

# Preparing for Closure of the John Sevier Fossil Plant: Re-Routing of the Bottom Ash Pond Outfall Driven by NPDES Requirements

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## INTRODUCTION

The Tennessee Valley Authority (TVA) retired two coal-fired units and idled two units at the John Sevier Fossil Plant at the end of 2012. TVA and Stantec teamed to develop a closure strategy for the closure of coal combustion product (CCP) disposal facilities and ancillary structures, including the Bottom Ash Pond (BAP). In Tennessee, closure is defined as taking the actions at the termination of a disposal operation that are necessary to finally close the disposal facility. As with many regulatory agencies, the Tennessee Department of Environment and Conservation (TDEC) does not have specific regulations relative to closure of non-hazardous wastewater impoundments and has not developed formal closure and post-closure guidelines for impoundments.

TVA will manage closure of the BAP under the National Pollutant Discharge Elimination System (NPDES) permit regulatory framework. Given that nearly all plant waste streams ultimately flow through the BAP, this facility must be the last to close. In order to extend the length of the operation of the BAP during closure of other disposal facilities and to meet newly established NPDES discharge limits, specifically for arsenic and selenium, modifications to the treatment processes or discharge procedures were required. The goal of the project was to re-route and/or reconfigure the BAP discharge outfall to comply with newly established regulatory discharge limits until the pond is closed and the outfall removed from the NPDES permit. The result of the re-route provides for relocation of the outfalls' discharge point from Polly Branch, a low flow stream, to the Holston River, providing greater assimilative capacity.

## GENERAL PROJECT INFORMATION

The John Sevier Fossil Plant (JSF) is located in Rogersville, a community situated in the northeastern portion of Tennessee approximately 30 miles (48.3 kilometers) southwest of Kingsport, as shown in Figure 1. The plant has four coal-fired generating units and the following ash disposal facilities: Dry Fly Ash Stack (DFAS), Bottom Ash Pond and

Ash Disposal Area J (previously closed). Figure 2 shows the layout of the three facilities along with other ancillary structures.

TVA consulted with the TDEC to revise its NPDES discharge permit for the Bottom Ash Pond at JSF. TVA retained Stantec to design a re-route and/or reconfiguration of the discharge outfall to comply with newly established regulatory discharge limits. The purpose of the re-route was to relocate the outfalls' discharge point from Polly Branch to the Holston River.



Figure 1. Vicinity Map

## PLANT BACKGROUND

Construction of the JSF Plant began in 1952 and was completed in 1957. At one time, the plant's four coal-fired generating units consumed approximately 5,700 tons (5,200 metric tons) of coal per day and generated approximately 5 billion kilowatt-hours of electricity a year, enough to supply more than 350,000 homes. The winter net dependable generating capacity was 712 megawatts<sup>1</sup>.

Approximately 215,000 tons (195,000 metric tons) of dry fly ash was collected in silos each year and hauled to an onsite permitted dry stack disposal area (DFAS). Approximately 20,000 dry tons (18,000 metric tons) per year of bottom ash was wet-sludged to the BAP.

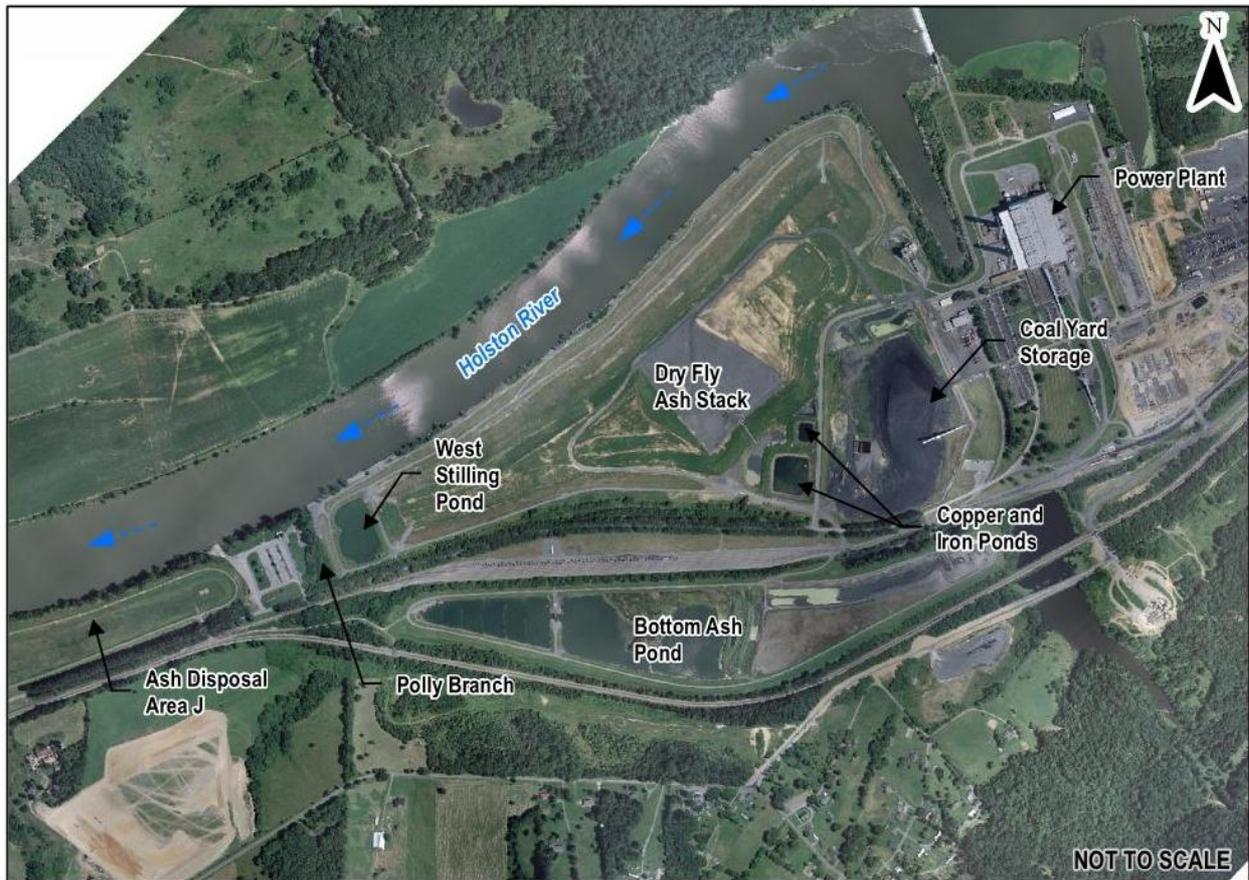


Figure 2. John Sevier Fossil Plant Overview Map

## BOTTOM ASH POND BACKGROUND

The Bottom Ash Pond came online in 1979 to receive all sluiced bottom ash and infrequent sluiced fly ash. A Stilling Pond exists in the west end of the facility, accessed through a rock weir in an internal divider dike. Water passes through the Stilling Pond and discharges through two concrete risers (weirs) before finally discharging at a permitted outfall into Polly Branch, a tributary of the Holston River.

Bottom ash was stacked in the southeastern portion of the facility starting in 1981. In 1987, sluicing stopped at the Bottom Ash Pond and the ash was dry hauled offsite for disposal. Ash was again sluiced to this area starting sometime between 1990 and 1993. In 1999, a bottom ash reclaiming facility was erected at the east end of the facility and operated by Appalachian Products for offsite marketing of bottom ash. The BAP received sluiced bottom ash, intermittent fly ash (sluiced to a separate trench for settlement), and discharges from the Coal Yard Runoff Pond, Chemical Treatment Pond – Iron, Chemical Treatment Pond – Copper, and miscellaneous plant stormwater and wastewater discharges. The BAP has reportedly been partially dredged several times since 1979 to restore its capacity to receive ash.

## EXISTING BOTTOM ASH POND CONDITIONS

This 42-acre (170,000-square meter) structure was formed by constructing an 8,600-foot (2,621-meter) long earthen dike, measuring approximately 20 feet (6.1 meters) in height and with a 16-foot (4.9-meter) wide crest. For the purposes of planning closure and restoration, the BAP may be considered to include three sub-areas located from east to west (Figure 3):

- Sub-Area 1: Dredge Cell. This sub-area contains principally bottom ash that settled during initial hydraulic deposition in the BAP as well as lesser amounts of finer grained ash dredged periodically from other sub-areas of the BAP and consolidated in this sub-area.
- Sub-Area 2: Intermediate Pond. This sub-area contains finer grained ash that settled more slowly during hydraulic deposition.
- Sub-Area 3: Stilling Pond. This sub-area is used for gravity polishing of water prior to release from the BAP through Outfall 001.

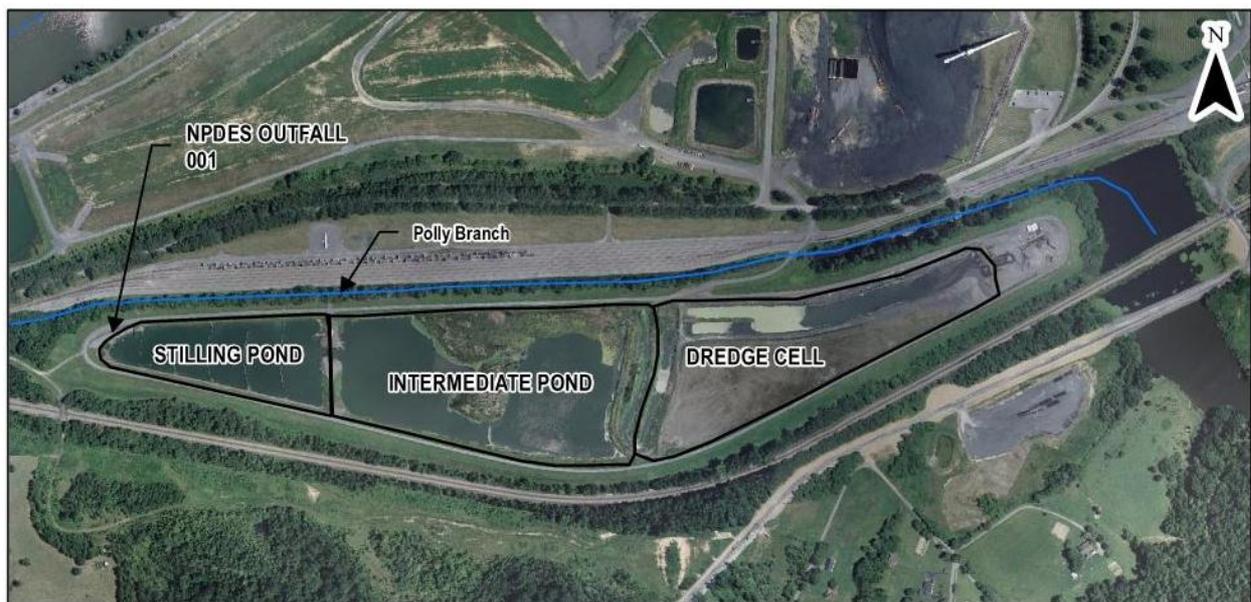


Figure 3. Bottom Ash Pond Sub-Areas

Previously, the BAP discharged through Outfall 001 directly to Polly Branch (a tributary of the Holston River) via a concrete pipe spillway system. The spillway system consisted of two 48-inch (1.2-meter) concrete risers approximately 13-feet (4.0-meter) in height with removable corrugated metal skimmers. The risers were connected to 36-inch (0.9-centimeter) concrete pipe barrels that outlet through the embankment to Polly Branch. From the discharge point, Polly Branch flows open-channel generally west for a short distance, then turns northward through two culverts beneath the adjacent

railroad and roadway embankment, before emerging into another open channel that discharges to the Holston River. In total, the stream traversed a distance of approximately 1,600-feet (488-meter) downstream of the outfall to the river.

## REGULATORY FRAMEWORK FOR DESIGN

TVA plans to manage future closure of the BAP under the NPDES regulatory framework. Given that nearly all plant waste streams ultimately flow through the BAP, this facility must be the last to close. In order to extend the length of the operation of the BAP during closure of other disposal facilities and to meet newly established NPDES discharge limits, specifically for arsenic and selenium, modifications to the treatment processes or discharge procedures were required. The goal of the project was to re-route and/or reconfigure the BAP discharge outfall to comply with newly established regulatory discharge limits until the pond is closed and the outfall removed from the NPDES permit.

Until July 31, 2013, the current permit only requires reporting of quarterly monitoring for arsenic and selenium at Outfall 001. After July 31, 2013, the permit requires that arsenic and selenium levels not exceed the criteria outlined in the permit at this outfall. Since Outfall 001 discharges directly to Polly Branch which has a seven-day, consecutive low flow with a 10-year return frequency (7Q10) of 0 million gallons per day (MGD) (0 m<sup>3</sup>/s), the effluent from Outfall 001 is required to meet the instream water quality criteria at the discharge point. Based on historic sampling data, arsenic and selenium levels have been higher than these criteria at the outfall. Therefore, TVA would not be able to meet the proposed discharge limits of these constituents without modifying the treatment processes or discharge procedures.

TVA consulted with TDEC to find a solution for compliance with these limits. Efforts have been made to identify the source of the arsenic and selenium to isolate and treat them or remove them. Use of existing ditches and new wastewater treatment processes were discussed. Due to time constraints and the need to continue discharging various flow sources into the pond, it was decided that closing the BAP was not feasible. Initial discussions with TDEC established that re-routing the outfall directly to the Holston River, to gain greater assimilative capacity, would be an acceptable option. A compliance schedule was developed around a project completion date of July 2013. In order to meet the TDEC commitment, a conceptual design of the selected solution was submitted to TDEC by February 17, 2012; design, approval, permitting, and vendor selection was completed by July 31, 2012; and construction completed and operational by July 31, 2013. TVA elected to complete construction by the end of 2012.

## PROJECT GOAL

The goal of this project was to identify and implement a solution to achieve acceptable discharge limits for arsenic and selenium from the BAP discharge without disrupting the use of the pond. Changing the receiving stream (by re-routing the outfall location) and revising the existing NPDES permit to reflect the new outfall allowed the BAP to meet the current NPDES discharge limits and continue operating while the CCP closure

strategy is implemented. This solution involved extending the existing spillway system so the discharge point is located at the Holston River. Ultimately, TVA determined that re-routing the discharge through new outfall pipe(s) would be the most flexible option given the scheduling unknowns on plant process water and BAP closure. Stantec developed multiple alternatives (alignments) based on the main solution (re-route the discharge) to meet the project goal.

## ALTERNATIVE EVALUATION CRITERIA

Alignments were evaluated relative to one another according to a specific set of criteria. The results of the evaluation were used to recommend an alignment to TVA. The evaluation criteria used in this analysis were:

- Cost – A probable opinion of construction cost was prepared for each alignment based on each alignment's unique layout and constraints.
- Ability to handle design storms – The new pipeline must pass a 10-year, 24-hour rainfall event with no overflows, and a probable maximum precipitation (PMP) rainfall event without overtopping the BAP dikes.
- Proposed outfall elevation – Backwater from the Holston River could influence the flow from the proposed outfall pipeline if it is above the outfall invert elevation. It is preferred to maintain the proposed outfall invert elevation above the 100-year water surface elevation.
- Impact on dike stability – Working on and excavating into dike slopes has potential to temporarily impact dike stability. Minimal or no impact is desired.
- Conflicts with existing utilities or infrastructure – Each proposed alignment crossed multiple utilities or infrastructure that created conflicts or increased the difficulty of construction.
- Difficulty of construction – The space available for excavation equipment and the steepness of grade where a pipe trench is proposed to be cut were considered for each alignment. Non-typical installation methods were also considered (i.e. creek crossing, jack and bore).
- Amount of site clearing required – The amount of trees and brush needed to be cleared for each alignment was considered.
- Conformance to traditional storm sewer design – Significant topographic changes and other unique site constraints required some alignments to vary from traditional storm sewer design considerations. Minimum and maximum slopes and the need for drop manholes were considered for each pipe alignment.
- Disturbance to land used by public – Disturbing land used by the public was undesirable and was considered in this evaluation.

## HYDROLOGIC AND HYDRAULIC CONSIDERATIONS

The new pipeline needed to be designed to pass the existing plant process flows plus the stormwater runoff from a selected rainfall event. There is potential that some or all of the source flows will be discontinued. However, the timeline for discontinuing the flows had not been finalized at the time of the design. Therefore, it was assumed that all process flows would continue into the BAP after construction of the new pipeline is complete.

Plant process flows were obtained from a TVA wastewater flow schematic. According to this document, the maximum flow through Outfall 001 will be 12.1 cubic feet per second (cfs) (0.342 m<sup>3</sup>/s). This outflow consists of approximately 7.08 cfs (0.200 m<sup>3</sup>/s) from fly ash and bottom ash sluice water, 3.61 cfs (0.102 m<sup>3</sup>/s) from the station sumps, and 1.56 cfs (0.044 m<sup>3</sup>/s) from other miscellaneous sources, while approximately 0.15 cfs (0.004 m<sup>3</sup>/s) is lost through evaporation. Therefore, 12.1 cfs (0.342 m<sup>3</sup>/s) is the process flow used in the hydrologic and hydraulic analyses.

The alignments were modeled using hydrologic (HEC-HMS, v3.4) and hydraulic (XPSWMM) modeling software. There were two hydraulic considerations for the new outfall pipeline.

- Flow through the new pipe in conjunction with the available storage in the Bottom Ash Pond must be able to store or pass a 6-hour PMP rainfall event.
- The new pipe must be able to pass the flow from a 10-year, 24-hour rainfall event with no overflows.

Per Section 1.8 of TVA CCP Management Programs, Master Programmatic Document, spillway capacity for wet ash disposal impoundments must be sufficient to safely pass the inflow from a PMP rainfall event without overtopping the dikes. The new pipeline has been designed to pass some of the flow from the PMP and allow a portion to be stored in the BAP. However, some of the flow will be lost from the new pipeline through overflows at manholes. This was deemed acceptable as long as there are no overflows during the 10-year, 24-hour event. During the PMP event, the BAP maintains approximately six feet of freeboard.

According to the NPDES permit, the minimum design storm the new pipeline needs to be able to pass without an overflow is a 10-year, 24-hour event. All alignments pass at least the 100-year, 24-hour rainfall event with no overflows, thereby surpassing the NPDES requirement.

## GEOTECHNICAL CONSIDERATIONS

Stantec performed a geotechnical exploration in the areas of the proposed alignments. Results of the exploration indicated the top of bedrock to be mostly below target flow-lines or invert elevations, thus would not impact construction of any of the proposed alignments. Auger refusal occurred at three borings approximately one to two feet (0.3 to 0.6 meters) above the proposed pipe or manhole invert elevations. The majority of

the upper layer of bedrock in this area is weathered shale which is typically easily excavated. Excavation into bedrock was not anticipated to increase the construction costs by a substantial amount. Therefore, it was not a deciding factor into which alignment was selected.

#### ALTERNATE SOLUTIONS CONSIDERED

Four alternatives (alignments) were considered to re-route the existing BAP outfalls to the Holston River. All the alignments have the following features:

- It was estimated that each alignment will consist of 36-inch (0.9-meter) diameter high density polyethylene (HDPE) pipe with a dimension ratio (DR) of 32.5.
- The two existing 36-inch (0.9-meter) reinforced concrete pipes (RCP) from the BAP Stilling Pond will discharge into a single proposed junction structure which will be approximately 18 feet (5.5 meters) long by 6 feet (1.8 meters) wide by 6 feet (1.8 meters) tall.

#### IMPLEMENTED DESIGN SOLUTION

The constructed alignment is approximately 1,400 feet (427.8 meters) in length, as shown in Figure 4. From the existing BAP outfall location, it exits through the west wall of the proposed junction structure towards a hillside covered with brush and trees. The alignment veers towards the south and passes through a gently sloping ridge. The alignment follows an existing unimproved road and crosses over two parallel 60-inch (152.4 cm) corrugated metal pipes (CMP). Shortly after passing over the two CMPs, the alignment makes an approximate 90 degree bend, crosses perpendicular to a swale (which drains to Polly Branch), and then crosses under the railroad tracks, and TVA Road. The pipe was advanced underneath the railroad and TVA Road by bore and jacking. On the north side of TVA Road, the alignment crosses under an existing underground electric line, an existing 18-inch (45.7 cm) CMP culvert and a 15-inch (38.1-cm) reinforced concrete pipe (RCP) storm sewer. The alignment continues to the Holston River and discharges through a headwall at elevation 1,078.3 feet (328.7 meters) mean sea level (MSL).

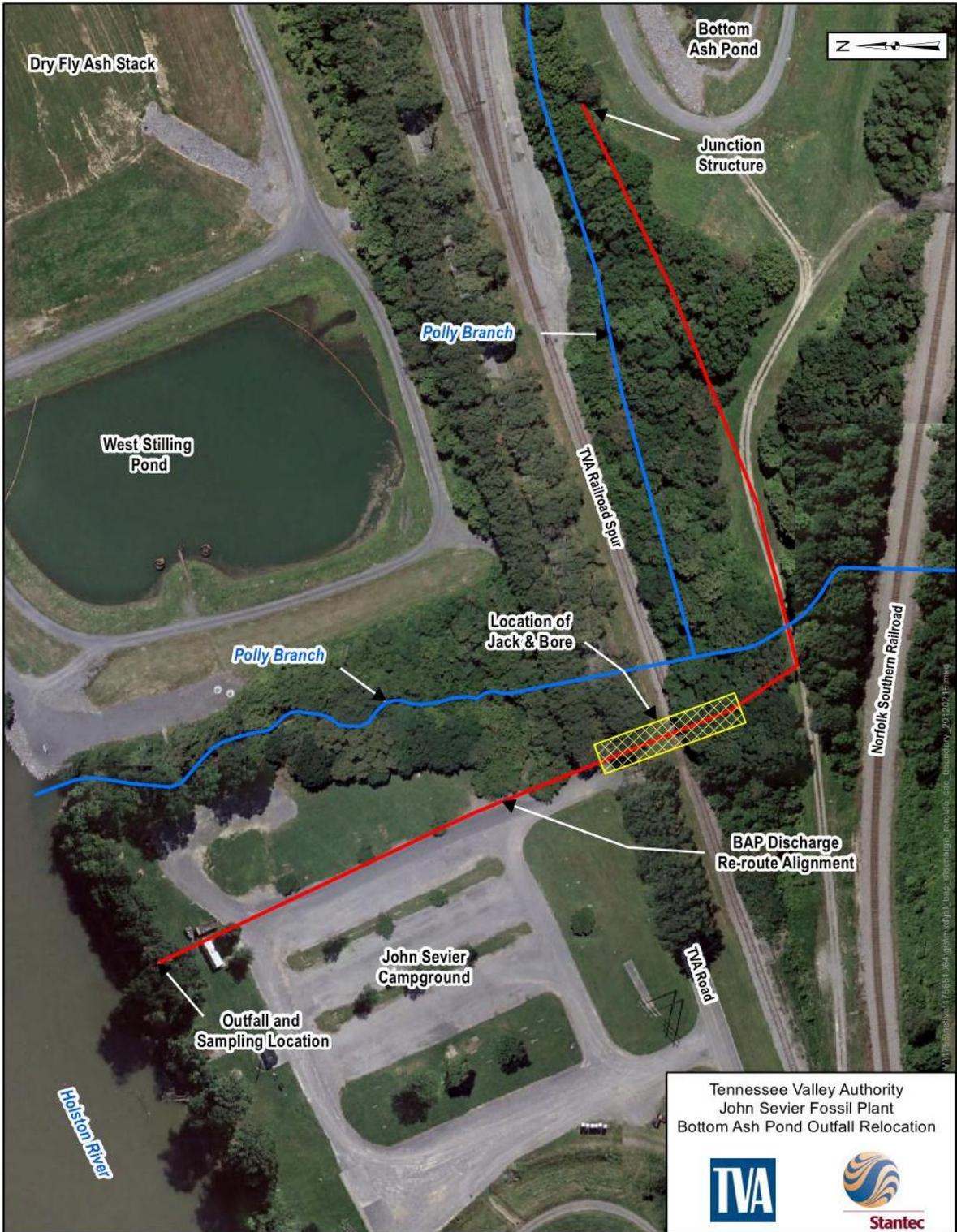


Figure 4. Selected BAP Discharge Re-Route Alignment

The recommended design solution was developed around certain assumptions, limitations, and identified risks. The following unverified assumptions, limitations, and risks are recognized for the project:

## RISKS

The following items were considered potentially critical to the success of the project. If these items were not addressed appropriately, the project goals and objectives would not be accomplished.

- Not meeting TDEC commitments and/or exceeding allowable discharge limits could result in fines, penalties, or other regulatory enforcement action from TDEC and/or the EPA.
- TVA may not be able to renew the NPDES permit prior to the next cycle resulting in further enforcement activities.
- The proposed pipe extension must pass through a railroad and roadway embankment in order to discharge to the Holston River. This will require horizontal boring and pipe jacking to install the discharge system. Obstacles could be encountered within or near the embankment that would prevent pipes from being installed in this manner.
- Environmental permits to construct the improvements could be difficult to obtain and may require additional design adjustments to address permitting issues. This could add additional cost and time to the design process, which in-turn could threaten the TDEC implementation deadline.
- Inadequate Quality Control Procedures could result in additional re-work and time delays.

## CRITICAL SUCCESS FACTORS

The following measures were considered potentially critical to the success of the project. If not addressed appropriately, the project goals and objectives would not be met.

- If the contractor and/or his subcontractors fail to follow the plans and specifications, the quality of work could be compromised and/or the project completion date delayed.
- If the contractor and/or his subcontractors fail to report field conditions which are significantly different from the plans (e.g. unknown buried pipes, bedrock, etc.), the constructability/implementability of the project could be compromised and/or the project delayed.

The following measures helped to mitigate the previously mentioned actions and were critical to the successful completion of the project.

- Open communication between TVA Capital Projects, Routine Operation and Handling, Environmental and Stantec.
- Comprehensive observation and engineering oversight of the construction and adherence to the quality control processes.

## ENVIRONMENTAL AND OPERATIONAL IMPACTS

The following environmental permit needs were identified with respect to the proposed BAP Discharge Re-Route:

- NPDES Construction General Permit - Whenever any new construction or change in existing construction in a wastewater treatment facility is performed, a registered engineer must plan, design, and inspect the construction of such works (TN Rule 1200-4-2-.01).
- Notice of Intent (NOI) and Stormwater Pollution Prevention Plan (SWPPP) for the Construction Permit - Since more than one acre was disturbed during the closure activities, a Notice of Intent (NOI) to discharge stormwater associated with construction activities was submitted to TDEC's Division of Water Pollution Control (DWPC). A site-specific SWPPP was developed and submitted as required by the NOI along with applicable permit fees.
- TVA obtained coverage under the Tennessee Multi-Sector Permit (TMSP) for stormwater discharges after construction was completed.
- NPDES Permit Modification – The NPDES permit was modified to reflect the relocation of the outfall.
- Categorical Exclusion Checklist (CEC) – This TVA required document is completed for all proposed actions at TVA facilities. It verified that there are no extraordinary circumstances associated with this project and if there are, whether they are insignificant to require a categorical exclusion.
- USACE Nationwide Permit – A permit for the construction of the outlet headwall and riprap slope protection was required.

## CONCLUSION

Given the pending EPA regulations and likelihood of CCP impoundment closure facing the power industry, utilities are forced to consider alternative means of storing coal combustion products. Ponds such as JSF's Bottom Ash Pond serve not only as storage but also as detention and settling ponds for much of the plant's process water. This is a common scenario found at many power plants throughout the nation. As utilities consider the economic vitality of coal-fired power plants under heightened regulatory environments, they must consider the impact of closing such critical components to their systems. TVA's retirement and idling of the John Sevier Fossil Plant's four coal-fired

generating units resulted in a thorough study culminating in a CCP closure strategy that quickly identified the Bottom Ash Pond as a critical element. Ultimately, when all plant flows cease, the BAP will be closed. Re-routing of the discharge from the BAP provided a means to begin the closure process and allowed TVA to comply with newly established regulatory discharge limits until the pond is closed and the outfall removed from the NPDES permit.

## REFERENCES

<sup>1</sup> [www.tva.com/sites/johnsevier.htm](http://www.tva.com/sites/johnsevier.htm)

<sup>2</sup> TDOT Design Division Drainage Manual, January 1, 2010.

<sup>3</sup> Hydrometeorological Report No. 56, Probable Maximum and TVA Precipitation Estimates with Areal Distribution for Tennessee River Drainages Less Than 3,000 Mi<sup>2</sup> in Area, October 1986.

<sup>4</sup> TVA River Operations Group, computed flood profiles for Holston River mile 106.3 downstream.

<sup>5</sup> Handbook of Polyethylene Pipe, 2nd Edition, The Plastics Pipe Institute, Irving, TX, 2008.

<sup>6</sup> Naval Facilities Engineering Command, Soil Mechanics (DM-7.1) & Foundations and Earth Structures (DM-7.2), Department of the Navy, May 1982.

<sup>7</sup> US Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 11, Design of Riprap Revetment, Publication No. FHWA-IP-89-016, March 1989.