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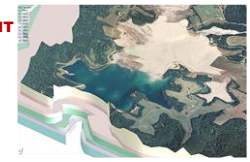
Groundwater Modeling for Closure of the Little Blue Run CCR Disposal Area

Prepared For
2017 NGWA GROUNDWATER SUMMIT
NASHVILLE, TN
DECEMBER 4-7, 2017



Presented By
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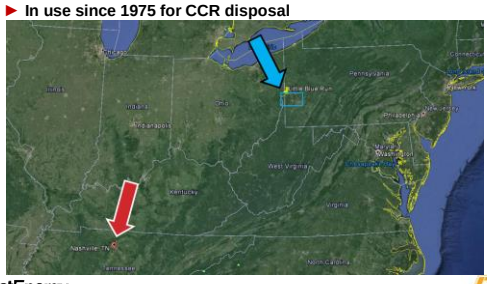
333 Baldwin Rd. Pittsburgh, PA 15205

FirstEnergy Generation, LLC

Introduction
Little Blue Run CCR Disposal Impoundment

- Located in Beaver County, PA and Hancock County, WV
- Disposal area for FirstEnergy's Bruce Mansfield Station
- In use since 1975 for CCR disposal



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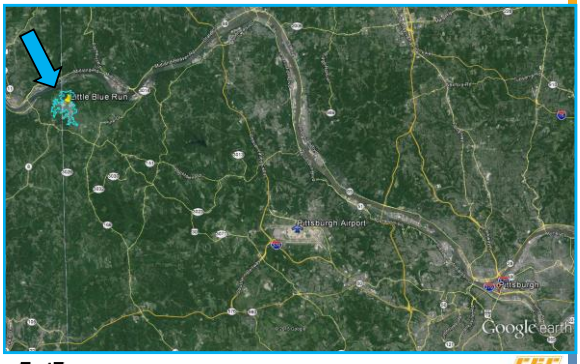

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Introduction
Little Blue Run CCR Disposal Impoundment

- Impoundment formed behind 400 ft. high dam
- LBR Valley is dominated by steep slopes and drains to the Ohio River
- CCR was pumped as a slurry from the power station to the impoundment
- Low permeability CCR solids settle filling Little Blue Run Stream valley
- Standing water present over portions of CCRs

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Currently 952 Acres

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Closure Plan

- Consent decree entered in 2012, requiring cessation of CCR disposal at LBR on December 31, 2016
- Major permit modification approved to
  - Reduce standing water and main pool
  - Place geomembrane liner, cushion geotextile, and one foot thick final cover soil layer
- Closure to be performed over 15 years,
  - The final permit was approved to occur over 12 years, completing in 2028

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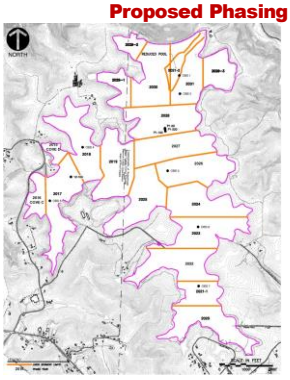
Proposed Phasing Plan for Closure



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Model Purpose

- Elimination of standing water and capping expected to greatly reduce water levels within CCR material
- Water level changes expected to significantly impact settlement, slopes, and surface drainage.
- Groundwater modeling was performed to prepare a prediction of water level drawdown
- Water level drawdown was used to perform a settlement analysis

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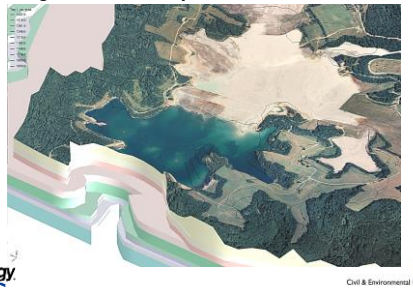
Groundwater Modeling

- Computer software used to simulate groundwater flow field during and after closure
- Based on an interpretation of geological, hydrological, and site-specific conditions.



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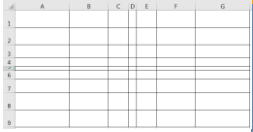
Groundwater Model Build-Out

- Model area separated horizontally into model cells.
  - 130 Rows
  - 120 Columns
  - Variable size to show greater detail over impoundment
  - Cell size range 112' by 112' to 900' by 900'



- Model area separated vertically into layers.
  - 9 Layers
    - 5 Aquifers
    - 4 Aquitards

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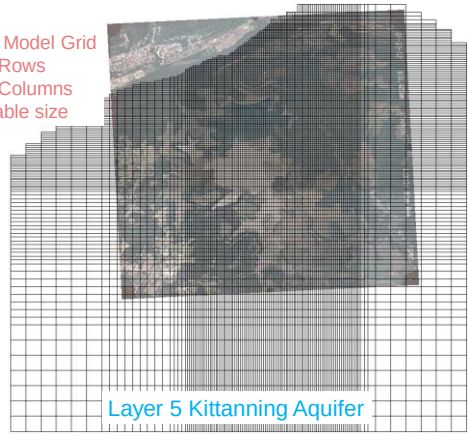
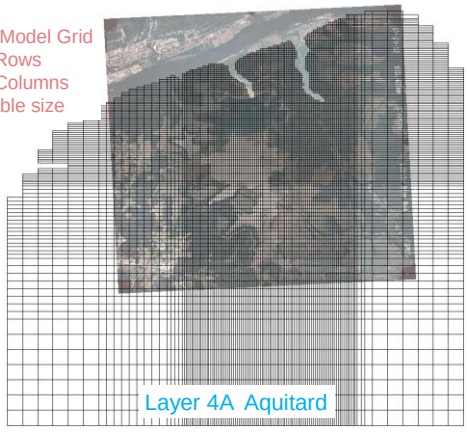
LBR Model Grid
130 Rows
120 Columns
Variable size

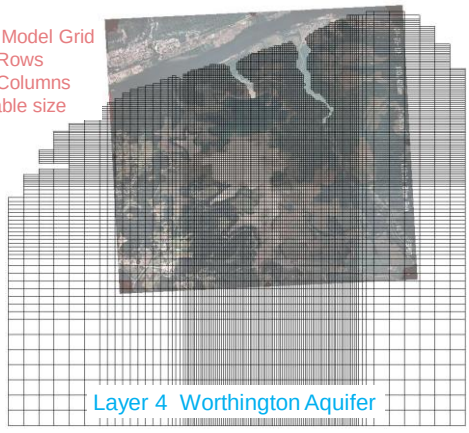


LBR Model Grid
130 Rows
120 Columns
Variable size



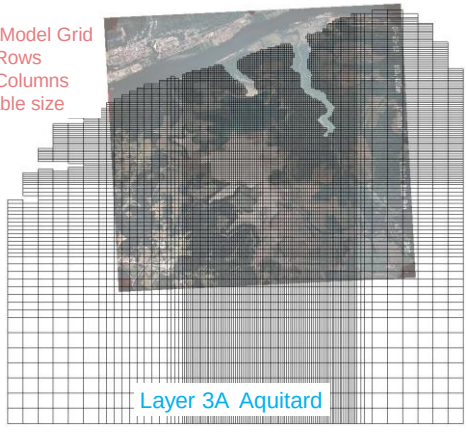
Layer 4A Aquitard

LBR Model Grid
130 Rows
120 Columns
Variable size



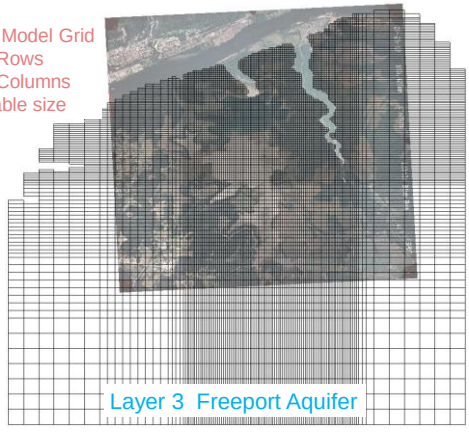
Layer 4 Worthington Aquifer

LBR Model Grid
130 Rows
120 Columns
Variable size



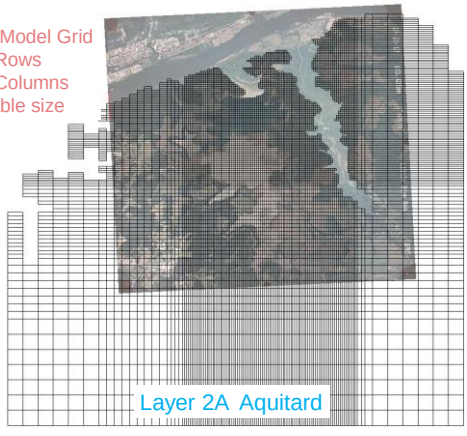
Layer 3A Aquitard

LBR Model Grid
130 Rows
120 Columns
Variable size



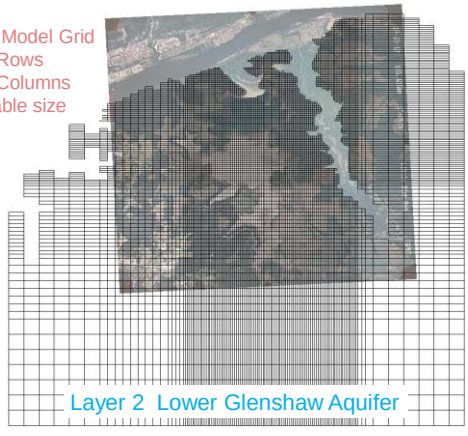
Layer 3 Freeport Aquifer

LBR Model Grid
130 Rows
120 Columns
Variable size



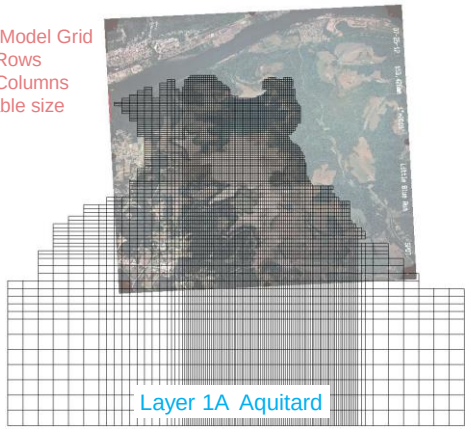
Layer 2A Aquitard

LBR Model Grid
130 Rows
120 Columns
Variable size

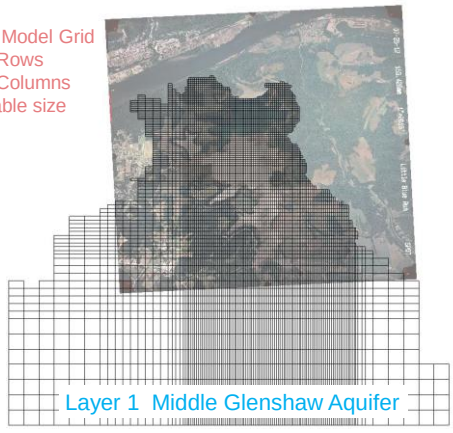


Layer 2 Lower Glenshaw Aquifer

LBR Model Grid
130 Rows
120 Columns
Variable size



LBR Model Grid
130 Rows
120 Columns
Variable size



Model Calibration

- **Model calibrated to match observed water levels in the various aquifers and observed hydrologic volumetric budget**
- **Input Parameters Modified:**
  - Boundary Conditions
  - Recharge – based on HELP modeling
  - Horizontal and Vertical Hydraulic Conductivities
    - Aquifers
    - Aquitards
    - Weathering rind
    - Fracture traces
    - CCR

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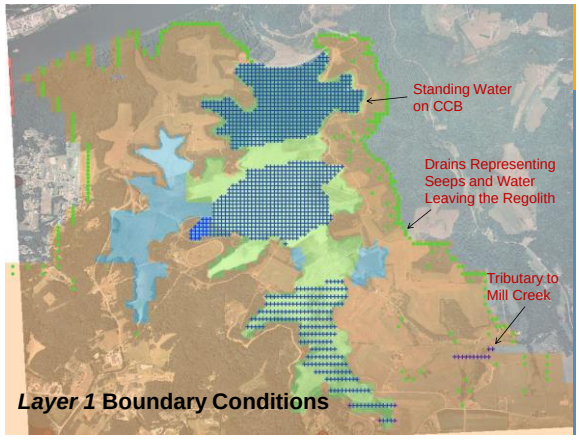

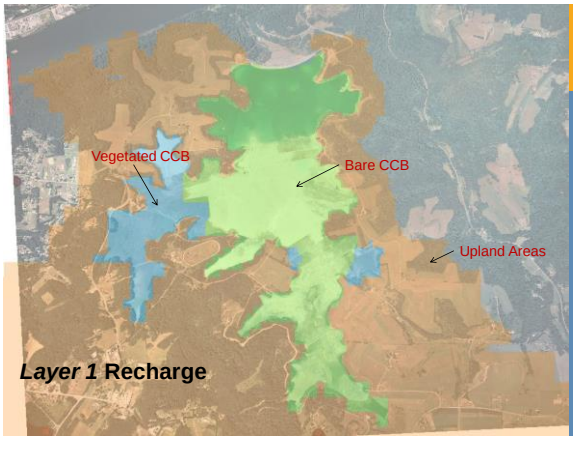

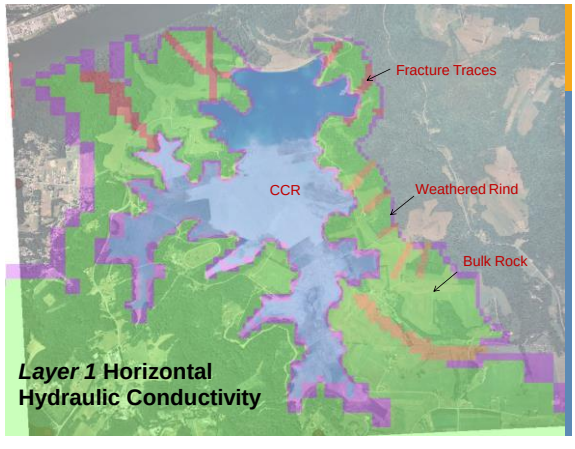

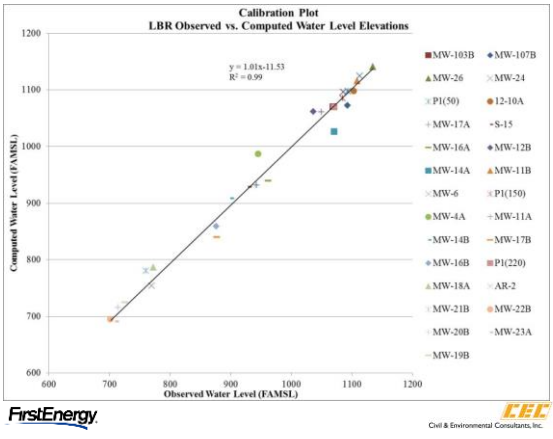
Calibration Plot
LBR Observed vs. Computed Water Level Elevations
y = 1.01x-11.53
R² = 0.99
Computed Water Level (FAMSL)
Observed Water Level (FAMSL)
MW-103B
MW-107B
MW-26
MW-24
P1(50)
12-10A
MW-17A
S-15
MW-16A
MW-12B
MW-14A
MW-11B
MW-6
P1(150)
MW-4A
MW-11A
MW-14B
MW-17B
MW-16B
P1(220)
MW-18A
AR-2
MW-21B
MW-22B
MW-20B
MW-23A
MW-19B
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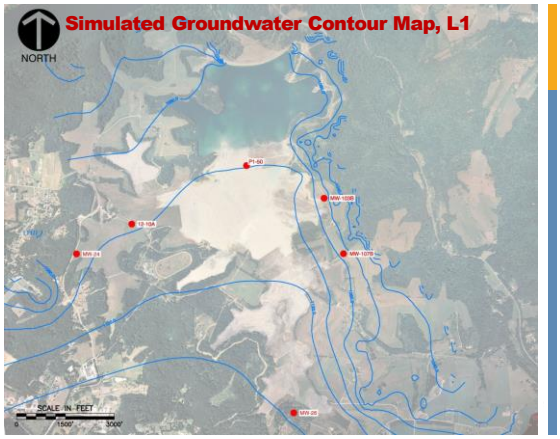
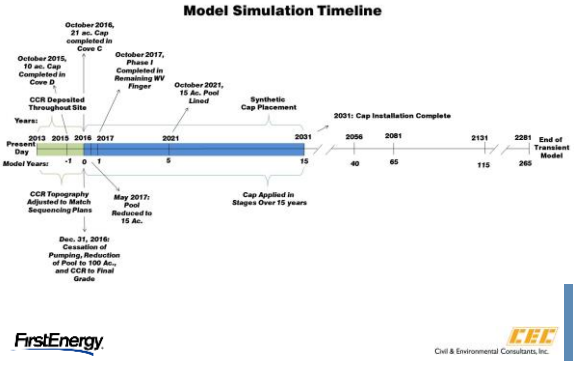

Simulated Groundwater Contour Map, L1
NORTH
SCALE IN FEET


Model Simulation Timeline
October 2016, 21 ac. Cap completed in Cove C
October 2015, 10 ac. Cap Completed in Cove D
October 2017, Phase I Completed in Remaining WV Finger
CCR Deposited Throughout Site
October 2021, 15 Ac. Pool Lined
Synthetic Cap Placement
2031: Cap Installation Complete
Years:
Present Day
Model Years:
End of Transient Model
CCR Topography Adjusted to Match Sequencing Plans
May 2017: Pool Reduced to 15 Ac.
Cap Applied in Stages Over 15 years
Dec. 31, 2016: Cessation of Pumping, Reduction of Pool to 100 Ac., and CCR to Final Grade
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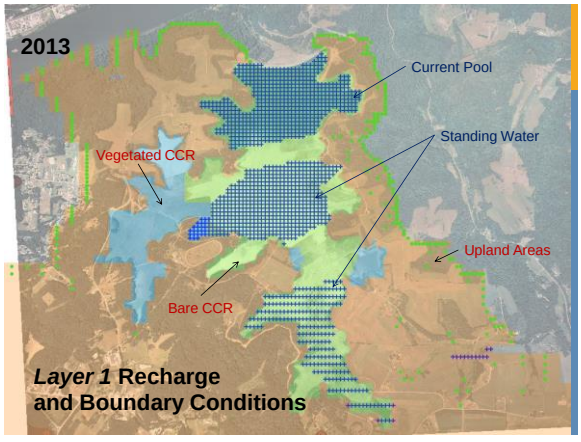
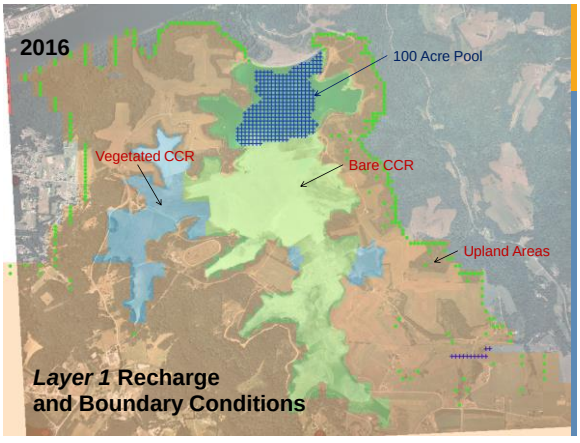
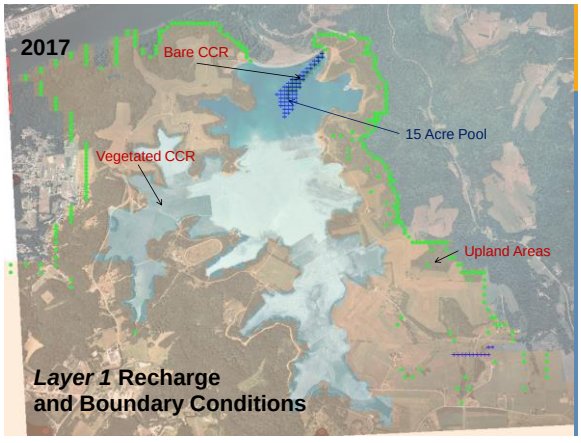
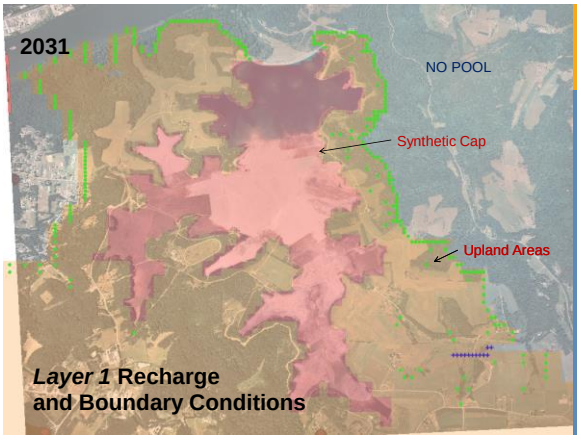
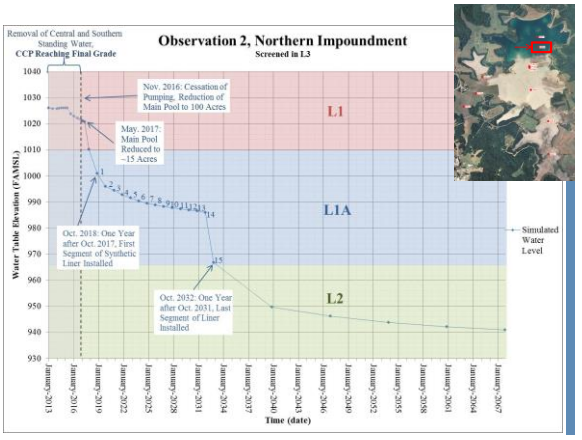
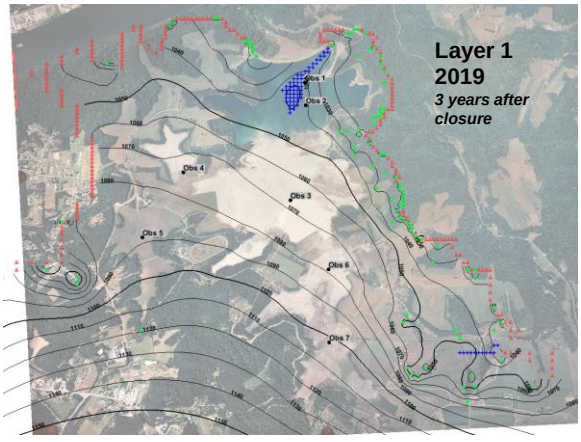

2013
Current Pool
Standing Water
Vegetated CCR
Upland Areas
Bare CCR
Layer 1 Recharge and Boundary Conditions

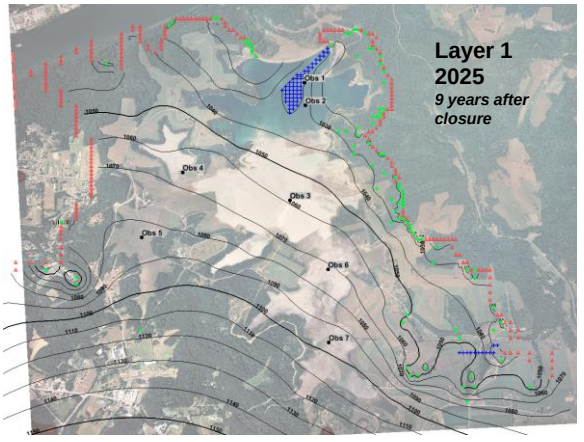

2016
100 Acre Pool
Vegetated CCR
Bare CCR
Upland Areas
Layer 1 Recharge and Boundary Conditions

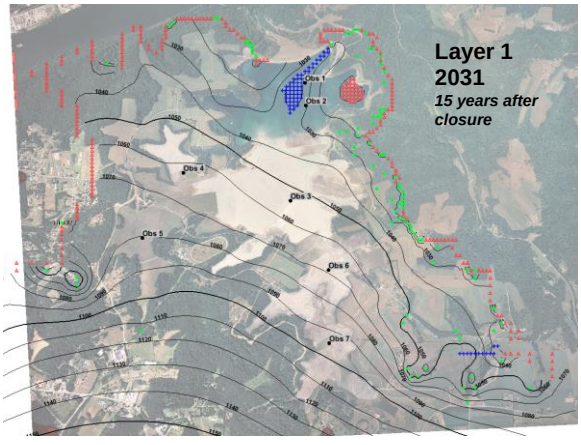

2017
Bare CCR
15 Acre Pool
Vegetated CCR
Upland Areas
Layer 1 Recharge and Boundary Conditions

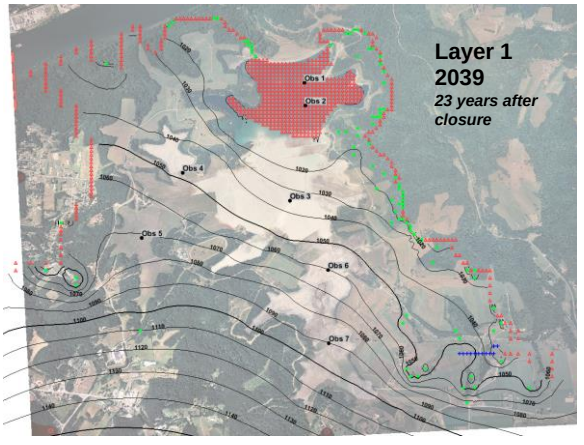

2031
NO POOL
Synthetic Cap
Upland Areas
Layer 1 Recharge
and Boundary Conditions

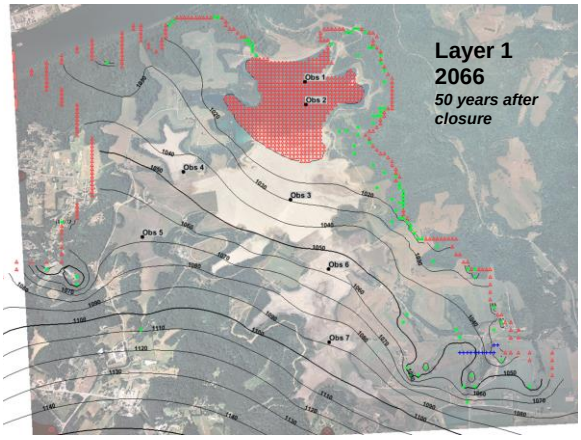

Removal of Central and Southern Standing Water.
CCP Reaching Final Grade
Observation 2, Northern Impoundment
Screened in L3
Nov. 2016: Cessation of Pumping, Reduction of Main Pool to 100 Acres
May. 2017: Main Pool Reduced to ~15 Acres
Oct. 2018: One Year after Oct. 2017, First Segment of Synthetic Liner Installed
Oct. 2032: One Year after Oct. 2031, Last Segment of Liner Installed
L1
L1A
L2
Simulated Water Level
Water Table Elevation (FAMSL)
Time (date)

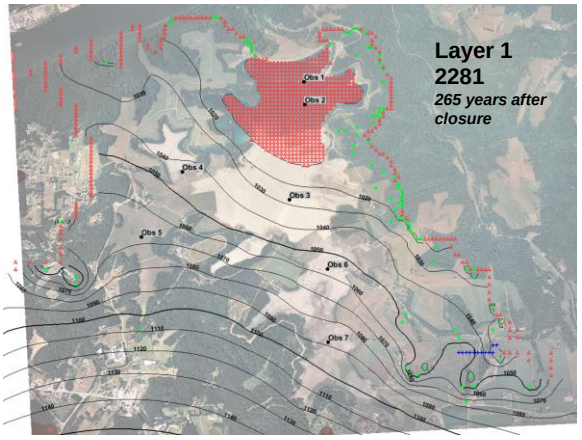

Layer 1
2019
3 years after
closure

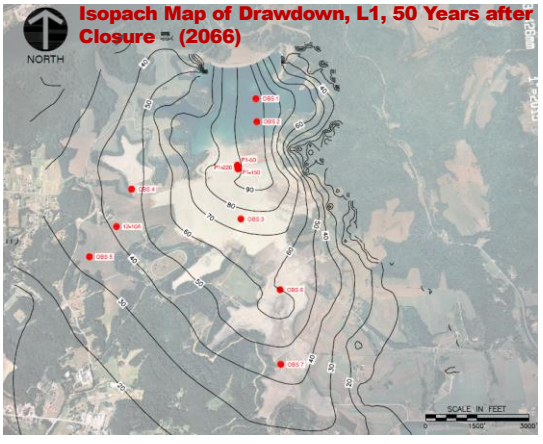

Layer 1
2025
9 years after
closure


Layer 1
2031
15 years after
closure


Layer 1
2039
23 years after
closure







Conclusions

- (1) Reductions in water levels within the CCR will be realized prior to cap placement because of reductions in the aerial extent of standing water pools within LBR.
- (2) Reductions in water levels will occur within the CCR at a higher rate after cession of pumping CCR, reduction of the main pool, and initiation of cap placement.
- (3) The majority of draw-down within the CCR may occur in less than 30 years of the cessation of pumping CCR and the initiation of cap placement, with a smaller percentage of additional draw-down happening after.

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Conclusions

- (4) The greatest amount of draw-down within the CCR will be realized in the northern and central portions of the impoundment where the CCR deposits are thickest.
- (5) Only portions of CCR in Layer 1 completely dewater over the course of the 250 year model simulation.

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