OSMRE releases two technical studies:

Mine Pool Hydrologic Characterization Studies

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Outline

- Public release - Wednesday, November 19th
- General info and reports findings
- Implications

Underground Mine Hydrology Study

- Two Mine-pool Characterization Reports:
  - ✓ North Branch of the Potomac (Upper Freeport and Bakerstown Coal Seams), Maryland and West Virginia
  - ✓ Fairmont, West Virginia (Pittsburgh Coal Seam)
- Both are large complex pools with closed/active underground mines

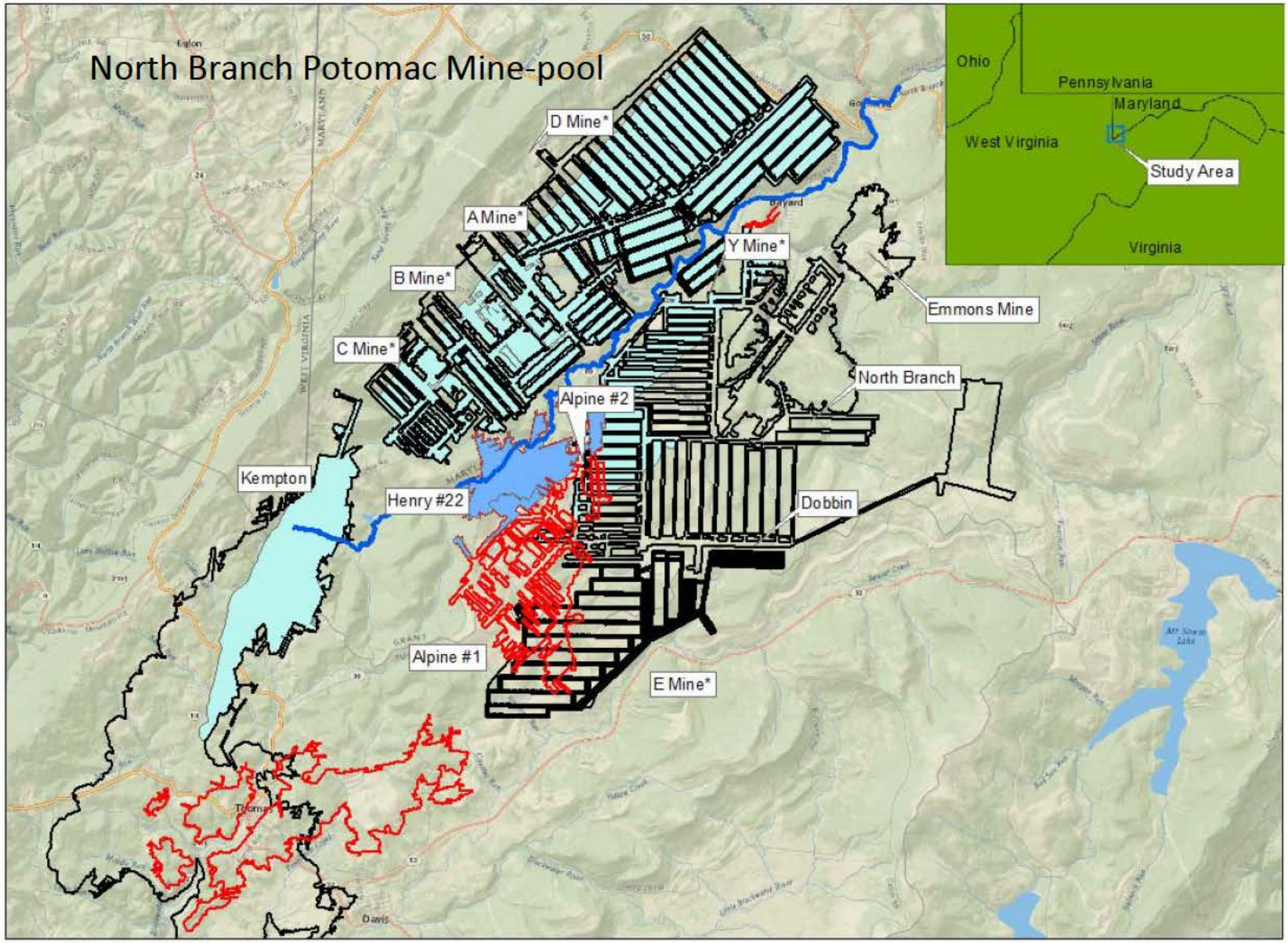
- Both have the potential to discharge poor quality water to major river.
- Long Term; monitoring on decades time scale.
- Water levels in the pools are currently maintained by pumping and discharges treated to compliance standards by industry.

The study area encompasses 12 underground mine complexes in 2 coal seams across more than 25,000 acres and includes closed, active, and abandoned mine-works.

NORTH BRANCH POTOMAC RIVER MINE POOL ASSESSMENT

Key findings:

- Water levels are currently being controlled by pump and treat operations by industry, and remain below breakout elevations. At present, not leak into the North Branch of the Potomac.
- Most likely breakout locations were predicted. Also target elevation to prevent outbreak was assessed and is presently being maintained by industry.
- Water chemistry varies within the mine-pool based on coalbed, degree of flooding and timing of mining. Metals, sulfate and dissolved solids are the main water quality concerns for the mine-pool.



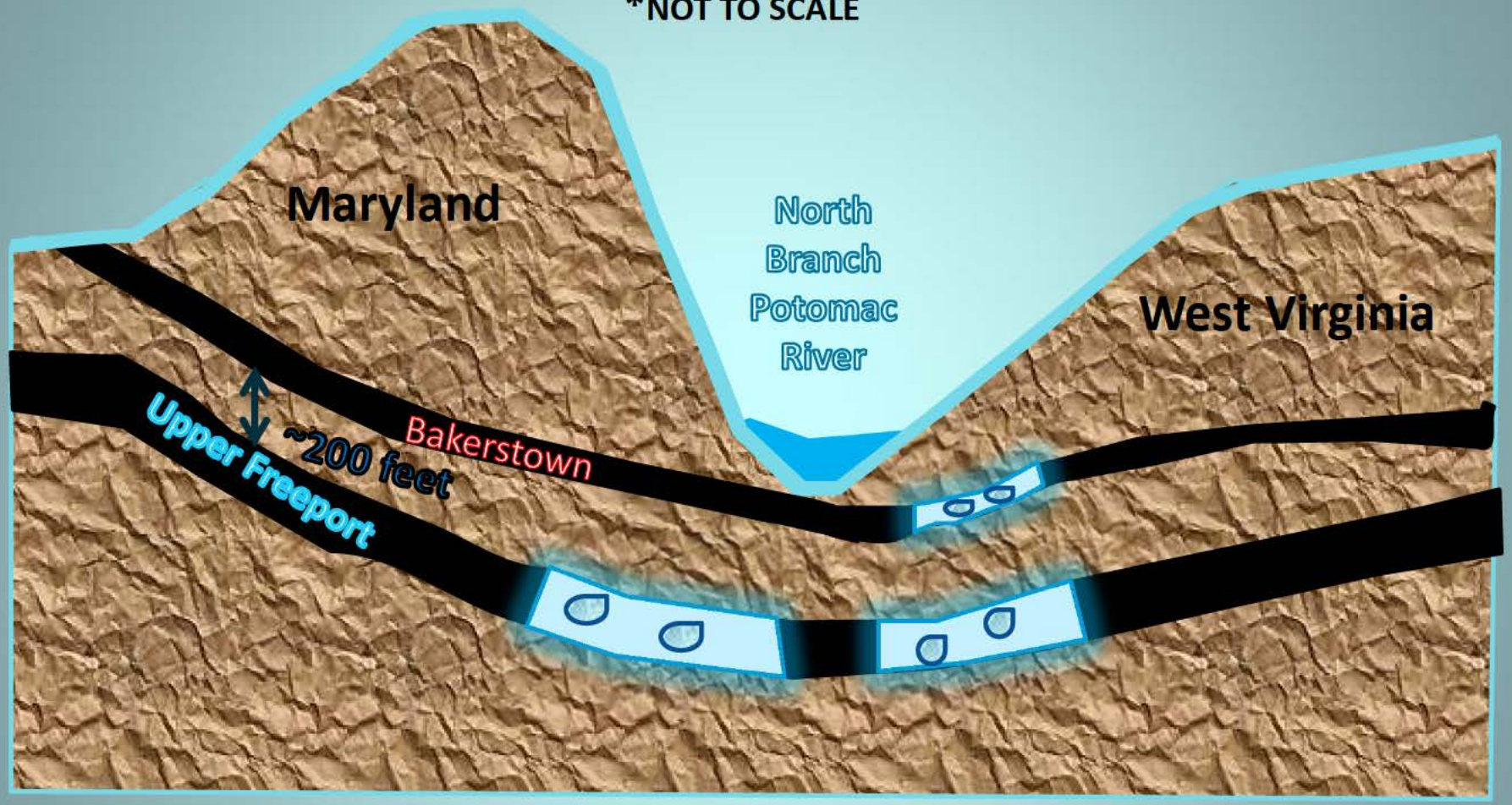
Bakerstown Coal Seam Mines
Upper Freeport Coal Seam Mines
North Branch Potomac River

Figure 1

Minepools in Bakerstown Seam
Minepools in Upper Freeport Seam

Schematic of Study Area Geology

*NOT TO SCALE

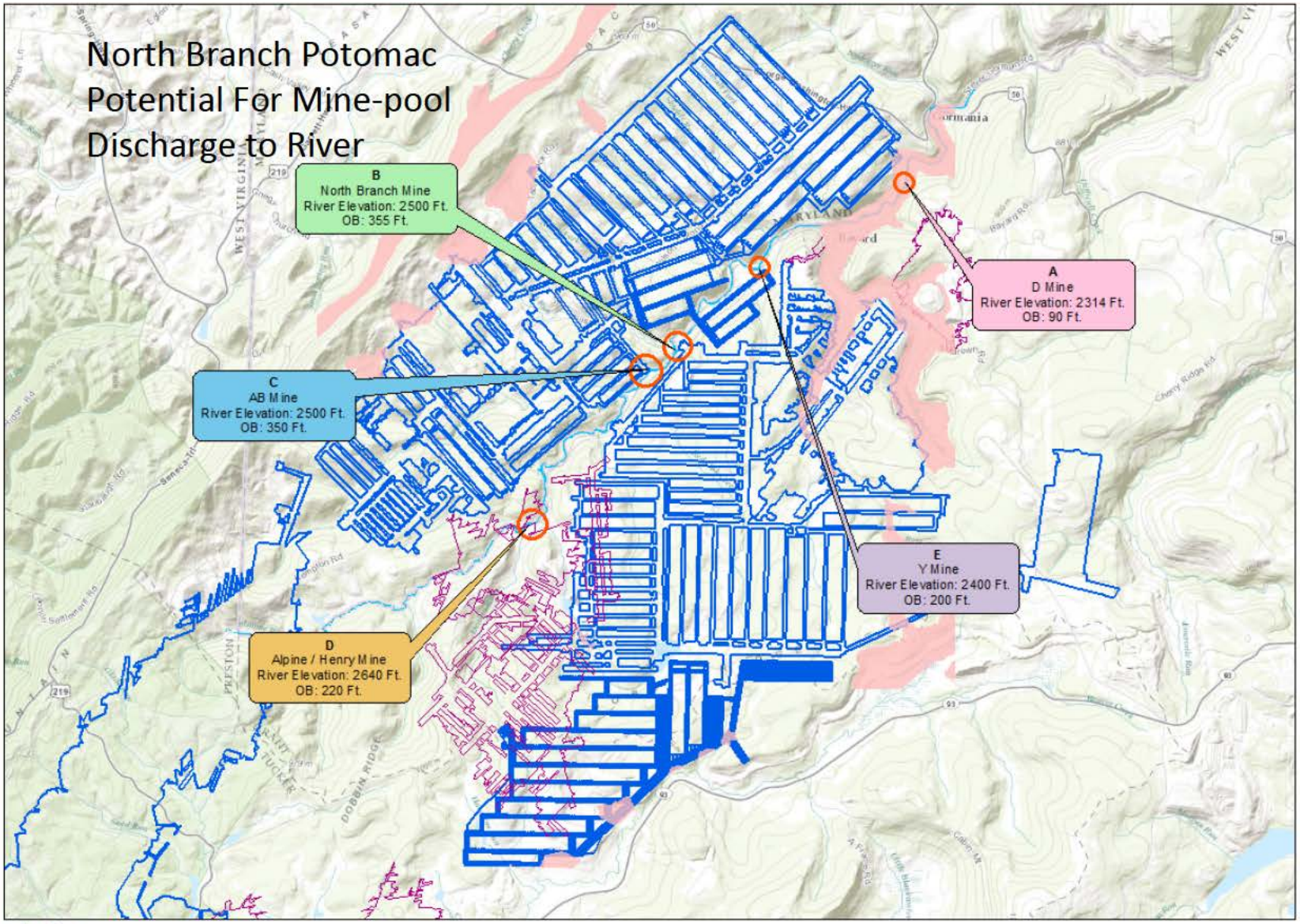


RIVER BREAKOUT LOCATIONS

[River locations with the greatest risk for mine pool leakage and discharges]

- Predicted Mine Pool Head – future maximum mine pool elevation [THE MINE POOL HEAD MUST BE GREATER THAN THE RIVER ELEVATION FOR LEAKAGE TO OCCUR]
- Critical River Elevation – the elevation of the river located in close proximity to the mine pool, if exceeded could result in mine water discharging directly into the river.
- Vertical and lateral distance from the river to the mine pool considered in addition to the geologic setting.

North Branch Potomac Potential For Mine-pool Discharge to River

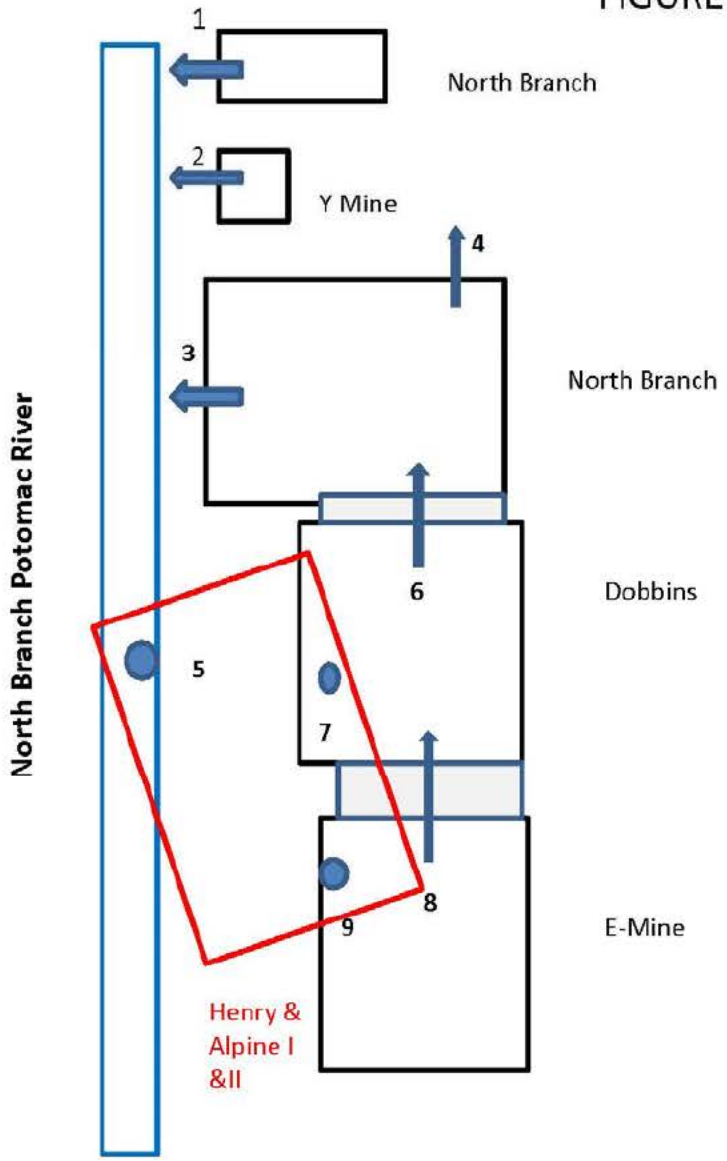


Bakerstown Mine Outlines
Upper Freeport Mine Outlines
Overburden < 200 feet

Figure 21

0 0.375 0.75 1.5 2.25 3 Miles

FIGURE 32



1. Leakage to river from Upper Freeport pool
2. Leakage to river from Upper Freeport pool
3. Leakage to river & discharge to river from Upper Freeport pool
4. Discharge to tributary from Upper Freeport pool
5. Vertical leakage & discharge to river from Bakerstown pool
6. Leakage across coal barrier Upper Freeport pool
7. Vertical leakage to Bakerstown pool
8. Leakage across coal barrier Upper Freeport pool
9. Vertical leakage to Bakerstown pool

Mine Pool Water Quality

- Mine pool water quality varies throughout the mine pools and spatially within the pool.
- Mine pools varies from acidic to alkaline.
- Kempton and North Branch Artesian mine pools were acidic.
- Mettiki mine pools were alkaline.
- Bakerstown mine pools were acidic with high metal concentrations.

Mine Pool Water Quality continued

- Generally, mine pool water is a calcium-sulfate type water.
- Mine pool water (Mettiki A,B,C,D) is stratified in the water column.
- Dissolved trace metal values in the mine pools were below USEPA drinking water standards (exceptions were beryllium, lead and nickel).

RISKS TO THE NORTH BRANCH POTOMAC RIVER

FROM MINE-POOL LEAKAGE AND DISCHARGES

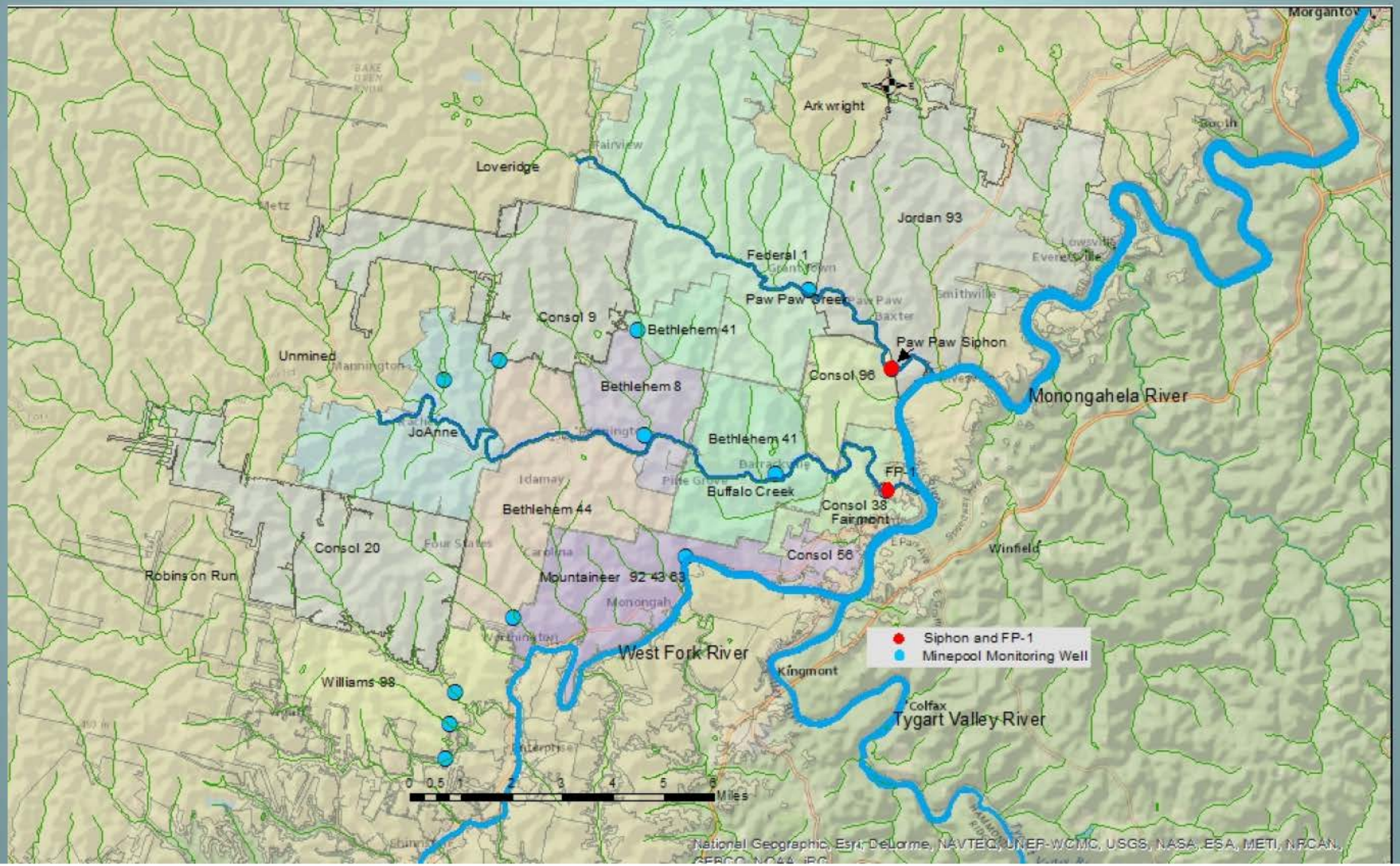
- All current mine-pools have a potential to leak or discharge to the river, or contribute to adjacent pools and reach a head elevation greater than the river.
- Mine-pools may leak directly into the river through existing boreholes or seepage zones in the river valley.
- Mine-pool discharges to the North Branch would increase concentrations of TDS, sulfate and iron.
- Mine pool discharges to the North Branch would potentially increase acidity, iron and aluminum concentrations and precipitates in streambed substrate.

The mine-pool encompasses 8 large and several smaller underground mines across 52,000 acres near, and under Fairmont, WV. . Three adjacent underground mines receive ground water outflow from the mine-pool and occupy an additional 29,000 acres.

FAIRMONT MINE-POOL CHARACTERIZATION

Fairmont, WV Mine-pool

Proximity to Monongahela River and Tributaries



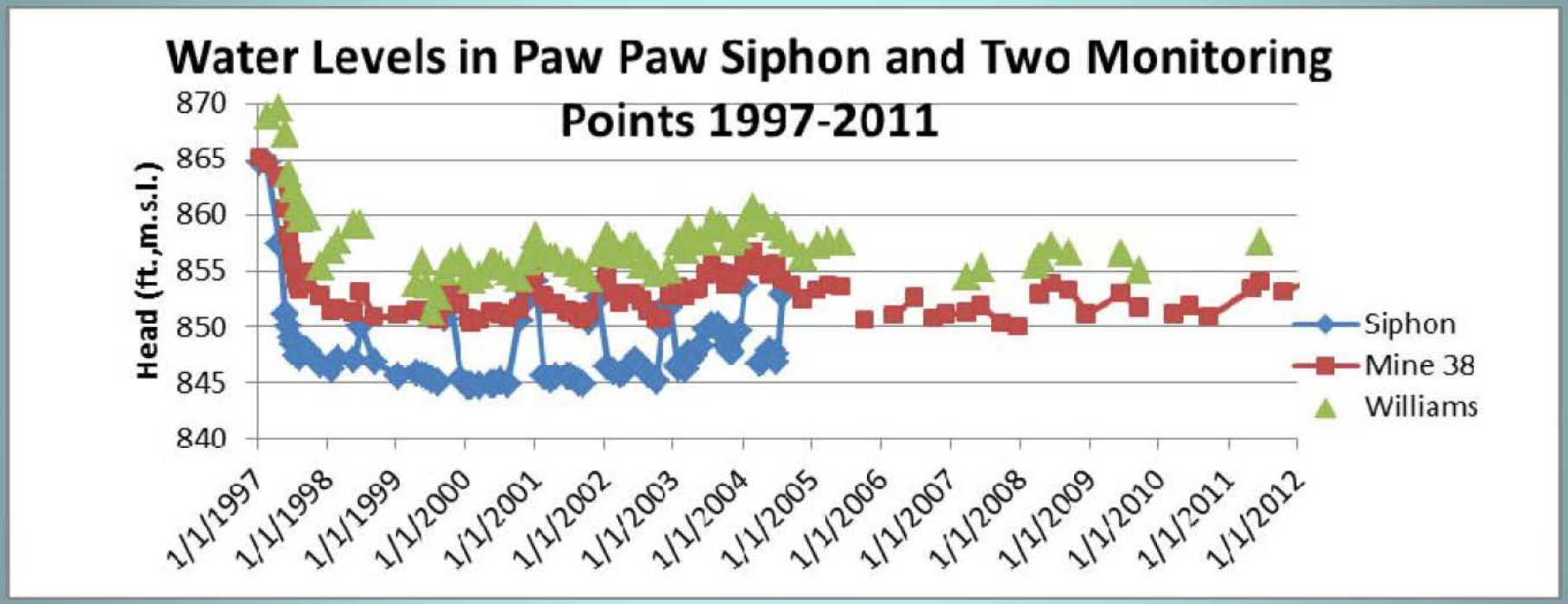
Fairmont Mine-pool Background

- Mines closed from 1940's to 1980's. At closure, pumping ceased. Mine-works begin to flood. Uncontrolled flooding = mine-pool discharge to streams draining into the Monongahela River.

- April, 1997, Consol began removing ~ 1500 gpm from the Fairmont pool using a siphon system. The water discharges into another mine complex and is routed to a central treatment facility. *The siphon and pump system is still operating in 2014.*

Prevent This →

Water Level Reduced (Drawdown) 10 Miles From Pumping Center



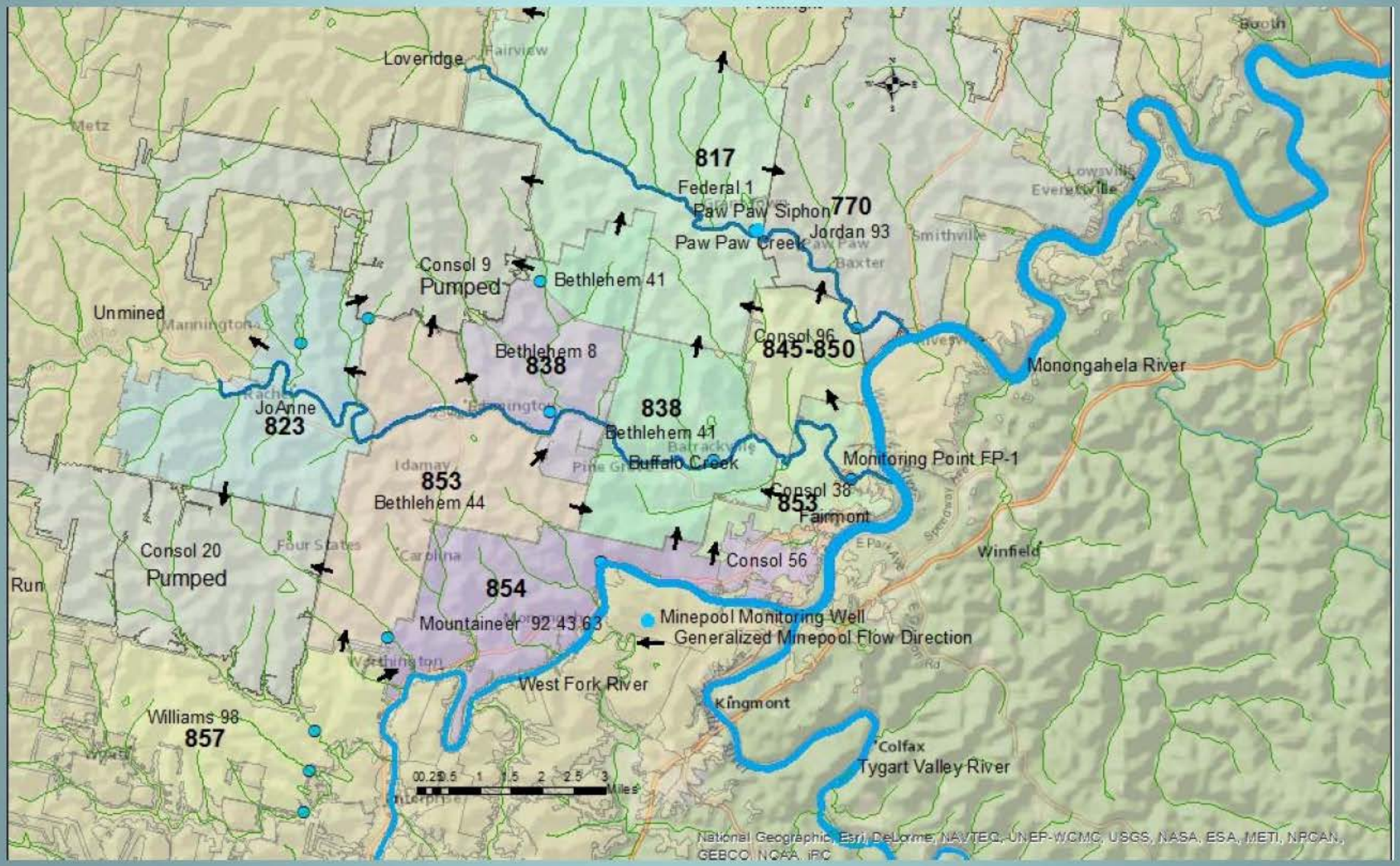
Pumping began early 1997 and water levels decreased. Williams mine (green triangles) is 10 miles from pumping center.

Fairmont Mine-pool
(Not much to see above ground)

The Siphon transfers about 850 gpm across a barrier from the "Fairmont mine-pool" to the "Morgantown mine-pool".

Monitoring well with pressure transducer for automated water level recording

Fairmont Mine-pool
Complex Ground Water Flow Pattern



Fairmont Mine-pool Water Budget

(About 37% of Outflow Removed by Pumping)

Table 3

Estimated Outflows and Mine Water Removal From the Fairmont Mine-pool, 2011 Conditions (1)

Source	Estimated Discharge Rate (gpm)	Percentage of Total
Siphon Withdrawal	850	37.2%
Barrier Leakage to Jordan 93	295	12.9%
Barrier Leakage to Consol 9	639	28.0%
Barrier Leakage to Consol 20	395	17.3%
Barrier Leakage to Loveridge	89	3.9%
Barrier Leakage to Arkwright	11	0.5%
Total Withdrawal and Outflow	2279	

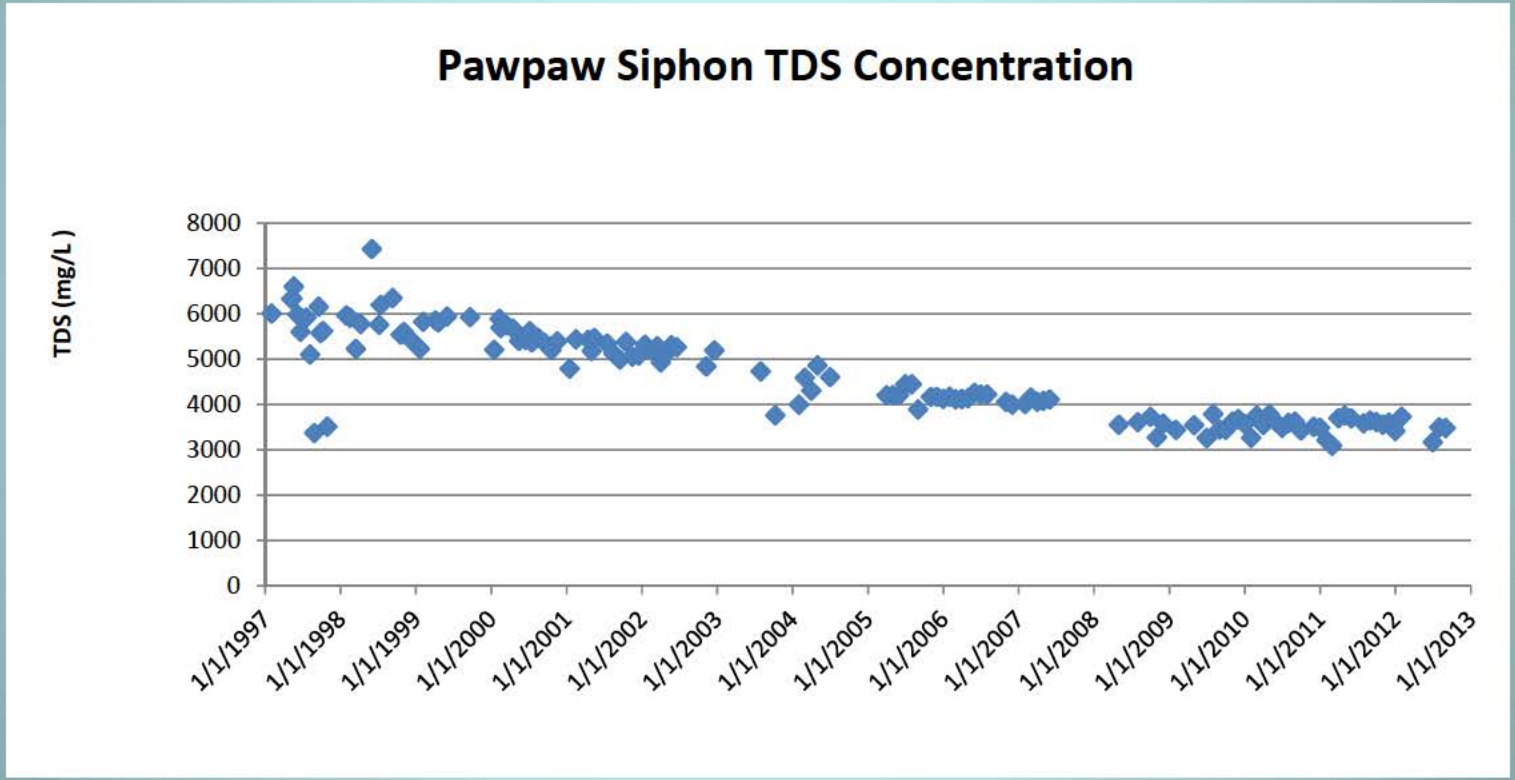
(1)Discharge rates derived using a single K value for all barrier segments (isotropic K).

Fairmont Mine-pool

- **The siphon and pumping system has maintained the Fairmont mine-pool head below "breakout" elevation for 17 years**
- The Fairmont mine-pool has hydrologic interaction with adjacent mines to the west and north. The Fairmont mine-pool would respond to a change in head or pumping rate in the adjacent mines.
- **Barrier pillars leak significant quantities of water between mines, but they control water levels and flow within the mine-pool aquifer.**
- Mine-pool water level in flooded mines can be controlled from a single withdrawal (pump) over distance. Observed same in other flooded mine-pools.

- Monitoring still needed. Lots of hydrogeology details that interest the techies.

Fairmont Mine-pool
Water Quality Change (TDS) Over 15 Years



Water quality at main pumping location.

Water Quality Varies by Location Within The Mine-pool Flow System

Site	pH	Alkalinity	Total Dissolved Solids	Iron	Sodium	Sulfate
Mine 38 (Recharge Area, **Start of flowpath)**	7.32	180	548	3.44	105.7	207
Mine 63 (**Mid Flow path**)	7.31	590	3301	33.9	853.4	1697
Dakota Siphon (**End Flowpath**)	7.20	568	5194	134.8	1254	2812

pH in S.U., others in mg/L

Fairmont Mine-pool

- Water composition in recharge areas is mixed Calcium-Sodium-Bicarbonate-Sulfate, and evolves to Sodium-Sulfate as water flows through the mine-pool. Alkalinity and dissolved solids <u>increase</u> 2 to 10 times along flow path <u>within</u> the mine-pool.

- Concentrations of iron, sulfate , dissolved solids, sodium and other constituents are slowly declining. Therefore treatment load is declining with time. Overall water quality remains poor.

Common conclusions from both studies

- At present, there is no potential for imminent danger from the underground mine pools.
- Mine-pool water quality can vary spatially and improves slowly with time.
- Mining companies are currently pumping water from the mine pools and treating to meet effluent standards
- Without continuing management, mine pool water levels will increase to an elevation sufficient to cause potential leakage of mine water into surface and ground water sources that lead to key rivers, tributaries, and watersheds.

Common conclusions cont.

- Treatment of the water discharged from the mine pools must continue to prevent pollution of either ground or surface water leading to tributaries, rivers, and watersheds.
- The studies support the finding that thousands of acres of water from underground mines are tied together, that the water can travel between mines by leaking across coal barriers, and that those mine pools will discharge polluted water if the mine pools are not properly maintained, and the water that is discharged during pumping requires treatment to meet effluent limits.

Implications

- Two mine-pools are representative of a larger population of closed, partially to fully flooded underground mines, some of which pose a risk to surface and ground water resources and aquatic biota.
- Development of new underground mining adjacent to an existing mine-pool, or in overlying/underlying coalbeds, should consider mine water flow between existing mine-pool and active mine works.

Implications

- Reports have the appropriate degree of information and analysis necessary in PHCs and CHIAs for underground mines?
- Will the responsible companies remain viable or attempt to transfer future liabilities to other companies or state bond pools?
- How can the states bonding system handle such huge potential liabilities over the long term?

Questions?