



TVA Clinch River SMR Project

Groundwater Evaluation

Purpose

Present Groundwater Investigations Performed Clinch River Site and Results Obtained

Agenda

Groundwater Studies

- Regional Groundwater Flow
- Regional Recharge
- Groundwater Withdrawals
- Local Hydrogeology

Accident Release Pathway and Potential Exposure Scenarios

Groundwater Flow Model

Future Monitoring

Groundwater Studies

Groundwater Studies

Review and Evaluation of Hydrogeologic Data Includes:

- Review of regional “desktop” study based on published state, Federal (including TVA and DOE Oak Ridge Reservation (ORR) studies), and other sources;
- Review of documentation addressing proposed, demonstration Clinch River Breeder Reactor Plant (CRBRP) originally planned at site;
- Review of preliminary Small Modular Reactor (SMR) plant layouts, plot plans, and excavation plans for Clinch River (CRN) site;
- Evaluation of site-specific geotechnical, geologic, and hydrogeologic field study conducted for CRN SMRs;
- Evaluation of site-specific data in conjunction with regional and local information

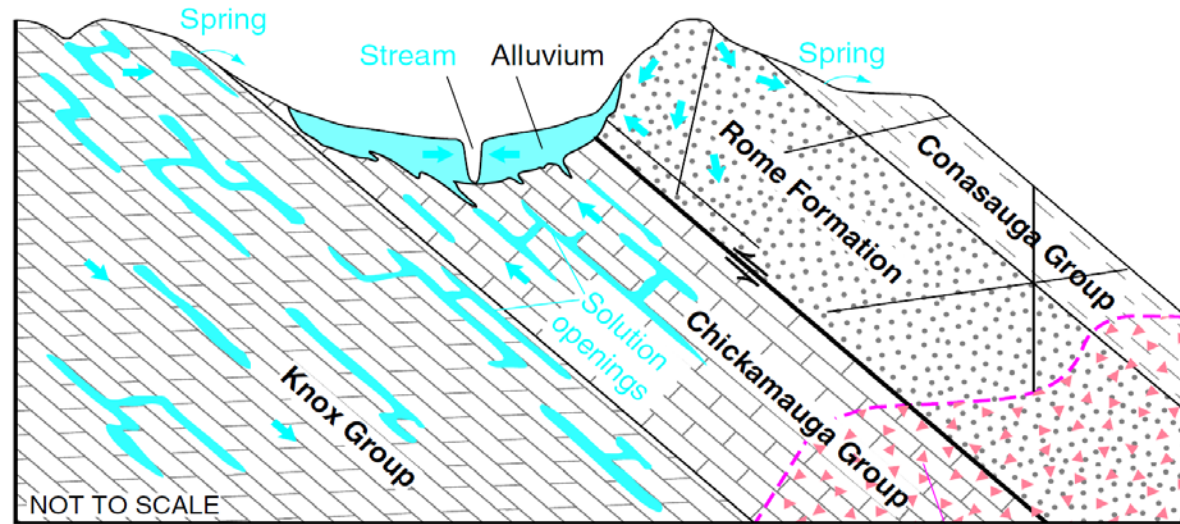
Regional Groundwater Flow (1/2)

- Groundwater flow in eastern Tennessee Valley and Ridge Province localized as result of repeating lithology created by thrust faulting and intersecting streams
- Regionally groundwater levels mimics land elevation – groundwater flows from higher ridges to valleys and discharges to streams that flow parallel to long axes of valleys
- Within local flow systems, predominant groundwater flow occurs within 300 feet of land surface through fractured jointed rocks
- Locally groundwater flow occurs parallel to bedding planes (strike) of rocks and discharge to local springs or streams

Regional Groundwater Flow (2/2)

Most important aquifers are carbonate rocks underlying majority of province

Knox Group most important aquifer in eastern Tennessee and mostly comprised of dolomite



adapted from Lloyd, O.B., and Lyke, W.L., 1995

Chickamauga Group (comprised of interbedded siltstone and limestone) and Knox Group are of particular interest near CRN site

Regional Recharge

- Long-term average annual precipitation in vicinity of CRN site ~50 in
- Estimated long-term annual average runoff 25-30 in
- Groundwater recharge from precipitation is seasonal and varies with lithology ranging from ~2-25 in/yr
- Higher recharge observed at ridges such as Pine and Chestnut Ridges
- Very small portion of groundwater recharge enters deep aquifer

Groundwater Withdrawals

Groundwater Withdrawals from Surrounding Counties

County	Year	Industrial (mgd)	Public Supply (mgd)	Irrigation (mgd)	Total Groundwater Withdrawal (mgd)
Anderson	2010	NR	0.22	0	0.22
	2005	0.12	0.28	0.12	0.52
	2000	NR	0.96	0.01	0.97
Knox	2010	1.13	NR	0.02	1.16
	2005	0.67	0.67	0.04	1.38
	2000	0.13	0.93	0.1	1.16
Loudon	2010	0.01	0.8	NR	0.81
	2005	0.02	0.35	NR	0.37
	2000	NR	1.2	NR	1.2
Morgan	2010	NR	NR	NR	NR
	2005	NR	NR	NR	NR
	2000	NR	NR	NR	NR
Roane	2010	NR	1.28	0	1.28
	2005	NR	1.03	0.01	1.03
	2000	NR	0.2	NR	0.2
Total	2010	1.14	2.3	0.02	3.5
	2005	0.79	2.33	0.18	3.3
	2000	0.13	3.29	0.11	3.5

Source: Hutson et. al. (2004), Bohac and McCall (2008), and Bohac and Bowen (2012)

NR: Not Reported

Identified sole-source aquifers in EPA Region 4 beyond boundaries of local and regional hydrogeologic systems associated with CRN site

Site does not impact any identified sole source aquifer

Clinch River Site will not use groundwater during construction or operation

Local Hydrogeology (1/8)

Numerous groundwater investigations performed at ORR provide hydrogeologic property data for bedrock units

- Slug tests in wells
- Packer tests in boreholes
- Aquifer pumping
- Tracer tests

CRBRP site investigated via 129 borings, 37 observation wells, 11 piezometers, and 117 bedrock packer permeability tests

- Investigation also included collection of groundwater level data and performing survey of local groundwater users

Local Hydrogeology (2/8)

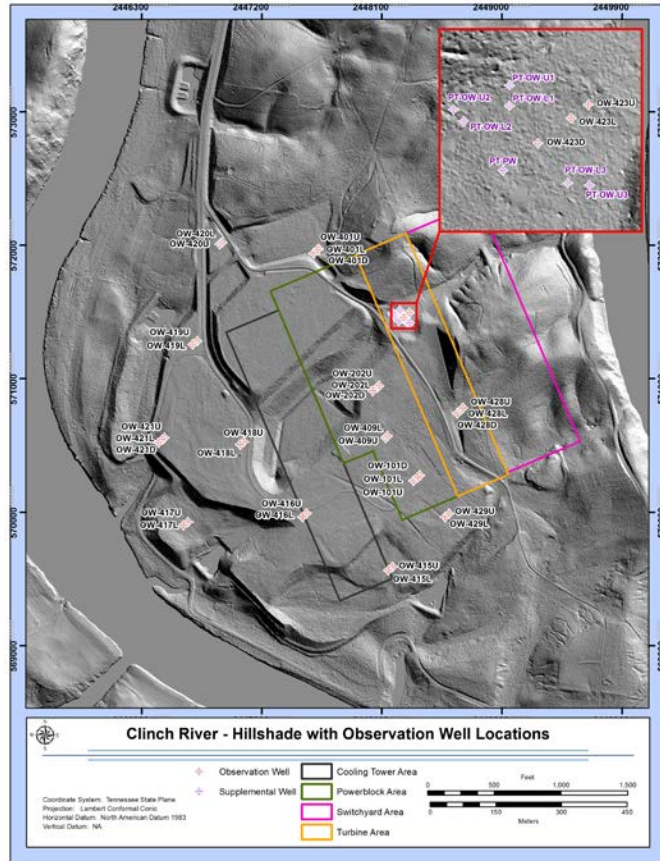
Clinch River ESPA site field investigation included:

- 82 borings
- 3 test pits
- 44 wells
- In-situ/ex-situ tests on soil, rock, and groundwater

Groundwater characterization activities included:

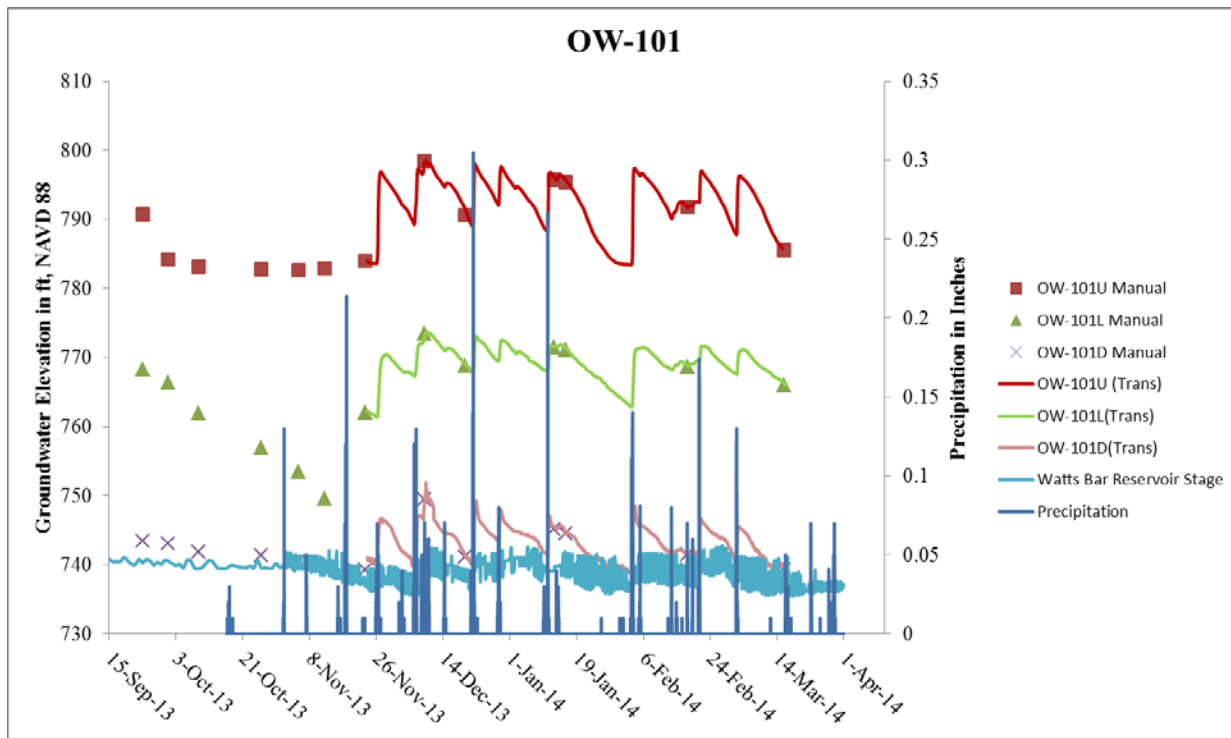
- Groundwater level monitoring
- Packer tests in boreholes
- Slug tests in observation wells
- Aquifer pumping test
- Groundwater geochemical sampling

Local Hydrogeology (3/8)



- Current Site Topography and Observation Well Locations
- Water level measurement program will continue until two years of groundwater levels are collected
- Manual measurements from all observation wells (excluding wells installed for pumping test)
- Pressure transducer water level measurements from 13 observation wells

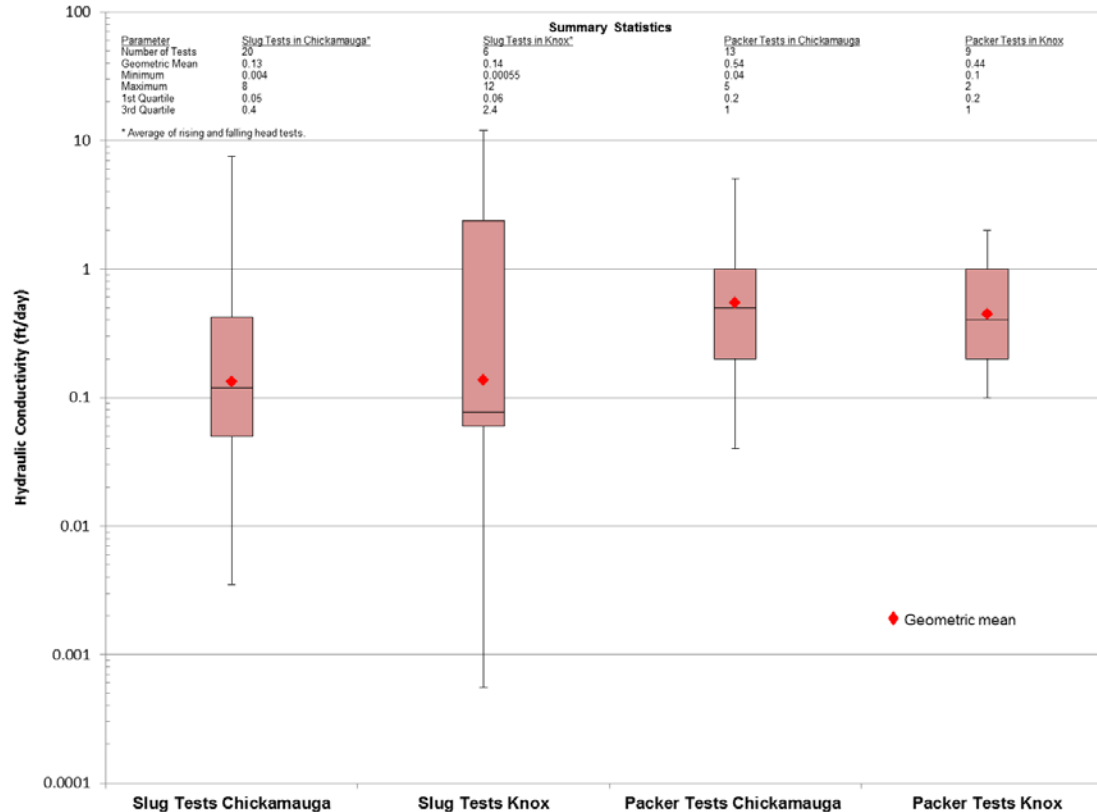
Local Hydrogeology (4/8)



Typical Well Hydrograph

- Maximums in Winter Periods
- Minimums in Fall Periods
- Fluctuations with Precipitation

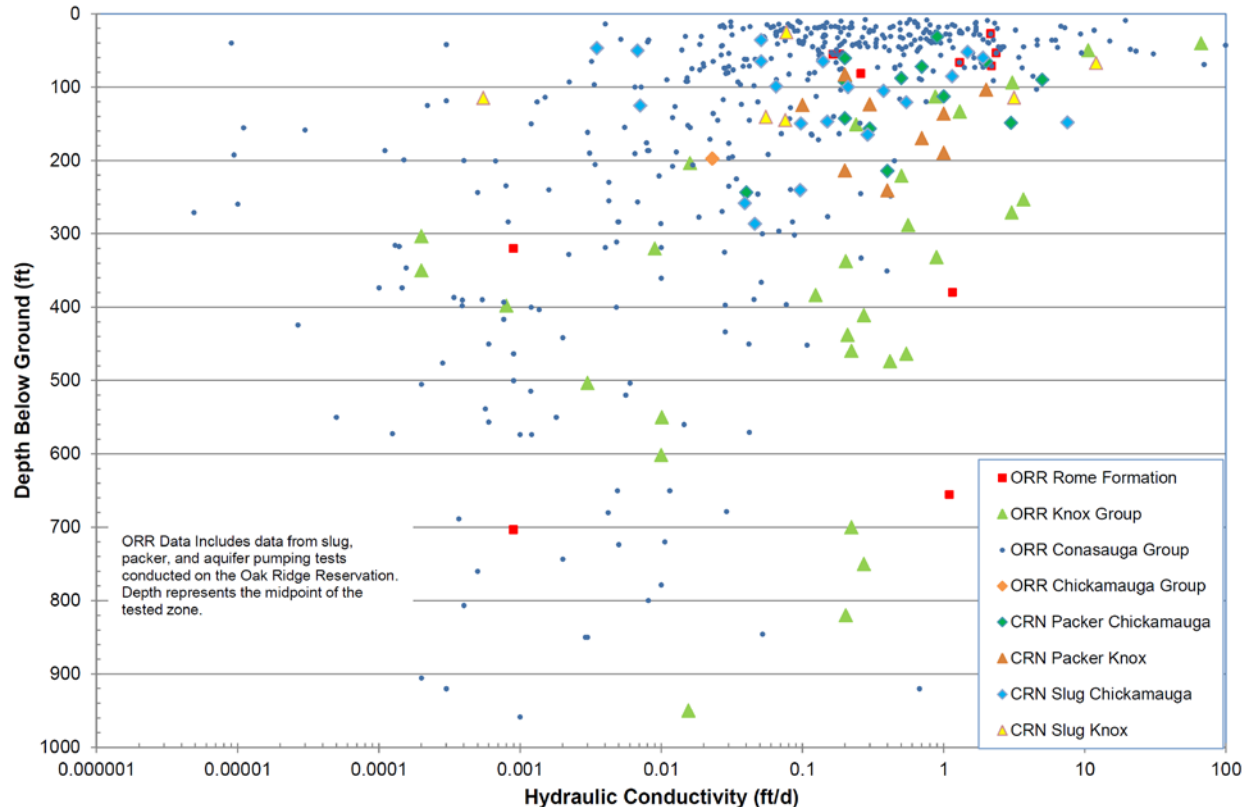
Local Hydrogeology (5/8)



Comparison of
Slug and
Packer Test
Results

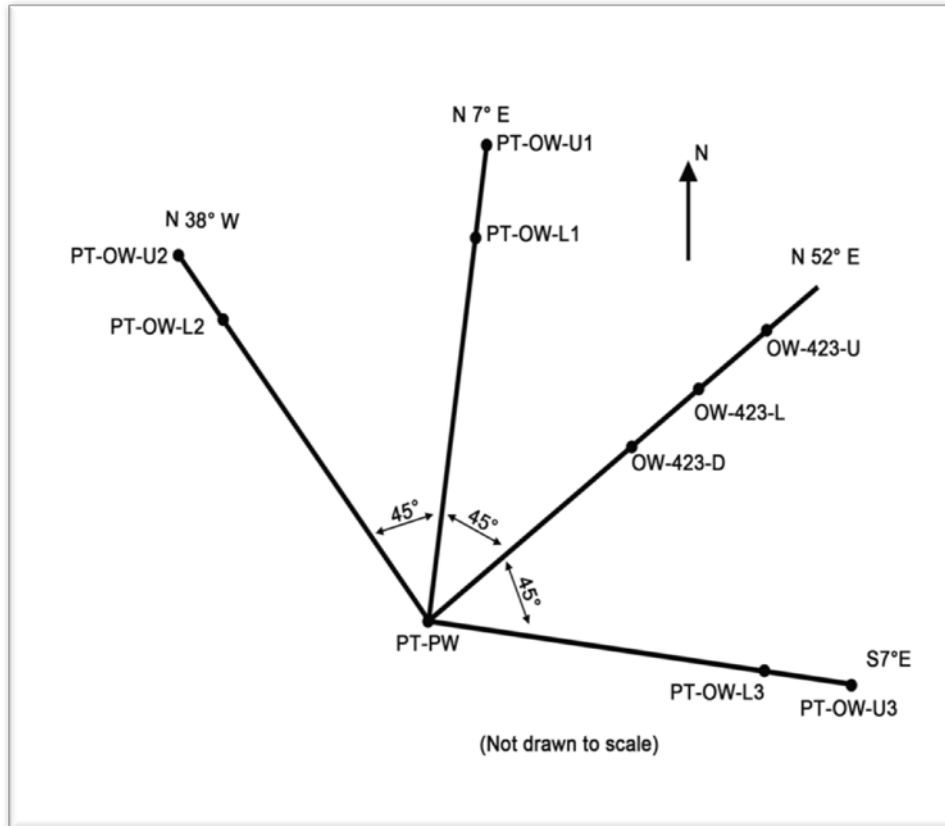
Local Hydrogeology (6/8)

Bedrock Hydraulic Conductivity Values



Results indicate decreasing trend in hydraulic conductivity at depths > ~100 ft below ground surface

Local Hydrogeology (7/8)

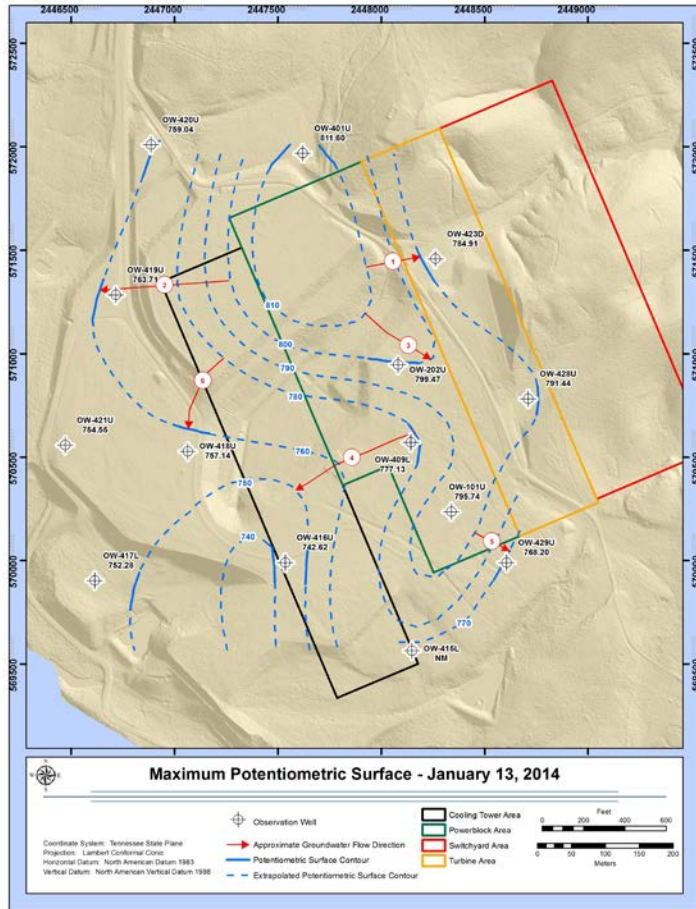


Pumping Test Results

Transmissivity (ft²/d): 7 – 410
Storage Coefficient: 2.7E-4 to 4.8E-2
Hydraulic Conductivity (ft/d): 0.06 – 2.6
Highest transmissivity along N52° E (along strike)

Comparison of test results to published results indicates data from site-specific pumping test fall within range of tests performed on adjacent ORR

Local Hydrogeology (8/8)



- Groundwater flows generally ~SW and SE from power block area
- Horizontal hydraulic gradients range from 0.03 to 0.11 ft/ft (0.05 to 0.17 ft/ft for upper shallowest site observation wells only)
- Average vertical hydraulic gradients range from -0.71 to 1.15 ft/ft (positive change indicates downward hydraulic gradient)

Accident Release Pathway and Potential Exposure Scenarios

Accident Release Pathway and Potential Exposure Scenarios

Clinch River site surrounded on three sides by Clinch River arm of Watts Bar Reservoir (CRAWBR)

- Most likely pathway for groundwater flow is recharge in upland areas of site with discharge to CRAWBR
- Alternate groundwater pathway involves groundwater discharge to surface, via springs and seeps to onsite surface drainages and surface water discharge into CRAWBR during the wet period

Groundwater Flow Model

Groundwater Flow Model (1/2)

Two-dimensional cross-sectional groundwater models (profile models) developed along geologic strike of bedding planes (principal flow direction) at CRN site

- Profile models used to evaluate maximum groundwater level from future construction and operation

Two profile models developed – northern sector and southern sector of power block area, both oriented along strike of bedding planes

Groundwater Flow Model (2/2)

Both profile models encompass Chickamauga Group of interbedded siltstone and limestone

Profile models calibrated by matching simulated heads against maximum observed heads within power block area

- Sensitivity of simulated heads to model parameters (hydraulic conductivity and recharge) evaluated during model calibration phase
- Simulated groundwater heads underneath structures in deep foundations varied between ~802–816 ft NAVD 88 at power block

Future Monitoring

Future Monitoring

TVA plans to:

- Evaluate existing groundwater observation well network and develop environmental monitoring program during future detailed design stage (to detect changes in bedrock aquifer and backfill that may impact groundwater levels or accidental release analysis)
- Measure groundwater level measurements in bedrock aquifer and backfill observation wells (existing or future) during construction and operation
- Perform geochemical sampling and analysis of bedrock aquifer and backfill wells during construction and operation
- Employ best practices to minimize potential for adverse impacts to the groundwater during construction and operation

Operational effluent and process monitoring program will be addressed in COLA

Summary

TVA Performed Extensive Studies and Field Work to Characterize Groundwater at Clinch River Site

TVA Methods Conform to Best Practices and Regulatory Guidance

No Adverse Impacts were Identified

Clinch River Site will not Use Groundwater during Construction or Operation

Closing

Questions?

Follow-up Action Review