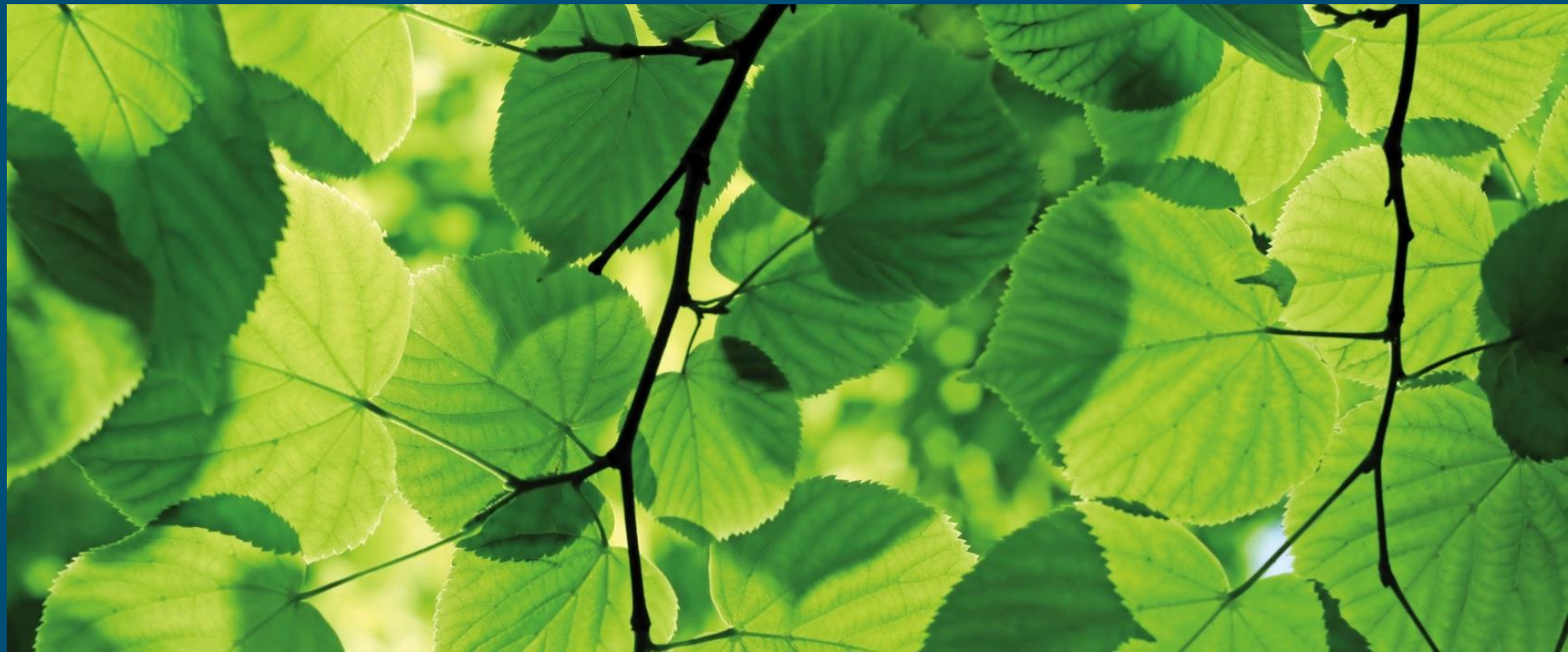
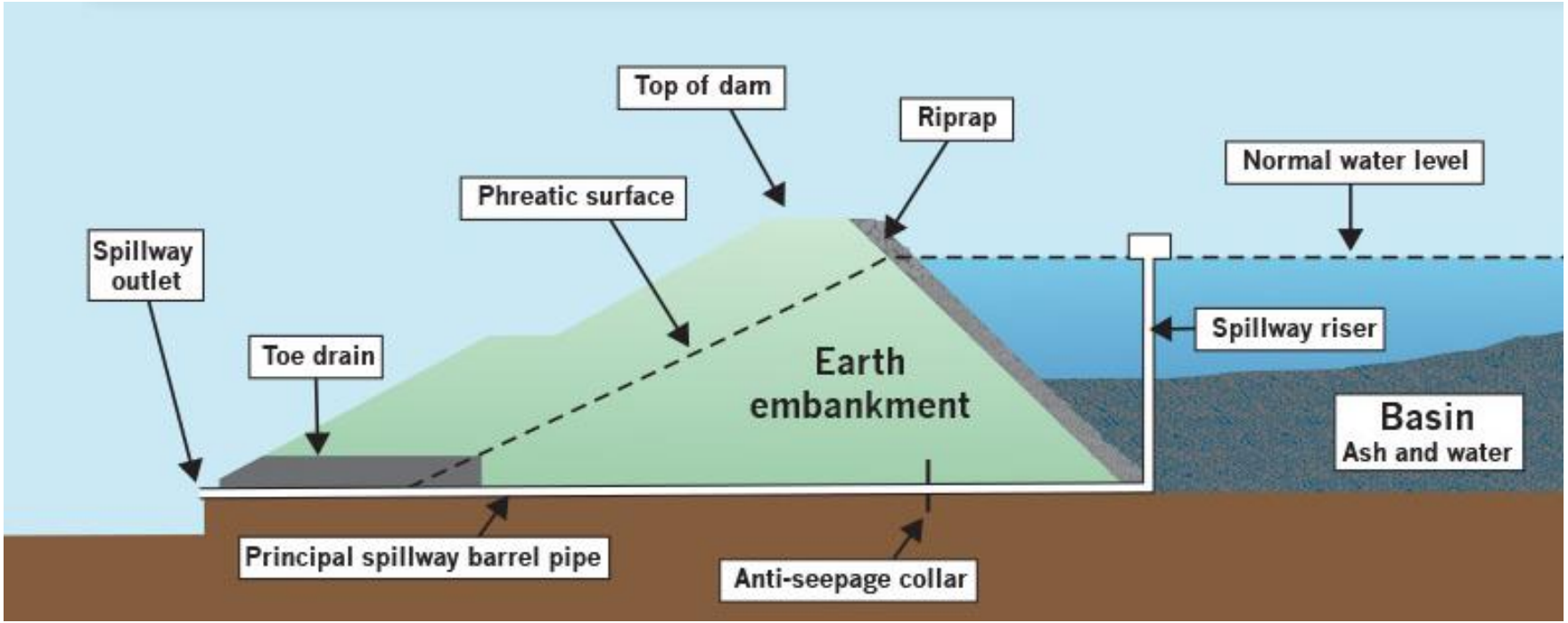
Ash basins and groundwater

May 2018



Anatomy of a basin



Groundwater monitoring

- An elaborate network of monitoring wells track groundwater conditions near ash basins.
- Scientific studies demonstrate ash basins are not affecting neighbors' drinking water wells, and we have been proactive in addressing potential issues.
- We've conducted thorough groundwater studies as part of requirements in the N.C. coal ash law.
- The federal coal ash rule also requires separate monitoring immediately around the basins and is intended to identify the ash basins that utilities should close.
- Results do not impact our plans, since we are already closing basins and are well down that planning path.
- Results inform corrective action steps.

EPA vs. NC standards

Parameter	Federal EPA Maximum Contaminant Level (MCL)	North Carolina 2L Groundwater Standard
Arsenic	10 ug/L	10 ug/L
Antimony	6 ug/L	1 ug/L
Cadmium	2 ug/L	2 ug/L
Chromium	100 ug/L	10 ug/L
Lead	15 ug/L	15 ug/L
Mercury	2 ug/L	1 ug/L
Selenium	50 ug/L	20 ug/L
Thallium	2 ug/L	0.2 ug/L (IMAC)
Iron	300 ug/L	300 ug/L
Manganese	50 ug/L	50 ug/L
pH	6.5-8.5	6.5-8.5
Sulfate	250 mg/L	250 mg/L
TDS	500 mg/L	500 mg/L
Zinc	5 mg/L	1 mg/L
Boron	no MCL or SMCL	700 ug/L
Cobalt	no MCL or SMCL	1 ug/L (IMAC)
Hex Chrome	no MCL or SMCL	no 2L standard
Sodium	no MCL or SMCL	no 2L standard
Vanadium	no MCL or SMCL	0.3 ug/L (IMAC)

State 2015 “do not drink” guidance:
0.07 ppb hexavalent chromium
0.30 ppb vanadium

State agencies lifted that guidance about a year later after more study.

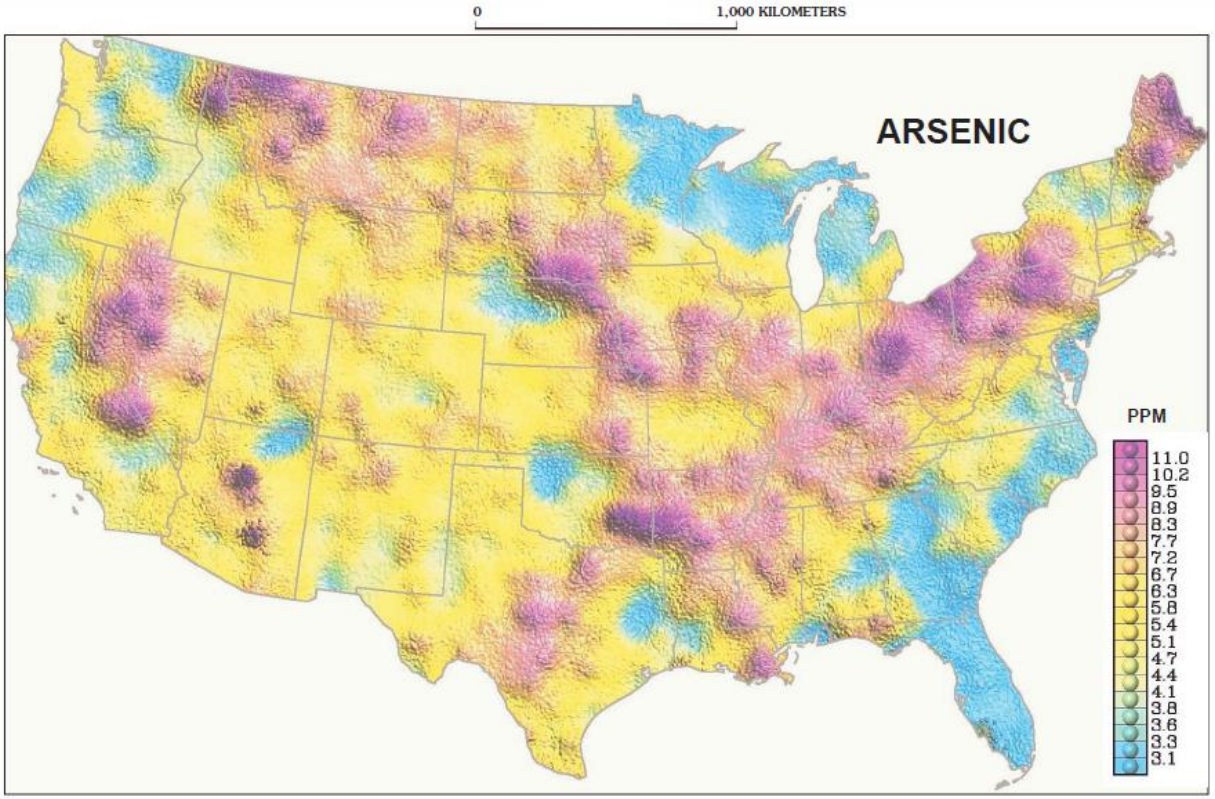
The same quality of drinking water that serves millions of Americans daily in their public water systems would have triggered “do not drink” advisories if coming from a private well near an ash basin at the time.

Few other N.C. wells had been tested for these substances.

- The same elements that triggered state “do not drink” guidance for neighbors are found naturally at elevated levels in regional soils and groundwater. The prevalence of certain elements varies with geology (Piedmont vs. Coastal.)
- Neighbors’ well results are consistent with background testing across the state by various agencies (e.g., NCDEQ, USGS, UNC, Duke, etc.)
- Neighbors’ well results do not exhibit indicators of potential coal ash influence.

- Groundwater flow is away from neighbors and toward adjacent water bodies.
  - Testing in those rivers and lakes confirms water quality remains safe.
- Neighbors' wells are in upgradient locations, and the substances of concern often increase with depth—indicating natural occurrence from geology.
  - Coal ash contaminants are dissolved in water with no measurable increase in density, as compared to other substances that would tend to "sink" in the aquifer, such as denser saltwater.
  - The installed monitoring wells are located between ash basins and any potential receptor, including off site wells. If there was an impact at greater depth, then the bedrock wells would capture this influence.
- Computer modeling indicates that flow is expected to continue moving away from neighbors in the future.

- US Geological Survey soil data show these elements occur naturally, regardless of ash basins.



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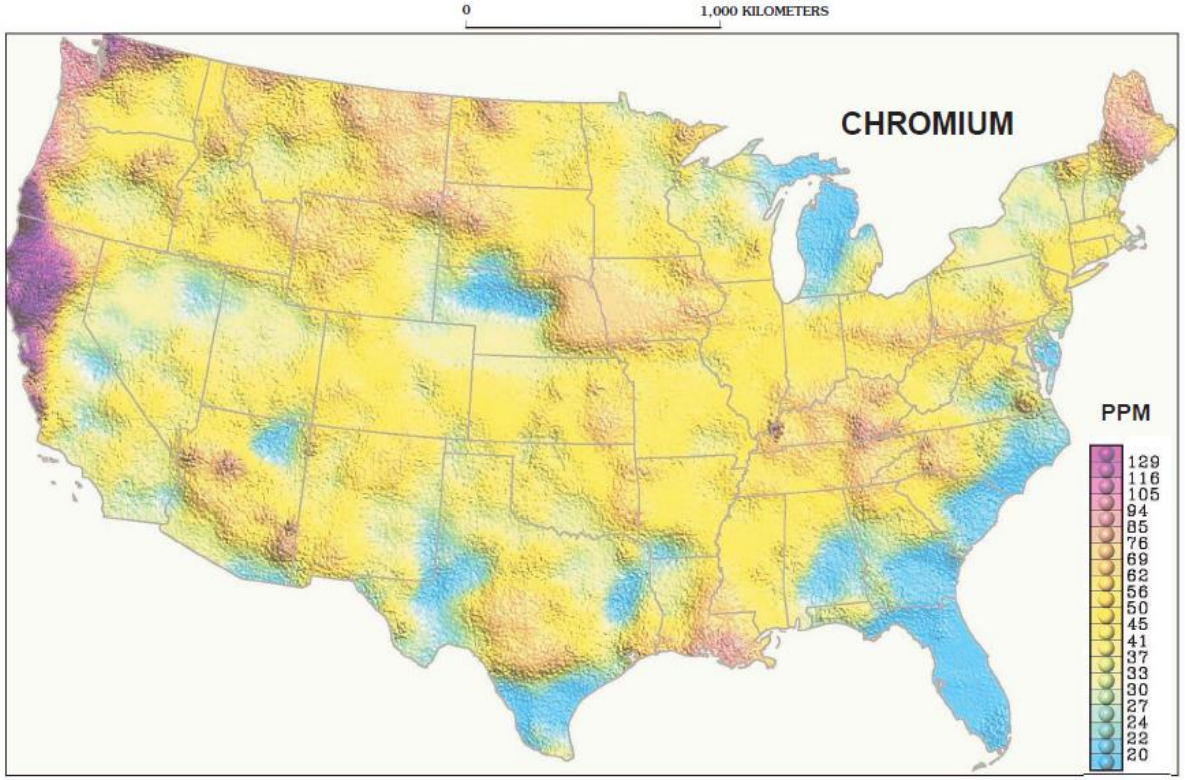

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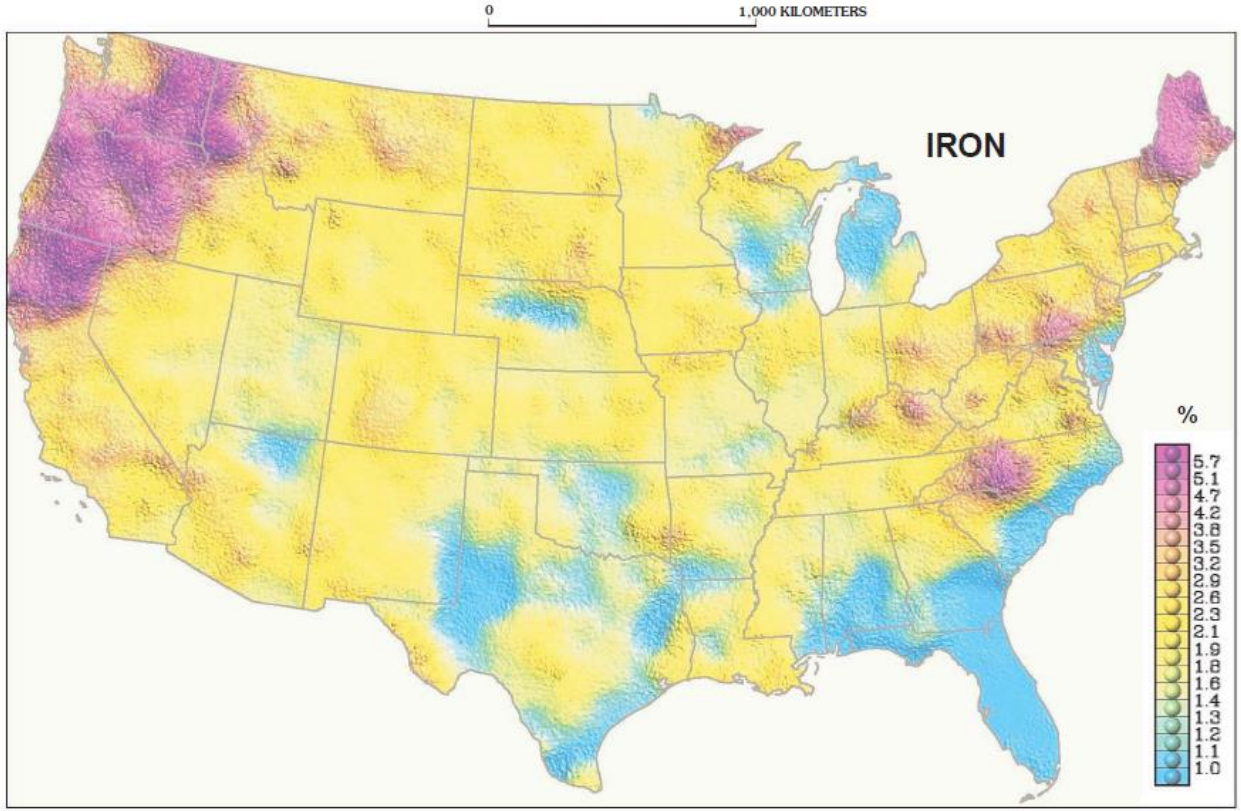

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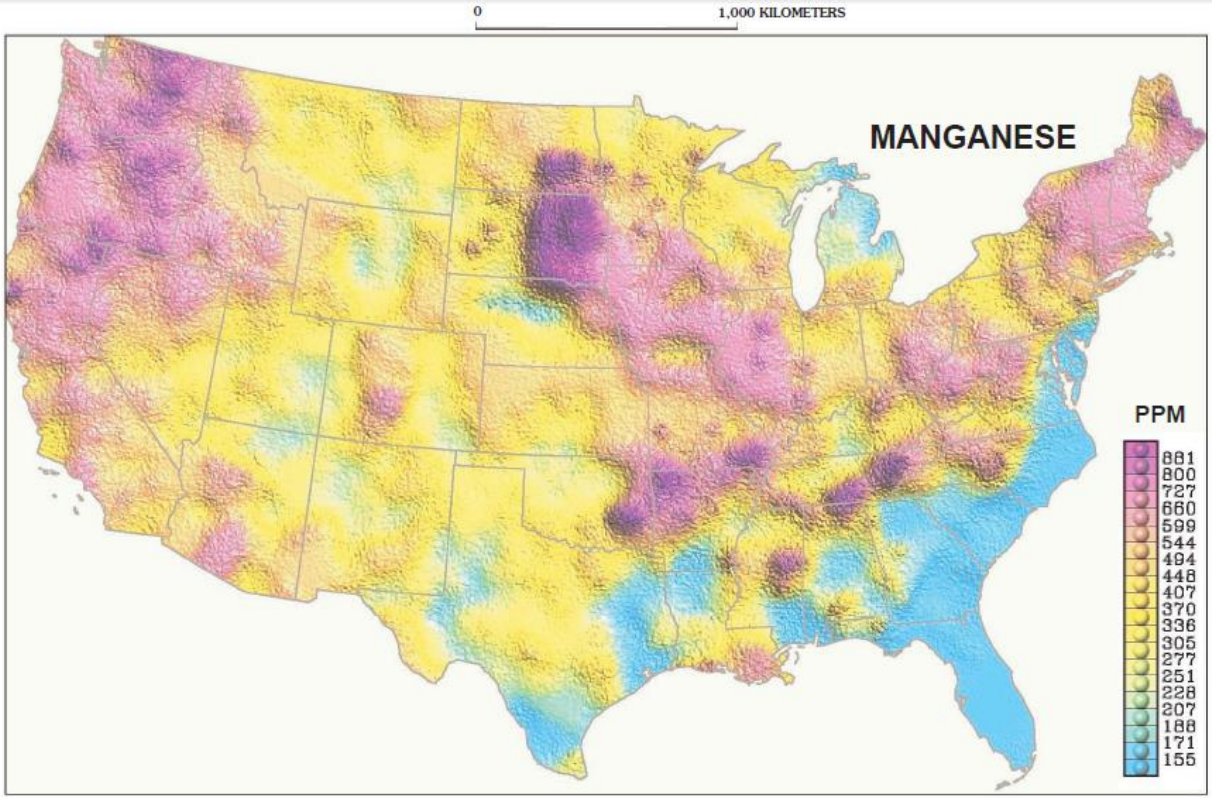

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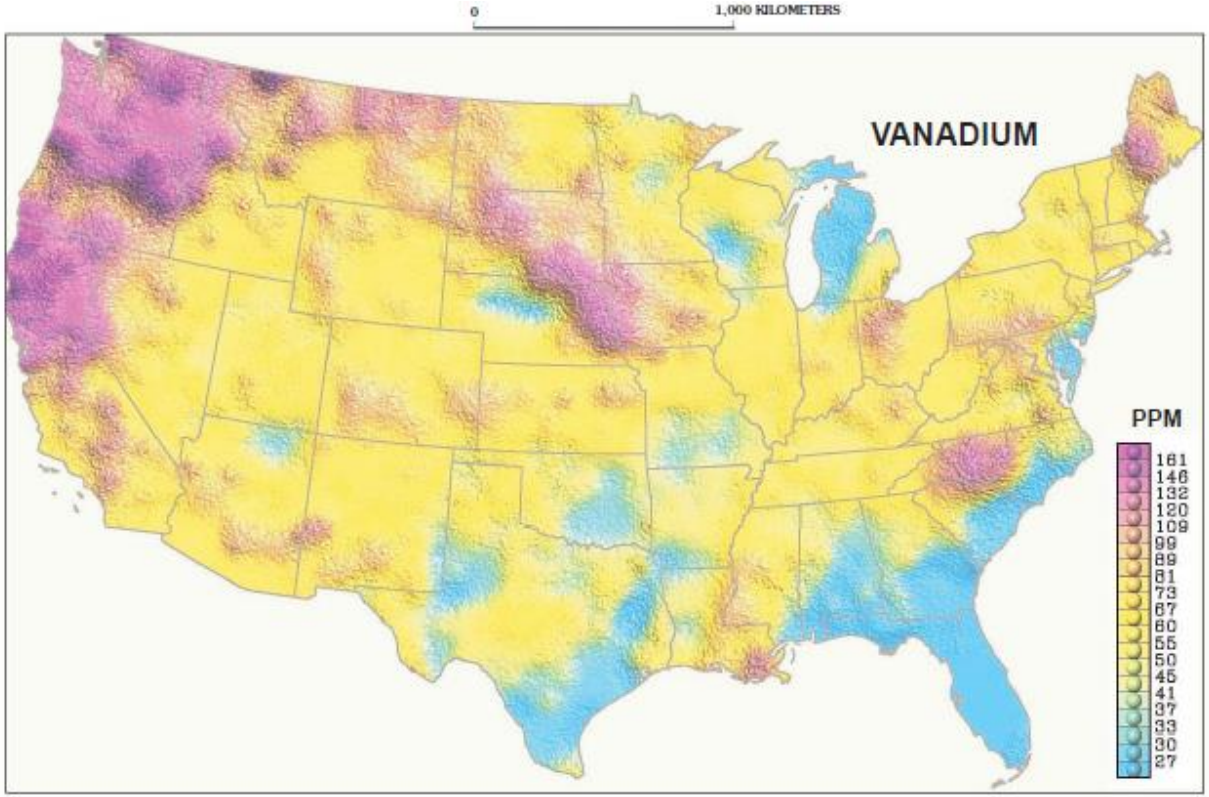
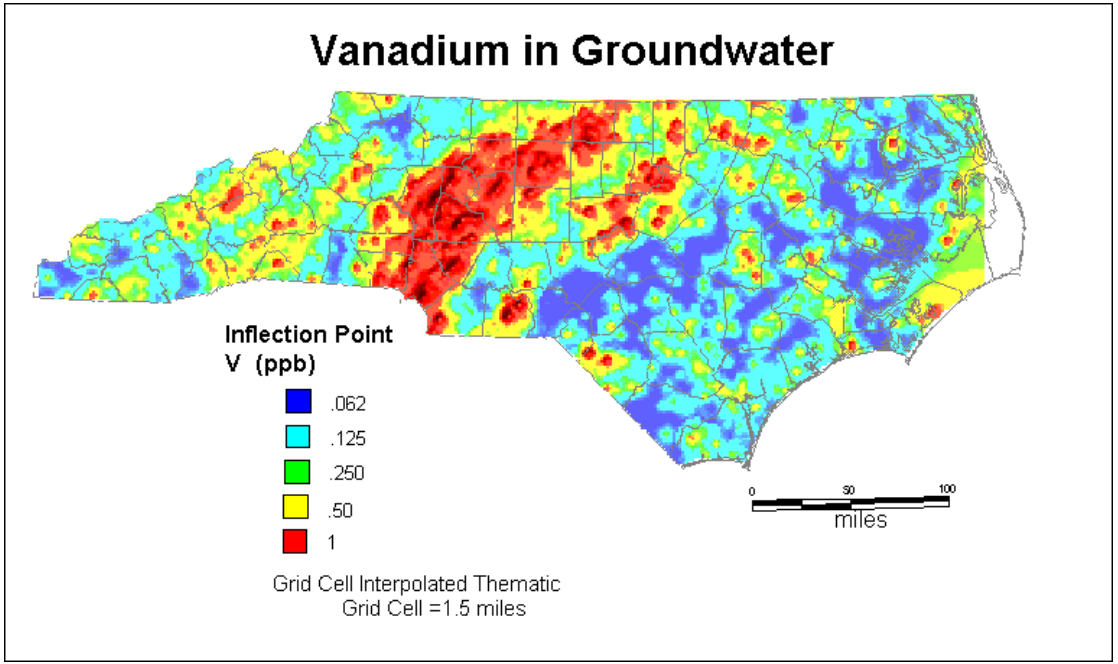


- NC Department of Environmental Quality data show these elements occur naturally across the state. Background testing of wells in the same geologic area but far from ash basins showed results similar to plant neighbors' wells.



"Vanadium is the 22nd most abundant element in the earth's crust with an average concentration of 100 ppm."

--Toxicological Profile for Vanadium, U.S. Department of Health & Human Services, September 2012

- A Duke University study demonstrates hexavalent chromium is naturally occurring in N.C. groundwater and does not originate from ash basins.

HEXAVALENT CHROMIUM IS WIDESPREAD IN N.C. WELLS BUT NOT LINKED TO COAL ASH

October 26, 2016
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Note: Avner Vengosh is available for additional comment at (919) 491-6792 or vengosh@duke.edu.

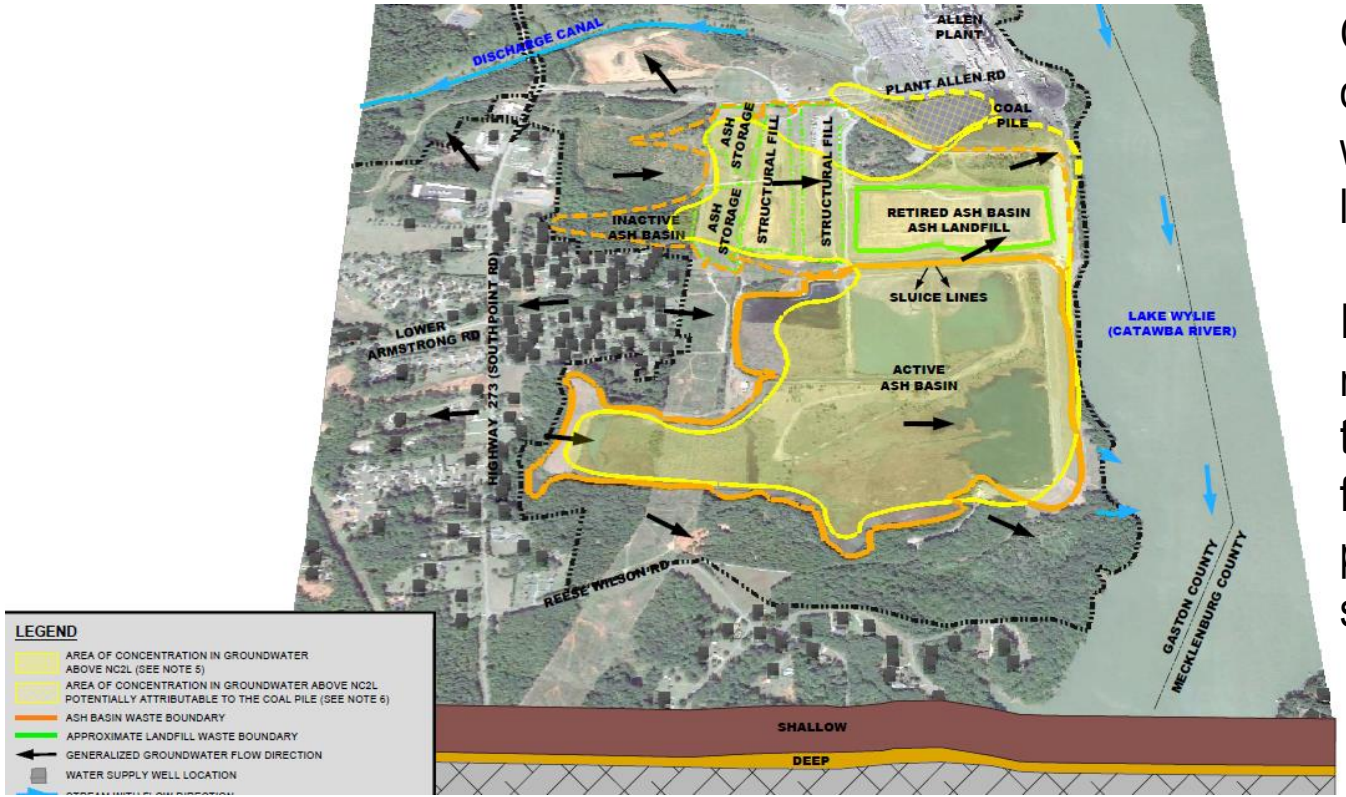
DURHAM, N.C. – Hexavalent chromium, a carcinogen made famous by the movie *Erin Brockovich*, is far more abundant in drinking water wells in North Carolina than previously thought, a new Duke University study finds.

The contamination doesn't, however, stem from leaking coal ash ponds as many people feared after state officials tested wells near coal plants last year and detected potentially harmful levels of hexavalent chromium in the water.

Instead, it's caused by the natural leaching of mostly volcanic rocks in aquifers across the Piedmont region.

"About 90 percent of the wells we sampled had detectable levels of hexavalent chromium, and in many cases the contamination is well above recommended levels for safe drinking water. But our analysis clearly shows it is derived from natural sources, not coal ash," said Avner Vengosh, professor of geochemistry and water quality at Duke's Nicholas School of the Environment.

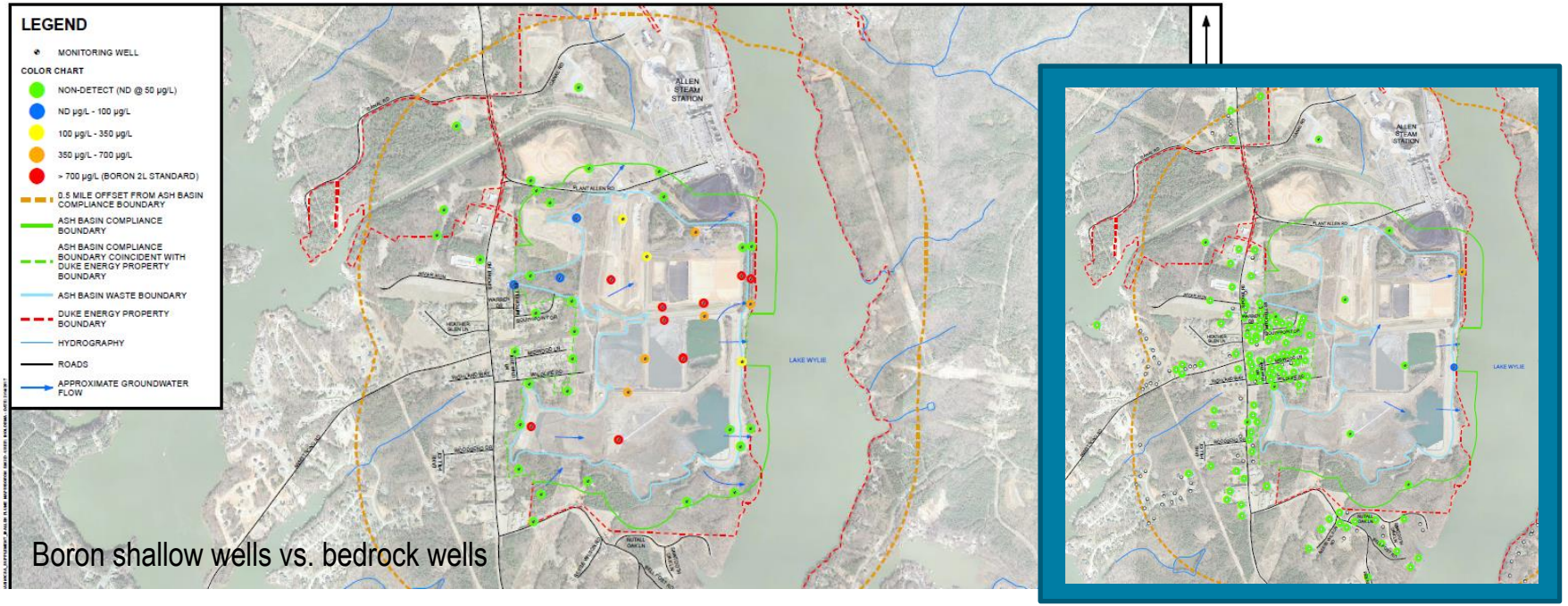
"This doesn't mean it poses less of a threat," Vengosh stressed. "If anything, because the contamination stems from water-rock interactions that are common across the Piedmont region, people in a much larger geographic area may be at risk. This is not limited only to wells near coal ash ponds.



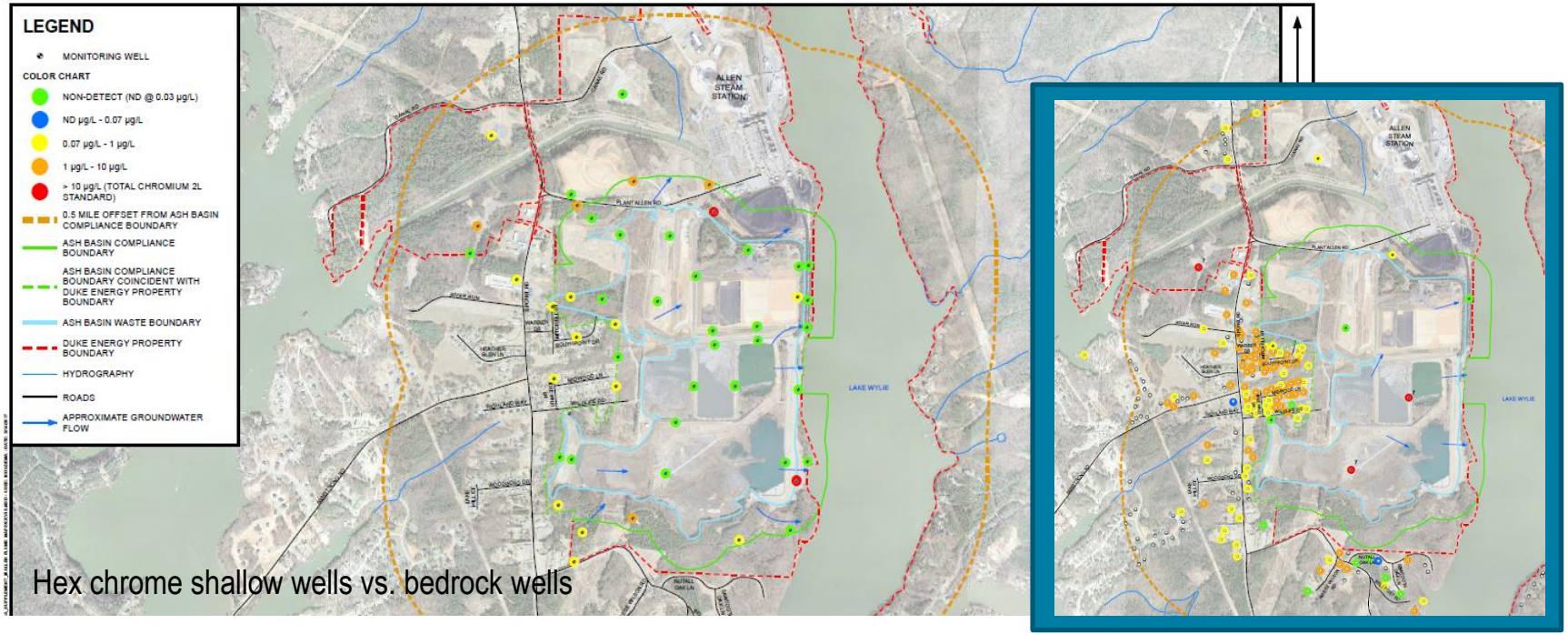
Groundwater flow is determined by monitoring well data (elevations and levels of constituents.)

It is not determined by modeling. Modeling is a tool that helps predict future conditions based on past data under various scenarios.

- Boron, a leading coal ash indicator, is clearly originating from ash basins. However, it's not present at elevated levels in neighbors' well water.



- Hexavalent chromium levels in basins are low and are not consistent with the higher levels observed in neighbors' wells and bedrock monitoring wells. This is consistent with what you'd expect to see from natural geology.



Hex chrome shallow wells vs. bedrock wells

How do you know?

- Outside experts at Haley & Aldrich in 2016 compared state test results of neighbors' wells with our groundwater monitoring data near ash basins.
  - Groundwater flow
    - With the exception of Sutton, groundwater is not flowing from these facilities to areas where private wells are located.
  - Ash indicators
    - Boron and sulfate are the major indicators of coal ash influence in groundwater.
    - If influence exists, both will be present, at levels above background, their concentrations will be correlated and there would be a definable plume.
    - With the exception of Sutton, which is already addressed, there are no ash indicators.
  - Lack of exceedances of drinking water standards
    - Very few MCL exceedances (most are pH and SMCL exceedances.)
    - Very few 2L exceedances (most are pH and vanadium.)
    - Very few DHHS exceedances (most are vanadium and hexavalent chromium.)
    - Very few exceedances of purely risk-based standards.

How do you know?

- A strong regional database for background conditions and for wells near the facilities show these data sets are very similar.
  - Of the 14,970 DEQ private well analyses, approximately 7% are above a NC screening level.
  - Of the 544 DEQ background well analyses, approximately 4% are above a NC screening level.
  - Of the 4,995 Duke background well analyses, approximately 7% are above a NC screening level.
- The risk-based drivers for the NC screening levels are vanadium and hexavalent chromium.
  - Comparison of the DEQ private well results for both constituents to background levels from various sources (local, state, national) indicate that the results are consistent with these background data sets.

- Conclusion
  - Neighbors' well results near proposed capping sites are consistent with background and do not exhibit a coal ash signature.

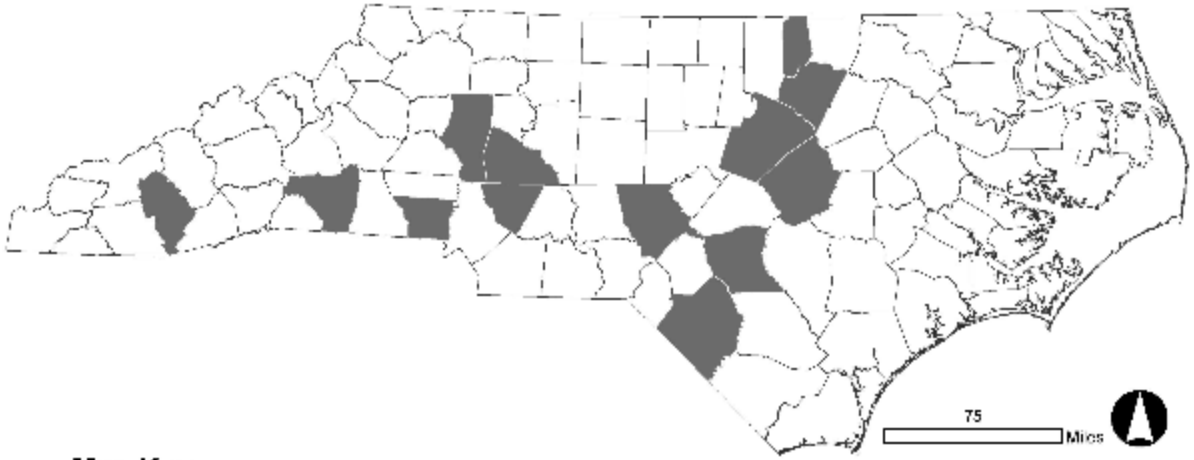
Federal groundwater process

- We posted the baseline data for each of our sites on Feb. 6, 2018, and are in the early stages of an extended process.
- *Maximum Contaminant Level (MCL)

Groundwater monitoring

- The groundwater monitoring wells for the federal CCR rule are located immediately next to the basin or landfill and do not reflect groundwater conditions farther away or off plant property where neighbors are located.
- We continue to see no concerns for nearby drinking water wells or surface water.
- Elements (including radium) occur naturally in rocks and soils.
- Radium has been detected at our sites in background wells (wells hydraulically upgradient of our ash basins.)
- Geology in the Carolinas often includes granite and other rock formations that include uranium, and uranium degrades as radium.
- A Duke University study indicated several N.C. counties had public water sources with naturally occurring radium above the U.S. EPA drinking water limit of 5 piC/L.

Counties with Public Water Sources that Have Exceeded
US EPA Limits for Combined Radium Levels



Map Key

Counties containing at least one public water source with combined radium levels exceeding US EPA limit (5 pCi/L)

Lake Norman is safe

- Drinking water supplies near Lake Norman and lake water quality remain safe.
  - New testing through a well-respected, third-party lab in mid-April has verified that Lake Norman, Mountain Island Lake and Lake Wylie do not have elevated radium levels. (In fact, all samples were < 1 piC/L.)
  - Those who recreate on these lakes and use them for drinking supplies can continue these activities with confidence.
  - Water providers around Lake Norman have confirmed they have observed no elevated levels for radium or other parameters and meet all state and federal drinking water standards.

Next steps

- Our next step in this federal groundwater monitoring process is to determine how much radium is the natural background level at each plant site and if ash basins are a contributor.
- Interestingly, we have not detected elevated radium in ash pore water, permitted outfall monitoring or in many shallow wells. This is where you would expect to find elevated levels if the ash itself was contributing radium.
- This may mean that site geochemistry is more of a driver of radium in groundwater than the ash.
- While all this additional groundwater data is useful to gather, we are not waiting for this analysis to act. We have closure activities underway at many sites or projects in flight to prepare for the closure process.

- Only about 4% of the groundwater samples collected near Catawba River ash basins to date reflect results above the federal MCL for radium (5 piC/L).

Radium Summary			
Riverbend		# Samples	**Results > 5 pCi/L
CAMA		282	5
CCR		-	0
Allen			
CAMA		511	0
CCR		433	5*
Marshall			
CAMA		395	52
CCR		350	29
Totals		**1971**	**86**

*Samples from grout contaminated wells and wells were re-drilled.

**Zero results above 5 pCi/L in ash pore water samples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