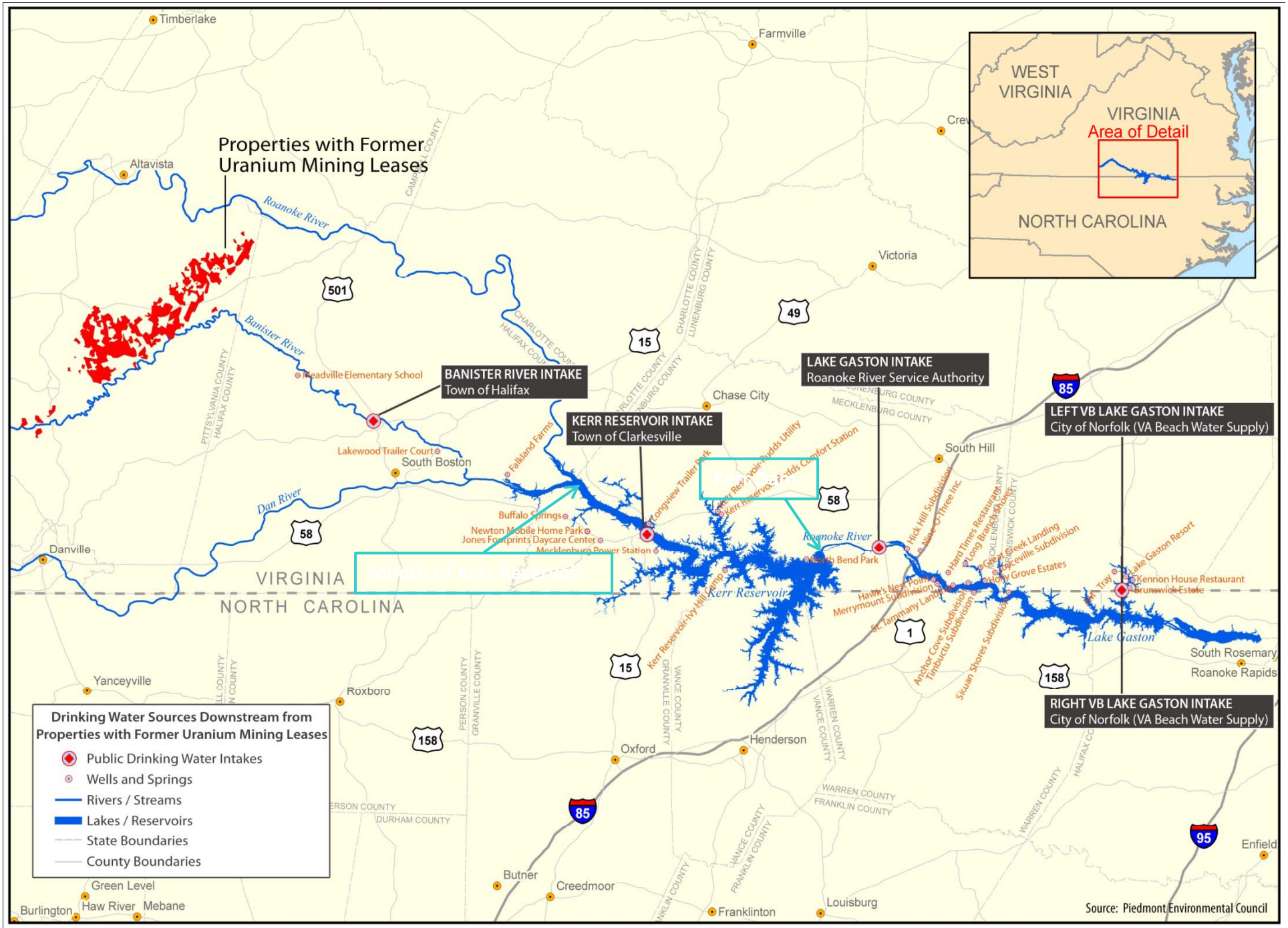
City of Virginia Beach
Uranium Mining Impact Study

City Council Briefing

February 1, 2011


Properties with Former Uranium Mining Leases
BANISTER RIVER INTAKE
Town of Halifax
KERR RESERVOIR INTAKE
Town of Clarkesville
LAKE GASTON INTAKE
Roanoke River Service Authority
LEFT VB LAKE GASTON INTAKE
City of Norfolk (VA Beach Water Supply)
RIGHT VB LAKE GASTON INTAKE
City of Norfolk (VA Beach Water Supply)
WEST VIRGINIA
VIRGINIA
Area of Detail
NORTH CAROLINA
Roanoke River
Banister River
Dan River
Kerr Reservoir
Lake Gaston
VIRGINIA
NORTH CAROLINA
Timberlake
Altavista
Farmville
Victoria
Chase City
South Hill
South Boston
Danville
Yanceyville
Roxboro
Oxford
Henderson
Butner
Creedmoor
Franklinton
Louisburg
Enfield
South Rosemary
Roanoke Rapids
Burlington
Green Level
Haw River
Mebane
Readville Elementary School
Lakewood Trailer Court
Falkland Farms
Buffalo Springs
Newton Mobile Home Park
Jones Footprints Daycare Center
Mecklenburg Power Station
Longview Trailer Park
Kerr Reservoir Ivy Hill Camp
Kerr Reservoir Dudds Utility
Kerr Reservoir Dudds Comfort Station
Kerr Reservoir Boat Ramp
Kerr Reservoir Bluestone Park
Kerr Reservoir Mouth of Kerr Reservoir
Kerr Reservoir Buggs Island Lake
Kerr Reservoir South Bend Park
Hick Hill Subdivision
Nine O Three Inc
Hard Times Restaurant
Long Branch Shores
Occoneechee Creek Landing
Roanoke Rapids Subdivision
Holly Grove Estates
Hawk's Nest Point
Merrymount Subdivision
Sr. Tammany Landing
Anchor Cove Subdivision
Timbuctu Subdivision
Sicuan Shores Subdivision
Lake Gaston Resort
Kennon House Restaurant
Brunswick Estate
Trail
Drinking Water Sources Downstream from Properties with Former Uranium Mining Leases
Public Drinking Water Intakes
Wells and Springs
Rivers / Streams
Lakes / Reservoirs
State Boundaries
County Boundaries
Source: Piedmont Environmental Council

The Lake Gaston Water Transfer: Roanoke River Basin to Virginia Beach

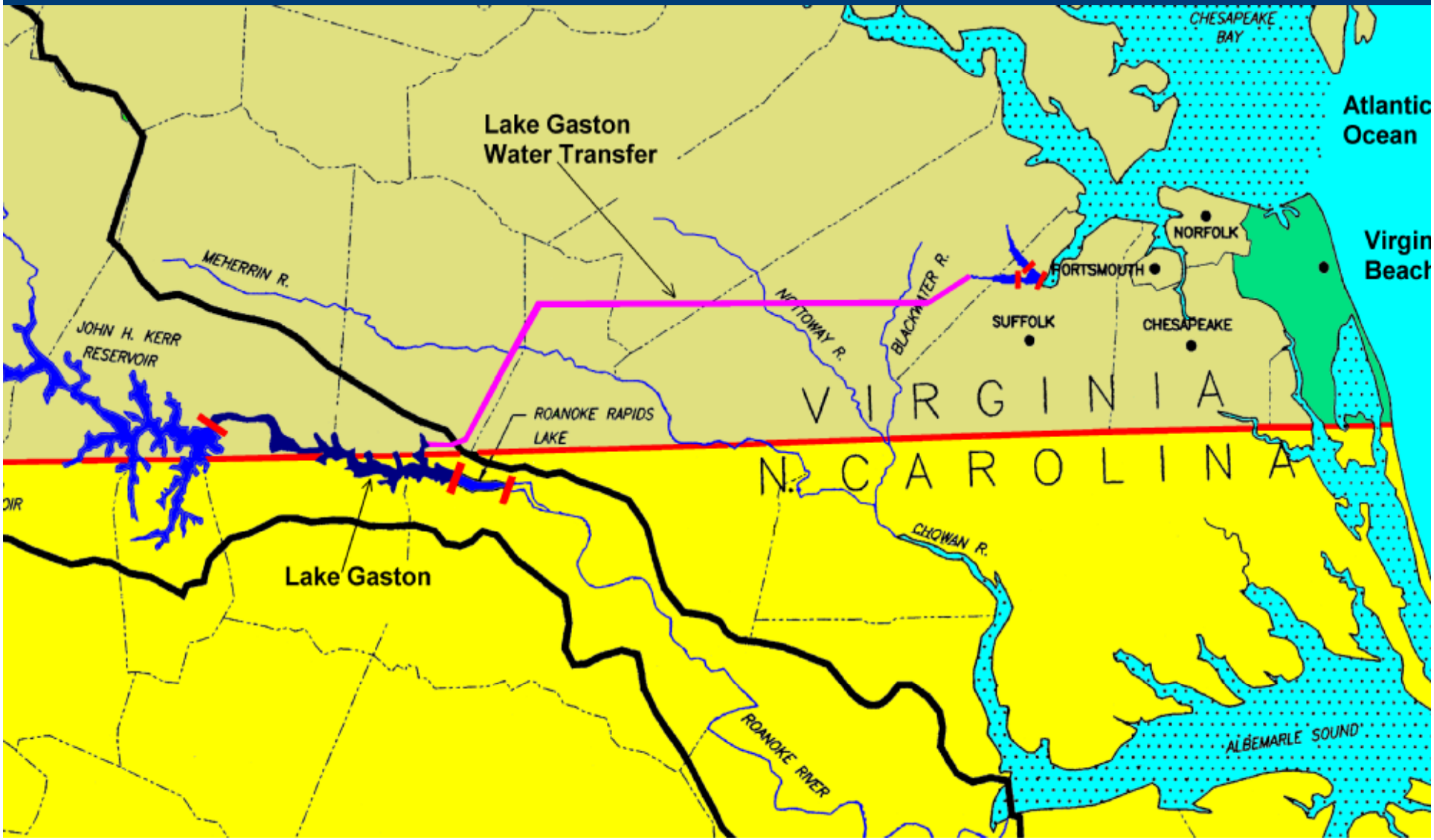
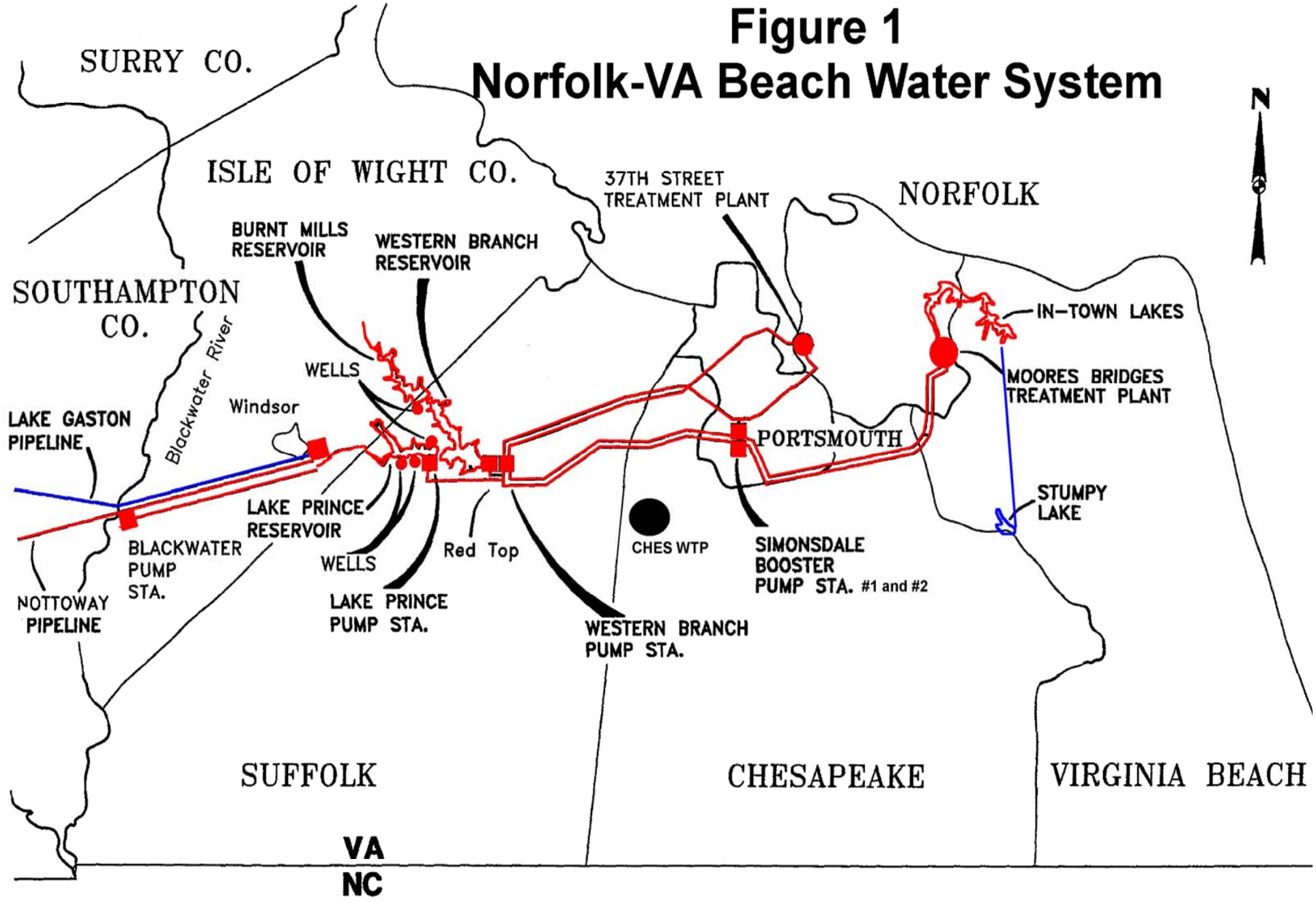


Figure 1
Norfolk-VA Beach Water System



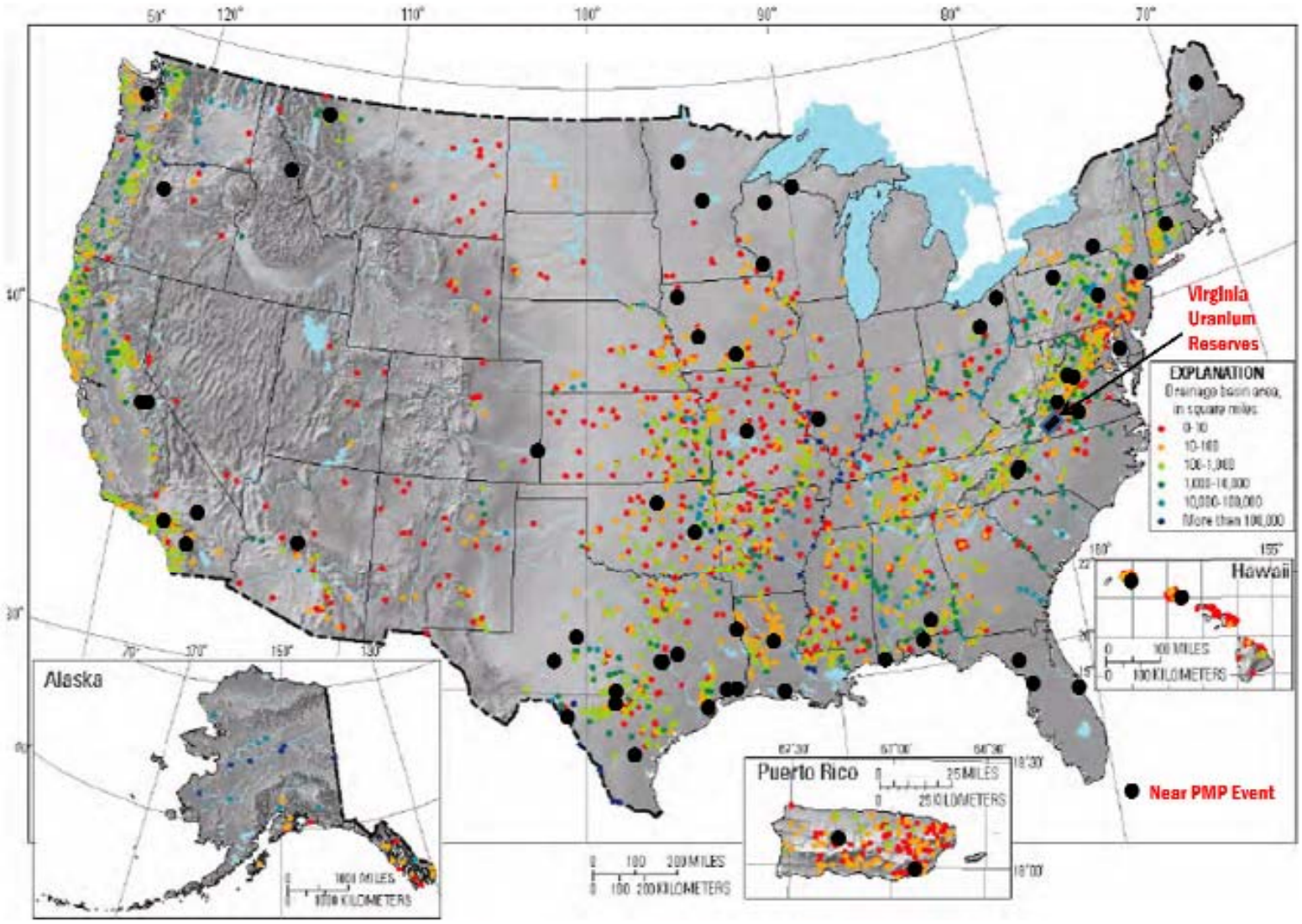


Figure 8. USGS Gages Where Largest Peak Discharges Exceeded Extreme Flood Criteria and Locations of Gages that Recorded Near-PMP Events

Task and Purpose of the Study

- Model and estimate the water quality impacts from a storm-based breach of a uranium mill tailings confinement structure, which results in a large release of mill tailings downstream to the Banister or Roanoke rivers
- Provide the results to the National Academy of Sciences Uranium Mining Committee for consideration as part of its study due Dec 2011

Study Qualifiers

- The study is simulating a rare event that regulations are supposed to prevent
- The model does not address the issue of whether there will be a catastrophe – it only simulates the outcome if one did occur
- In order to deliver a credible product in the time frame provided and within the resources allotted, certain assumptions and concessions were made

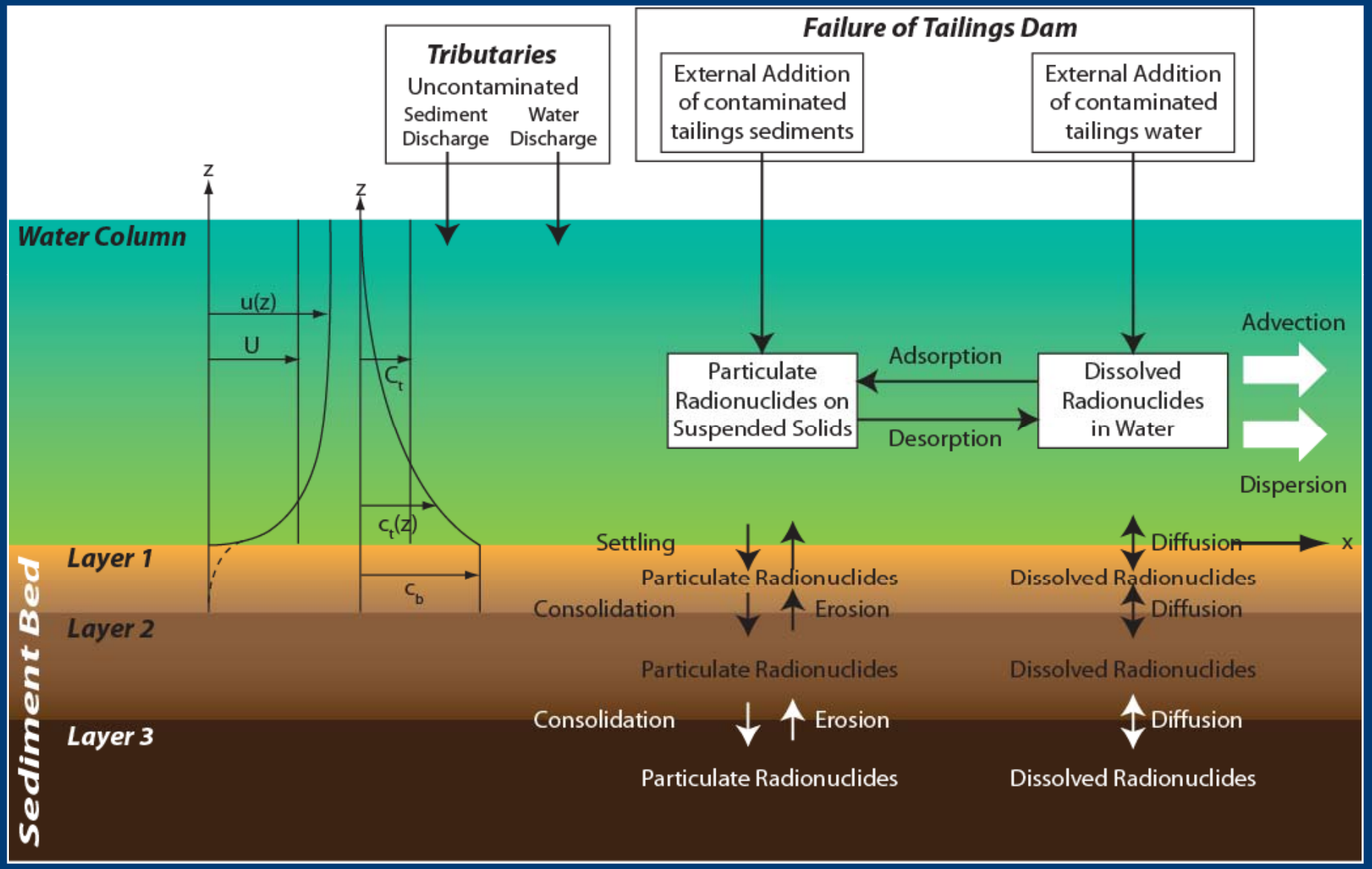
Model Scenarios

- Roanoke River Basin, Dan River Basin and Banister River Basin from headwaters to Kerr Dam
- 10-yr, 100-yr, and 500-yr floods were modeled, as well as “sunny-day” failures
- After each flood, a typical year with normal flows was appended to judge long-term effects
- Confinement cell dam heights: 5, 15, 30 & 50 m
- Radioactivity of tailings – RAD1 (lower) and RAD2 (higher)

Aftermath of a Tailings Release

- Tailings separate into particulate and dissolved components
- Most of the particulates tend to remain above Kerr Dam – in the reservoir, river bed and flood plain sediments
- The dissolved contaminants move downstream with the water and flow into Kerr Reservoir and then into Lake Gaston
- Ultimately, most dissolved contaminants flow downstream - out of the two reservoirs

Particulate vs Dissolved Contaminants

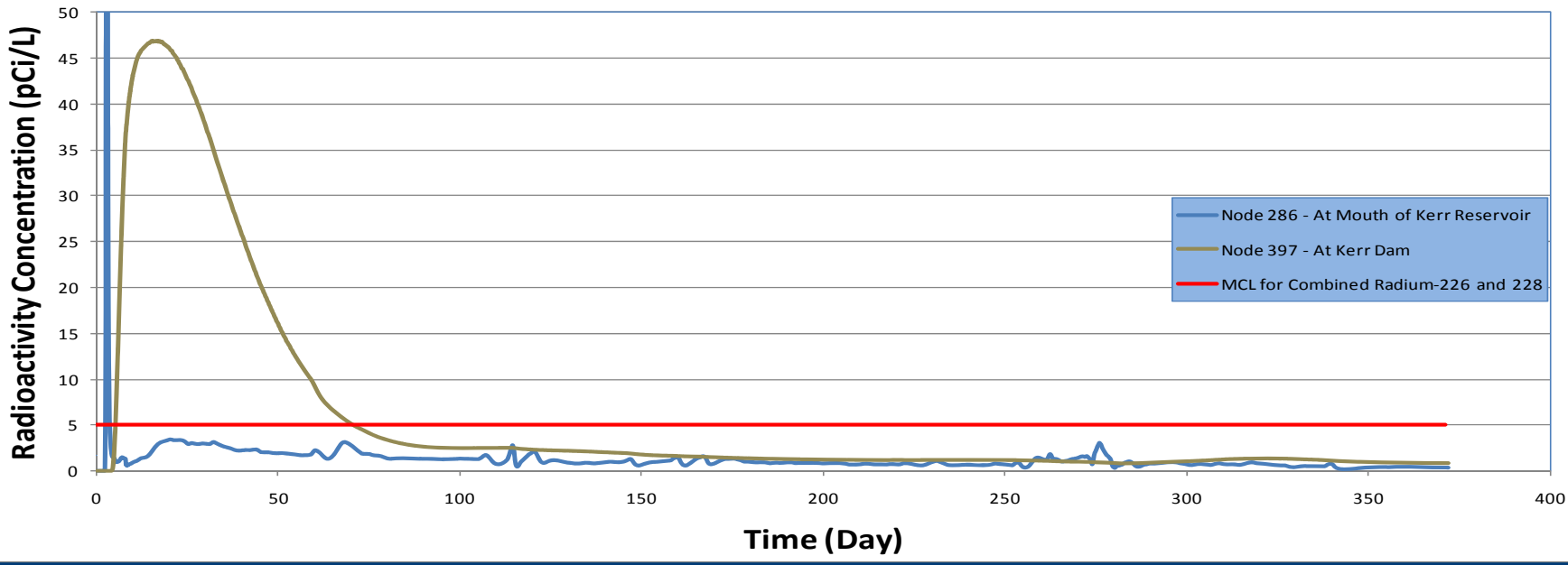


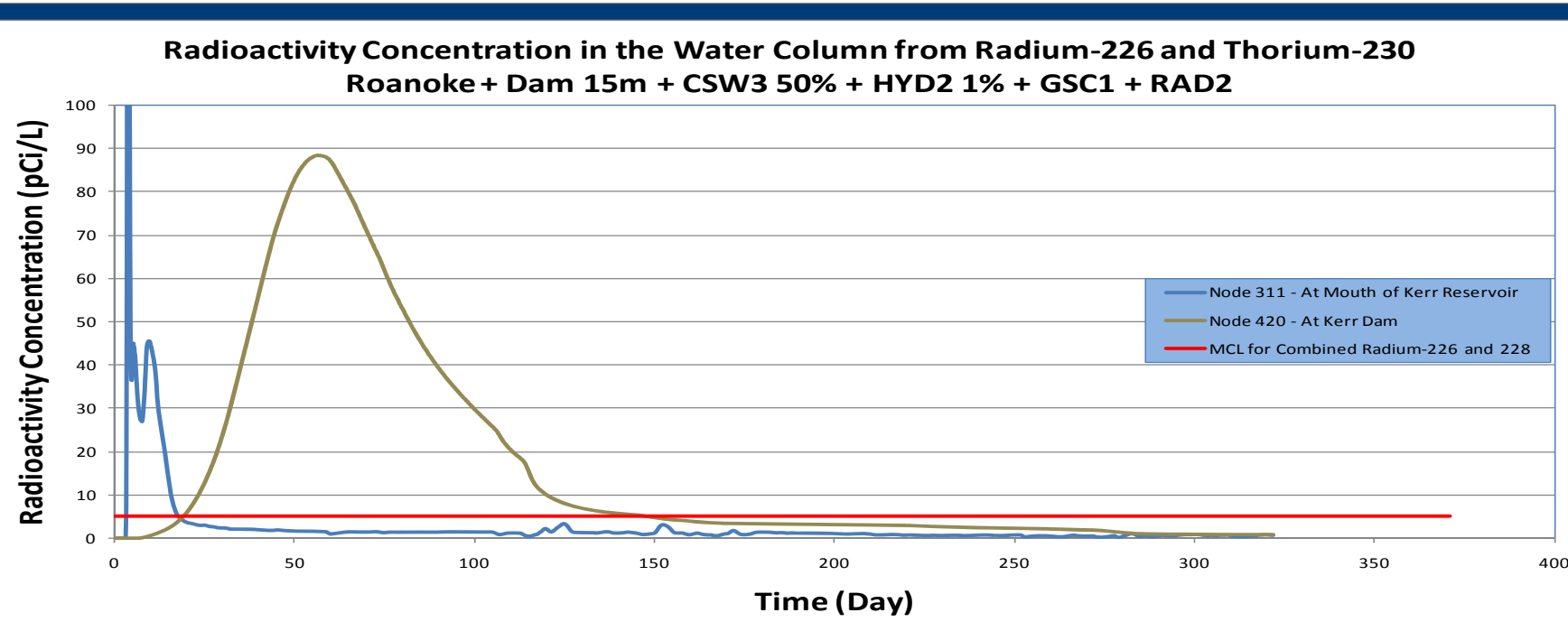
Impacts Above Kerr Dam

- Significant radioactive sediments in the river bed, flood plain and reservoir
- Radioactivity in the water column is initially very high, but declines as the particulates settle and the dissolved contaminants flow downstream
- Radioactivity of the sediments remains high on a long-term basis
- High flows re-suspend a portion of the settled particulates and move them incrementally to Kerr
- Most particulates will remain in the flood plain, river bottom, or Kerr Reservoir

Water Quality Impacts in Kerr Reservoir

- Radioactivity in the water column 10 – 20 times greater than SDWA MCL's accumulates in Kerr Reservoir over a period of months
- With normal inflows, contaminants in Kerr settle out or are flushed from the water column into Lake Gaston in roughly two to six months
- In time, contaminants would flow out of Gaston
- Flushing time is very dependent upon the magnitude and timing of stream flows after a tailings release


Radioactivity Concentration in the Water Column from Radium-226 and Thorium-230
Banister + Dam 15m + CSW3 50% + HYD2 1% + GSC1 + RAD2
Radioactivity Concentration (pCi/L)
Time (Day)
Node 286 - At Mouth of Kerr Reservoir
Node 397 - At Kerr Dam
MCL for Combined Radium-226 and 228


Radioactivity Concentration in the Water Column from Radium-226 and Thorium-230
Roanoke + Dam 15m + CSW3 50% + HYD2 1% + GSC1 + RAD2
Radioactivity Concentration (pCi/L)
Time (Day)
Node 311 - At Mouth of Kerr Reservoir
Node 420 - At Kerr Dam
MCL for Combined Radium-226 and 228

Model Limitations – Flushing Time

- Kerr Reservoir was modeled as a large, one-dimensional channel – a giant river
- Reasonable during flood periods. During normal and drought periods, Kerr Reservoir will act more like a lake
- Dissolved contaminants will experience mixing, dispersion, stagnation. May add to flushing time
- Lake Gaston has a volume equal to about half of Kerr Reservoir which will add to flushing time

Flushing Time in Kerr and Gaston

- Retention time for Kerr and Gaston combined:
  - About one month during severe flooding
  - About six months during normal flows
  - About one year during droughts
- In one-dimensional river flow, most dissolved contaminants are flushed in one retention time
- In a lake with good mixing – about two retention times
- *Depending upon whether it is wet or dry following a significant contamination event, it could take two months or two years to flush dissolved and suspended contaminants from both reservoirs*

Fate of Radiological Contaminants in the System after One Year

	Banister River, Various Modeling Scenarios	Roanoke River, Various Modeling Scenarios
Percent of Radioactivity Leaving the System (Flowing Downstream as a Dissolved Contaminant)	5-11%	11-19%
Percent of Radioactivity Remaining in the Water Column	0-2%	0-2%
Percent of Radioactivity Remaining in the System (In the Flood Plain, River Bed or Kerr Reservoir)	89-93%	78-87%

Fate of Uranium as a Heavy Metal in the System after One Year

	Low Partition Coefficient (High solubility of Uranium)	High Partition Coefficient (Low solubility of Uranium)
Percent of Uranium Leaving the System (Flowing Downstream as a Dissolved Contaminant)	47 to 73%	3-4%
Percent of Uranium Remaining in the System (In the Flood Plain, River Bed or Kerr Reservoir)	27 to 53%	96-97%

Model Sensitivity to Certain Variables

- Dam height (amount of tailings released)
  - 1.0 MCY (15 m dam), 2.0 MCY (30 m dam)
  - About one-third of tailings in the cell
  - Recent TVA fly ash impoundment failure: 4.0 MCY
- Initial radioactivity of the tailings
- Assumption of stream flow patterns after a simulated tailings release
  - Wet weather: lower concentrations, faster flushing
  - Dry weather: higher concentrations, slower flushing

Conclusions (1 of 2)

- Hydrology in Virginia is more than adequate to move tailings downstream
- Tailings separate into particulate and dissolved phases
- Particulates settle in the flood plain, river bed, and bottom of Kerr Reservoir
- Dissolved contaminants move downstream
- Radiation in the water column rises significantly above SDWA levels

Conclusions (2 of 2)

- Time required to flush radioactive contaminants out of Lake Gaston could be as little as a few months or as much as two years
- Kerr Reservoir is a significant trap for particulates
- Impacts upstream and in Kerr are more significant and more lasting than impacts downstream

Recommended Future Investigations

- Model Kerr and Gaston to better define flushing time of contaminants from both reservoirs in normal and dry periods
- Narrow the range of storm intensity, dam height, volume and radioactivity of tailings to reduce the number of scenarios
- Better definition of tailings & partition constants

Recommended Future Investigations

- Capacity and ability of water treatment plants in the region to remove uranium, thorium and radium
- Assist communities upstream of Kerr that may want to use the model to better define environmental and water quality impacts
- Five to six months, $165,000
- Supplemental Report to NAS

City Resolution – Dec 2, 2008

- The City is opposed to uranium mining in Virginia and elimination of the existing moratorium until it can be demonstrated that there will be no significant release of radioactive sediments downstream – This condition has not been met, at this time
- Many secondary conditions in the resolution have been satisfied or partially satisfied – but mostly because of the City's study

Recommended Council Action

- No change from current position as stated in the resolution
- Authorize additional investigations
- Provide supplemental information to NAS Uranium Committee as appropriate
- Wait for NAS Study (Due in December 2011)

Questions?