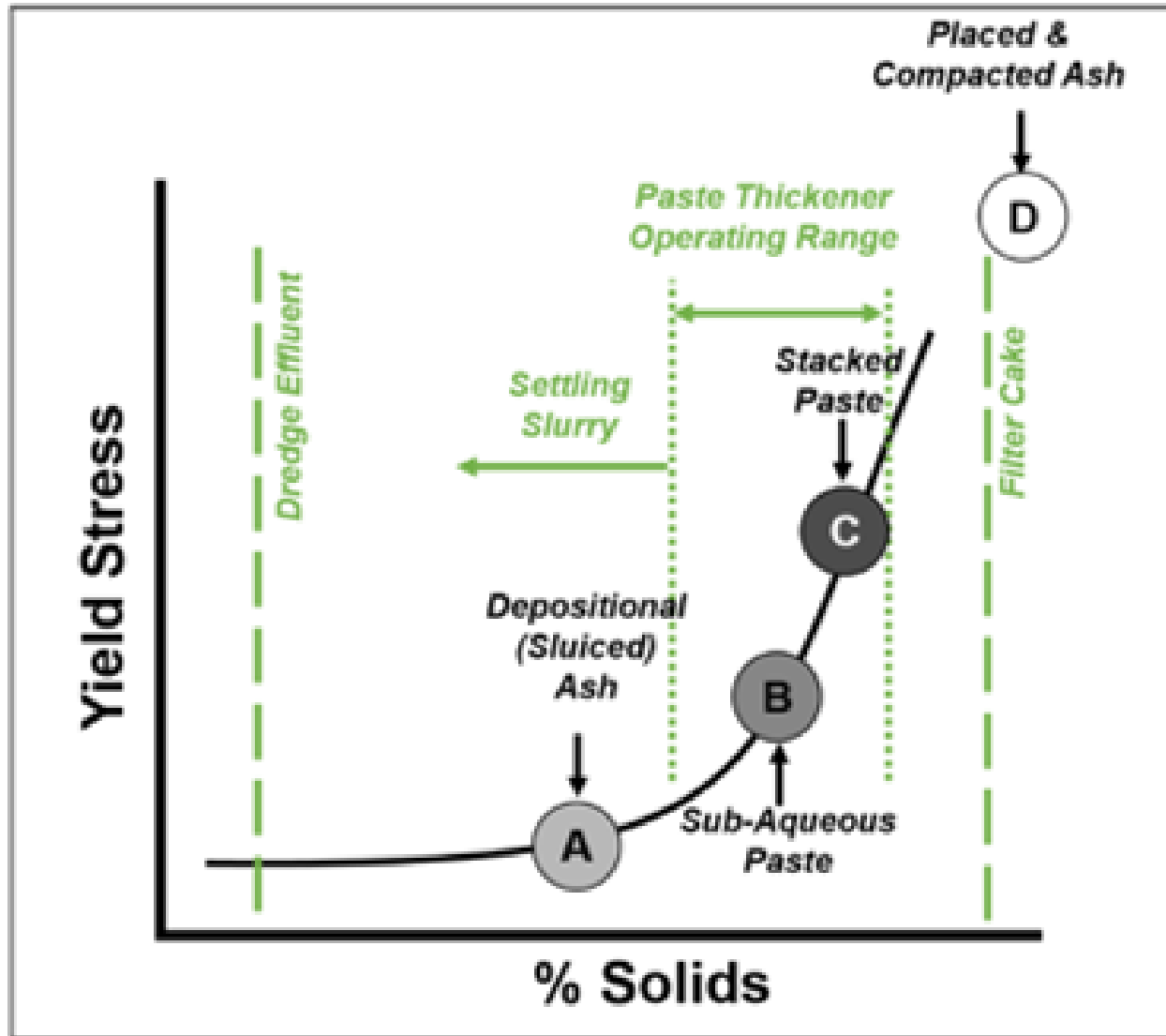


Paste → Encapsulation / Water Treatment Applications

- An alternative to High CAPEX Biological FGD Brine WWT
- Encapsulation of CCR Materials – w/ Binder Addition
- As Mine Backfill / Stabilization Solution



% Solids / Water Continuum



Brine Encapsulation in a Nutshell



Brine



Fly Ash

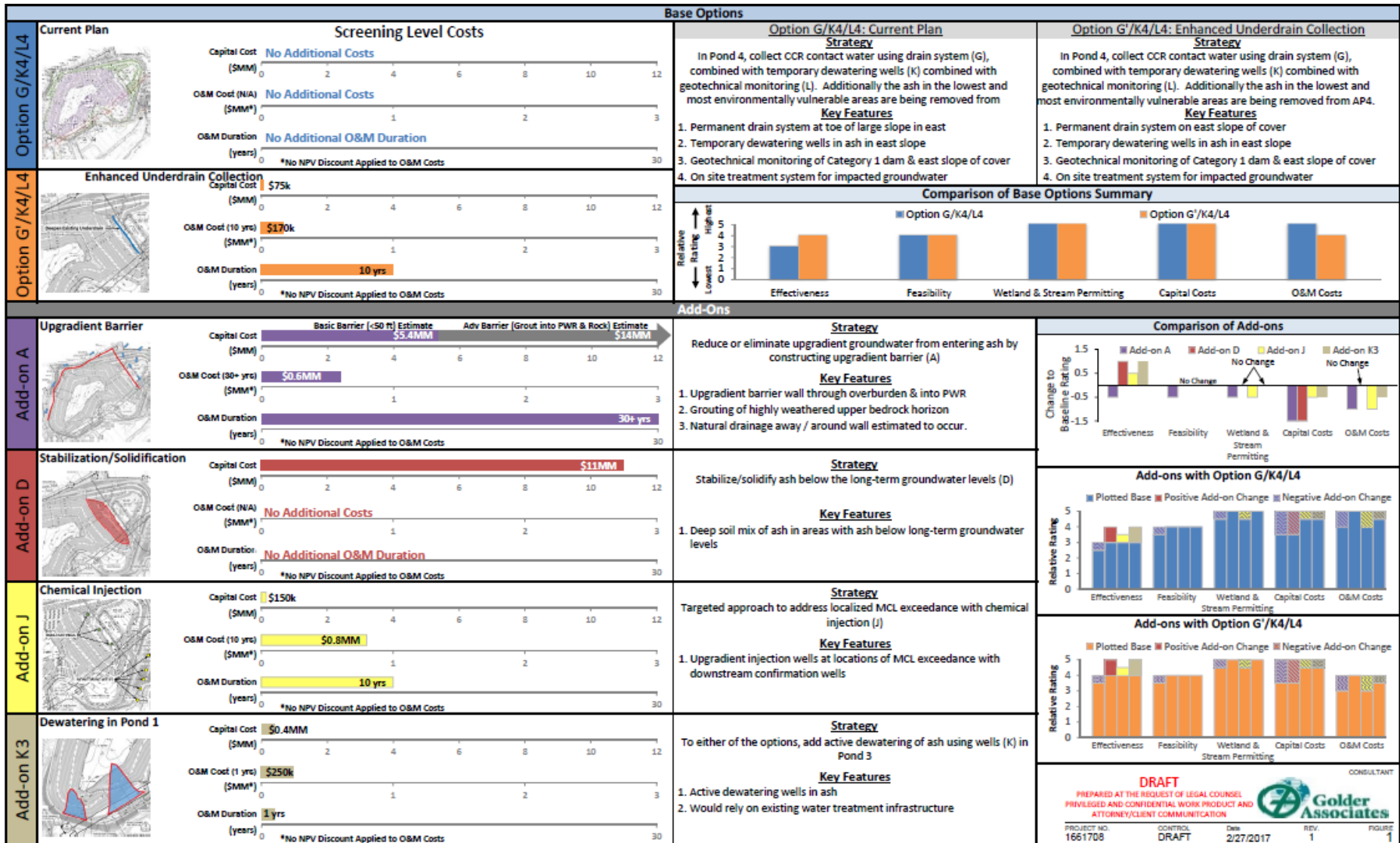


Quick
Lime



Options Assessment & Decision Making Tools

Options Evaluations – Dashboard Presentations



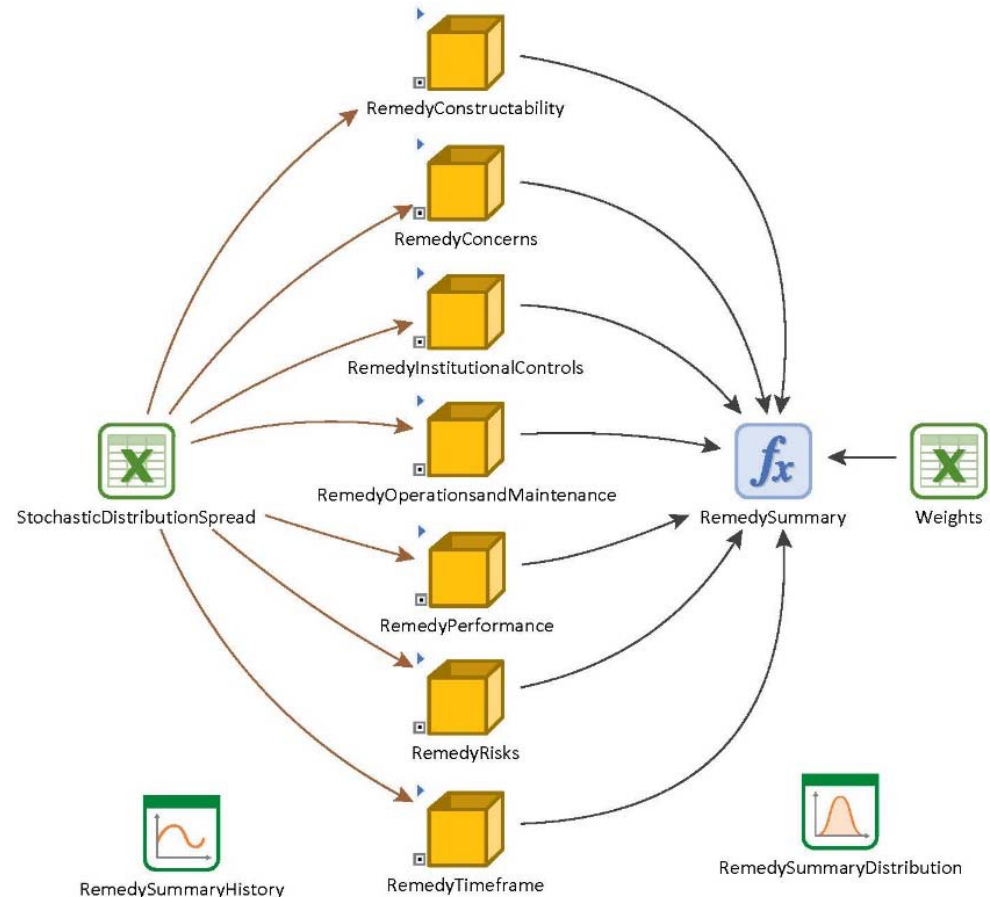
Options Evaluations – Dashboard Presentations



Monte Carlo Assessments - GoldSIM

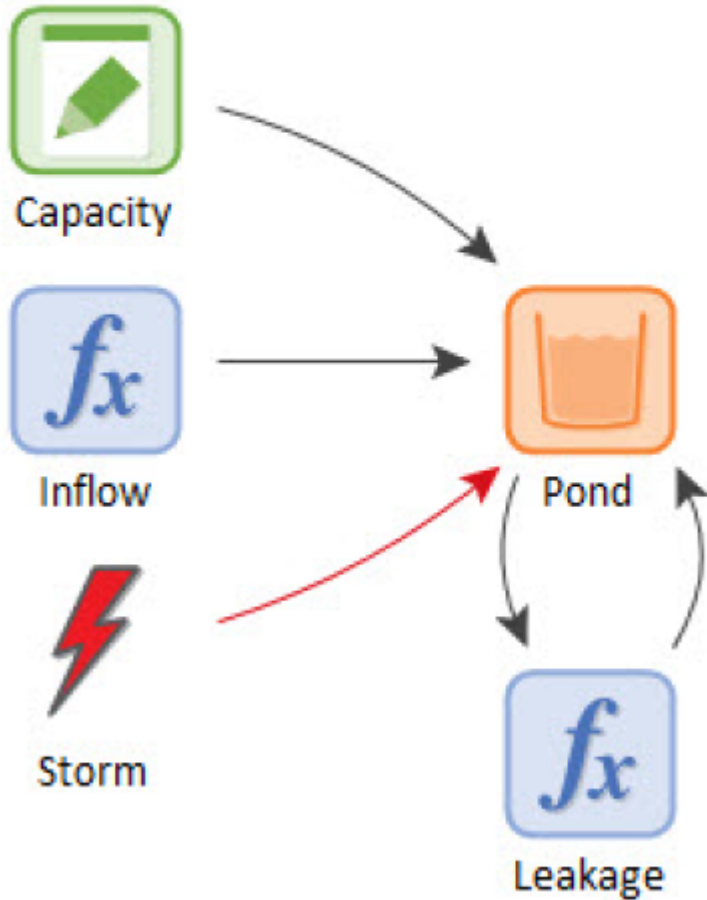
GOLDSIM

- Dynamic Monte-Carlo simulation software
- GoldSim is a graphical, object-oriented program for dynamic, probabilistic simulations of complex systems
- GoldSim has a wide variety of specialized elements
- You build a model by connecting the outputs of elements to the inputs of another element



What is GoldSim?

- VISUAL SPREADSHEET

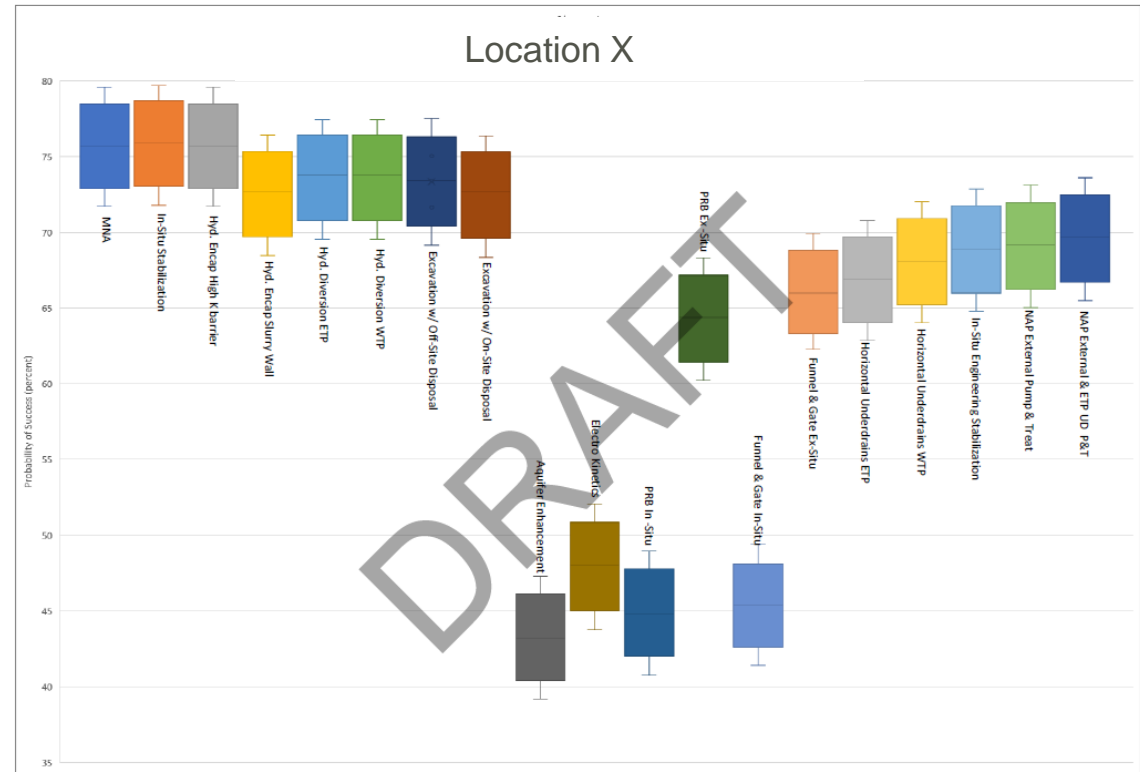


- GoldSim is a graphical, object-oriented program for dynamic, probabilistic simulations of complex systems
- Wide variety of specialized elements
- You build a model by connecting the outputs of elements to the inputs of another element.

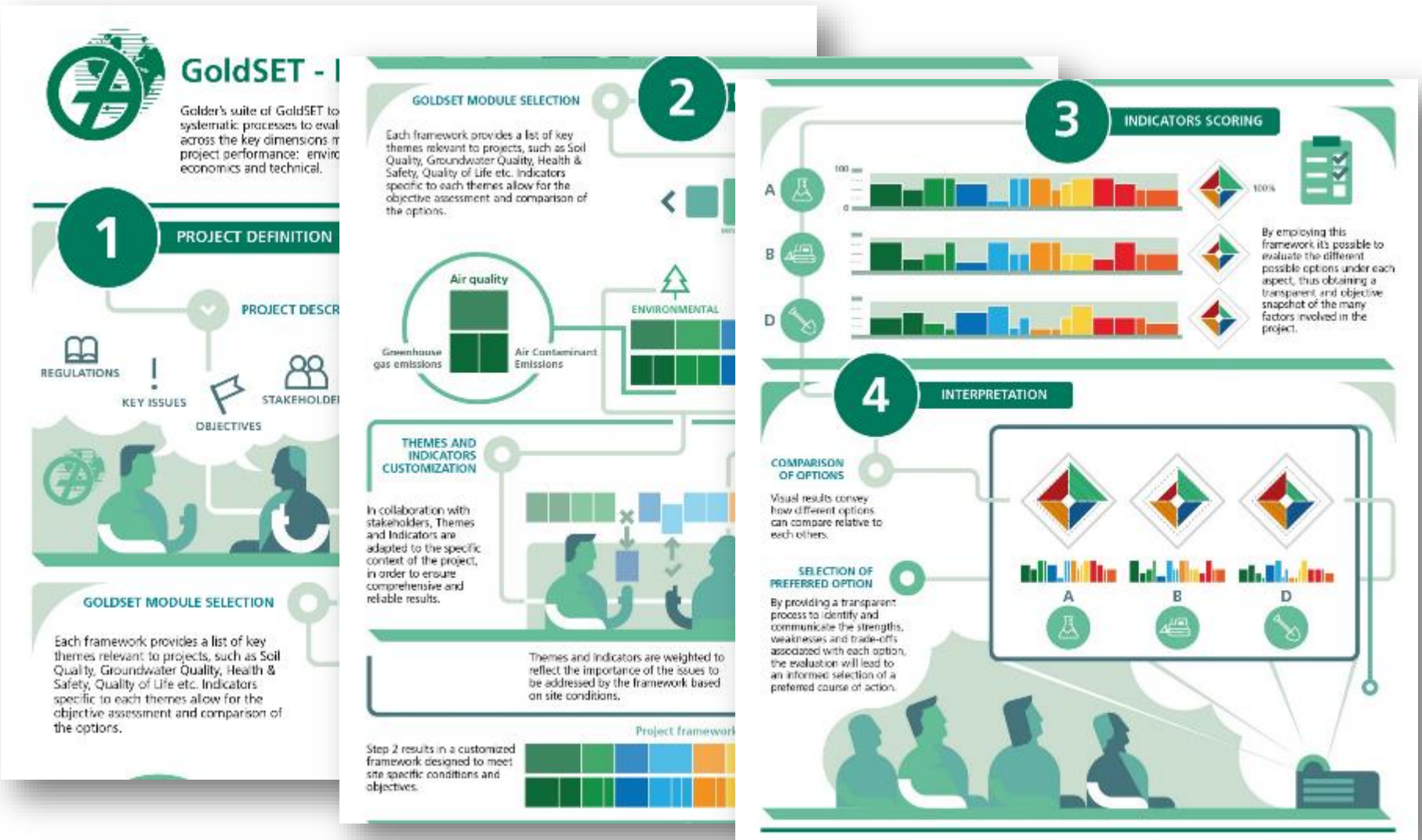
Assessment of Corrective Measures

GOLDSIM EXAMPLE

- Multi-criteria analysis by ranking objects
- Different COIs, site specific
- Upfront engineering and design costs considered
- Rankings based on pump and treat as the “average” option
- Risk is considered as 30% of weighting (e.g., risk of well failure, COI release, dam failures)



GoldSET Multi-Criteria Assessment Tool



Multi-Criteria Analysis (MCA)

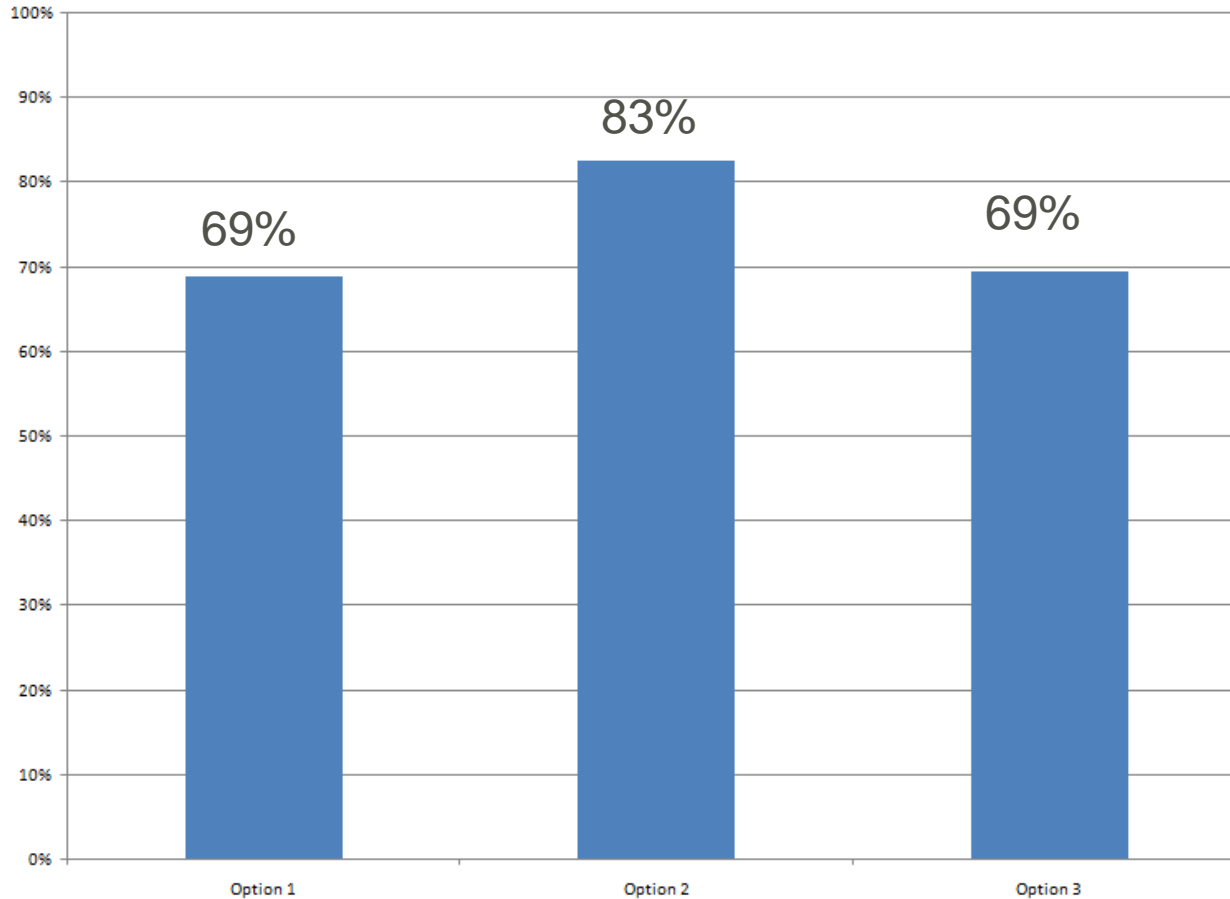
A structured MCA approach explicitly defines:

- **Indicators** against which to measure options
- **Scoring schemes** for the indicators to use for measuring
- A mechanism to account for the **relative importance** of indicators

And in doing so, a thorough MCA:

- Provides **traceability and accountability**
- Allows us to **explicitly identify** our **priorities** in decisions
- **Removes subjectivity** from the decision making process
- Make an **informed decision** based upon the **factors** that we consider to be the **most important**

Multi-Criteria Analysis (MCA) - Conventional

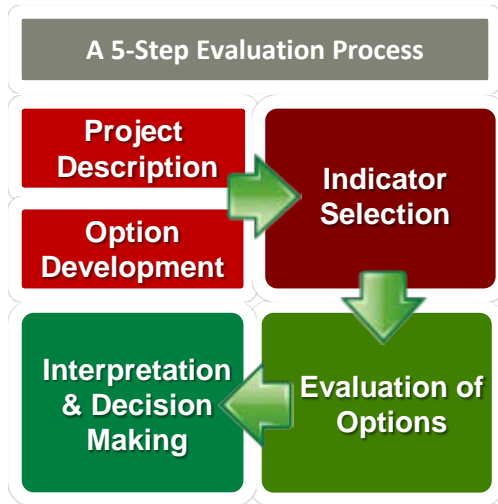


How do we make meaning from this?

Is Option 2 really the best?

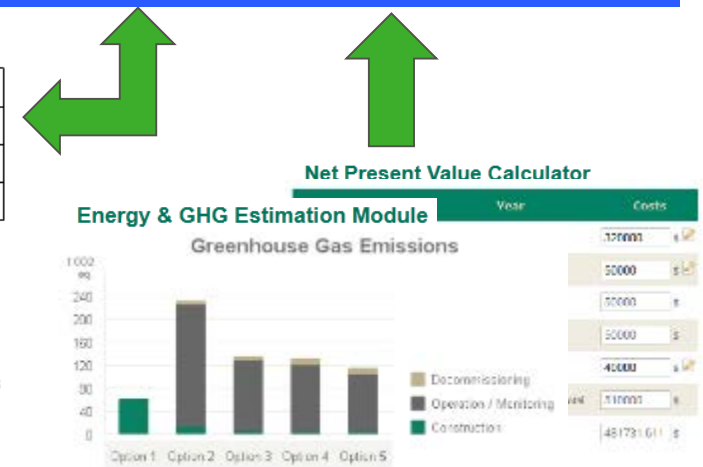
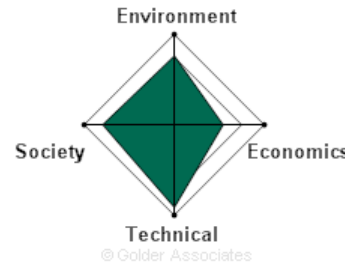
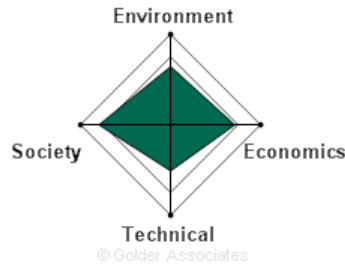
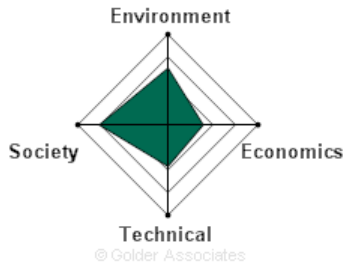
Are Options 1 and 3 actually equivalent?

GoldSET approach in a Nutshell



Environmental Aspect						
Code	Indicator	OPTION 1	OPTION 2	OPTION 3	Weight	
ENV-1	Are offset gains additional to future trajectory based on status quo?	50	100	50	3	
ENV-2	Can the offset site be expanded upon, or, the method intensified, to incorporate future offsets?	150	50	100	2	
ENV-3	Complimentarity of offset with regional conservation goals.	50	100	0	1	
ENV-4	Does the offset site create the opportunity for buffering of important site(s), or, to enhance connectivity in landscape?	50	100	50	2	
ENV-5	Ratio of impact footprint area versus area required for NNL offset. (= "offset efficiency").	25	50	25	1	
ENV-6	Offset enhancement technology performance risk.	100	100	50	2	
Social Aspect						
Economic Aspect						

OPTION A		OPTION B		OPTION C	
ENVIRONMENT	62%	ENVIRONMENT	64%	ENVIRONMENT	75%
SOCIETY	75%	SOCIETY	79%	SOCIETY	79%
ECONOMICS	39%	ECONOMICS	71%	ECONOMICS	54%
TECHNICAL	46%	TECHNICAL	51%	TECHNICAL	91%



Example CCR Pond Closure Options



Cap in Place
Over Existing
Footprint

Option 1



Reshaped
Cap in Place
Area

Closure by
Removal
Area

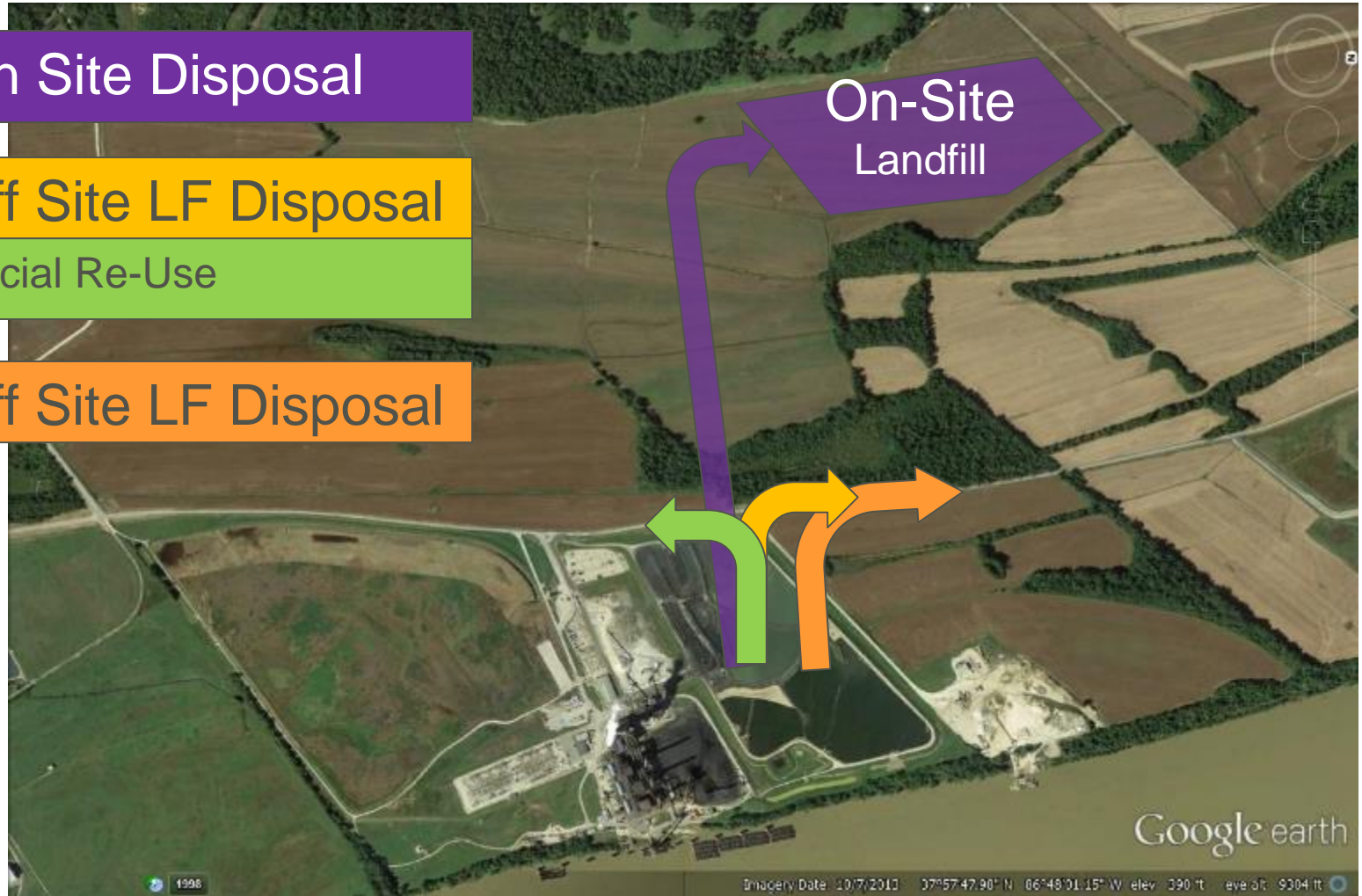
Option 2

Example CCR Pond Closure Options

Opt 3: On Site Disposal

Opt 4: Off Site LF Disposal
w/ % Beneficial Re-Use

Opt 5: Off Site LF Disposal



Project Description and Option Development

English Important: Please do not use the navigation buttons on your browser's toolbar (Back + Forward). Instead, use the GoldSET Menu buttons to navigate within the tool. [Home](#) [ghebler](#) (Log off)

Active project : [CCR Pond Closure Example](#)
Current Version : [Version 1 \(13/01/2015\)](#)

Golder Associates | GoldSET Contact

Project Selection | General Information | **Project Description** | Option Development | Indicator Selection | Weighting | Quantitative Evaluation | Qualitative Evaluation | Interpretation

GoldSET is tailored for a wide variety of uses. Data entered in the tool is exported while creating the evaluation report.

Step 1 - Project Description : Conceptualization

Project Objective and Constraints

Project Objective(s)

Describe the project objective(s) :



Project Selection | General Information | Project Description | **Option Development** | Indicator Selection | Weighting | Quantitative Evaluation | Qualitative Evaluation | Interpretation

Step 2 - Option Development



Option	Name	Status	Duration (Years)	Actions
1	Cap in Place - Retain Footprint	Selected	2	

Option Description

General description of the approach versus objective(s)

Provide a general description of the approach and explain how the approach will meet the project objective(s):



This option consists of placing a relatively impermeable cap over the CCR pond, breaching the dike to not further impound water, and providing surface water control and dike stability.

Is the proposed approach expected to meet the objectives ?

Yes

Description of technology

Technology

Provide a summary of the technology and explain how the technology will meet physical site constraints if any :



Risks & Opportunities

General Description

Site Geology & Hydrogeology

Site Contamination

Receptors

Indicator Selection and Weighting

Environmental			
Selection	Theme	Indicator	Description
<input checked="" type="checkbox"/>	Soil Quality	Soil Quality	
<input type="checkbox"/>	Sediment Quality	Sediment Quality	
<input checked="" type="checkbox"/>	Sediment Quality	Sediment Quality	
<input type="checkbox"/>	Soil Vapour Intrusion	Soil Vapour Intrusion	
<input checked="" type="checkbox"/>	Water	Groundwater Quality	
<input type="checkbox"/>	Water	Free Product	
<input checked="" type="checkbox"/>	Water	Surface Water Quality	
<input checked="" type="checkbox"/>	Water	Waterborne Contaminant Migration	
<input type="checkbox"/>	Water	Water Usage	
<input checked="" type="checkbox"/>	Atmosphere	Greenhouse Gas Emissions	
<input checked="" type="checkbox"/>	Energy Consumption	Energy Consumption	
<input checked="" type="checkbox"/>	Waste	Quantity of Wastes	
<input type="checkbox"/>	Waste	Hazardous Wastes	
<input checked="" type="checkbox"/>	Soil	Contaminated Soil Erosion and Transport	
<input checked="" type="checkbox"/>	Fauna and Flora	Impacts on Fauna and Flora Resulting from the Proj	
<input checked="" type="checkbox"/>	Fauna and Flora	Impacts on Fauna and Flora During the Project	
<input checked="" type="checkbox"/>	Impact of Technology	Residual Impact of Technology	
<input checked="" type="checkbox"/>	Groundwater Quality	Groundwater Quality	

Economic Performance Potential Litigation

Evaluates the likelihood that potential litigation will be avoided by implementing the option.

Scoring Scheme :

- 0 = Legal action likely not avoided
- 50 = Likely to reduce potential for legal action
- 90 = Legal action likely avoided
- 100 = Legal action avoided

Reference :

Social			
Selection	Theme	Indicator	Description
<input checked="" type="checkbox"/>	Water	Drinking Water Supply	
<input checked="" type="checkbox"/>	Health & Safety	Community Health and Safety	
<input checked="" type="checkbox"/>	Health & Safety	Worker's Health and Safety	
<input checked="" type="checkbox"/>	Impact on Community	Direct Local Employment	
<input checked="" type="checkbox"/>	Impact on Community	Opportunities for Local Business Generation	
<input checked="" type="checkbox"/>	Impact on Community	Public Disruption (Duration of Work)	
<input checked="" type="checkbox"/>	Impact on Community	Quality of Life (During the Project)	
<input checked="" type="checkbox"/>	Impact on Community	Public Use	
<input type="checkbox"/>	Impact on Community	Cultural Heritage	
<input checked="" type="checkbox"/>	Impact on the Landscape	Impact on the Landscape	
<input checked="" type="checkbox"/>	Management Practices	Management Practices	

Economic			
Selection	Theme	Indicator	Description
<input checked="" type="checkbox"/>	Corporate Image	Corporate Image	
<input checked="" type="checkbox"/>	Standards, Laws & Regulations	Standards, Laws and Regulations	
<input checked="" type="checkbox"/>	Economic Performance	Net Present Value of Options' Costs	

Four dimensions to be evaluated:

Environmental – Direct & Indirect Impacts

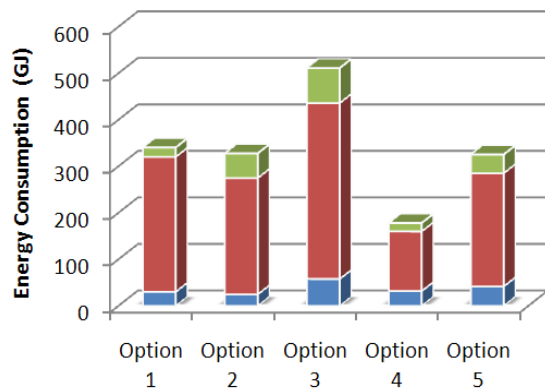
Social – Benefits & Nuisances

Economics – Bottom Line

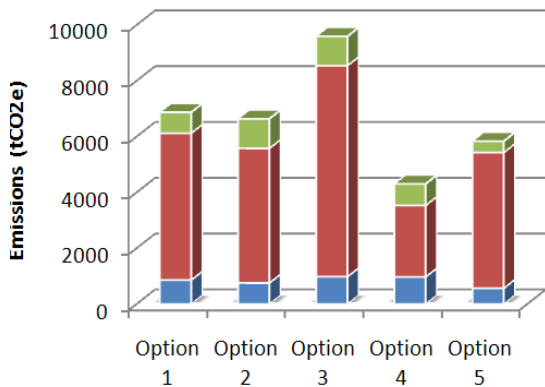
Technical – Reliability Vs. Complexity

Evaluation of Options (Quantitative and Qualitative)

Energy Consumption



Greenhouse Gas Emissions



Environmental Aspect					
	Units	Cap in Place - Retain Footprint	Cap in Place - Reduced Footprint Away from River	Excavate and Disposal in On-Site Landfill	Excavate and Offsite Disposal with Ben. Re-Use
ENV-6 Greenhouse Gas Emissions	Tonnes CO2 e.	7.36	8.28	58.64	54.53
ENV-7 Energy Consumption	MMBTU (PFE)	105.02	119.2	846.41	790.23
ENV-8 Quantity of Wastes	Tons	1000000	1000000	1000000	500000
Social Aspect					
	Units	Cap in Place - Retain Footprint	Cap in Place - Reduced Footprint Away from River	Excavate and Disposal in On-Site Landfill	Excavate and Offsite Disposal with Ben. Re-Use
SOC-6 Public Disruption (Duration of Work)	Years	2	3	12	8
Economic Aspect					
	Units	Cap in Place - Retain Footprint	Cap in Place - Reduced Footprint Away from River	Excavate and Disposal in On-Site Landfill	Excavate and Offsite Disposal with Ben. Re-Use
ECONO-3 Net Present Value of Options' Costs	\$	2818182	3190083	4983316	6295732
Technical Aspect					

Quantitative evaluation

Results & Interpretation

Process is Systematic, Repeatable, Defensible – inputs, trade-offs, relationships and assumptions explicit & fully documented

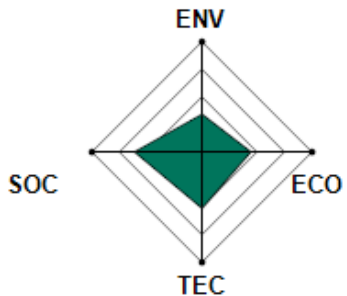
Avoiding unintended consequences by systematically considering environmental, social, economic and technical factors

Obtaining support & buy-in from stakeholders through a collaborative process → greater potential for community approval

Model is reusable with a long “shelf life” once the cost/suitability surface is developed, it may be used repeatedly for similar applications

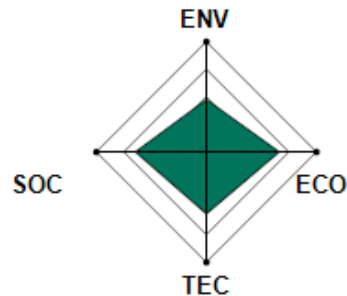
Detailed Results

Cap in Place - Retain Footprint		Cap in Place - Reduced Footprint Away from River		Excavate and Disposal in On-Site Landfill		Excavate and Offsite Disposal with Ben. Re-Use	
Environmental	34%	Environmental	48%	Environmental	63%	Environmental	80%
Social	61%	Social	64%	Social	53%	Social	54%
Economic	44%	Economic	65%	Economic	76%	Economic	67%
Technical	51%	Technical	56%	Technical	58%	Technical	68%



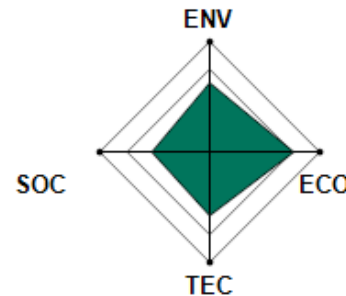
© Golder Associates

Public Disruption (Duration of Work) :
2 Years
Net Present Value of Options' Costs :
2,800,000 \$



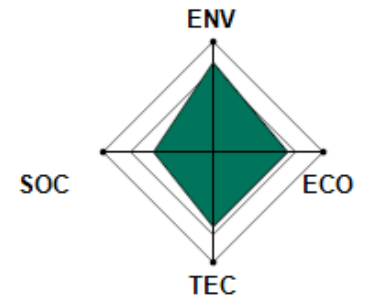
© Golder Associates

Public Disruption (Duration of Work) :
3 Years
Net Present Value of Options' Costs :
3,200,000 \$



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Public Disruption (Duration of Work) :
12 Years
Net Present Value of Options' Costs :
5,000,000 \$



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Public Disruption (Duration of Work) :
8 Years
Net Present Value of Options' Costs :
6,300,000 \$

Importance of Water Management in CCR Projects – Case Studies

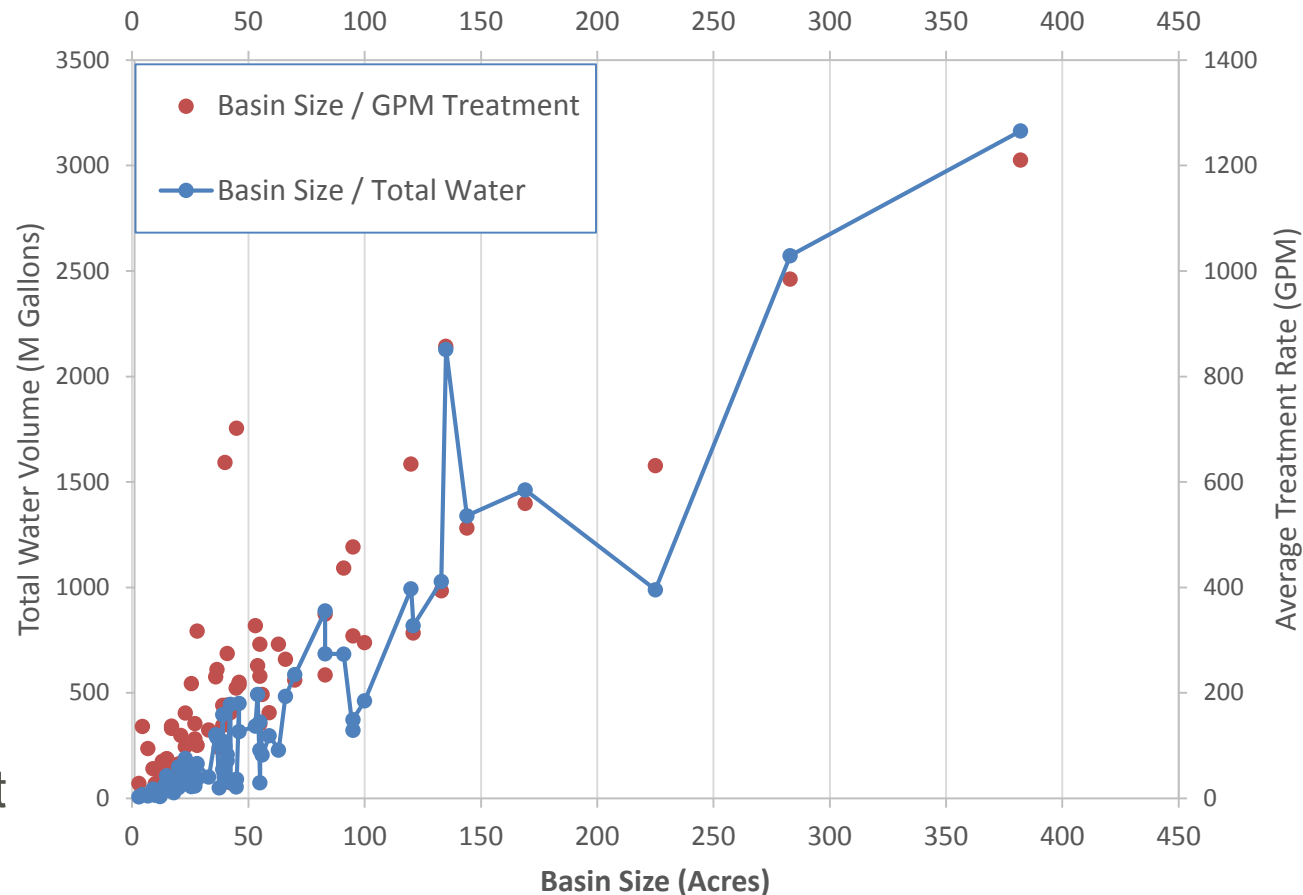
Volume of Water for Management & Treatment

Finite Sources:

- Pore Water
- Free Water

Variable Source - Storm Water

- Diversion Water
- Contact Water
- Closure Timeframe
- Weather dependent



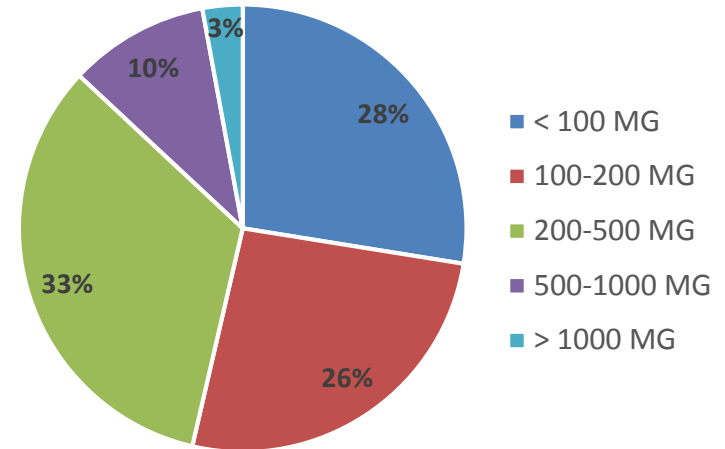
Data Source: Confidential Project Experience with Golder CCR Clients, includes more than 50 CCR basins across US.

Volume of Water for Management & Treatment

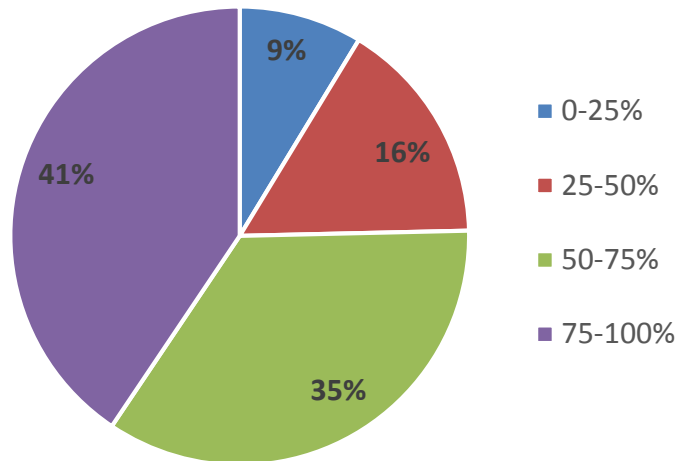
- 54% of sites have less than 200 MG total water
- 13% of sites have more than 500 MG total water



Percentage of Sites vs. Total Water Volume



Percentage of Sites vs. Rainfall Contribution



> 50% Rainfall Contribution at 76% of sites



- Diversion Water – Conveyance/TSS
- Contact Water – Site Specific Storage/Treatment Requirements

Data Source: Confidential Project Experience with Golder CCR Clients, includes more than 50 CCR basins across US.

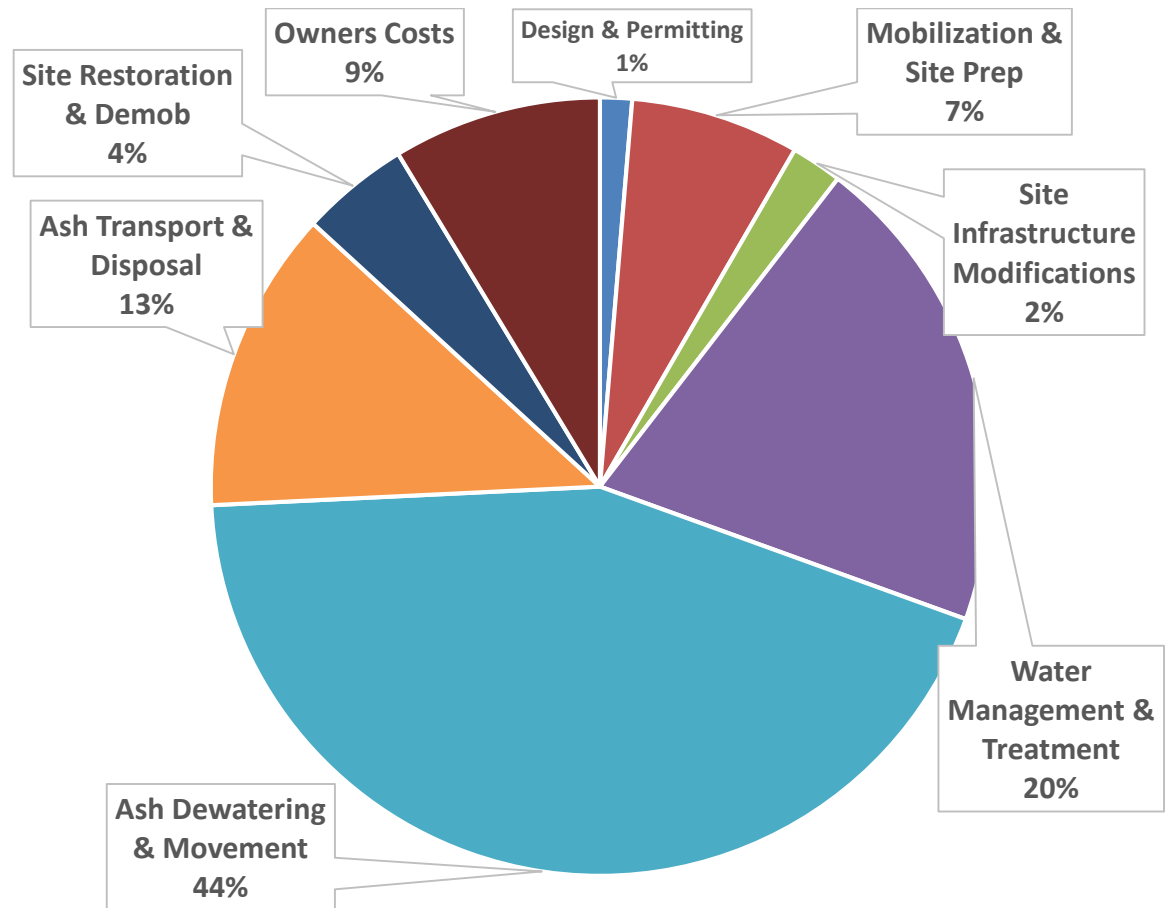
Relative Basin Closure Cost Impact

Closure Scenarios

- Clean Close
- Cap In Place
- Combination

Water Management & Treatment ~ 20%

- Water Storage
- Water Movement
- Water Treatment



Data Source: Confidential Project Experience with Golder CCR Clients, includes closure scenarios for more than 50 CCR basins across US.

Use of Temporary Covers – Case Study

PROJECT BACKGROUND

North Ash Pond (NAP)



Owner : Virginia Electric Power d/b/a Dominion Energy Virginia

Engineer : Golder Associates (Richmond, VA)

Original Scope of Work:

East Ash Pond - Clean Closure

North Ash Pond (NAP) - Interim and Final Capping

Motivation: Federal CCR Rule Compliance

East Ash Pond



Use of Temporary Covers – Case Study

CHALLENGE



Senate Bill 807

Virginia DEQ suspended the issuance of any permit to Virginia Electric Power Company d/b/a Dominion Energy Virginia for any CCR surface impoundment closure within the Chesapeake Bay Watershed.

Consequently... Closure-in-place activities were suspended.

Use of Temporary Covers – Case Study

CRITICAL SUCCESS FACTORS



Eliminate contact water volume generation.

Prevent increase in pore water phreatic surface elevation.

Use of Temporary Covers – Case Study

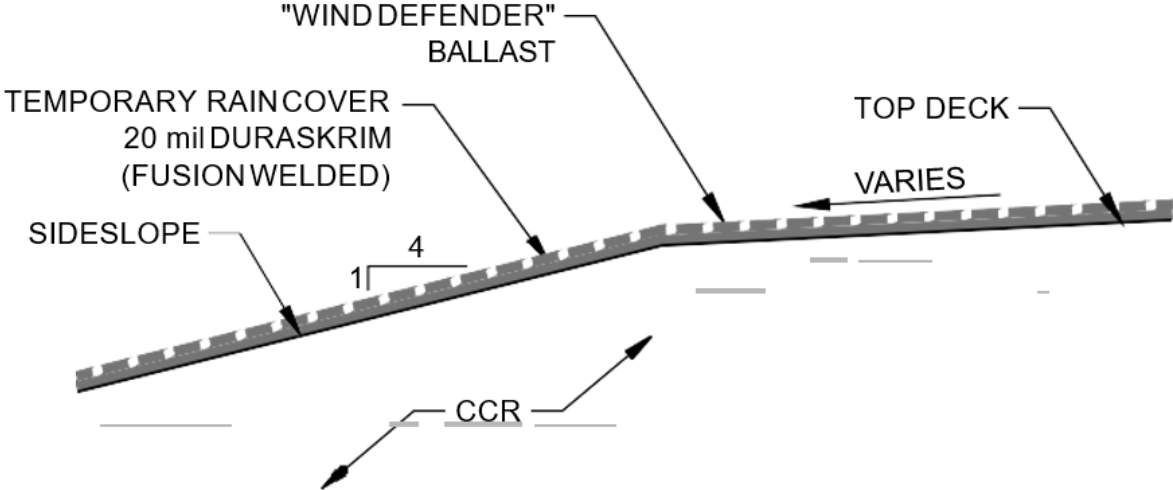
DESIGN CONSIDERATIONS



- ~68-acres
- Long drainage lengths
- Large volume of storm water
- Installation Phasing
- Wind uplift
- Snow loading
- UV degradation
- Ballast materials damaging underlying rain cover

Use of Temporary Covers – Case Study

SOLUTION



1 RAIN COVER DETAIL
21 NOT TO SCALE

Use of Temporary Covers – Case Study

TEMPORARY COVER

Same Closure Benefits as Final Closure

- Eliminate Contact Water
- Reduce Pore Water Generation
- Erosion & Dust Control
- UV Protection
- Improve Stormwater Run-off Water Quality
- Low Maintenance
- Cost-effective

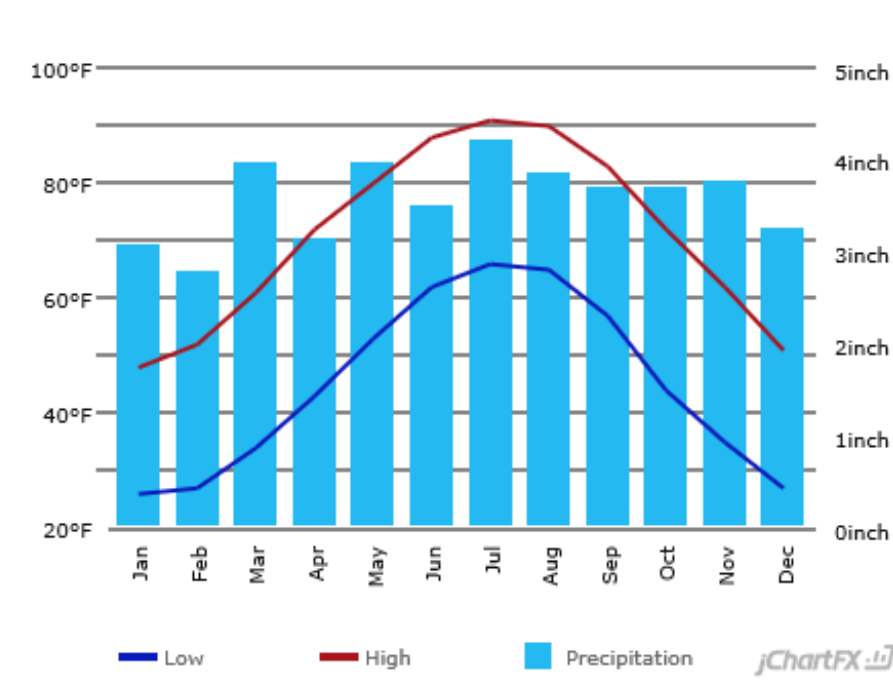


Use of Temporary Covers – Case Study

TEMPORARY COVERS



- Avg. Annual Rainfall Volume - ~79.3M gal
 - Area - ~68-acres (Lined Area) x 43,560 SF/acre
 - Avg. Annual Rainfall – (43-in/yr)/12-in/ft) = 3.58-ft/yr*
- Average Disposal Cost = \$0.10/gallon**
- Annual Estimated Treatment Cost – ~\$7.9M/yr. **
 - Avg. Annual Rainfall - ~79.3M gal
 - Avg. Disposal Cost - \$0.10/gal**
- Temp Cover System Supply & Install= ~\$1.5M**
- Contact water & pore water from the NAP is ~35% of the total water treated by the site.



* Per U.S. Climate data

** Theoretical value for comparison purpose only.

Use of Temporary Covers – Wind Defender

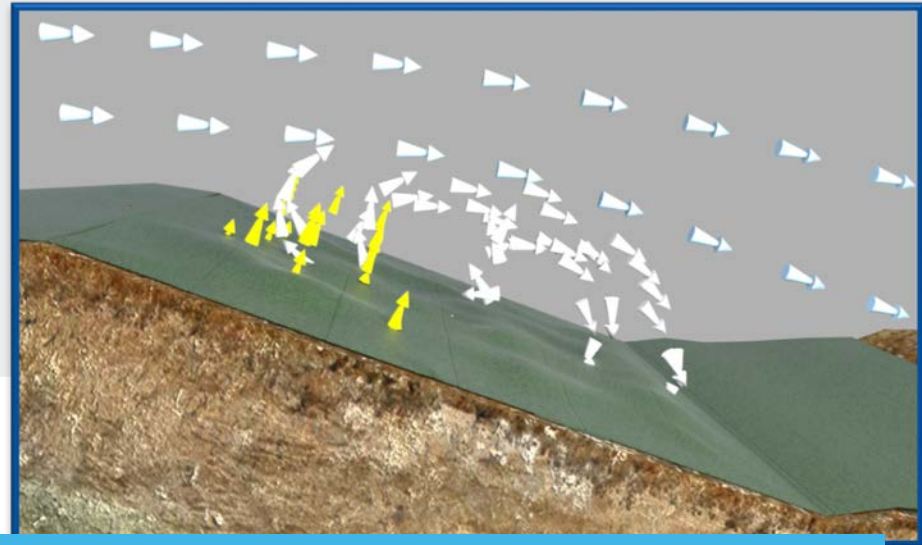
WIND LOADING



Cross Winds



Wind Uplift or Negative Pressure



The key performance property of a ballast system is to withstand the wind uplift force through a downward force used to pin or hold down the geomembrane. Wind Defender utilizes aerodynamics to diffuse and cancel out the forces causing wind uplift.





GOLDER

Follow up Questions & Discussion

Greg Hebler, PhD, PE
Gheber@golder.com
770-492-8252 (Direct)