TN Department of Environment & Conservation

Investigating CCR Impacts: An Overview of the EIP Process in Tennessee

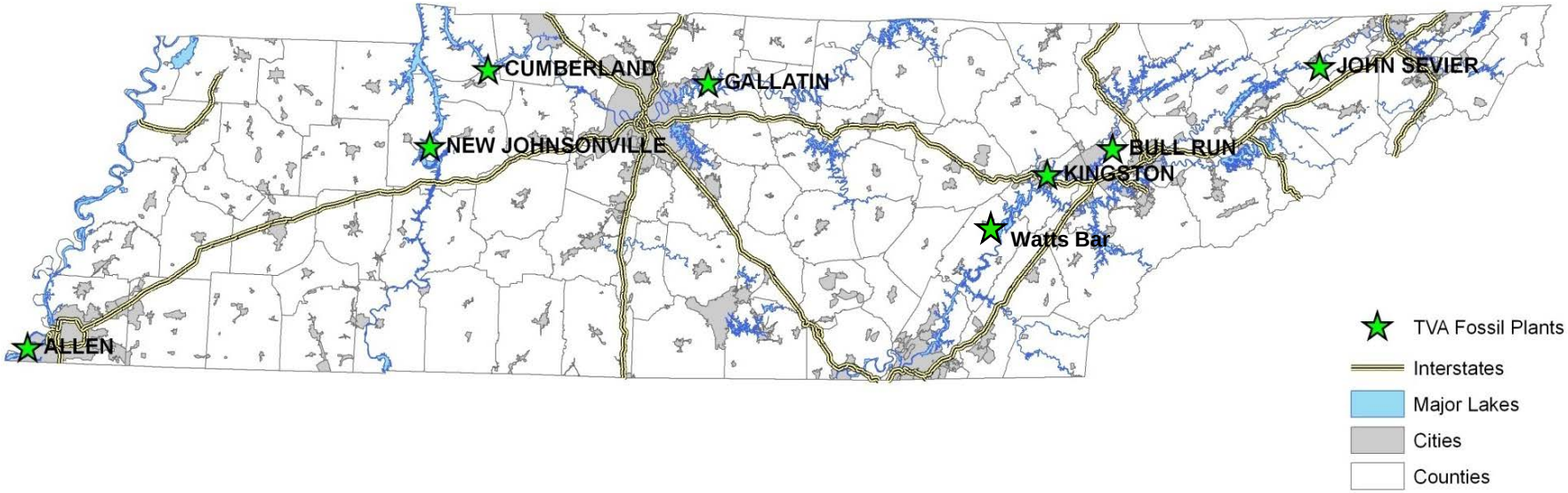
Air & Waste Management Association
Southern Section 2018 Annual Meeting and Conference

Robert Wilkinson P.G.,CHMM | September 27, 2018

Introduction

- Tennessee's Regulated CCR Units and Location
- Commissioner's Order OGC15-0177
- Environmental Investigation Plan (EIP)
- Commissioner's Order Site Updates
- TVA Allen Plant Remedial Investigation Update
- Questions and Comments

Tennessee TVA CCR Facilities



OGC15-0177 (Commissioner's Order) August 6, 2015

Order Has **Two** Purposes

1. Establish transparent and comprehensive process for the **investigation, assessment, and remediation** of unacceptable risks, resulting from the management and **disposal of coal combustion residuals (CCR)** at the TVA's coal-fired power plants in Tennessee.

2. **Implementation of the federal CCR rule** to insure coordination and compliance with Tennessee laws and regulations that govern the management and disposal of CCR.

Brief History of the Order

- August 2015 – Final Order Issued
  - Applicable to 7 of 8 TVA CCR Sites in TN (Gallatin excluded)
- 2016
  - Site investigation conferences
  - TDEC issues Environmental Investigation Plan (EIP) request letters
  - Revision 0 EIP's submitted by TVA
- 2017
  - Continued review and revision of EIPs for each facility
- 2018
  - Final EIP revisions are being completed
  - All Interested Parties (AIP) and Public Comment on EIPs
  - EIP implementation begins fall 2018

Environmental Investigation Plan (EIP)

- **Investigation:** The Order requires TVA to develop an EIP for each site that, when implemented, shall provide the information necessary to "*fully identify the extent of soil, surface water, and ground water contamination by CCR*"

- **Assessment:** Environmental Assessment Report (EAR) is an analysis of the extent of soil, surface water, and ground water contamination by CCR at the site.
  - The process set-out shall be repeated until the Department determines there is sufficient information to adequately characterize the extent of CCR contamination in soil, surface water, and ground water at each site.

- **Remediation:** Corrective Action/Risk Assessment (CARA) Plans that shall specify all actions TVA plans to take at the site and the basis of those actions.

Objectives of the EIP

- Define background conditions:
  - soil
  - groundwater
  - pre-construction site conditions (topography, hydrology)
- Determine how each unit was constructed and modified during lifetime
- Develop a thorough understanding of the geology at the site
- Define groundwater flow and chemistry at the site
- Delineate potential impacts to groundwater, soil, surface water, sediment, and aquatic life

Objectives of the EIP

- Characterize CCR material
  - quantity
  - chemistry
  - physical characteristics (geotechnical)
  - saturation levels
  - existing and modeled for potential closure scenarios
- Data generated will be used to develop a final Environmental Assessment Report (EAR) and ultimately, an appropriate selection of remedy for each site

EIP Structure

- State clear objectives and goals for the investigation
- Develop specific information and deliverables for the investigation
- Incorporate existing and ongoing data collection efforts where applicable
  - Federal CCR rule compliance
  - State permit required monitoring
  - Historical assessments and data that meet QA/QC standards
- Develop site specific Sampling and Analysis Plans (SAPs) and schedule for investigation activities
- Site specific Quality Assurance Project Plan (QAPP) and programmatic Data Management Plan (DMP)

Sampling and Analysis Plans (SAPs)

- The SAPs provide detailed plans for conducting studies to obtain new data and will describe how it will be used to respond to specific information requests
- The SAPs are structured as independent documents that guide the work of the SAP execution teams
- Included as Appendices to the EIP

Example SAPs

- Material Quantity SAP
- Material Characteristic SAP
- Background Soil SAP
- Hydrogeological Characterization SAP
- Groundwater Characterization SAP
- Exploratory Drilling SAP
- Water Use SAP
- Benthic SAP
- Seep SAP
- Surface Stream SAP
- Fish Tissue SAP
- Stability SAP

CCR Parameters

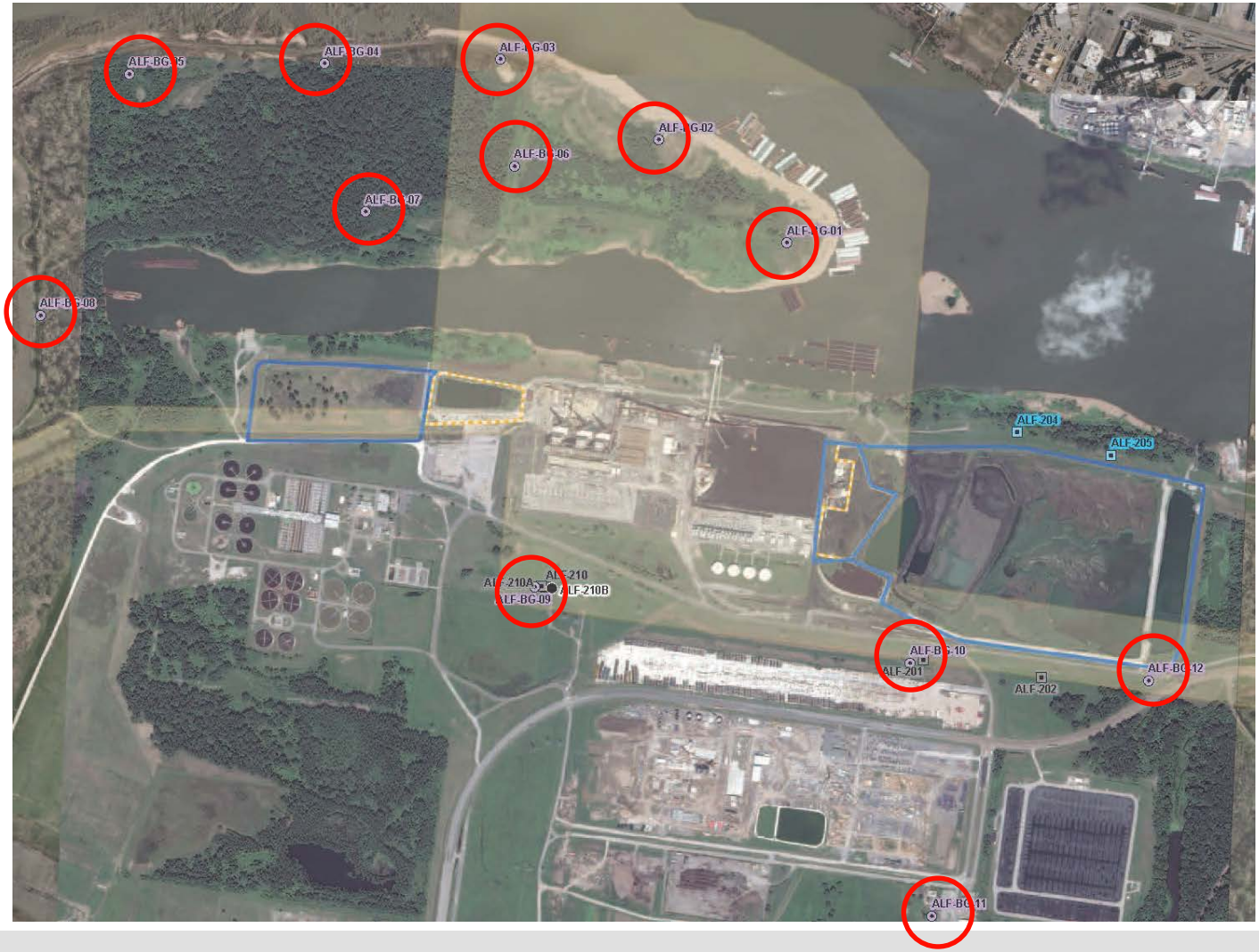
40 CFR Part 257 Appendix III Constituents	40 CFR Part 257 Appendix IV Constituents
Boron	Antimony
Calcium	Arsenic
Chloride	Barium
Fluoride	Beryllium
pH	Cadmium
Sulfate	Chromium
Total Dissolved Solids	Cobalt
	Fluoride
	Lead
TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents	Lithium
Copper	Mercury
Nickel	Molybdenum
Silver	Selenium
Vanadium	Thallium
Zinc	Radium 226 and 228 Combined

Background Soil SAP

Objective: characterize in place, native, soils unaffected by CCR material in the vicinity of the ALF

- Samples will be analyzed for CCR parameters
- Samples of surficial soil will be collected and analyzed for percent ash to determine the presence or absence of CCR

Background Soil SAP

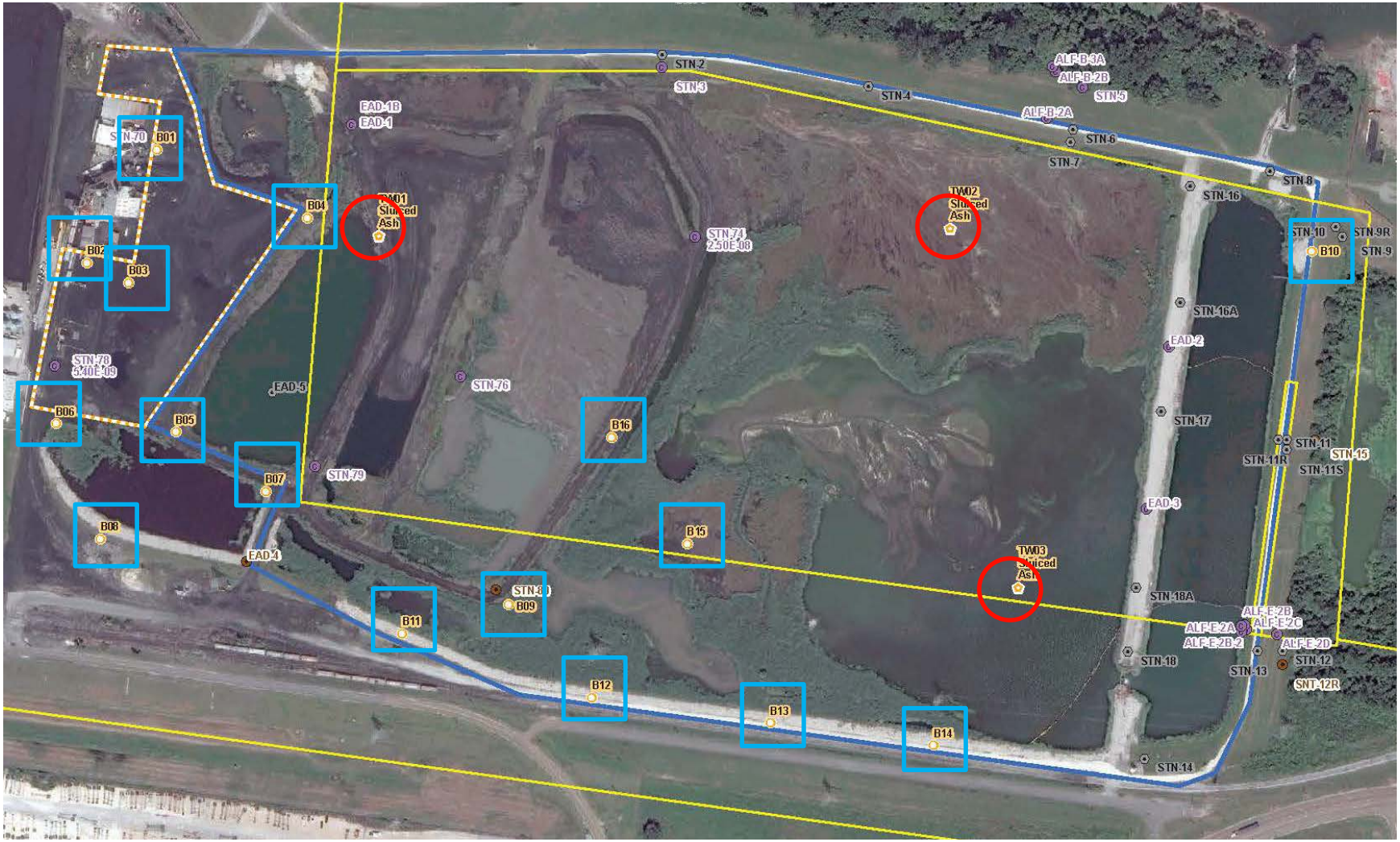


Exploratory Drilling SAP

Objective: close data gaps and supplement existing data, with respect to CCR material quantity, water levels, CCR material characteristics, and subsurface materials.

- perform additional soil borings, piezometer installation, and laboratory testing to refine subsurface characterization and material quantity estimates
- install temporary wells to allow for pore water sampling and measuring piezometric (i.e., water) levels within CCR units

Exploratory Drilling SAP



Material Quantity SAP

- Objectives of the Material Quantity SAP are:
  - describe the methods TVA will use to determine CCR unit geometry
  - determine CCR material quantity
  - determine groundwater elevations, saturation levels, and subsurface conditions

Material Quantity SAP

- Activities will be completed to:
  - Estimate the volume of CCR below and above groundwater
  - Estimate the volume of CCR below and above the piezometric level of saturation
  - Develop three-dimensional models of the subsurface from ground surface to bedrock and CCR volume estimates for each CCR unit
- Data will be collected through the Exploratory Drilling SAP

CCR Material Characteristics SAP

- Objective is to characterize the leachability of CCR and potential for future migration
- Procedures to collect and analyze pore water and CCR material and to characterize them for the CCR Parameters list (totals and leachable concentrations)

CCR Material Characteristics SAP

Hydrogeological Investigation SAP

- Objectives of the Hydrogeological Investigation SAP is to:
  - further characterize the groundwater flow at the facility
  - install monitoring wells to provide locations to collect groundwater samples for analysis of CCR parameters

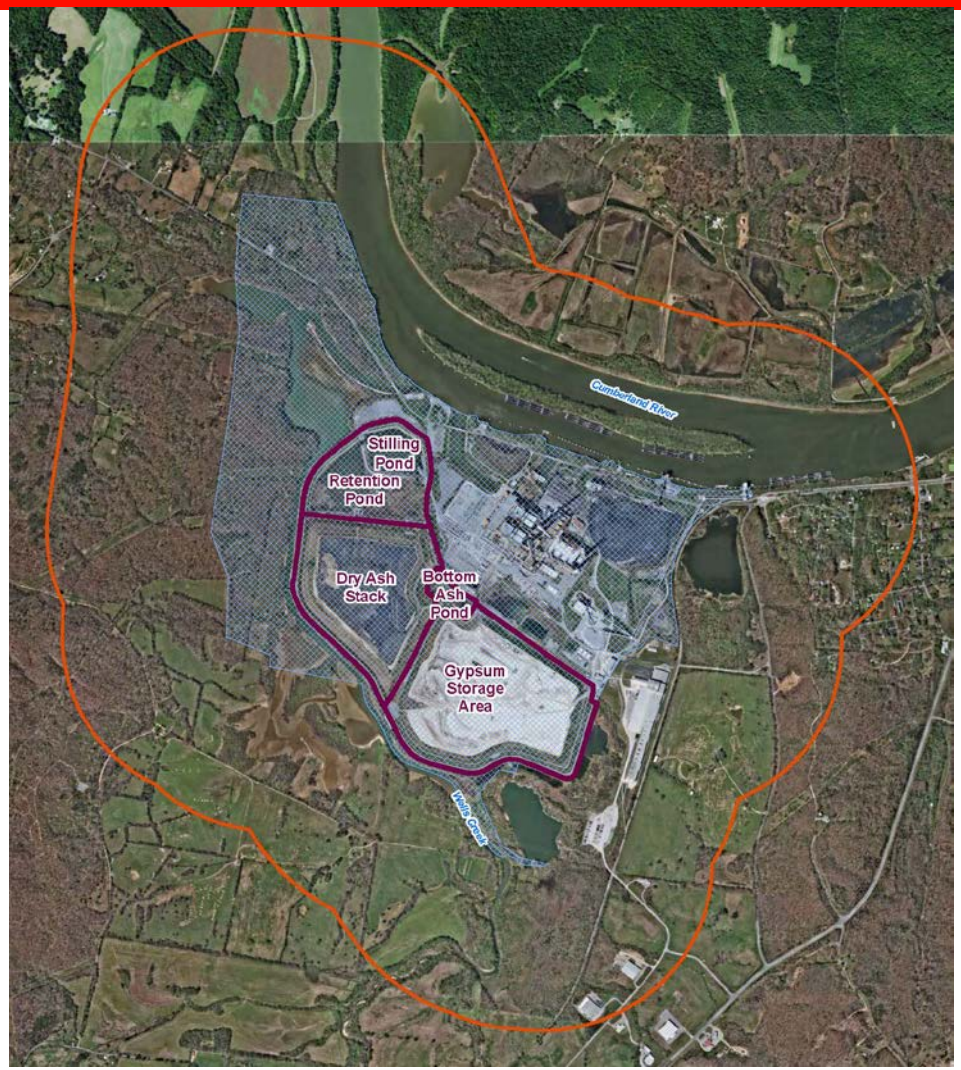
Hydrogeological Investigation SAP

Water Use Survey SAP

Objective: identify and sample usable water supply wells and surface water sources being used for domestic purposes located within ½ mile of the site

- Property and Owner Identification
- Door-to-door Survey
- Samples will be analyzed for CCR parameters

Water Use Survey SAP



Groundwater Investigation SAP

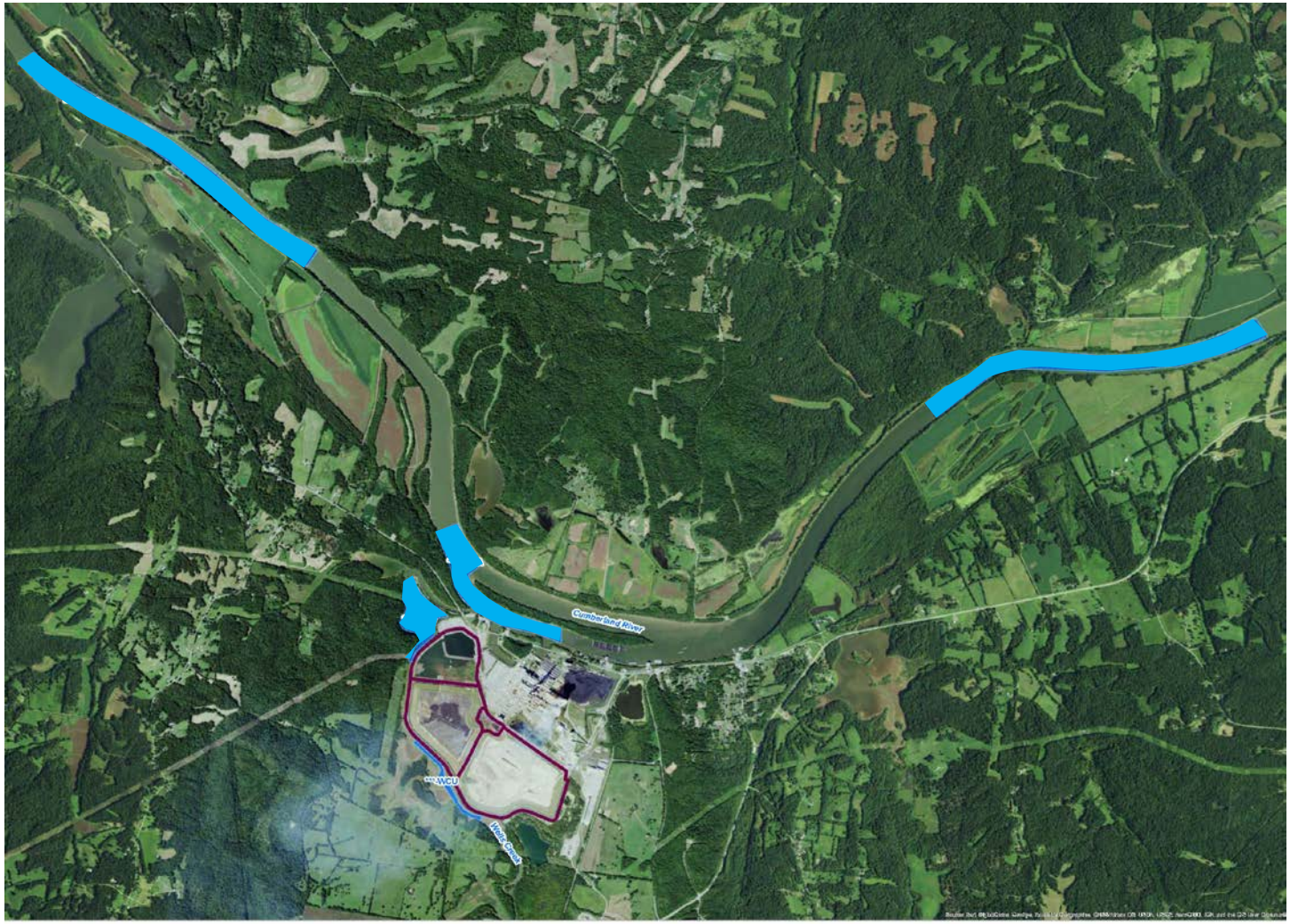
- The objectives of the Groundwater Investigation SAP are
  - to provide the procedures necessary to characterize existing groundwater quality and chemistry
  - delineate potential impacts to groundwater

Groundwater Investigation SAP

Benthic SAP

- The objectives are:
  - characterize sediment chemistry
  - determine benthic macroinvertebrate (invertebrate) community composition
  - define benthic invertebrate bioaccumulation
- Delineate potential impacts to sediment and benthic communities on or adjacent to the site

Benthic SAP



Seep SAP

- The objectives of the Seep SAP are
  - identify and characterize active seeps at the facility for CCR parameters
  - identify information that may explain and/or assess the potential movement of groundwater/pore water with dissolved CCR constituents into surface water streams on or adjacent to the facility, through seepage

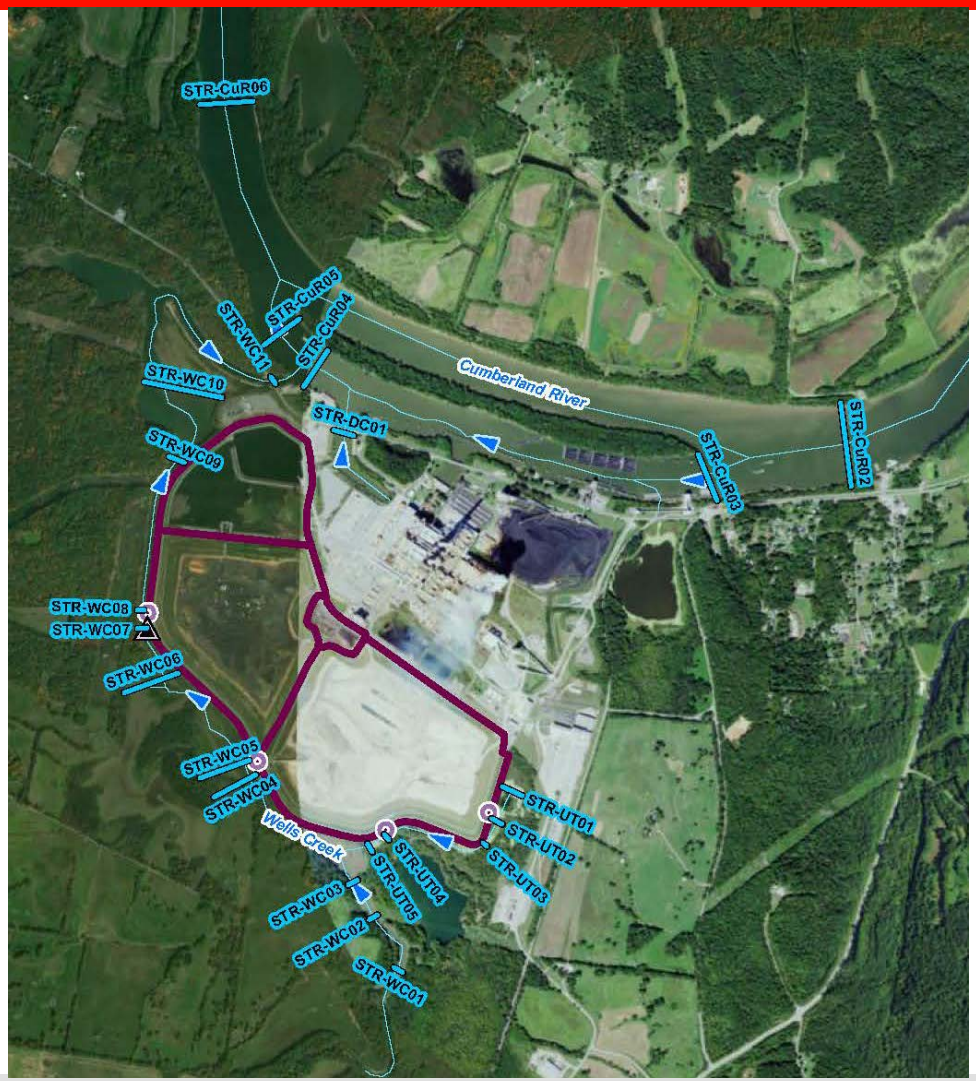
Seep SAP


Seepage Area 17
Seepage Area 14
Dry Ash Stack
Bottom Ash Pond
Seepage Area 16

Surface Stream SAP

- Objectives of the Surface Stream SAP are
  - characterize surface stream water quality on or adjacent to the site for CCR parameters
  - identify information that may explain the potential transport of CCR constituents into those surface streams
  - delineate potential impacts to surface water on or adjacent to the site

Surface Stream SAP

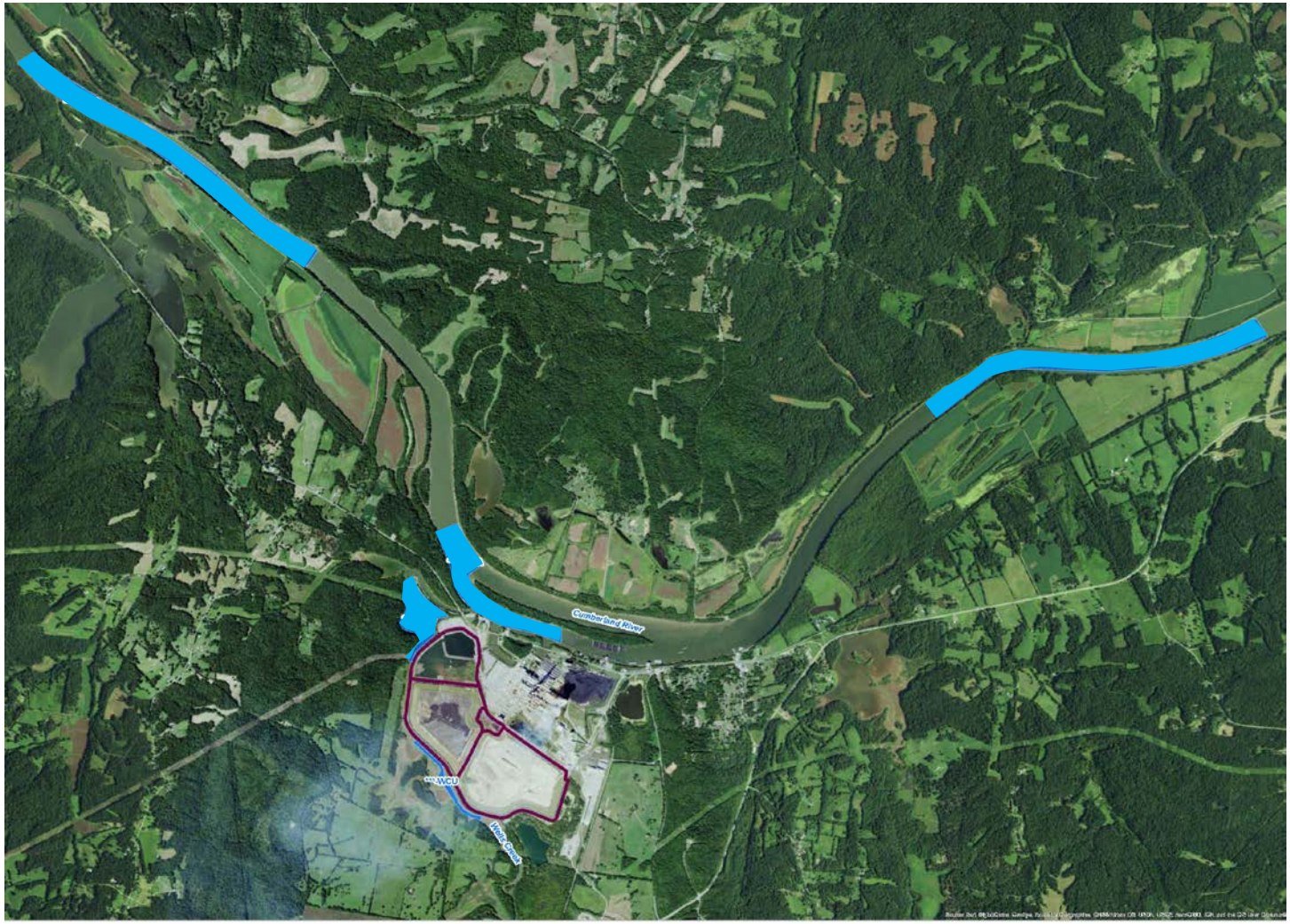


Fish Tissue SAP

Objective: assess whether fish in the immediate vicinity and downstream of the facility have higher tissue concentrations of CCR parameters than the same species of fish from reference locations not adjacent to or downstream of the facility

- Samples will be analyzed for CCR parameters (excluding TDS, chloride, fluoride, pH, sulfate, radium) and Strontium
- Species collected will include five specific trophic levels:
  - Top Carnivores – largemouth bass (*Micropterus salmoides*)
  - Invertivores – bluegill (*Lepomis macrochirus*)
  - Bottom Feeding Invertivore – redear sunfish (*Lepomis microlophus*)
  - Bottom Feeding Omnivore – channel catfish (*Ictalurus punctatus*)
  - Planktivore (Forage Fish) –shad (*Dorosoma spp.*)

Fish Tissue SAP



Stability SAP

Objective: to outline the methods that will be used to develop slope stability models (including material parameters) and perform slope stability analyses for selected CCR units

- The selected locations represent critical cross sections based on reviews of previous stability analysis results, subsurface stratigraphy, material properties, and structure geometry
- For selection of analysis section(s) for post-earthquake stability, the location of potentially liquefiable materials is also considered

Stability SAP

ses	Seismic Cases		
ng-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
Typ.[4]	X[5]	Typ.	X[5]

TVA Commissioner's Order Sites

- TVA Cumberland Fossil Plant (CUF)
  - Active facility and will continue to be
  - Completed and accepted Final EIP Revision 3 w/ response to public comments
  - Currently collecting investigation data
- TVA Johnsonville Fossil Plant (JOF)
  - Closed facility
  - Currently in public comment period for EIP Revision 3
- TVA Kingston Fossil Plant (KIF)
  - Active facility and will continue to be active
  - Public comment ends September 28th

TVA Commissioner's Order Sites

- TVA Bull Run Fossil Plant (BRF)
  - Active facility and will continue to be active
  - Currently in public comment for EIP Revision 3
- TVA John Sevier Plant (JSF)
  - Closed facility
  - TVA currently responding to public comments, EIP Revision 4 due October 8th
- TVA Watts Bar Plant (WBF)
  - Closed facility
  - Currently in public comment for EIP Revision 2

TVA Commissioner's Order Sites

- TVA Allen Fossil Plant (ALF)
  - Facility shut down first week of April 2018
  - Public comment for EIP Revision 2 opens October 8th
  - Portions of the Groundwater Investigation have been accelerated under TDEC Division of Remediation (DOR) due to arsenic, lead, and fluoride concentrations above US Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs) and TVA's initial plan to utilize the Memphis Sands Aquifer as a cooling water source for the new combined cycle plant
  - TVA is no longer planning on using the MSA wells as a cooling water source

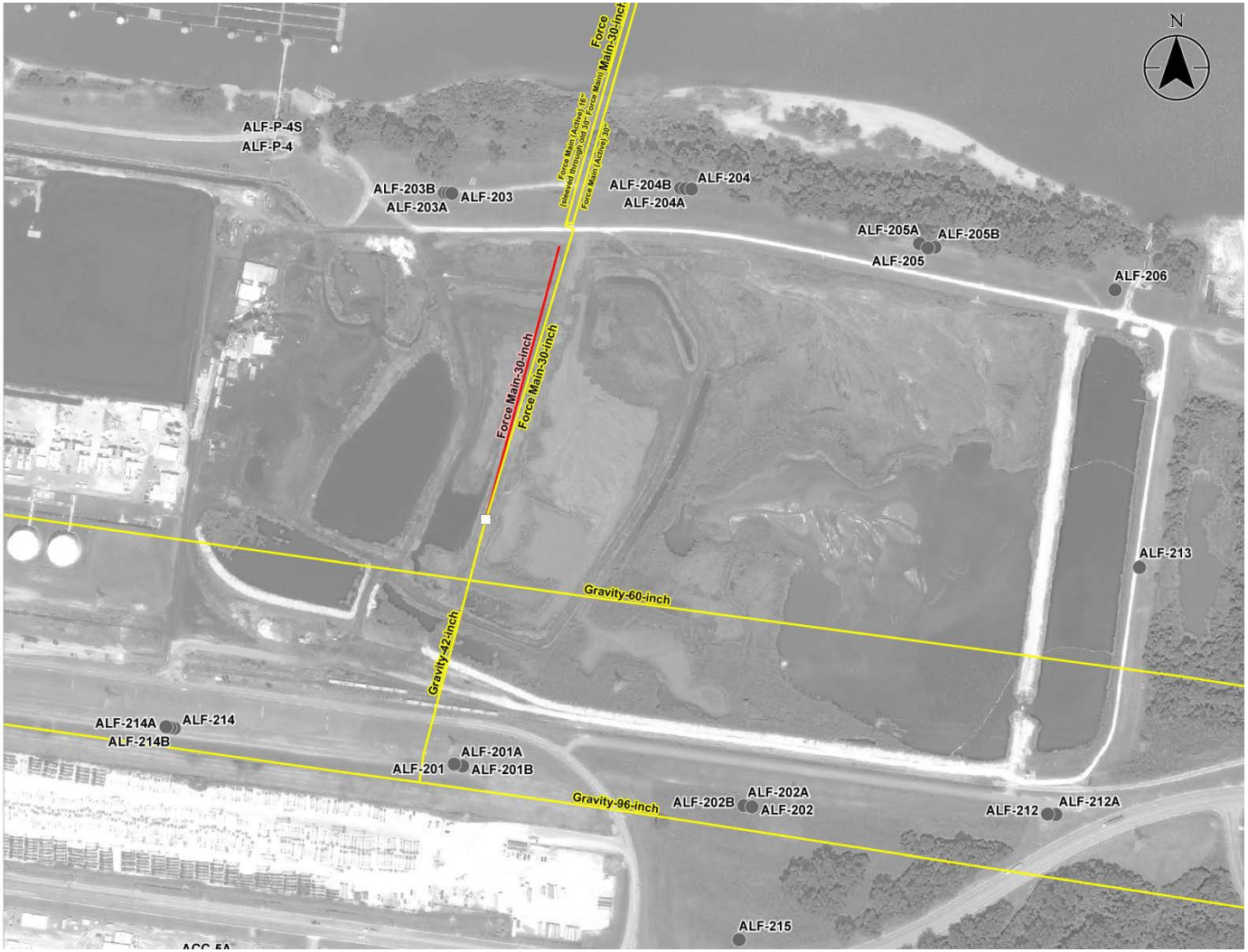
ALF Remedial Investigation (RI)

- Objectives of the RI:
  - Source area identification and delineation
  - Complete horizontal and vertical delineation of the groundwater contaminant plume(s) for CCR constituents in the Alluvial aquifer
  - Characterization of the Alluvial aquifer
  - Completion of a three-dimensional model for the site to evaluate groundwater flow and transport of CCR constituents in the Alluvial aquifer

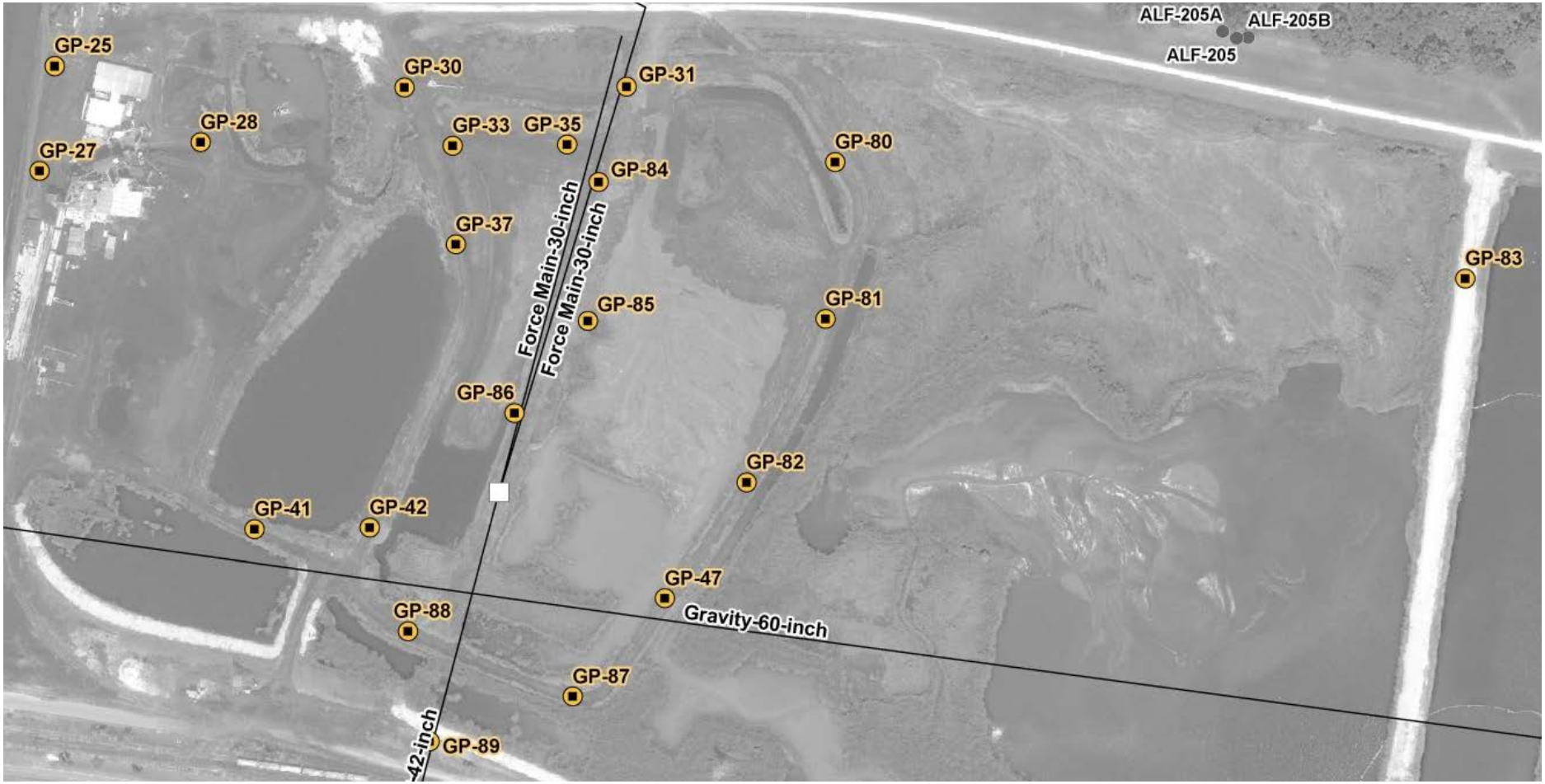
ALF Remedial Investigation (RI)

- Source area evaluation included the review of sewer systems and industrial facilities in the vicinity of ALF, and collection of ash pore water and ash samples from the East Ash Disposal Area

ALF Remedial Investigation (RI)



ALF Remedial Investigation (RI)



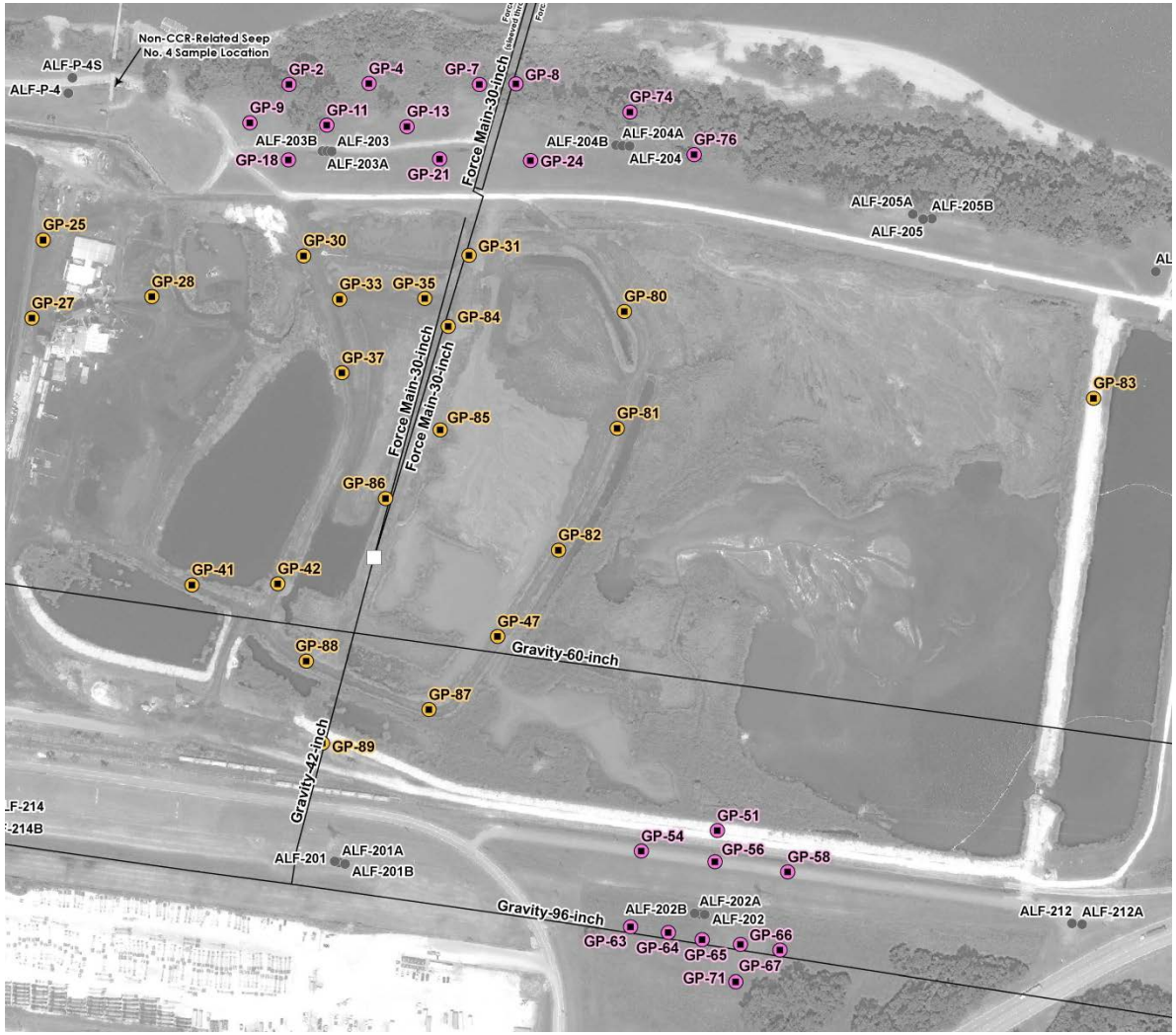
ALF Remedial Investigation (RI)

- Ash pore water exhibits high pH (average of approximately 10 SUs) and low oxidation-reduction potential (average of approximately -130 mV)
- Concentrations of arsenic in the ash pore water (unfiltered) ranged from 1.4 to 13,700 micrograms per liter (ug/L), with an average of 1,350 ug/L
- Concentrations of arsenic in ash ranged from 1.4 to 424 milligrams per kilogram with an average of 85 mg/kg

ALF Remedial Investigation (RI)

- To complete the horizontal and vertical delineation of arsenic in the Alluvial aquifer near wells ALF-203 and 202, TVA drilled 22 DPT borings and collected 60 groundwater samples from various depths

ALF Remedial Investigation (RI)



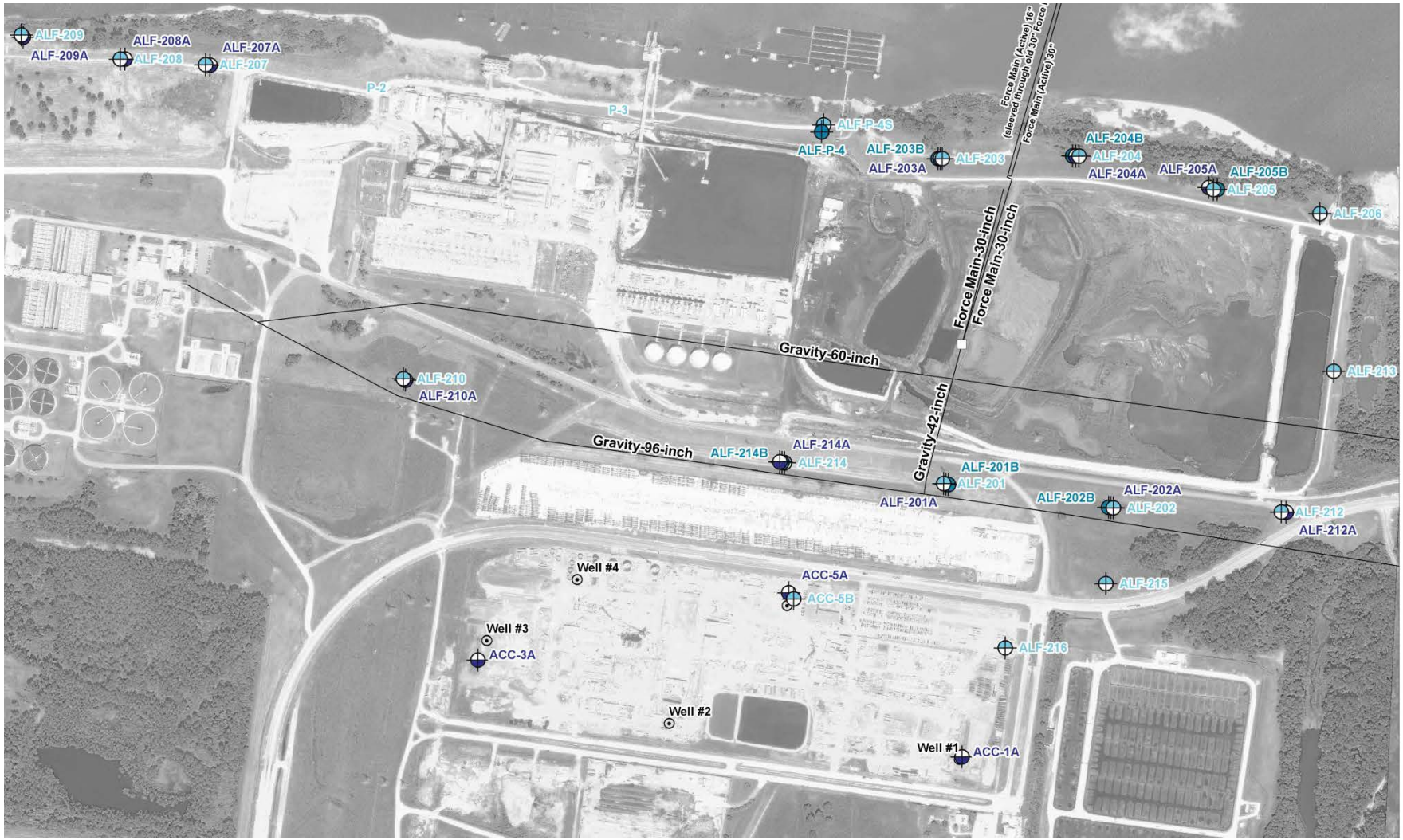
ALF Remedial Investigation (RI)

- The highest concentrations of arsenic were still found north and south of the pond, at wells ALF-203 and 202
- Fluoride and lead were found at concentrations above their MCLs in smaller areas within the boundaries of the arsenic areas
- No additional constituents were found above MCLs
- The highest concentrations of arsenic, fluoride and lead were found within the upper 40 feet of the Alluvial Aquifer, which is about 20 to 60 feet below ground surface

ALF Remedial Investigation (RI)

- TVA installed 22 new shallow, intermediate and deep monitoring wells, increasing the well network to a total of 32 wells
- Groundwater samples were collected from the wells 3 times, and 96 samples were analyzed

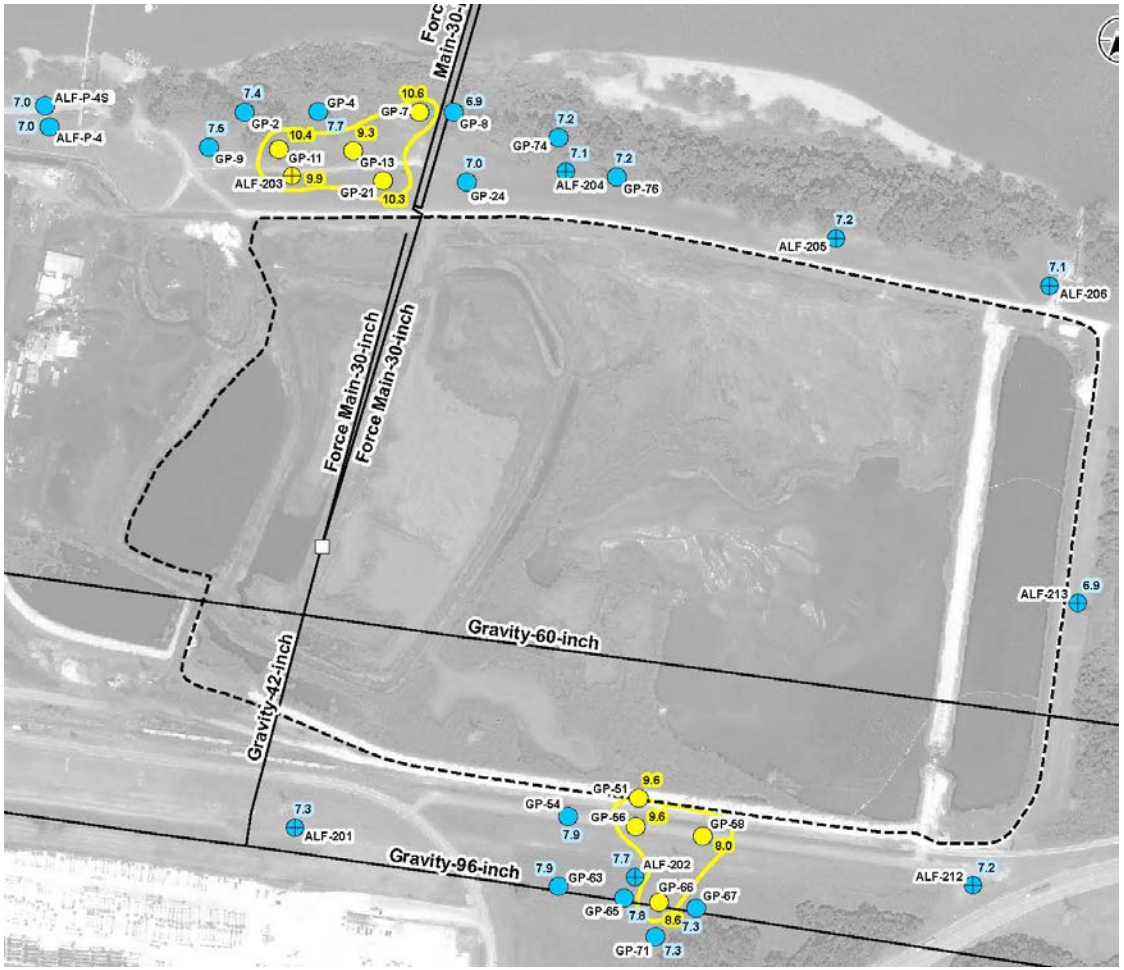
ALF Remedial Investigation (RI)



ALF Remedial Investigation (RI)

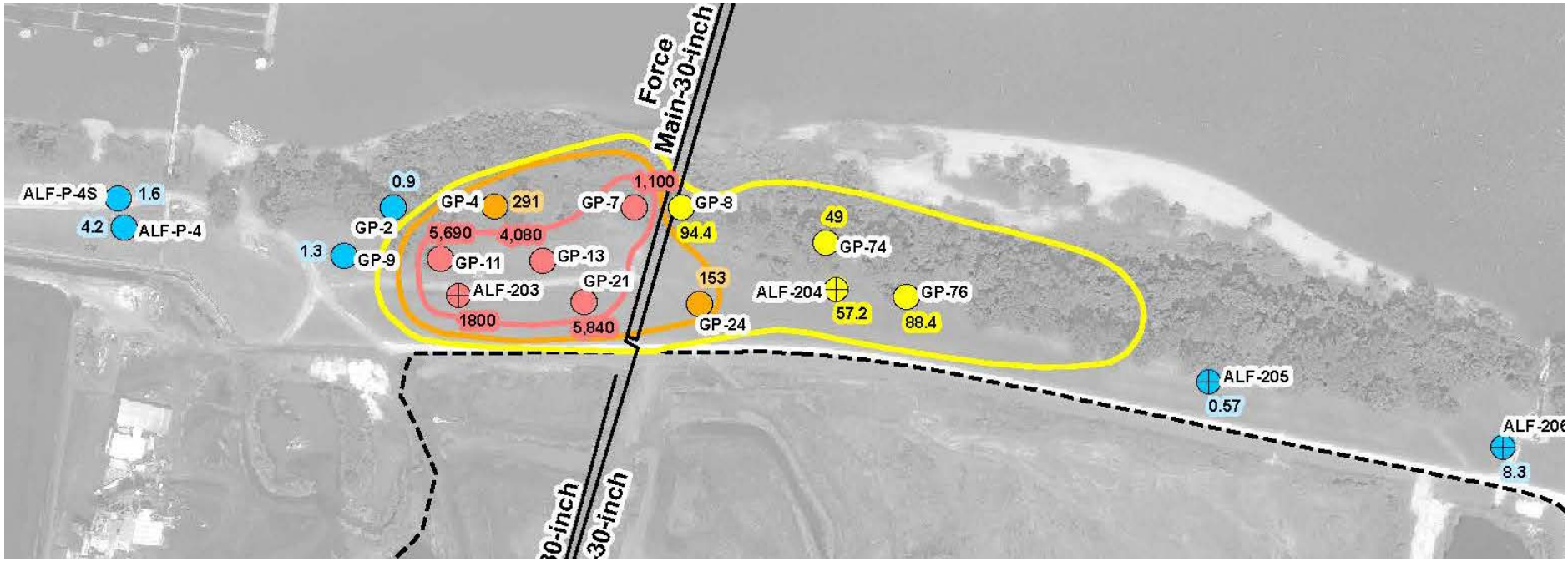
- Arsenic, fluoride, and lead were found predominantly in the shallow wells (less than 55 feet deep) north and south of the East Ash Disposal Area at ALF-203 and ALF-202
- Arsenic was detected in one intermediate well (ALF-203B, 89 feet bgs), but no constituents were found in deep wells (110 to 165 feet bgs) in the Alluvial aquifer

ALF Remedial Investigation (RI)



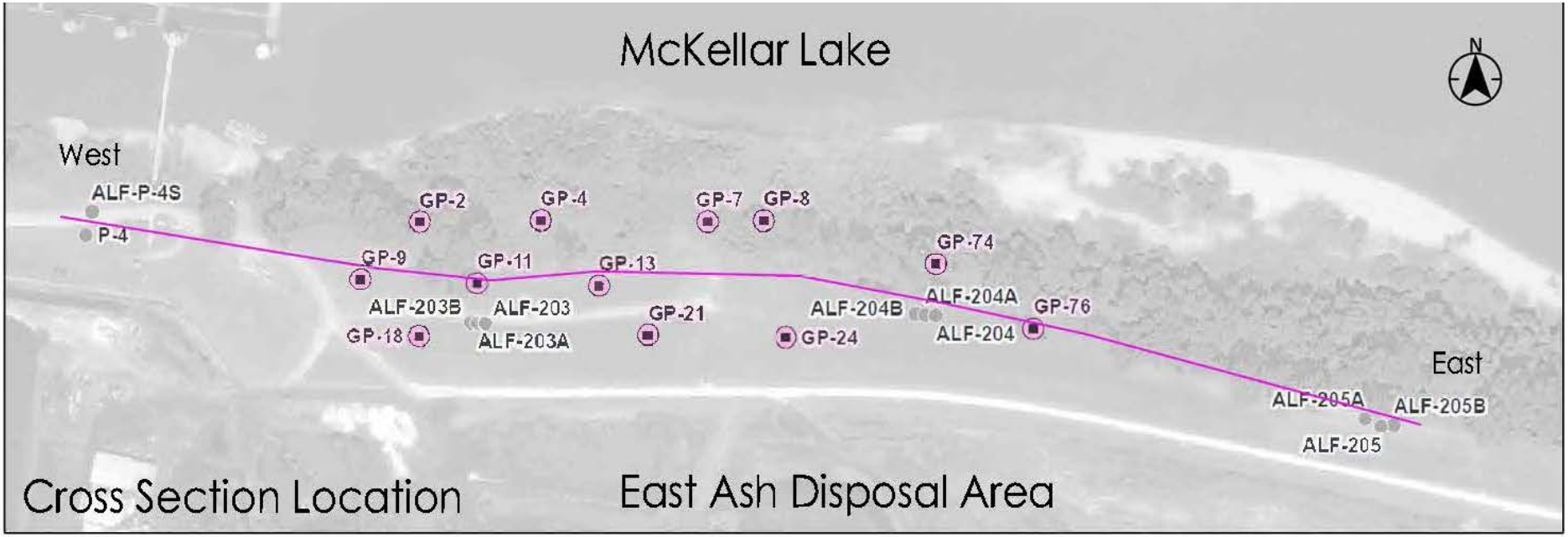
- pH contours in Alluvial Aquifer

ALF Remedial Investigation (RI)

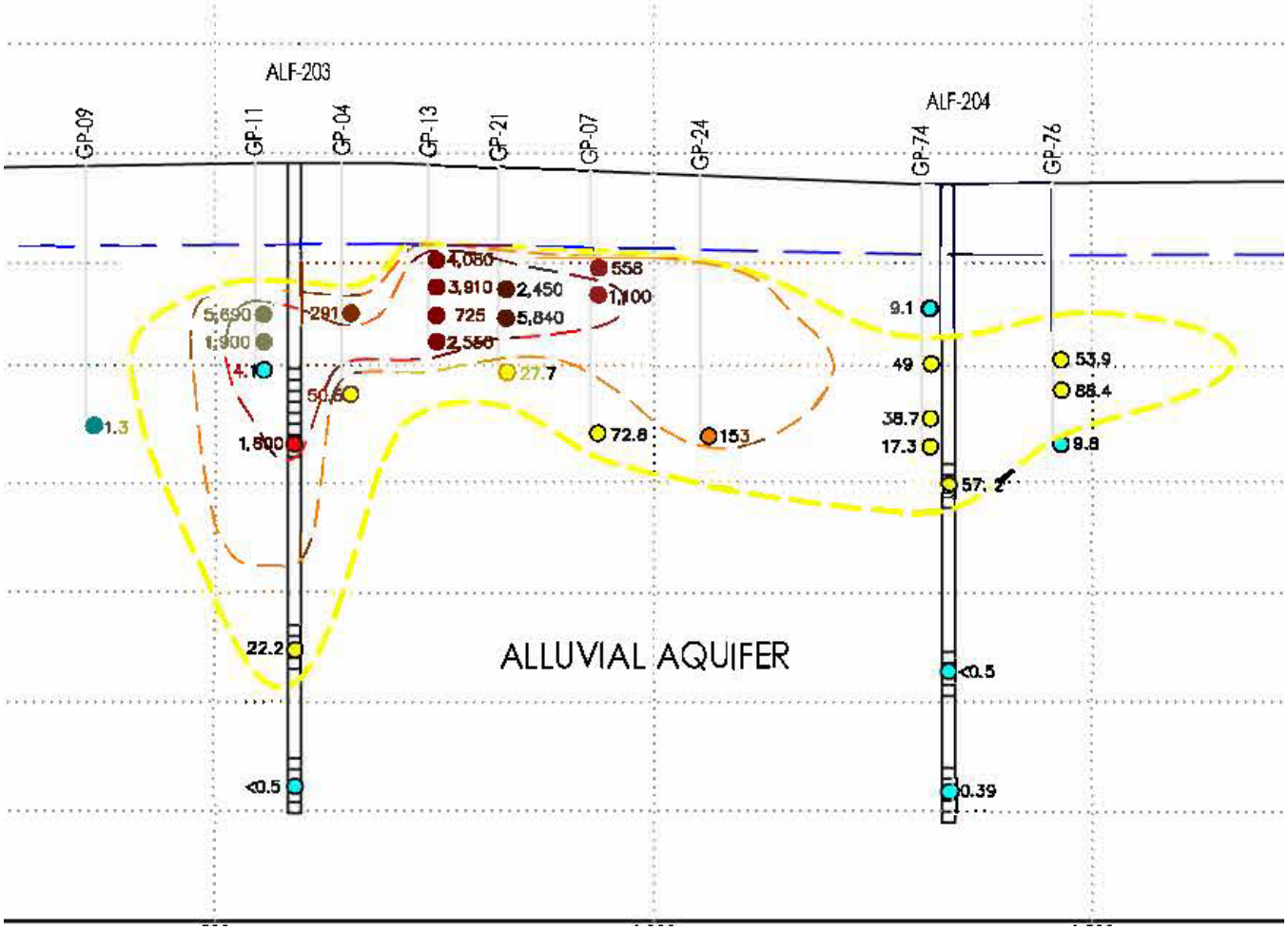


- Alluvial Aquifer arsenic concentrations

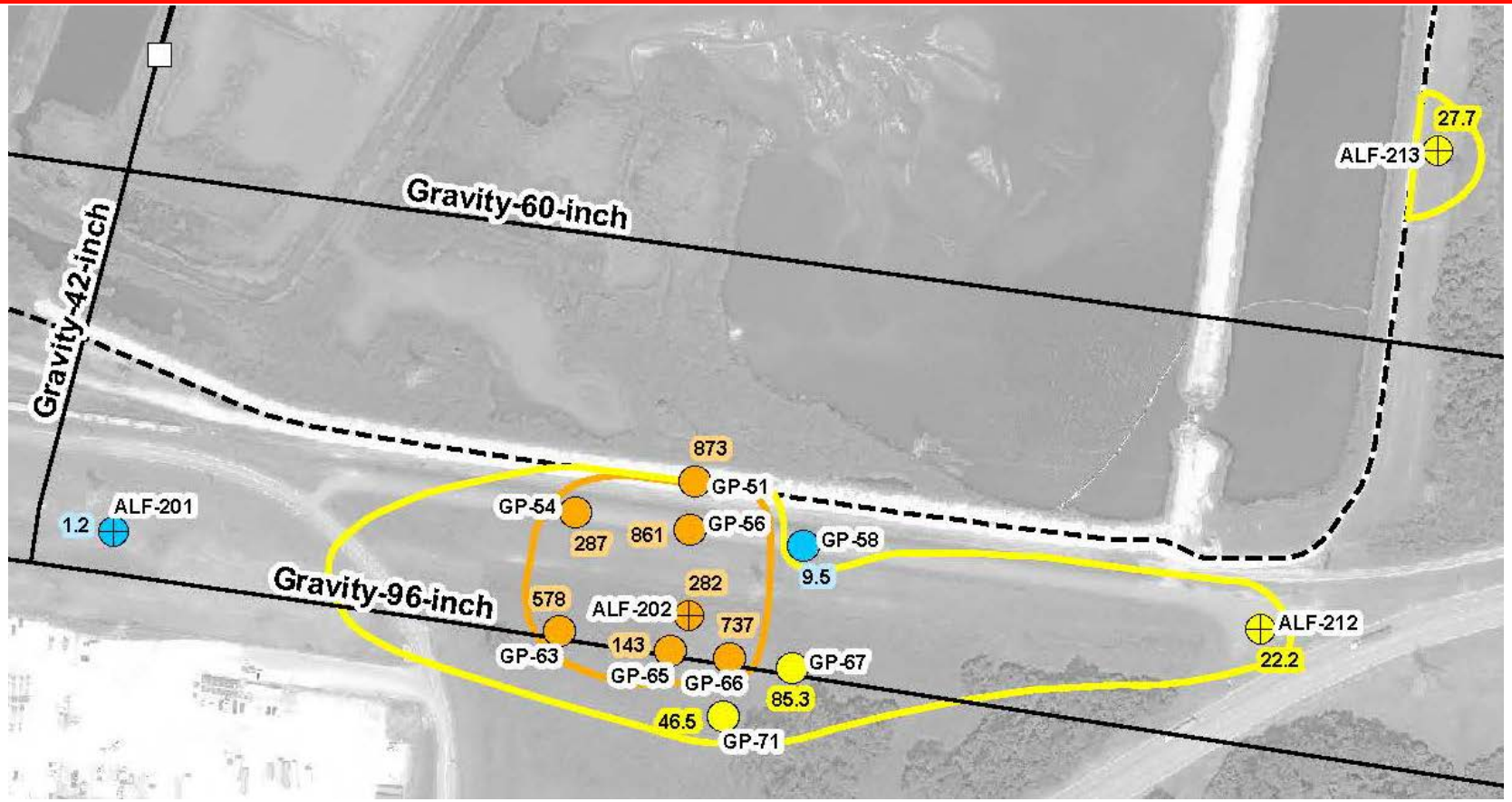
ALF Remedial Investigation (RI)



ALF Remedial Investigation (RI)

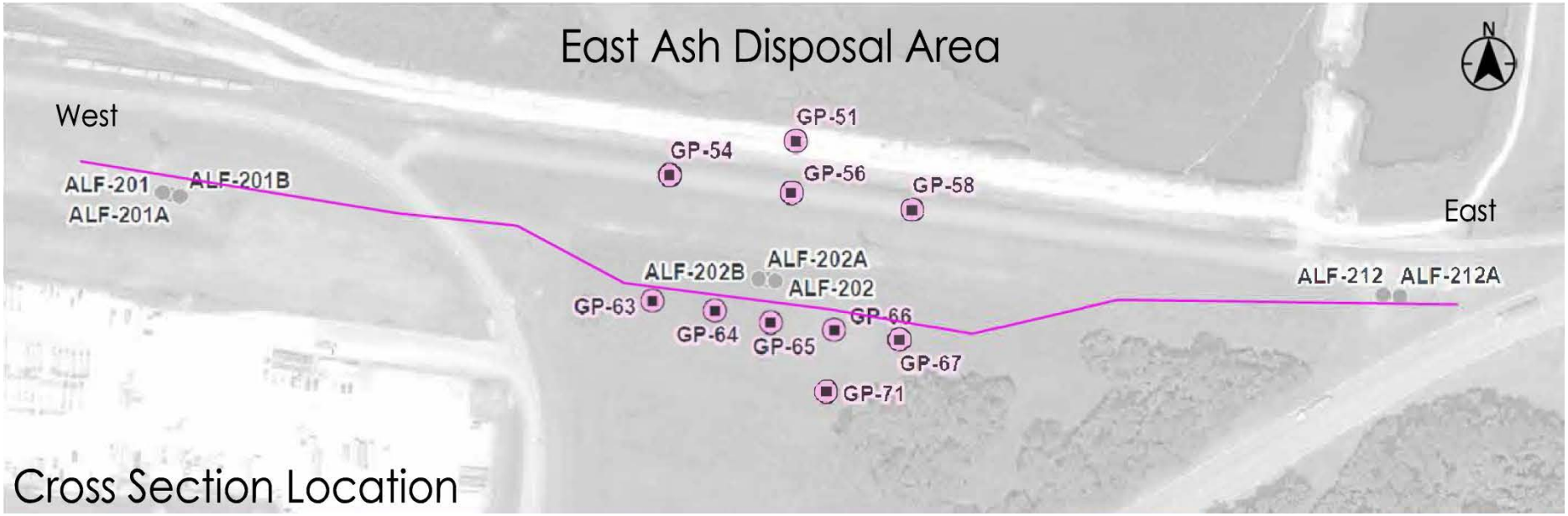


ALF Remedial Investigation (RI)

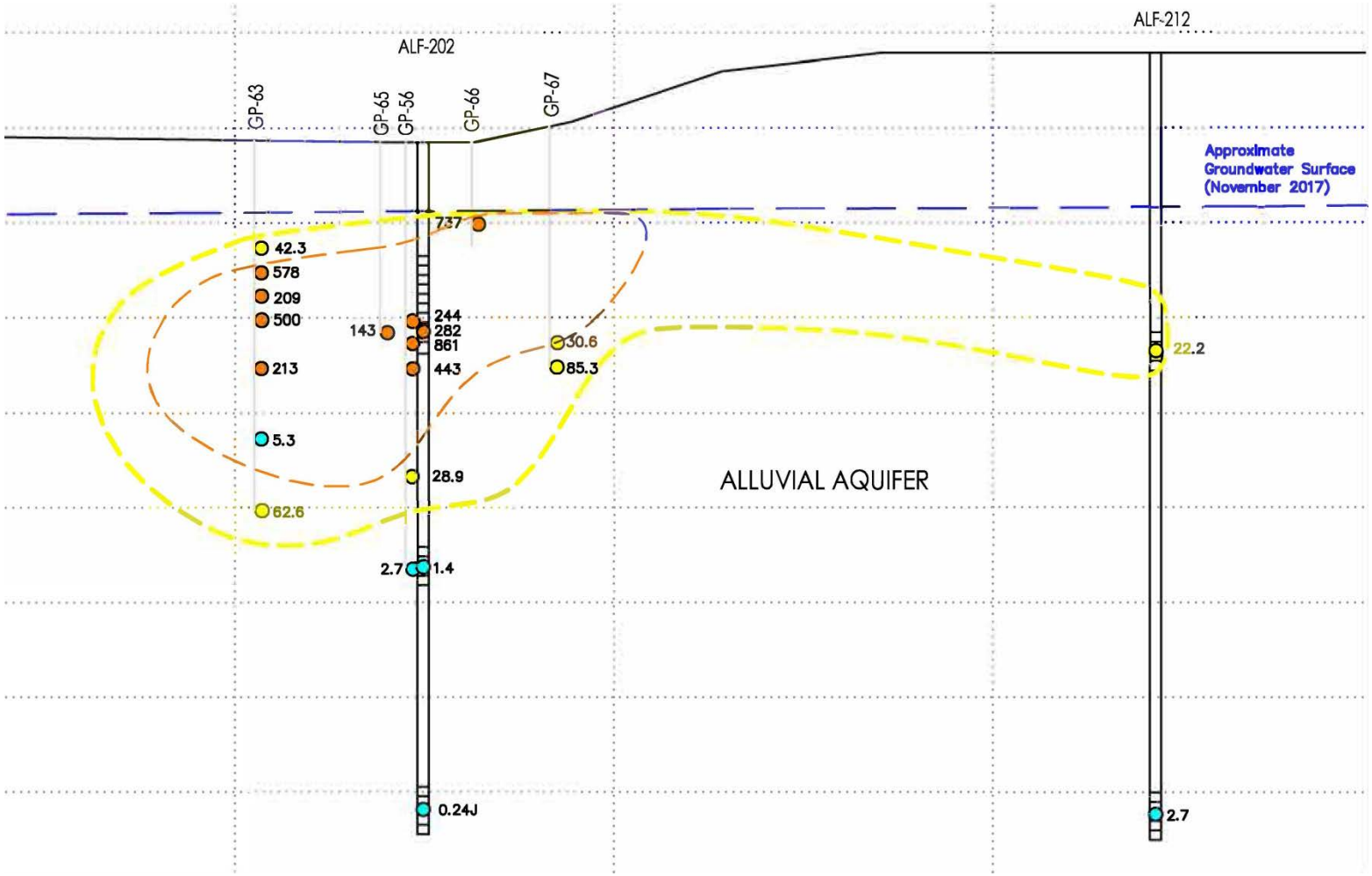


- Arsenic concentrations in GW

ALF Remedial Investigation (RI)



ALF Remedial Investigation (RI)



ALF Remedial Investigation (RI)

- In general, groundwater in the region flows from south to north, towards McKellar Lake
- However, McKellar Lake can rise and fall by almost 30 feet, and this can affect the groundwater flow direction in the shallow portion of the Alluvial aquifer

ALF Remedial Investigation (RI)

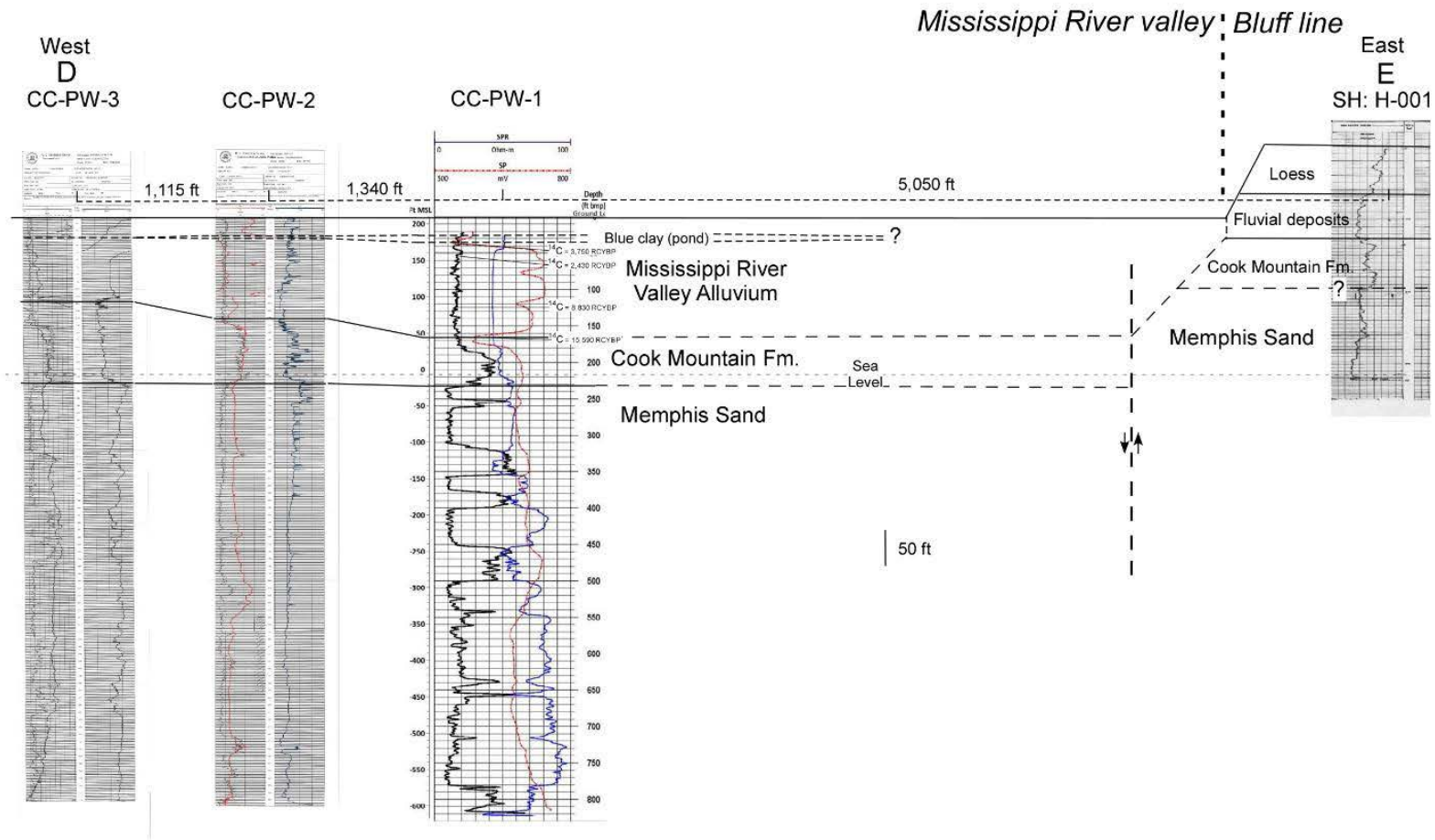
- TVA drilled four deep soil borings into the upper Claiborne confining unit collected groundwater samples from the Memphis aquifer
- USGS-CAESAR to perform a pumping test using the production wells
- TVA found that the upper Claiborne is a low-hydraulic conductivity clayey unit, up to 69 feet thick
- A stratigraphic offset was identified in this unit near the southeast corner of the East Ash Disposal Area

ALF Remedial Investigation (RI)

- USGS-CAESER inferred that an approximate North 70 degrees East (N70E) trending fault has off-set the sedimentary sequence comprising the Alluvial aquifer, upper Claiborne confining unit, and upper part of the Memphis aquifer in this area by varying amounts
- Erosion of part of the upper Claiborne confining unit, combined with potential faulting, illustrates the complex relationship of hydrogeologic units in this area

ALF Remedial Investigation (RI)

ALF Remedial Investigation (RI)



ALF Remedial Investigation (RI)

- Groundwater samples from the production wells in the Memphis aquifer were collected three times by TVA and once by USGS
- No constituents were detected above USEPA drinking water standards (MCLs)
- USGS-CAESER conducted a pumping test of the Memphis aquifer production wells at TVA's Allen Combined Cycle (ACC) Plant
- Prior to the pumping test, Tritium (a radioactive isotope unrelated to Allen) was detected in the production well samples collected by USGS
- This indicates "modern" or "young" groundwater in the region had previously entered the Memphis aquifer

ALF Remedial Investigation (RI)

- Results of the pumping test indicated that pumping the production wells produced discernible drawdown in the Alluvial aquifer
- This indicates that a hydraulic connection exists locally between the Memphis aquifer and the Alluvial aquifer
- The largest drawdown in the Alluvial aquifer was observed in the southeastern part of the ALF property and along the eastern side of the ACC Plant property

ALF Remedial Investigation (RI)

- TDEC is currently reviewing proposed Interim Remedial Measures to capture and remove impacted groundwater at the ALF
- TDEC is currently reviewing a Supplemental RIWP to address identified data gaps, specifically additional hydrogeologic and groundwater data along the eastern boundary of the East Ash Disposal area
- TVA is currently preparing a NEPA assessment for closure of the East Ash Disposal area with Closure by Removal as the preferred option

TN Department of Environment & Conservation

END

Questions and Comments ?