Designing Stormwater Management Systems & Constructability Issues Associated with Active Ash Pond Closures

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CCR Surface Impoundment Closures

Many factors go into the planning, design and construction of CCR pond closures.

This session will focus on design/management of stormwater for ponds undergoing closure.
Review of CCR Impoundment Stormwater Design Criteria

1. How is stormwater management regulated for CCR impoundments?
2. What peak stormwater discharge governs design?
3. How does the CCR Final Rule impact the design?
How is stormwater management regulated for CCR impoundments?

STATE DAM SAFETY AGENCIES VIA FEMA GUIDELINES

• Dams that do not produce power (CCR surface impoundments) are typically regulated by State Agency
• Dams are regulated based on hazard classification per FEMA Federal Guidelines for Dam Safety
  • **Low** – no loss of life + low economic/environ. loss
  • **Significant** – no loss of life + high economic/environ. loss
  • **High** – probable loss of life
How is stormwater management regulated for CCR impoundments?

**COAL ASH POND DAM STATS:**

- Nearly half of all CCR ponds are listed as **Significant or High Hazard** (per EPA.gov CCR website and Summary Table for Impoundment Reports 7/31/14)
  - Approx **680** ponds at 240 facilities in US as of 2009
  - High Hazard: **50+/-** ponds at 32 facilities in 12 states
  - Significant Hazard: **260+/-** ponds at 120+/- facilities in 30 states
  - 30 states have ash ponds designated either High or Significant Hazard
What peak stormwater discharge governs design?

**PROBABLE MAXIMUM PRECIPITATION (PMP) & PROBABLE MAXIMUM FLOOD (PMF)**

- Peak runoff requirement varies state by state
- Significant and High Hazard dams generally require management of runoff associated with PMP/PMF
- PMP = that rainfall over a basin which would produce a flood with no risk of being exceeded (…we’re talking massive rainfall of epic proportions)
What peak stormwater discharge governs design?

PROBABLE MAXIMUM PRECIPITATION (PMP)

So how much rain are we talking about really?
For perspective, take southeast Ohio for example:
• 10-Year rainfall = 3.6 inches (local road culverts)
• 50-Year rainfall = 4.9 inches (some DOT box culvert road crossings)
• 100-Year rainfall = 6.0 inches (bridges typ. designed to pass this storm)
• 500-Year rainfall = 7.1 inches (hospitals typ. built above 500-Yr floodplain)
• 1000-Year rainfall = 7.8 inches

PMP rainfall = ???
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PMP rainfall = \textbf{26.8 inches}
How does the CCR Final Rule impact the design?

**CCR FINAL RULE GUIDELINES ARE SIMILAR... BUT CAN BE MORE RESTRICTIVE**

- Stormwater Design requirements are specified in Section 257.82(a)
  - Low Hazard – 100 Yr event
  - Significant Hazard – 1000 Yr event (~25% to 50% PMF)
  - High Hazard – PMF
How does the CCR Final Rule impact the design?

**CCR FINAL RULE GUIDELINES ARE SIMILAR... BUT CAN BE MORE RESTRICTIVE**

- State Dam Safety requirements vary state and can be more or less restrictive – but generally fall in this range

**However,** the state will still regulate the dam closure. Therefore, the impoundment must be able to pass the more restrictive peak runoff condition to satisfy **both State and Final Rule.**
Designing for the passage of large storm events through a CCR impoundment becomes even more interesting when you throw in:

- Closure Aspects
- Water Quality/NPDES Requirements
- Ponds in Series
- Etc...
CCR IMPOUNDMENT CLOSURE STRATEGIES
Overcoming Stormwater Management Challenges

1. Get the Big Picture
2. Develop a Functional Conceptual Plan and H&H Model
3. Review Conceptual Plans in-house & with regulators
4. Finalize Design Plans & H&H Modeling
5. Develop Preliminary Construction Sequencing Plan
Once the decision has been made to prepare for closure of an impoundment, consider how the closure will fit into the overall facility operations or retirement plans.

This is the time to put everything out on the table and ask questions.
CCR Impoundment Closure Strategies

1 Get the Big Picture

Is the impoundment a stand alone...
CCR Impoundment Closure Strategies

1 Get the Big Picture

...or part of a network that operates in series?
Will closure of the impoundment impact the ability to manage stormwater down-gradient?
CCR Impoundment Closure Strategies

1 Get the Big Picture

Can up-gradient pond water level be temporarily lowered to aid in detaining water for the closure construction?
Can up-gradient stormwater be temporarily, or permanently, rerouted to bypass pond during closure?

There are potential benefits to adding drainage bypass system to capture routine discharges and direct them away from impoundment during construction that should be considered.
CCR Impoundment Closure Strategies

1. Get the Big Picture

Can run-on diversions be added upstream of the pond network to reduce overall stormwater inflow?

Incorporation of run-on diversion ditches are low cost and can reap benefits.
CCR Impoundment Closure Strategies

1. Get the Big Picture

- Outlet Pipe/Structure vs. Dam Breach Alternatives?
  - If inactive and closed within 3 years, pipe outlet is an option
  - If not, dam must be breached per CCR Final Rule (Section 257.100)

- Other Considerations:
  - Are there options for How/Where to implement Dam Breach/Outlet(s)?
    - Will access across breach be needed post-closure?
      - I.e. access to utilities, emergency site egress, etc.

  - Inverted vs. Crown cap?
    - Is dam height restricted by overhead utilities, etc?
    - Is there additional material to be placed in impoundment prior to closure?
CCR Impoundment Closure Strategies

2. Develop a Functional Conceptual Plan & H&H Model

Gather results of Big Picture review to begin assembly of plan

1. OUTLETS - Decide rough outlet/breach location(s) and whether pipe or breach
2. ASH LIMITS - Confirm top, depth and limits of ash
3. DRAINAGE AREA - Review contributing drainage area
   1. Incorporate run-on diversions (if possible)
   2. Add up-gradient stormwater bypass system (if feasible)
CCR Impoundment Closure Strategies

2  Develop a Functional Conceptual Plan &

4. GENERATE BASIC CAP SURFACE
   1. Set approximate outlet invert and whether crown or inverted cap
   2. If inverted, add rough channel & cap surface layout (in 2-D only) to develop preliminary cap 3-D surface
      1. Channel & Cap slope Goals:
         1. mild channel slopes (1% min)
         2. Channel spacing based on maximum anticipated sheet flow distance
            (300 ft max for 3% (min) cap slopes)
Develop a Functional Conceptual Plan & H&H Model

5. PREPARE MODEL - Develop preliminary H&H model to rough size outlet and channel geometry
1. Utilize worst case peak rain event (state or CCR Final Rule)
2. Use conceptual surface to set stage/storage conditions
Once a Conceptual Plan has been developed, let it be scrutinized...

In-House Review
- Call a sit down with site/civil, geotech & environmental engineers, and especially site operations personnel to review the plan

Regulatory Review
- Meet with state dam safety staff on informal basis to solicit initial input
- You will gain valuable input/insight and bolster rapport
- Be Proactive - Consider requesting Alternative Compliance Standard for peak flow analysis (for during construction condition)
CCR Impoundment Closure Strategies

4 Finalize Design Plans & H&H Modeling

(Note: Several additional design steps have been intentionally skipped for this review so stormwater specific elements could be highlighted.)

1. Refine outlet design to provide stormwater attenuation for smaller rainfall events
   - A piped outlet can more readily accommodate this aspect
   - A breach design will require a more creative solution
     • Gabion Basket notch weir
     • 3-sided flume or chute with stepped spillway above
     • Separate down-gradient structure
CCR Impoundment Closure Strategies

4. Finalize Design Plans & H&H Modeling

2. Add Channels to final cover surface
3. Incorporate Design Features to Minimize Risk of Erosion During Post-Closure
   1. Size channels for at least the 100-Year frequency storm – despite regulatory requirement
   2. Install erosion protection within entire channel – small additional up front cost for future savings in maintenance/repair cost
3. Avoid sharp bends in channels, at outlets
   1. If necessary, provide energy dissipation for events up to 100-year frequency storm
4. Minimize steep slopes as much as possible
Key Points to Keep in Mind...

- **Passage of Peak Storm During Construction** - Final Rule & Regulators do not distinguish between construction and post-construction conditions
- **What about Contractor’s Means & Methods?** - Regulators may require assurance for passage of peak storm during construction necessitating a plan be prepared for permitting
- **State may allow temporary reduced peak discharge** - Alternative Compliance Standard is an option... with some risk
Existing Outlet Structure

New Outlet/Breach

BASIC SEQUENCE
Existing Outlet Structure

New Outlet/Breach

BASIC SEQUENCE

1. Construct bypass system
Existing Outlet Structure

New Outlet/Breach

**BASIC SEQUENCE**

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2. Dewater & construct temp channel w/in pond to existing outlet
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5. Construct final cover upslope of temp channel
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1. Construct bypass system
2. Dewater & construct temp channel w/in pond to existing outlet
3. Incorporate settling basins in-line for turbidity control
4. Construct new outlet & regrade ash to design subgrade
5. Construct final cover upslope of temp channel
6. Decommission existing structure & reroute water to new outlet. Reconstruct settling basin as needed.
New Outlet/Breach

BASIC SEQUENCE
1. Construct bypass system
2. Dewater & construct temp channel w/in pond to existing outlet
3. Incorporate settling basins in-line for turbidity control
4. Construct new outlet & regrade ash to design subgrade
5. Construct final cover upslope of temp channel
6. Decommission existing structure & reroute water to new outlet. Reconstruct settling basin as needed.
7. Remove settling basin, grade remaining ash and install final cover over remainder.
Thank You!