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SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

Operational Improvements to Optimize Selective Catalytic Reduction Systems at Five Fossil Plants

Tennessee, Alabama, and Kentucky

PREPARED BY:
TENNESSEE VALLEY AUTHORITY

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SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

OPERATIONAL IMPROVEMENTS TO OPTIMIZE SELECTIVE CATALYTIC REDUCTION SYSTEMS AT FIVE FOSSIL PLANTS

TENNESSEE, ALABAMA, AND KENTUCKY

THE PROPOSED DECISION AND NEED

Tennessee Valley Authority (TVA) is proposing improvements to optimize operation of 17 selective catalytic reduction (SCR) systems installed at five fossil plants (Colbert, Cumberland, Kingston, Paradise, and Widows Creek). The proposed improvements would enable TVA to sustain high nitrogen oxide (NOx) removal rates while extending the SCR catalyst life until the next scheduled outage. The final environmental assessment (EA) on *Replacement or Rejuvenation of Catalyst for Selective Catalytic Reduction of Nitrogen Oxides at Seven TVA Fossil Plants in the Tennessee Valley* (TVA 2005) states that replacement of spent catalyst would be carried out during scheduled outages. This would also apply to catalyst additions. (Prior to December 31, 2008, when annual SCR operation begins, catalyst replacement or addition can occur for SCR systems that have flue gas bypass at any time during the nonozone season. After December 31, 2008, catalyst replacement or addition must occur for all SCR systems during unit outages.)

The original SCR catalyst design assumptions were that the initial catalyst charge would achieve a 90 percent NOx reduction at a maximum 2 parts per million by volume (ppmv) ammonia slip (defined below under “Ammonia Slip”) for a given time period. The time period estimates varied from unit to unit and ranged from 12,000 to 20,000 hours of operation. The catalyst manufacturer made assumptions concerning the longevity, removal efficiency, and final disposition of the slip, and it appears that the assumptions were conservative. The catalyst is lasting longer, and there is less ammonia on the ash than anticipated. The generalized 2-ppmv slip was conservatively approximated to ensure compliance with applicable wastewater discharge requirements and was based on ammonia on ash concentrations that would eventually end up in ash ponds and storm water runoff pond discharges. If the slip limit were to be relaxed or removed so that ammonia slip could go higher than 2 ppmv, a given SCR would be able to achieve design NOx reduction performance for a longer time, assuming all other operating conditions remained the same. This would prolong the time when catalyst addition or replacement would be needed. The dates at which units could use higher ammonia slip to extend catalyst life are shown in Table 1.

Raising the slip limit would also allow higher NOx reduction to be sustained throughout the catalyst life. There may be unit operational constraints that will prevent operation at higher slip. For example, air preheater (APH) fouling from accumulation of ammonium bisulfate will occur if there is high slip and if there are high enough levels of sulfur trioxide in the flue gas. Likewise, for the units burning high-sulfur fuel, it may not be possible to increase slip much before excessive APH fouling occurs from the deposition of ammonium bisulfate.

Table 1. Dates at Which Units Could Use Higher Ammonia Slip to Extend Catalyst Life

Fossil Plant	Unit	Date
Allen	1	2009
	2	2009
	3	2009
Bull Run		2010
Colbert	5	2010
Cumberland	1	2010
	2	2010
Kingston	1	2011
	2	2012
	3	2009
	4	2011
	5	2009
	6	2009
	7	2009
	8	2009
	9	2010
Paradise	1	2009
	2	2009
	3	2011
Widows Creek	7	2009

BACKGROUND

In order to meet the requirements of Title 1 of the Clean Air Act pertaining to ozone for which NOx is a precursor, TVA has installed and operates SCR systems at seven of its fossil plants. After considering several alternative types of SCR systems for these fossil plants, high-dust SCR systems were installed at all of the plants. These SCR systems reduce emissions of NOx from the seven plants by as much as 92 percent. Twenty-one SCR systems have been installed as shown in Table 2.

Table 2. TVA Fossil Plants With Installed SCR Systems

Plant Name	Acronym	Unit Number(s)
Allen	ALF	1, 2, 3
Bull Run	BRF	1
Colbert	COF	5
Cumberland	CUF	1, 2
Kingston	KIF	1, 2, 3, 4, 5, 6, 7, 8, 9
Paradise	PAF	1, 2, 3
Widows Creek	WCF	7, 8

EAs were completed for SCR systems at all seven plants (listed under the section below titled "Other Environmental Reviews and Documentation"). These EAs included a commitment stating that the SCR systems shall not be routinely operated with an ammonia slip exceeding 2 parts per million (ppm) and that brief system process excursions or process upsets would be an exception to this limit.

TVA has experienced difficulty in determining the actual slip rates, but we do have good empirical data for ammonia on ash and ammonia in wastewater discharges.

In October 2006, an EA was completed and a finding of no significant impacts was reached for Allen Fossil Plant (ALF). This EA (TVA 2006a) replaced the 2-ppm commitment with a more flexible strategy that allowed for higher slip levels. The higher slip levels were contingent on ammonia-nitrogen (NH_3-N) concentrations in the plant wastewater not exceeding the Tennessee National Pollutant Discharge Elimination System (NPDES) permit action limit of 1.0 milligram per liter (mg/L) net and the plume opacity remaining below the 20 percent air quality opacity standard during normal operations. A similar type of approach will be taken in this supplemental EA for the plants listed in Table 2 except for ALF and Bull Run Fossil Plant (BRF). TVA will ensure that applicable opacity standards, water quality criteria, NPDES action levels, or toxicity reference values are met. BRF will be covered in a separate environmental review at a later date due to data collection needs.

Regarding the United States Environmental Protection Agency's (USEPA) 1999 Revised Freshwater Aquatic Life Criteria, the United States Fish and Wildlife Service recently suggested to USEPA that the revised ammonia criteria are currently too high. They believe concentrations lower than the revised criteria may be detrimental to state- and/or federally listed mussels. Currently, Colbert Fossil Plant (COF) is the only fossil plant with threatened and endangered mussel species in the immediate vicinity of the plant.

AMMONIA SLIP

The SCR systems inject ammonia into boiler flue gas and pass it through a catalyst bed where the ammonia and nitrogen oxide gas react to form nitrogen and water vapor. Ammonia slip, the emission of unreacted ammonia, is caused by the incomplete reaction of injected ammonia with NOx present in the flue gas. In high-dust SCR systems, the ammonia slip adheres to and commingles with the fly ash, can be deposited on the APH surfaces, and can be disposed with the fly ash. The higher the ammonia slip is, the greater the expected concentration of ammonia on the fly ash. A small amount of ammonia does exit the stack, and this issue is discussed further in this EA in the section entitled "Atmospheric Nitrogen Deposition." Bottom ash is heavier than fly ash; therefore, it is captured in the bottom of the boiler and is not in contact with the injected ammonia.

Currently, TVA operates the SCRs during "ozone season" from May to October. Beginning January 1, 2009, TVA will operate the SCRs year-round. During operation of the SCRs, the catalysts become depleted. The catalysts are replaced or rejuvenated during scheduled unit outages to maintain the needed NOx reduction. To retain optimal NOx removal from the flue gas between scheduled outages, more ammonia would be injected to the system as the catalysts are depleted. Increasing the amount of ammonia injected would increase the ammonia slip, which would increase the ammonia on ash concentration, and increase the ammonia concentration in the receiving pond(s).

AMMONIA CRITERIA

The discharges to the receiving streams must meet water quality criteria, NPDES action levels, and/or toxicity reference values for ammonia to be in compliance. The USEPA acute aquatic life criterion (ALC) for ammonia in fresh water is termed the criterion maximum concentration, or CMC, and the USEPA chronic ALC for ammonia in fresh water is the criterion continuous concentration, or CCC. The CMC is the one-hour average concentration of total NH_3-N (in mg of nitrogen per liter [N/L]) which is not to be exceeded at the discharge more than once every three years on average. The CMC is pH dependent: As the pH increases, the ammonia CMC decreases to remain protective of aquatic organisms. The CCC is the 30-day average concentration of total NH_3-N/L, which is not to be exceeded more than once every three years on average. The CCC is pH and temperature dependent: As pH and/or temperature increase, the ammonia CCC decreases to remain protective of aquatic organisms. At COF, the discharge must also meet a “trigger point” of 0.4 mg NH_3-N/L to protect several federally listed mussel species that are found in the vicinity of COF. Cumberland Fossil Plant (CUF) and Kingston Fossil Plant (KIF) have specific NPDES permit action levels for ammonia.

RECENT AMMONIA STUDY

A 2006 cold-weather study at Paradise Fossil Plant (PAF) demonstrated ammonia removal (including uptake and/or conversion) rates from the ash pond ranging from 31 percent to 94 percent with a pond retention time of approximately one day (TVA 2006b). During the growing season, biochemical uptake rates of ammonia would generally be even greater than during cold-weather months.

NUTRIENT CRITERIA

Because addition and conversion of ammonia increases the nutrient enrichment potential of pond aquatic discharges (total nitrogen, NO2+NO3-N, organic nitrogen), nutrient water quality criteria for the receiving water bodies are important considerations. States’ water quality standards contain criteria to protect surface waters from the adverse effects of nutrient enrichment. These criteria have historically been in the narrative form (prohibit the formation of objectionable accumulations of floating materials), but more recently, a major emphasis by USEPA and the states is to develop numeric, “not to exceed,” concentrations of the nutrients nitrogen and phosphorous or of biological (i.e., algal biomass) or other (i.e., water transparency) values that protect against use impairment. Alabama has promulgated nutrient criteria for the Tennessee River and its tributaries based on the response variable chlorophyll a (algal biomass). Tennessee has adopted Alabama’s criteria for Pickwick and Guntersville reservoirs (seasonal mean photic-zone values measured in the deep forebay areas above the dams) but has not yet promulgated numeric nutrient criteria for other water bodies where TVA fossil plants are located. USEPA is pushing states to promulgate numeric nutrient criteria that will be protective of downstream, even far-field, uses such as in the Gulf of Mexico hypoxic zone (see discussion under “Atmospheric Nitrogen Deposition” below). Should any receiving stream segment become listed as “impaired” on a state’s 303(d) list due to exceedence of either existing or future ammonia and/or nutrient criteria, TVA will reduce the amount of ammonia and/or nutrient discharged as required to comply with water quality standards and NPDES permit limits.

OTHER ENVIRONMENTAL REVIEWS AND DOCUMENTATION

- *Paradise Fossil Plant Units 1, 2, and 3, Selective Catalytic Reduction Systems for Nitrogen Oxide Control Environmental Assessment* (TVA 1999), Index Number 434

- *Cumberland Fossil Plant Units 1 and 2, Selective Catalytic Reduction Systems for Nitrogen Oxide Control Environmental Assessment* (TVA 2000), Index Number 630
- *Allen Fossil Plant Units 1, 2, and 3, Selective Catalytic Reduction Systems for Nitrogen Oxide Control Environmental Assessment* (TVA 2001a), Index Number 652
- *Widow Creek Fossil Plant Units 7 and 8, Selective Catalytic Reduction Systems for Nitrogen Oxide Control Environmental Assessment* (TVA 2001b), Index Number 690
- *Kingston Fossil Plant Units 1 Through 9, Reduction Systems for Nitrogen Oxide Control Final Environmental Assessment* (TVA 2002a), Index Number 768
- *Bull Run Fossil Plant Unit 1, Selective Catalytic Reduction Systems for Nitrogen Oxide Control Final Environmental Assessment* (TVA 2002b), Index Number 743
- *Colbert Fossil Plant Units 1 Through 5, Reduction Systems for Control of Nitrogen Oxides Final Environmental Assessment* (TVA 2003), Index Number 816
- *Replacement or Rejuvenation of Catalyst for Selective Catalytic Reduction of Nitrogen Oxides at Seven TVA Fossil Plants in the Tennessee Valley Final Environmental Assessment and Finding of No Significant Impact* (TVA 2005), Project Number 2004-115

ALTERNATIVES AND COMPARISON

<u>DESCRIPTION OF THE PROPOSED ACTION</u>

The proposed changes would be operational rather than physical. The primary change would be to allow higher slip through the SCR systems at COF, CUF, KIF, PAF, and Widows Creek Fossil Plant (WCF). In order to extend the life of the catalyst to better coordinate plant outages, ammonia levels would have to be increased to maintain NOx removal levels. As ammonia inputs increase, the amount of unreacted ammonia that enters the waste stream, or slip, may also increase.

In the proposed action, ammonia slip would be allowed to increase to a point that would not violate any water quality criteria for ammonia and/or nutrients, NPDES action levels, or toxicity reference values as appropriate based on constraints at individual facilities. Because the catalyst in any given SCR unit is replaced in layers (rather than all at once) and some portions of the SCR catalyst would be near end of use at any given time, the SCR would likely operate at a stable slip rate. This project would result in extending catalyst life up to 18 months so that catalyst replacement outages can be coordinated (matched to) with routine plant outages.

Ammonia use would increase by less than 1 percent. This would result in only a small increase in the number of ammonia truck tank deliveries to the plant sites per year.

<u>ALTERNATIVES</u>

1. <u>Alternative Considered but Eliminated From Further Study</u>. Extend the catalyst life without increasing slip. This would result in gradually decreasing levels of NOx reduction (down to 80 percent). This alternative is not considered in more detail

because it would only satisfy part of the purpose and need. It would not allow a plant to sustain NOx reduction at the design level.

2. Proposed Action. Extend the catalyst life by increasing slip up to values that do not cause violations of applicable opacity standards, water quality criteria, NPDES action levels, or toxicity reference values based on constraints at individual facilities. This would allow some SCR units to optimize operations, both by extending catalyst life and by allowing NOx reduction to be sustained at the design level.

3. No Action Alternative. The 2-ppm slip level commitment would be maintained at all five SCR systems. To coordinate catalyst replacement with routine outages, catalyst might have to be replaced before its useful life ended. Most plants would not be able to increase NOx reduction at the design level under the No Action Alternative.

SCOPE OF THE ANALYSIS

The following resources have the potential to be affected by the proposed action:

- Air Quality
- Coal Combustion By-Products
- Groundwater and Surface Water
    - Aquatic Life (toxicology)
- Transportation Infrastructure (roads, rails, barge)

AIR QUALITY

Affected Environment

All of the previous SCR EAs discuss environmental impacts on air quality, terrestrial ecology, wetlands and floodplains, land use, visual aesthetics, noise, archaeological and historic resources, aquatic ecology, and surface water quality. They also cover the potential for environmental effects from ammonia storage and handling, accidental release of anhydrous ammonia, solid and hazardous waste, and wastewater. Because of the nature of the proposed action, potential environmental effects are expected to be limited to those resulting from an increased ammonia slip. During scoping, it was determined that the proposed action has the potential to affect air quality, transportation, and water/wastewater quality.

The control of NOx emissions—a precursor to the formation of ozone—at TVA contributes to affected nonattainment areas' goals of achieving attainment with the ozone standard. The rate of ammonia injection in the SCR affects the control efficiency for NOx reduction. The increase in ammonia injection feed rate would result in an increase in the reduction of NOx emissions but could also result in the increase of ammonia slip.

Environmental Consequences

Previous source testing of NOx emissions from TVA units with SCRs in combination with other NOx controls (TVA Environmental Data Report, which may be accessed at the following link: http://www.epa.gov/airmarkets/emissions/docs/edr22iny2006.pdf) determined that the units were achieving at least a 90 percent reduction in NOx emissions. It is anticipated that an increase in ammonia slip within reasonable control limits would not interfere with the facility's ability to meet regulatory emission limits or have an adverse impact on air quality in the area. Both ammonia and NOx can react with other compounds in the atmosphere to form secondary particulate matter. The potential for a small increase in particulate due to ammonia emissions would be more than offset by the decrease in particulate due to NOx reductions associated with optimized SCR operation.

Significant production of ozone from a NOx source does not occur until emissions travel 20 to 80 kilometers (approximately 12-50 miles) downwind of the NOx source. However, ozone concentrations below background levels can occur immediately downwind of NOx sources, such as power plants, due to ozone scavenging, i.e., when NOx emissions consume ozone. The reduction of NOx emissions may reduce the size of the area in which ozone scavenging occurs. While ozone concentrations may increase in areas previously affected by ozone scavenging, they are not expected to increase above background ozone levels. The overall impact from optimizing the operation of the SCR control equipment should be a net improvement in air quality, both locally and regionally.

Atmospheric Nitrogen Deposition

A 2007 study involving the Atmospheric and Environmental Research Inc., the Southern Company, and the Electric Power Research Institute (EPRI) looked at modeling of atmospheric nitrogen deposition from a coal-fired power plant with and without NOx SCR and selective noncatalytic reduction (SNCR) controls. The study indicated that the overall nitrogen depositional footprint is greatly reduced when NOx controls are in use. Plants equipped with SCR technology are capable of converting up to 90 percent of the NOx gases into innocuous nitrogen and water. Plants equipped with SNCR technology are capable of converting 20-40 percent of NOx into the same by-products. Both of these technologies use ammonia as a reagent to convert the NOx compounds. Particularly as the catalyst in the SCR ages, there is an amount of ammonia that does not react, which is commonly referred to as slip. The SNCR technology has a less efficient reaction, so this slip number is typically higher than for SCR. This ammonia can react with ash and other compounds found in the flue gas, such as sulfur compounds, and form compounds that can be removed in APHs, electrostatic precipitators (ESPs), and scrubbers. The study utilized three EPRI contractor-modified versions of the USEPA's Community Multiscale Air Quality (CMAQ), a screening level watershed model Export Coefficient Method (ECM) based on USEPA's Pollutant Loading Model (PLOAD), and an intermediate level model, Regional Nutrient Management (ReNuMa) from Cornell University. CMAQ was modified to improve treatment of aerosol processes using the Model of Aerosol Dynamic, Reaction, Ionization, and Dissolution (MADRID). It was also modified for a subgrid scale treatment of the emissions of selected point sources using the Advanced Plume Treatment (APT) and CMAQ-VISTAS (i.e., CMAQ version 4.5.1 with secondary organic aerosol modifications for the VISTAS Regional Planning Organization).

USEPA has recently completed a reassessment of the science and underlying causes of hypoxia (approximate 8,000-square-mile “dead zone” due to lack of oxygen) in the Gulf of Mexico. In November 2007, the USEPA Science Advisory Board completed a working-draft reassessment of Gulf hypoxia and causes, which led to issuance of a revised draft 2008 action plan by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force that will replace the 2001 plan, which has been less than effective in reducing the hypoxic zone (2007 was the third-largest since 1985). The revised draft 2008 action plan states that “at least a 45 percent reduction in riverine total nitrogen flux . . . measured against the average flux over the 1980-1996 time period may be necessary” to achieve the coastal goal of reducing the size of the hypoxic zone to 5,000 square kilometers (approximately 1,930 square miles) by 2015. The reassessment concluded that 41 percent of the nitrogen load to the Gulf of Mexico is coming from the Tennessee and Ohio rivers. The action plan is looking at all sources of nitrogen and establishes a critical need to identify critical watersheds, assess current conditions, and maximize potential nitrogen and phosphorus reductions with the most cost-effective approaches.

Although the results of the 2007 study mentioned above are not directly transferable to TVA's situation, TVA can draw some basic total nitrogen reduction numbers from the research. The 970-megawatt four-unit plant in the study utilizes both SCR and SNCR technology for an estimated total NOx reduction of 79 percent during the ozone season. In the base case, prior to the installation of any NOx controls, it was estimated that the plant would emit 10,900 tons of NOx per year, and after installation of NOx control technology, a reduction of 8,600 tons is anticipated. The ammonia (NH_3) slip was estimated to be only 25 tons annually.

NOx control technology installed at TVA has produced a 64 percent reduction in NOx compound emissions since 1995, which also equates to an 81 percent reduction during the ozone season. In 2009, TVA will begin annual operation of the NOx control technology and will continue to add controls to units. In 2009, with the existing and new controls, TVA estimates an 82 percent annual reduction in the release of NOx compounds from 1995 emission rates.

WATER QUALITY

Affected Environment

Colbert Fossil Plant

The fly ash handling system at COF is a dry fly ash handling system, which has no wet sluicing capabilities. The fly ash is carried with the flue gas stream exiting the boiler. ESPs capture the fly ash from the flue gas stream in hoppers. From the hoppers the fly ash is pneumatically transported to silos. The dry fly ash in the silos is conditioned with water, loaded into dump trucks, and transported to the dry fly ash stacking area or utilization area. At any given time, the maximum active area of dry fly ash at the stacking area would be 10 acres or less. As stacking areas become inactive, the areas are stabilized using an interim cover such as grass or bottom ash. The dry fly ash stack is graded to a 1 to 2 percent slope at the end of each day to limit ponding and to encourage sheet flow runoff. Runoff from the dry fly ash stacking area flows to a sedimentation pond, Ash Pond 5, where it evaporates or overflows through Outfall Discharge Serial Number (DSN) 010 to the Tennessee River at Tennessee River Mile (TRM) 245.8. The only input to Ash Pond 5 is storm water runoff from the dry ash stacking area and direct precipitation.

The bottom ash is wet sluiced to Ash Pond 4. Other sources of flow to Ash Pond 4 include dry fly ash silo wash down wastewater, and APH wash water through the chemical treatment pond (Outfall DSN 001b).

Environmental Consequences

Colbert Fossil Plant

COF installed a high-dust SCR system on Unit 5 in 2004. In addition, an SNCR system was installed on COF Unit 4 in 2004. However, the SNCR is scheduled to cease operation prior to the start of the next ozone season; therefore, no additional ammonia loading will be assumed from the SNCR system for this assessment.

Effects at the Ash Pond 5 Discharge (Dry Stack Runoff Pond – DSN 010)
COF is located just downstream of Seven Mile Island in the Wilson Dam tailwater/Pickwick Reservoir (Tennessee River). Several federally listed mussel species are known to occur in this area. These species have been demonstrated to be particularly sensitive to impacts from ammonia. In order to address the potential for impacts to these resources, the behavior of the ammonia "plume" at the discharge was modeled to determine if mussels present in the river could be affected. A "trigger point" of ammonia concentrations of 0.4 mg NH_3-N/L at the bottom of the river was chosen to determine the potential for sublethal effects to listed mussels in chronic exposures (≥28 days).

The model used produces a three-dimensional (3-D) picture of the behavior of the ammonia plume after the outfall enters the Tennessee River. This discharge is near the surface of the river. Water depth drops off rapidly adjacent to the discharge to a depth of approximately 10 meters (about 33 feet). The model was based on extremely conservative assumptions regarding the amount of ammonia entering the river, the volume of ammoniated water released, and the velocity of the river at the time of release (Table 3). The numbers, which are far in excess of the USEPA HELP2 model predicted conditions and the measured river velocity, were used to somewhat artificially generate a plume for discussion.

Table 3. Assumptions of Ammonia Plume Model Compared to HELP2 Model and Observed Conditions

	3-D Plume Model Assumptions	Predicted Conditions Using HELP2 Model and 20-Year Rainfall Data
Ammonia concentrations in Outfall DSN 010 Discharge	3.0 mg NH_3-N/L	0.87 mg NH_3-N/L (Concentration at Maximum Calculated Flow)
Maximum flow from Outfall DSN 010	16 MGD (Observed)	10.36 MGD (Calculated)
Average velocity of the Tennessee River at Outfall DSN 010	0.1 m/s	0.37 m/s (Observed)

MGD = Millions of gallons per day
m/s = Meter per second

The plume model ammonia concentration was nearly 3.5 times higher than the HELP2 model value at maximum flow, the outfall discharge was 60 percent higher than the maximum flow determined by the HELP2 model, and flow in the Tennessee River was assumed negligible.

Even when these extreme conditions were modeled, an area of only about 5 meters by 100 meters (approximately 16 feet by 328 feet) was affected at the bottom of the river along the left-descending shore. Ammonia concentrations were in a range of 0.3 to 0.5 mg/L within this area. While these concentrations are in the toxic range based on results reported in laboratory chronic exposures, they would not be observed under "real world" conditions. Under "real world" conditions, no toxic ammonia plume would be observed, and mixing would occur almost instantaneously. No ammoniated water would reach the bottom of the river. Because habitat for listed mussels is very poor or absent in areas potentially affected by the plume and because a toxic ammoniated plume would not occur along the river bottom under any possible combination of discharge and river flow, no effects to listed mussel species in the Tennessee River would occur.

Assuming that no fly ash is marketed due to higher levels of ammonia on ash and assuming one of the units is in an outage (not Unit 5), approximately 925 tons of fly ash would be produced and disposed of at the dry fly ash stacking area per day. Approximately half of the fly ash produced would come from Unit 5.

The worst-case condition evaluated for dry stacking assumed that a rainfall event generated runoff from the fly ash stacking area when the exposed surface of the stack had just reached maximum capacity before being covered. All the ammonia in the top 1.0 centimeter (cm) (0.39 inch) of the 10-acre exposed area is assumed to be released to Ash Pond 5.

Ammonia in the exposed area of the dry stack would most likely be solubilized and released to Ash Pond 5 with rainfall runoff. However, ammonia adhered to fly ash could also be released to the pond by erosion. Fly ash from TVA facilities, including COF, was determined to be similar to a silty loam soil (EPRI 1993). The United States Department of Agriculture's RUSLE2 model predicts erosion rates for given conditions. Assuming a silty loam soil with low organic material and other COF fly ash characteristics, the model estimated that only 0.62 cm (0.24 inch) of soil would erode over an entire year in Madison County, Alabama (this county was selected due to similarities to Colbert County, Alabama), with a 2 percent slope and 1,000-foot-slope length. For the period of record from 1940 to 2005, the Muscle Shoals, Alabama, area averaged 15 rainfall events of 1 inch or greater. If these were the only rain events that caused erosion, each event would only remove 0.04 cm (0.015 inch) on average. Research also indicates that rainfall interacts with chemicals in a shallow depth of soil called the mixing zone. Some quantify the depth of the mixing zone to be "about ¼ to ½ inch" (Iowa State University 1999), or up to 1.02 cm (0.40 inch) in some experiments (Havis 1992). Others have concluded "there exists an effective mixing depth where complete and uniform mixing of runoff, soil water, and infiltration takes place. This mixing depth appeared to be less than 3-4 mm [millimeters] rather than 10 mm as often used in literature" (Zhang 1997). Another researcher found that the effective depth of interaction was 0.25 cm (0.098 inch) and after 1.0 cm (0.39 inch) depth, the contribution of the chemical was negligible (Ahuja 1986). In addition, many runoff, erosion, and infiltration models (including CREAMS, GLEAMS, WEPP, and SWIM) assume the mixing zone to be 1.0 cm. "The CREAMS model incorporates essentially the same concept of a fixed mixing zone. The thickness of the mixing zone is defined as 1.0 cm, but it is assumed that only a fixed fraction of chemical available in this zone mixes with runoff water" (Ahuja 1986). Therefore, for this assessment, we assumed ammonia is released from a depth of 1.0 cm in the exposed dry stack area.

Determined by the 20-year simulation done in the original COF EA (TVA 2003), the average residence time for COF's Ash Pond 5 is approximately 389 days; however, the pond tends to flow during each significant rainfall event from October through March (M. A. Gean, TVA, personal communication, 2007). Therefore, based on the findings of the recent ammonia study at PAF (TVA 2006b), biochemical uptake rates of 50 percent during spring and summer and 20 percent during fall and winter are assumed for Ash Pond 5.

Under these conditions, if the NH_3-N concentration on the Unit 5 fly ash were 420 mg/kilograms (kg), using the same USEPA HELP2 model utilizing 20 years of actual rainfall data as in the original EA (TVA 2003), the NH_3-N concentration from Ash Pond 5 at Outfall

DSN 010 would be estimated to be 3 mg/L. As indicated previously in the discussion of the ammonia plume model, a concentration of 3 mg NH_3-N/L would not affect listed mussels. However, for pHs greater than 8.54, a concentration of 3 mg NH_3-N/L would exceed the CMC. The ammonia on ash concentration would have to be reduced to ensure the CMC is not exceeded for higher pHs as indicated in Table 4.

Table 4. Ammonia on Ash Concentrations for CMC Concentrations at pHs Greater Than 8.5

pH	8.54	8.6	8.7	8.8	8.9	9.0
CMC	2.97	2.65	2.2	1.84	1.56	1.32
NH_3-N on Ash (mg/kg)	420	380	320	264	224	188

If the ammonia on ash concentration remained below 188 mg NH_3-N/kg then, according to the results of the HELP2 model assessment, the CMC would not be exceeded for the NPDES permit limits for pH at Outfall DSN 010 (6.0-9.0).

Effects at the Ash Pond 4 Discharge (DSN 001)

Ash Pond 4 could receive ammoniated waste from the dry fly ash silo wash down and wash water from the Unit 5 APH. Both of these waste streams are intermittent and therefore would be mixed and diluted in Ash Pond 4 and with the combined Ash Pond 4 and condenser cooling water (CCW) discharges (1,224 millions of gallons per day [MGD]) prior to reaching the Tennessee River. The dry fly ash silo wash down is unlikely to cause a negative impact at the receiving stream due to low concentrations of ammonia at the discharge.

The APH wash water is routed to the chemical treatment pond, which discharges to Ash Pond 4. TVA already monitors Outfall DSN 001 quarterly for ammonia and annually conducts 48-hour acute toxicity testing. TVA would continue to comply with all NPDES permit requirements.

Receiving Stream

The receiving stream in the vicinity of COF is not listed as impaired by ammonia or nutrients in the Alabama Department of Environmental Management's 2006 303(d) List, nor is it listed in the draft 2008 303(d) List. The receiving stream is also in compliance with Alabama's nutrient criterion for Pickwick Reservoir.

Affected Environment

Cumberland Fossil Plant

The fly ash handling system at CUF is a dry fly ash handling system, which has retained wet sluicing capabilities. The fly ash is carried with the flue gas stream exiting the boiler. ESPs capture the fly ash from the flue gas stream in hoppers. From the hoppers, the fly ash is pneumatically transported to silos. The dry fly ash in the silos is conditioned with water and transported to the dry fly ash stacking area in the ash pond complex. At any given time, the maximum active area of dry fly ash at the stacking area would be 20 acres or less. As stacking areas become inactive, the areas are stabilized using an interim cover such as grass or bottom ash. The dry fly ash stack is graded to a 1 to 2 percent slope at the end of each day to limit ponding and to encourage sheet flow runoff. Runoff from the dry fly ash stacking area flows to the ash pond and discharges through internal monitoring point (IMP) 001 to the CCW discharge channel. During times when the fly ash is wet sluiced, the fly ash is discharged directly to the ash pond. CUF produces 1,540 tons of fly ash daily.

The bottom ash is wet sluiced to two bottom ash dewatering cells, located in the ash pond complex, which discharge to the ash pond. Other sources of flow to the ash pond include the rim ditch dewatering area of the flue gas desulfurization (FGD) disposal area and the APH wash water, which is routed through the coal yard runoff pond prior to discharging to the ash pond.

Environmental Consequences

Cumberland Fossil Plant

CUF installed high-dust SCR systems on both units in 2003 and 2004. The CUF NPDES permit ammonia action level for IMP 001 is 0.86 mg NH_3-N/L. If concentrations of NH_3-N are detected in the effluent of IMP 001 that are equal to or exceed 0.86 mg NH_3-N/L, CUF would have to implement corrective action as required by the NPDES permit. Such actions could include lowering ammonia injection rates into the boiler flue gas.

Effects on the Ash Pond Discharge

Dry Stack Runoff Only

Under normal operating conditions at CUF, all of the fly ash from both units that is not marketed is dry stacked. Due to the higher concentrations of ammonia on ash, no fly ash is assumed to be marketed. The worst-case condition evaluated for dry stacking assumed that a rainfall event generated runoff from the fly ash stacking area when the exposed surface of the stack had just reached maximum capacity before being covered. All the ammonia in the top 1.0 cm (0.39 inch) of the 20-acre exposed area is assumed to be released to the ash pond. Because rainfall-runoff events are intermittent and relatively short in duration, the ash pond is assumed to not be in a steady-state condition with respect to ammonia. That is, ammoniated runoff enters the pond, the runoff is diluted, and it is discharged from the ash pond.

Inflow mixing with the ash pond volume varies. Inflow point of entry to the ash pond, weather conditions, thermoclines, density gradients, and ash buildup in the pond, among other variables, can all influence whether the inflow is well mixed with the pond volume or whether it short-circuits the pond. During rainfall events that induce runoff, ash pond conditions tend to be more turbulent, and some amount of mixing can be assumed. For this evaluation, an ammonia uptake rate of 20 percent is assumed, based on the recent ammonia study at PAF (TVA 2006b), and runoff from the dry stack is assumed to mix with 25 percent of the ash pond and stilling pond volumes.

After mixing with the ash pond and stilling pond volumes and with 100 percent of the ash pond discharge, the estimated ammonia concentration at IMP 001 for an ammonia on ash concentration of 240 ppm would be 0.85 mg NH_3-N/L, which is approximately equal to the NPDES action level of 0.86 mg NH_3-N/L. The calculated ammonia concentrations for different ammonia on ash concentrations are listed in Table 5. All of these values are less than the NPDES permit action level for IMP 001. Based on this evaluation and these conditions, if all the fly ash is dry stacked and the ammonia on ash concentration is equal to or less than 240 ppm, the NPDES permit action level at IMP 001 would not be exceeded. However, operational data could vary from the calculated data; therefore, discharge from IMP 001 would be monitored.

Table 5. Estimated IMP 001 Discharge Concentrations

Ammonia on Ash Concentration (ppm)	IMP 001 Discharge Concentration (mg NH_3-N/L)
175	0.62
200	0.71
240	0.85

Wet Sluicing

Sometimes fly ash is wet sluiced to the fly ash pond. The worst-case condition evaluated assumed that a rainfall event generated runoff from the fly ash stacking area when the exposed surface of the stack had just reached maximum capacity before being covered. All the ammonia in the top 1.0 cm (0.39 inch) of the stack was released to the ash pond while, concurrently, one unit was wet sluicing fly ash to the ash pond. (If both units were wet sluicing fly ash, then the active area of the dry stack would not be exposed.) If the wet sluicing were conducted for a period of time that did not allow steady-state conditions to be achieved in the ash pond and stilling pond, then mixing with pond volumes would effectively decrease the ammonia concentration. If steady-state conditions were reached in the pond, mixing probably would not appreciably alter the ammonia concentration.

Table 6 presents estimated maximum ammonia on ash concentrations for different operations and conditions that will not result in exceedences of the NPDES permit action level for IMP 001. By controlling the fly ash handling operations and/or controlling the conditions in the ash pond (e.g., installing baffles to increase mixing in the ash pond), higher ammonia on ash concentrations could still result in discharge concentrations that would not exceed the NPDES permit action level for IMP 001.

The ash pond discharge from IMP 001 mixes with the CCW discharge from Outfall 002 prior to reaching the receiving stream. The worst-case ammonia loading from the ash pond (rain event with the maximum exposed dry stack active area and 100 percent wet sluice) assuming no ammonia uptake would be equivalent to a concentration of 0.06 mg NH_3-N/L after mixing with the ash pond discharge and CCW discharge. The NPDES permit maximum limit for pH at the CCW Outfall 002 is 9.0. (Outfall IMP 001 does not have an upper limit for pH.) At pH 9.0, the CMC is 1.32 mg NH_3-N/L. The estimated concentration of 0.06 mg NH_3-N/L is much less than the most stringent CMC applicable to this outfall.

Table 6. Calculated Maximum Ammonia on Ash Concentration for Operations and Conditions That Would Not Exceed the NPDES Permit Action Level for IMP 001

Fly Ash Handing Operations	Not Steady-State Conditions Mix With Inflow/ Discharge, Mix With 25% of Ponds, 20% Uptake	Steady-State Conditions Mix With Inflow/ Discharge, 20% Uptake	Mix With Inflow/ Discharge Only
Wet sluice only	200 ppm	63 ppm	50 ppm
50-50 Dry stack/wet sluice	245 ppm	62 ppm	50 ppm
Maximum exposed active area on dry stack, wet sluice*	123 ppm	31 ppm	25 ppm

* This scenario is unlikely to occur. If 100 percent of the ash is being sluiced, the active area of the dry stack should be covered, even if it is a temporary cover.

At pH 9.0 and a temperature of 36.7 degrees Celsius (°C) (the NPDES permit upper pH and temperature limits for Outfall 002), the CCC would be 0.116 mg NH_3-N/L. The estimated concentration of 0.06 mg NH_3-N/L is much less than the most stringent CCC applicable to this outfall, even prior to mixing with the receiving stream.

APH Wash Water

The APH wash water is routed to the coal yard runoff pond, which discharges to the ash pond. CUF currently monitors the Ash Pond Outfall IMP 001 monthly for total ammonia to ensure compliance with the NPDES permit ammonia-action level of 0.86 mg NH_3-N/L.

Receiving Stream

The receiving stream in the vicinity of CUF is not listed as impaired by ammonia or nutrients in the Tennessee Department of Environment and Conservation (TDEC) Year 2006 303(d) List nor is it listed in the draft 2008 303(d) List. In January 2008, TDEC proposed listing the segment of Barkley Reservoir on the 303(d) list for temperature and dissolved oxygen.

Affected Environment

Kingston Fossil Plant

All the KIF fly ash and bottom ash is sluiced to the ash pond. Fly ash is removed from the ash pond and placed in dredge cells adjacent to the ash pond. The ash pond discharges through Outfall 001 to the KIF intake and eventually is discharged to the Clinch River through Outfall 002. The APH wash water is currently directed to the iron pond, which discharges to the ash pond. The APH wash water is held in the iron pond, evaluated, and then treated as needed. Scrubber systems are planned for all nine units, and once the scrubbers are operational, the coal type utilized at KIF would likely change. Currently, the total daily fly ash production for all nine units is 1,424 tons. After the scrubbers are installed, the projected fly ash production would be reduced to 1,369 tons.

Environmental Consequences

Kingston Fossil Plant

KIF installed high-dust SCR systems on all nine units during the years 2004-2006. The KIF NPDES permit action level for the ash pond discharge, Outfall 001, is 2.85 mg NH_3-N/L on a net basis. If the calculated value for net addition of ammonia as nitrogen exceeds this action level, KIF would have to implement corrective action(s) as necessary per the NPDES permit. Such actions could include discontinuing ammonia injections into the boiler flue gas.

Effects on the Ash Pond Discharge

Assuming that the ammonia on ash concentration was 338 mg/kg and 1,424 tons of the ammoniated ash (100 percent of KIF Units 1-9 daily production) was discharged to the ash pond, after mixing with the ash pond inflow, the ammonia concentration at the discharge would be approximately 2.85 mg NH_3-N/L. If the ammonia concentration at the plant skimmer weir were 0 mg/L, this would be the maximum allowable net concentration at Outfall 001. Assuming a 20 percent removal rate for ammonia at KIF, based on the recent ammonia study at PAF (TVA 2006b), an even higher ammonia on ash concentration of approximately 423 mg/kg would correlate with an Outfall 001 concentration of approximately 2.85 mg NH_3-N/L. However, background ammonia concentration in the receiving stream would reduce the allowable ammonia concentration discharged from Outfall 001 in order to meet the NPDES permit action level of 2.85 mg NH_3-N/L net.

Outfall 001 discharges to the plant intake and eventually is discharged through the CCW channel to the Clinch River/Watts Bar Reservoir. At pH 9.0 and a temperature of 36.1°C (the NPDES permit upper pH and temperature limits for the CCW Outfall 002), the CCC would be 0.12 mg NH_3-N/L. For an ammonia on ash concentration of 423 mg/kg, after mixing with Outfall 001 and Outfall 002 discharges, the ammonia concentration would be approximately 0.11 mg NH_3-N/L, which would not exceed the most stringent CCC limit for this discharge even prior to mixing with the receiving stream at Clinch River Mile 2.9 of the Watts Bar Reservoir and assuming no ammonia uptake in the pond. The CMC at pH 9.0 is 1.32 mg NH_3-N/L, which is not exceeded at Outfall 002 for an ammonia on ash concentration of 423 mg/kg.

If the biochemical uptake of ammonia were greater, ammonia on ash concentrations could be higher and still not result in discharge concentrations that exceed the NPDES action level of 2.85 mg NH_3-N/L at the Outfall 001 discharge and the CMC/CCC at Outfall 002.

The APH wash water is routed to the iron pond, which discharges to the ash pond. KIF currently monitors the skimmer wall (or comparable location) and the Ash Pond Outfall 001 twice monthly for total ammonia to ensure compliance with the NPDES permit net ammonia action level of 2.85 mg NH_3-N/L.

Receiving Stream

The receiving stream in the vicinity of KIF is not listed as impaired by ammonia or nutrients in the TDEC Year 2006 303(d) List nor in the draft 2008 303(d) List.

Affected Environment

Paradise Fossil Plant

The PAF fly ash is carried with the flue gas stream exiting the boilers. Fly ash produced by Units 1 and 2 is captured by the FGD system and is sluiced with the scrubber gypsum to the gypsum stacking areas, or it is sluiced directly to the Jacobs Creek Ash Pond (JCAP). The gypsum stacking areas drain to the FGD ponds, which discharge to the JCAP. All of the fly ash produced by Unit 3 is sluiced to the JCAP, most of it being captured in the highly efficient ESP beforehand. The JCAP discharges through Outfall DSN 001 to Jacobs Creek, which is considered a “zero-flow” stream. PAF has a pH control system at the JCAP prior to discharge.

Another important source of flow to the ash pond is the APH ash and the APH wash water. The APH ash is sluiced to the ash pond and the APH wash water is, or can be, routed through the chemical metal cleaning waste pond to the JCAP (DSN 006 and DSN 007).

Environmental Consequences

Paradise Fossil Plant

PAF installed high-dust SCR systems on all three units during the years 2001-2003.

Effects on the Jacobs Creek Ash Pond Discharge

Based on the recent ammonia study at PAF (TVA 2006b), for this evaluation, an ammonia uptake rate of 20 percent was assumed for the period of November through February, and a rate of 50 percent was assumed for March through October. The NPDES permit maximum limit for pH at Outfall DSN 001 is 9.0. From April 2000 through December 2007, the highest measured spring/summer pH at DSN 001 was 8.9, and the highest measured fall/winter pH was 8.7. However, for the months of November through February, the maximum measured pH at DSN 001 was 8.4. Outfall DSN 001 has no NPDES permit discharge limit for ammonia.

The CMC at pH 9.0 is 1.32 mg NH_3-N/L. However, because Jacobs Creek is considered a "zero-flow" stream, the CCC must not be exceeded at the point of discharge. The CCC is pH and temperature dependent: As temperature and/or pH increases, the maximum allowable ammonia concentration decreases (Table 7). Over the past two years, the highest temperature recorded at the DSN 001 discharge was 31°C; however, during the months of November through February, the highest recorded temperature was 12°C.

Table 7. CCC Values for Given pH and Temperature

	10°C	**15°C**	**20°C**	**25°C**	**30°C**	**35°C**	**40°C**
pH = 8.0	2.43	2.36	1.71	1.24	0.90	0.65	0.47
pH = 8.2	1.79	1.74	1.26	0.91	0.66	0.48	0.35
pH = 8.4	1.29	1.25	0.91	0.66	0.48	0.34	0.25
pH = 8.6	0.92	0.89	0.65	0.47	0.34	0.25	0.18
pH = 8.8	0.66	0.64	0.46	0.34	0.24	0.18	0.13
pH = 9.0	0.49	0.47	0.34	0.25	0.18	0.13	0.094

Assuming the ammonia on ash concentration is 210 mg/kg and 635 tons of the ammoniated ash (100 percent of PAF daily production) is discharged to the ash pond, after mixing with the ash pond inflow, the ammonia concentration in the JCAP would be approximately 0.96 mg NH_3-N/L. During the growing season months (March-October), the discharge concentration is calculated to be 0.48 mg NH_3-N/L assuming a 50 percent removal rate for ammonia. For the maximum measured temperature of 31°C and the NPDES permit pH limit of 9.0, the ammonia concentration at DSN 001 would have to be 0.17 mg NH_3-N/L or less in order not to exceed the CCC. One way to manage operations to reduce the ammonia concentration at DSN 001 would be to reduce the ammonia on ash concentration. If, for instance, the ammonia on ash concentration were reduced to 76 mg/kg, the calculated ammonia concentration at DSN 001 would be 0.17 mg NH_3-N/L (equal to the CCC limit) under the same conditions. However, if the temperature of the discharge were greater than 31°C, the ammonia concentration in the JCAP would have to be reduced even further not to exceed the corresponding lower CCC limit. Further, if the pH were reduced to 8.4, the CCC would not be exceeded at a temperature of 31°C (Table 7).

During the winter months (November-February), the discharge temperatures and pH are typically lower. For the maximum measured temperature and pH of 12°C and 8.4, the ammonia concentration at the DSN 001 discharge would have to be 1.29 mg NH_3-N/L or lower to meet the CCC. For an ammonia on ash concentration of 210 mg/kg, temperature of 12°C and pH of 8.4, the ammonia concentration at Outfall DSN 001 is calculated to be 0.77 mg NH_3-N/L assuming a 20 percent removal rate for ammonia. However, if the temperature or pH of the discharge increased, the corresponding CCC limit would be lower. Managing SCR and fly ash handling operations to ensure compliance with the CMC/CCC for ammonia could require reducing the ammonia concentration and/or ammonia toxicity at the JCAP discharge.

The APH wash water is, or can be, routed to the chemical metal cleaning waste pond, which discharges to the JCAP. PAF currently monitors the JCAP Outfall DSN 001 to ensure compliance with the CMC/CCC for ammonia. In addition, chronic toxicity testing at Outfall DSN 001 is currently conducted once per quarter.

Receiving Stream
The receiving streams, Green River and Jacobs Creek, in the vicinity of PAF are not listed as impaired by ammonia or nutrients in the Kentucky Department of Environmental Protection Year 2006 303(d) List nor in the draft 2008 303(d) List.

Affected Environment

Widows Creek Fossil Plant

The WCF fly ash is carried with the flue gas stream exiting the boiler. The Unit 7 ESP captures approximately 75 percent of the fly ash from the flue gas stream and collects it in hoppers. The fly ash from the ESP hoppers is wet sluiced to the ash pond, which discharges through Outfall DSN 001 to the Tennessee River. The partially cleaned flue gas from the Unit 7 ESP then flows through the scrubber system. A significant portion of the remaining fly ash is removed by the scrubber process. Unit 8 does not have an ESP; therefore, the fly ash is removed solely by the scrubber system. The waste slurry from Units 7 and 8 scrubber systems is wet stacked in the FGD wet stacking area, which drains to the FGD settling pond. The FGD settling pond discharges through Outfall DSN 008 to the Tennessee River.

The bottom ash is wet sluiced to the ash pond. Another source of flow to the ash pond is the APH wash water through the iron pond (Outfall DSN 001b).

Environmental Consequences

Widows Creek Fossil Plant

WCF installed high-dust SCR systems on Units 7 and 8 in 2003 and 2004, respectively.

Effects on the Ash Pond Discharge (Outfall 001)
Currently, only 75 percent of the fly ash from Unit 7 is sluiced to the fly ash pond. Assuming that the ammonia on ash concentration is 175 mg/kg, no ammonia uptake, and all the ammoniated ash from Units 7 and 8 (1,022 tons daily) is discharged to the ash pond, after mixing with the inflow to the ash pond, the ammonia concentration at the DSN 001 discharge would be approximately 1.31 mg NH_3-N/L, which is approximately equal to the CMC (1.33 mg/L) at pH 9.0. The NPDES permit maximum limit for pH at Outfall DSN 001 is 9.0.

At pH 9.0 and a temperature of 38.89°C (the NPDES permit daily maximum effluent temperature for the CCW, the source of the ash sluice water), the CCC would be 0.10 mg NH_3-N/L. For an NH_3-N on ash concentration of 175 mg/kg, if the entire estimated ammonia loading from Units 7 and 8 were discharged from a single discharge point during the Tennessee River 7Q10 low flow (i.e., 7-day average low flow having a recurrence interval of 10 years) at WCF (8,075 MGD), the ammonia concentration in the river after mixing is estimated to be 0.005 mg NH_3-N/L, which is two orders of magnitude less than the CCC.

APH wash water is sent to the iron pond, which discharges to the ash pond through Outfall DSN 001b. WCF currently monitors the ash pond outfall once per quarter for ammonia to ensure compliance with the CMC/CCC for ammonia. Acute toxicity testing is currently conducted once a year at DSN 001.

<u>Effects on the FGD Settling Pond Discharge (Outfall 008)</u>
Approximately all of the Unit 8 ammoniated fly ash and 25 percent of the Unit 7 ammoniated fly ash (approximately 640 tons of fly ash total) is transported to the FGD wet stacking area. Because of the high solubility of ammonia, all of the ammonia is assumed to dissolve in the water and flow into the FGD settling pond. Assuming that the ammonia on ash concentration is 175 mg/kg and complete mixing of the FGD settling pond inflow/outflow, the estimated concentration at the DSN 008 discharge would be 7.6 mg NH_3-N/L. Assuming a 20 percent removal rate for ammonia based on the recent ammonia study at PAF (TVA 2006b), with the same ammonia on ash concentration and mixing of the inflow/outflow, the estimated concentration at the DSN 008 discharge would be 6.08 mg NH_3-N/L.

The NPDES permit maximum limit for pH at Outfall DSN 008 is 9.0. To meet the CMC at the point of discharge, the pH would have to be 8.05 or lower for a discharge concentration of 7.6 mg NH_3-N/L. For a discharge concentration of 6.08 mg NH_3-N/L, the pH would have to be 8.16 or lower. The pH data collected from February 2000 to September 2007 had an average pH of 7.6, a maximum pH of 8.5, and exceeded the pH of 8.05 18 out of 92 sampling events and exceeded the pH of 8.16 eight times. If the pH and/or temperature were lower, and/or the biological uptake greater, ammonia on ash concentrations could be higher and still not exceed the CMC/CCC at the outfalls.

<u>Receiving Stream</u>
The receiving stream in the vicinity of WCF is not listed as impaired by ammonia or nutrients in the Alabama Department of Environmental Management Year 2006 303(d) List nor is it listed in the draft 2008 303(d) List.

<u>COAL COMBUSTION BY-PRODUCTS</u>

Affected Environment

During operation of the SCR system, ammonia slip will increase as the catalyst ages. Most of this ammonia will be absorbed on the fly ash in the form of ammonium bisulfate, which tends to be a sticky molecule. Most of the ammoniated ash will be removed in the ESPs and collected in hoppers for pneumatic transport to either the dry fly ash silos or sluiced to ash ponds. Excess ammonia slip that is not deposited on the dry fly ash will be dissolved in the scrubber slurry and removed from the scrubber modules with the gypsum slurry, which is routed either to the gypsum dewatering facility or to the rim ditch stack. Potential impacts of ammonia slip as a result of SCR operation could include undesirable levels of ammonia being accumulated on the dry fly ash.

Environmental Consequences

Fly Ash

Dry fly ash containing ammonia used in cement replacement and certain other uses can then, in turn, cause ammonia releases from the products when mixed with water or when the concrete products are placed in damp environments like basements or enclosed areas. If ammonia levels are high enough, the ammonia can be irritating to eyes and nasal passages. If concentrations of ammonia exceed 100 ppm in the dry fly ash, marketing may be impacted. Ammonia levels on fly ash in excess of 100 ppm are commonly linked to these problems. Generally, at levels below 100 ppm, fly ash can be used without detectable odor problems affecting usability. Ammonia odor problems have also been known to occur on fly ash disposal areas when the ash is conditioned with water for disposal or during rainfall events. This can affect worker safety and can be an odor problem for nearby neighbors. Unmarketable ash would have to be disposed of on site. The loss of revenue associated with the unmarketable ash would be in excess of $1.1 million per year.

Gypsum

Gypsum slurry water removed in a gypsum dewatering plant or in the rim ditch stack will flow through the ash pond complex. The additional amount of ammonia from this process is expected to be less then 1 percent of the total slip and does not need to be evaluated further. However, gypsum, which is processed in the dewatering plant on the belt filter presses, is usually washed with steam, which helps force out additional moisture and dries the material further. Any residual ammonia would be at a fairly low concentration in the processed gypsum. Gypsum that is either then used in wallboard or cement production would be heated in these processes, which should drive off any remaining ammonia and should not result in any detectable ammonia in the finished product. Gypsum in the rim ditch stack dewaters naturally, and dissolved ammonia will be removed with the liquid from the gypsum slurry and carried on through the ash pond complex. The concentration in this liquid will be dependent on the amount of ammonia slip, the amount of ammonia deposited on the dry fly ash, and the volume of liquid in the gypsum slurry and ash pond. Since the water is removed from the gypsum readily in both of these processes, very little ammonia is expected to remain associated with the gypsum. Due to the heating processes used in both the gypsum wallboard and the cement manufacturing processes, any residual ammonia in the gypsum used in these products should not result in odor problems. Therefore, no impacts are anticipated under either the No Action Alternative or the Action Alternative.

GROUNDWATER AND SURFACE WATER RESOURCES

Affected Environment

Cumberland Fossil Plant

A complete discussion of groundwater resources in the CUF plant vicinity is available in the original CUF SCR EA (TVA 2000). Additional description of shallow groundwater movement at the site as it relates to potential groundwater and surface water impacts associated with dry stacking of ammoniated fly ash is provided in this section.

The groundwater potentiometric surface shown on Figure 1 presents groundwater levels and inferred directions of shallow groundwater movement at the plant site. The potentiometric surface is based on water levels measured on August 9, 2007, in relatively sparse monitoring wells completed in the alluvial deposits underlying most of the reservation, along with approximate water levels for the gypsum and bottom ash ponds. Measured water surfaces for Wells Creek and Cumberland River are also used to control contouring at these boundaries. The inferred direction of groundwater movement in the vicinity of the dry fly ash stack is generally westward toward Wells Creek. Discharge of shallow groundwater from the dry stack area to Wells Creek is also supported by the presence of seeps along the eastern bank of the stream.

Environmental Consequences

Cumberland Fossil Plant

No Action Alternative

No additional groundwater resource impacts would be associated with this alternative beyond those associated with current plant operations.

Action Alternative

The proposed increase of ammonia slip is expected to increase the amount of ammonium bisulfate residue on fly ash. The resulting ash ammonia content is conservatively estimated to be approximately 175 mg NH_3-N per kg ash (personal communication, J. D. Giles, TVA, July 18, 2007). Although fly ash is occasionally wet sluiced to the ash pond, fly ash is generally dry stacked on the 90-acre dry ash disposal area. The presence of the higher content of ammonia on ash would be expected to increase ammonia levels in ash leachate entering groundwater beneath the dry fly ash stack, thereby increasing the risk of groundwater contamination.

A 20-year hydrologic water budget analysis of the CUF dry ash stacking facility reported by Edwards et al. (1992) indicated that, on average, 8.2 percent of the precipitation infiltrating the stack surface forms leachate drainage. Ammoniated ash leachate within the dry stack would seep downward through the partially saturated ash, emerge through the base of the stack, and enter older saturated ash deposits associated with a former ash pond. Once in the shallow saturated ash, leachate would be expected to migrate horizontally with ambient groundwater flow through the ash deposits and silty clay soils primarily toward Wells Creek, with some portion of the leachate discharging to the Cumberland River (Figure 2). Ammonia-affected leachate migrating from the dry stack would not traverse private property regardless of whether flow is to Wells Creek or the Cumberland River; consequently, there would be no impact to existing or future groundwater users in the site vicinity.

A conservative estimate of the in-stream ammonia concentration in Wells Creek is made assuming that all leachate from the dry stack area discharges to Wells Creek. The estimated leachate seepage rate from the 90-acre dry stack is 3,865 cubic feet per day based on an average annual precipitation of 52.7 inches for the region and the reported net infiltration rate of 8.2 percent of Edwards et al. (1992). Assuming complete leaching of ammonia from the mixed ash by infiltrating precipitation, the NH_3-N concentration of the

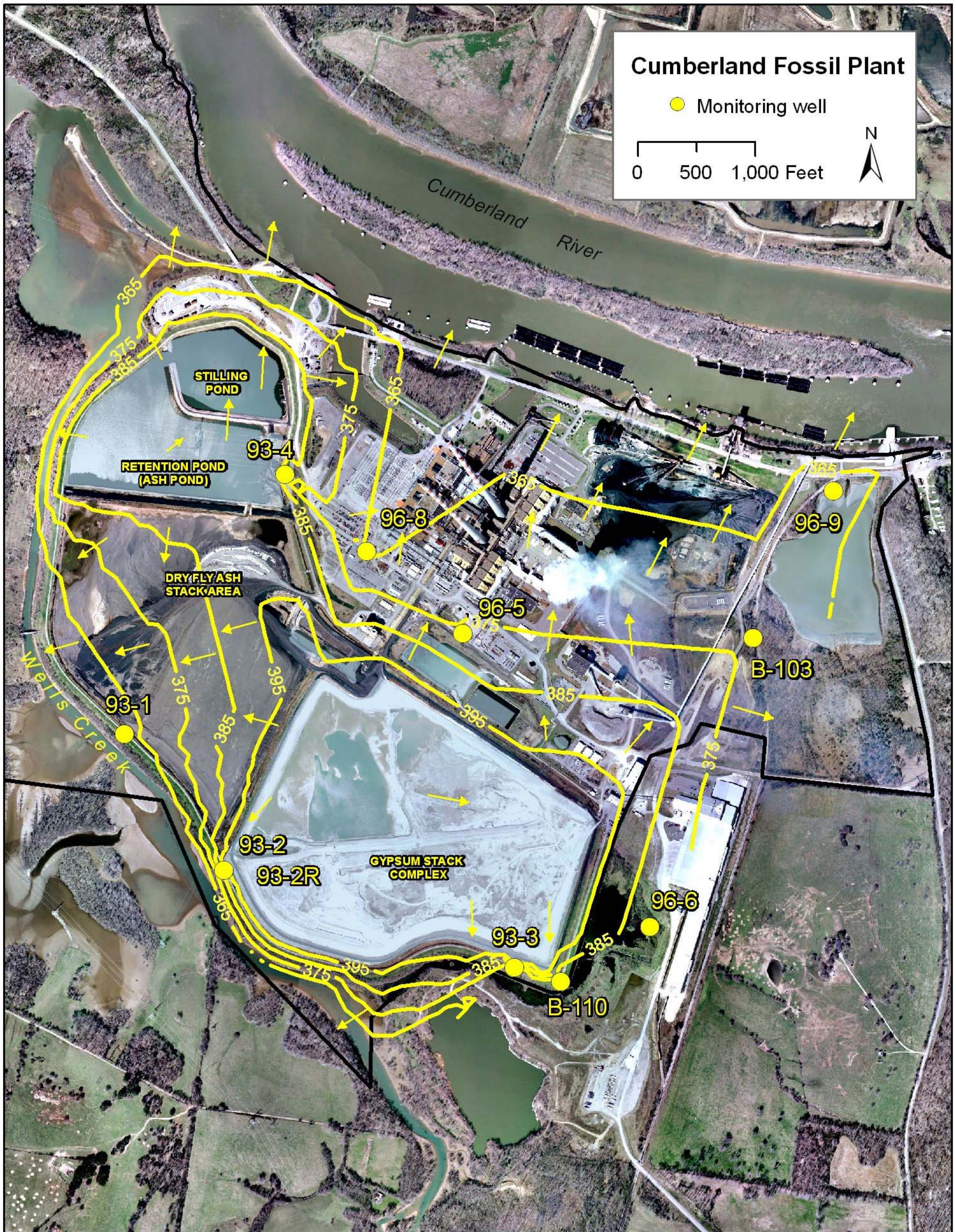

Figure 1. Groundwater Potentiometric Surface on August 9, 2007 (contours in feet mean sea level)

leachate would be approximately 627 mg/L. (This estimate assumes complete leaching of ammonia from a unit volume of ash by one pore volume of infiltrating precipitation, i.e., the pore water NH_3-N concentration is equal to the ash NH_3-N content of 175 mg/kg multiplied by ash density of 1.47 kg/L divided by ash porosity of 0.41.) The estimated NH_3-N loading to Wells Creek would be approximately 68.7 kg/day assuming no transformation or attenuation of ammonia during groundwater transport. The 7Q10 flow for Wells Creek is approximately 8.6 cubic feet per second (cfs) (M. J. McCall, TVA, personal communication, 2007). A worst-case in-stream NH_3-N concentration of 3.26 mg/L is calculated assuming complete mixing of the average NH_3-N loading (68.7 kg NH_3-N/day) resulting from leachate seepage with the 7Q10 low stream flow. As discussed in the "Aquatic Ecology" section of the EA (TVA 2005), the predicted NH_3-N concentration is below the Wells Creek specific toxicity test IC_{25} (inhibition concentration 25 percent) endpoint of 9.57 mg/L NH_3-N established for Wells Creek and, therefore, does not represent an adverse aquatic impact.

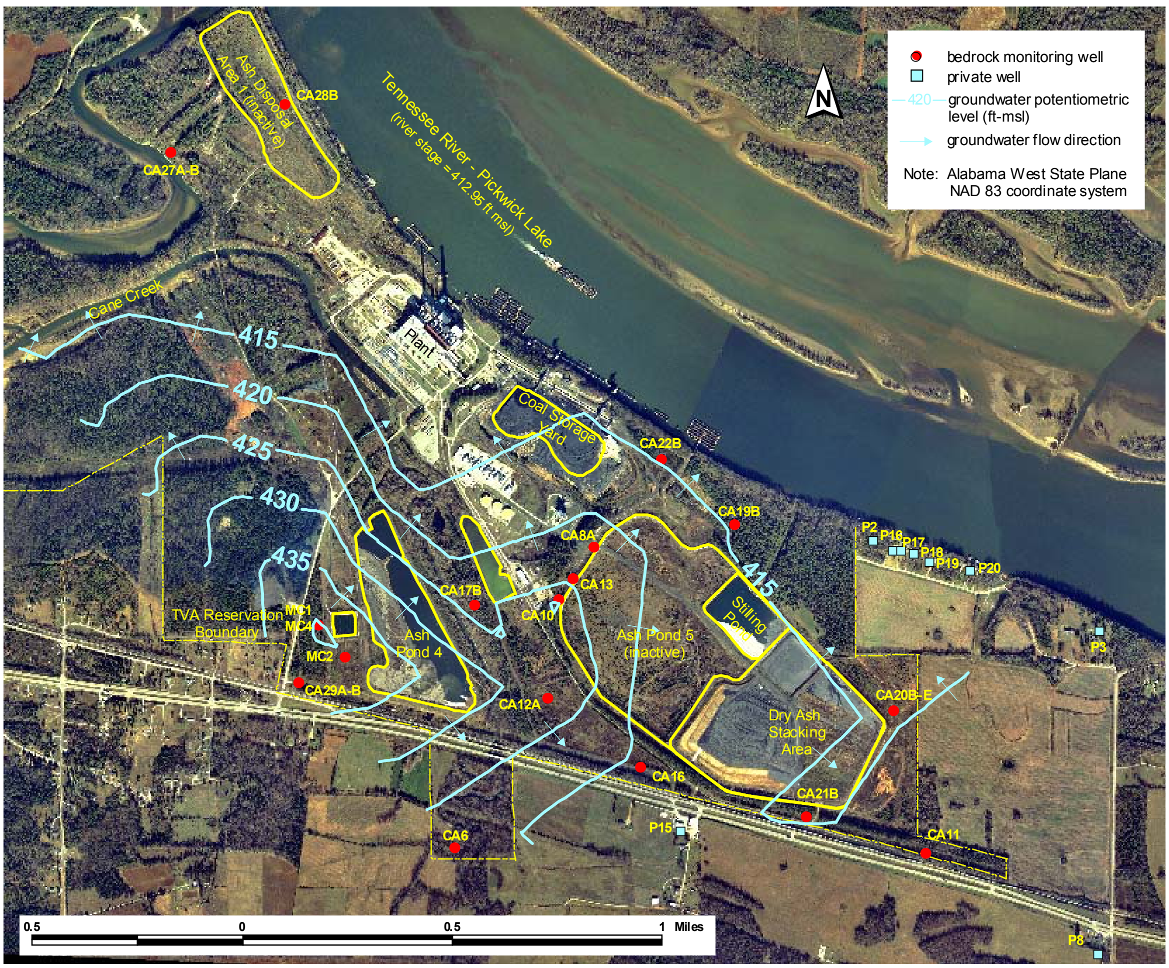

Figure 2. Groundwater Levels and Movement in Tuscumbia Aquifer (October 2001)

Note that any portion of the ammoniated ash leachate from the dry stack that might migrate to the Cumberland River would have a negligible impact due to the high dilution capacity of the river.

No adverse effects of ammoniated ash leachate seepage from the ash pond on groundwater or surface water quality are expected. The ash pond will occasionally receive temporary ammonia loadings associated with wet sluicing of fly ash and storm runoff from the dry ash stacking area. The predicted worst-case NH_3-N concentration at the pond outfall resulting from coincident ash sluicing and storm runoff events is 1.03 mg/L (see "Wastewater" section of TVA 2005). Based on inferred groundwater gradients, ammonia-affected ash pond water entering the shallow groundwater system below the pond would ultimately discharge partially to the Cumberland River and to Wells Creek without traversing private property (Figure 2). No adverse aquatic impacts to Wells Creek would be expected given the low NH_3-N concentration in ash pond seepage, the episodic nature of ammonia-affected seepage releases, and ammonia dilution/mixing in groundwater and the stream. All other operational impacts associated with the proposed SCR optimization would be similar to those discussed in the original CUF SCR EA (TVA 2000).

Affected Environment

Colbert Fossil Plant

The Tuscumbia Limestone (Mississippian age) constitutes bedrock over the majority of the plant site and consists of up to 200 feet of medium-bedded to massive, fossiliferous limestone with abundant chert (Benziger 1951). The Tuscumbia is underlain by up to 200 feet of cherty limestone of the Fort Payne formation (Mississippian), followed by 30 feet of the Chattanooga Shale (Devonian). These sedimentary units are essentially flat lying with regional dips of less than 1 degree. Past core drilling and outcrop observations have shown little evidence of bedrock faulting. Only one fault was identified, and its displacement was less than 1 foot (Benziger 1951). Surface lineament analysis and subsurface investigations indicate two major, near-vertical bedrock joint sets present in the bedrock (Lindquist et al. 1994). One joint set is oriented approximately N45°W and the other about N45°E. Groundwater circulation through these joints is believed to be the primary mechanism responsible for development of the numerous dissolution cavities observed in the bedrock. Evidence of karst terrain is abundant with numerous sinkholes across the site and several caves along the river bluff.

The upper bedrock surface at the site is extremely irregular due to differential weathering of the limestone. Consequently, thickness of the residual and alluvial soils, which mantle bedrock, is highly variable, ranging from about 1 to 80 feet. Residual soils are present across most of the reservation and generally consist of clay with variable amounts of chert gravel and cobbles. Quaternary-age alluvial deposits are limited to areas along Cane Creek and adjacent to the river beneath the inactive ash pond. The alluvium is typically composed of lenticular deposits of clay, silt, sand, and chert gravel averaging about 10 feet in thickness (Benziger 1951).

The first occurrence of groundwater beneath the site is generally near the base of the soil overburden or in the upper portion of bedrock. Exceptions occur in the immediate vicinity of plant surface impoundments, e.g., Ash Pond 4, the metal cleaning pond, and the stilling pond associated with inactive Ash Pond 5. In these areas, impoundment seepage artificially maintains saturation or near saturation of the soil profile below the impoundment. Natural recharge of the overburden is derived from infiltration of precipitation. The Tuscumbia Limestone represents the principal aquifer in the site locality. Groundwater occurs in bedrock fractures, joints, and bedding planes, many of which have been enlarged by dissolution of carbonate minerals present in the rock matrix. Borehole flow meter tests in 10 site wells indicate that hydraulically active fractures are typically limited to the upper

45 feet of bedrock, with the most transmissive zones occurring between elevations 377 and 413 feet mean sea level (Lindquist et al. 1994). Local recharge to the bedrock aquifer occurs from several sources including downward seepage from the soil overburden, direct infiltration of surface runoff through sinkholes and streams, and lateral inflow along the southern boundary of the plant reservation. Groundwater in the Tuscumbia generally flows northward and ultimately discharges into the Tennessee River (Figure 2).

Private water-supply wells in the plant vicinity are listed in Table 8 with locations shown on Figure 2. With the exceptions of Wells P2 and P8, all wells are used as backup water supplies and for nonpotable uses, such as lawn-garden irrigation and car washing. Well depths range from 136 to 265 feet, suggesting that all are completed in the Tuscumbia aquifer. TVA has monitored the water quality of Wells P2 and P8 at least semiannually since September 1989. Monitoring was also performed at Well P3 until May 1998 and at P15 until November 1994. Evaluation of water quality data for these wells indicates that none have been affected by plant operations (Lindquist et al. 1994; Milligan 2001).

Table 8. Off-Site Water-Supply Well Inventory in Plant Vicinity

Well Number	Owner	Well Use	Depth (feet)	Comment
P2	E. Buckley	residential	190	
P3	J. Newsome	backup	265	residence on public water
P8	G. Donald	residential	200	
P15	G. Foster	backup	136	residence on public water
P16	D. Sides	backup	220	residence on public water
P17	P. Sides	backup	220	residence on public water
P18	F. Seward	backup	unknown	residence on public water
P19	S. Dickinson	backup	250	residence on public water
P20	D. McAnalley	backup	180	residence on public water

Environmental Consequences

Colbert Fossil Plant

No Action Alternative

No additional groundwater resource impacts would be associated with this alternative beyond those associated with current plant operations.

Action Alternative

The proposed increase of ammonia slip is expected to increase the amount of ammonium bisulfate residue on fly ash. The resulting ash ammonia is conservatively estimated to be approximately 175 mg NH_3-N per kg ash (J. D. Giles, TVA, personal communication, July 18, 2007). Dry ammoniated fly ash produced during Unit 5 SCR operation at the maximum slip rate would be stacked directly on top of existing ash at the 80-acre dry fly ash stacking facility shown on Figure 1. No more than 10 acres of dry ash would be exposed at any time during the stacking period. The ash stack would ultimately be capped with 1 foot of clay having hydraulic conductivity of 10^{-7} cubic meters per second or less, followed by 1 foot of vegetated topsoil.

The quantity of ash leachate produced by infiltrating precipitation during stack development was estimated by Lindquist and Young (1989) to be approximately 23,000 gallons (87,000 liters) per day or about 8 percent of average annual precipitation. Their stack water budget analysis assumed an average stacking rate of 10 feet/year, an initial volumetric moisture content of 24 percent for the ash, and average annual precipitation of 51 inches/year. Ash leachate seepage through the base of the dry stack would migrate downward through the partially saturated residuum and into the underlying Tuscumbia aquifer. Ammonia present in leachate emerging from the base of the stack is expected to undergo microbial oxidation to nitrate during transport through the largely aerobic soil column. Consequently, most if not all of the ammonia would likely be transformed to nitrate before reaching the Tuscumbia aquifer. Groundwater flow patterns shown on Figure 2 indicate that leachate entering the shallow bedrock aquifer would then flow northeastward and ultimately discharge into the Tennessee River.

A conservative estimate of the in-stream ammonia concentration in Cane Creek is made assuming that all leachate from the dry stack area discharges to the Tennessee River. Given the uncertainty regarding the extent of transformation of ammonia to nitrate during groundwater transport, no attenuation or transformation of ammonia was assumed. An in-stream NH_3-N increase of approximately 0.001 mg/L was computed assuming complete mixing of ammoniated ash leachate with the 7Q10 flow for the Tennessee River of 12,000 cfs (E. A. Thornton, TVA, personal communication, 2002). Historical NH_3-N levels in the Tennessee River in the plant vicinity (TRM 260.8) range from less than 0.01 to 0.15 mg/L with median value of 0.03 mg/L based on measurements between April 1998 and October 2005. Note that the predicted NH_3-N increase is less than the conventional analytical detection limit of 0.01 mg/L and would not be detectable in river water samples. Consequently, the effects of ammonia leaching to the river from the dry ash stacking area would be insignificant.

Based on groundwater flow patterns in the plant vicinity, off-site Wells P2 and P16 through P20 appear to be situated downgradient of the dry ash stacking facility (Figure 2). P2 is the only known downgradient private well used for potable water supply and has been monitored at least semiannually since September 1989. As noted above, water quality data for P2 show no evidence of ash leachate contamination. Wells P16 through P20, which are not used for potable water supply, have been monitored semiannually since November 2002 for ammonia-related compounds. Thus far, data show no clear evidence of ammoniated-ash leachate effects. On this basis, groundwater quality impacts of ammoniated ash disposal at the dry stacking facility are not anticipated at off-site private water supply wells.

To ensure that local residential wells are not adversely affected by dry stacking of ammoniated ash, TVA will continue to monitor downgradient private Wells P2 and P16 through P20 for ammonia-related constituents including ammonia, total nitrate-nitrite, and total Kjeldahl nitrogen. If, in TVA's judgment, the water quality of any private well is impaired by ammoniated ash leachate such that water is no longer suitable for its intended use, the owner would be provided either a water treatment system, a connection to the local public water system, or a new well.

Affected Environment

Kingston Fossil Plant

Groundwater is derived from infiltration of precipitation and from lateral inflow along the western boundary of the reservation. Groundwater movement generally follows topography with flow in an easterly direction from Pine Ridge toward the Emory River and Watts Bar Reservoir. An exception to this trend occurs on the northern margin of the ash disposal area where groundwater movement is northerly toward Swan Pond Creek. Groundwater originating on, or flowing beneath, the site ultimately discharges to the reservoir without traversing off-site property.

Ammoniated ash produced from the SCR systems would be sluiced to the existing ash pond for disposal as described in the "APH Wastewater Management" section. The upper estimate for an NH_3-N concentration in the sluice water is approximately 2.85 mg/L. Once in the ash pond, the majority of ammoniated sluice water would be routed to the CCW intake, while a small fraction (i.e., less than 70,000 gallons per day) would infiltrate into the underlying alluvium. Under prevailing groundwater gradients, ammonia-affected sluice water entering the shallow groundwater system below the ash pond would ultimately discharge into the Emory River as seepage without traversing adjoining private property.

Environmental Consequences

Kingston Fossil Plant

The concentrations of ammonia resulting from groundwater seepage would be negligible since the fraction of infiltration is insignificant compared to the mixing zone volume in the Emory River or the CCW. Consequently, there would be no impacts to existing or future groundwater users in the site vicinity during either periodic or year-round SCR operation.

Affected Environment

Widows Creek Fossil Plant

In general, groundwater movement is radially away from the ponded areas of the active ash and FGD sludge areas. Groundwater movement is generally toward the river from the main plant site, the coal yard, and the southern boundary of the inactive ash disposal area. Near the FGD pond, groundwater movement is in the direction of Widows Creek. Groundwater levels are influenced by surface water levels in the vicinities of Widows Creek and the Tennessee River. The water table generally occurs near the overburden/bedrock interface but is considerably above or below this contact in some areas due to human intervention. The water table at FGD and ash ponds resides well within the overburden since these sites are elevated above the surrounding ground surface.

Environmental Consequences

Widows Creek Fossil Plant

Infiltration to groundwater from the FGD pond would be insignificant and ensure compliance with the CMC/CCC for ammonia as required in this document. Additionally, seepage of ammonia from the ash pond or the chemical treatment pond is not likely to occur based on the conclusions of ash leachate found in Julian and Danzig (1997).

Affected Environment

Paradise Fossil Plant

The evaluation of groundwater quality impacts presented in the original EA (TVA 1999) is applicable to optimizing the operation of the PAF SCR units. The original assessment emphasized the potential for groundwater contamination resulting from seepage of ammoniated ash leachate from the JCAP into Jacobs Creek. The maximum rate of seepage from the ash pond to the creek was estimated using groundwater modeling methods to be approximately 4×10^{-4} cubic meters per second.

Environmental Consequences

Paradise Fossil Plant

To estimate the ammonia as nitrogen (NH_3-N) loading to Jacobs Creek, the worst-case estimate of the maximum NH_3-N concentration in the ash pond assuming operation of all three units of 0.76 mg/L (from Table 9 of original EA) was applied to leachate seepage entering the creek. Note that the pond-effluent concentration estimate was based on a steady-state NH_3-N mass balance for the ash pond and would be applicable to year-round SCR operation. The resulting worst-case total NH_3-N loading of 26 grams/day (not 26 mg/day as incorrectly reported in the original EA) is negligible compared to the maximum potential effluent loading of NH_3-N to Jacobs Creek from JCAP (i.e., 7.78 kg per hour or 186,720 grams/day NH_3-N per Table 8 of original EA). JCAP effluent monitoring performed since January 2000 shows actual NH_3-N concentrations of less than 0.2 mg/L, which supports the conservatism and conclusions of the original seepage analysis. Increasing the in-pond concentration to 0.96 mg NH_3-N/L as shown in the “Wastewater” section of the original EA, is still negligible compared to the nitrogen load discharging though Outfall DSN 001.

In addition, the original assessment qualitatively evaluated the potential for groundwater contamination resulting from surface infiltration of ammonia from leaking storage tanks and associated transfer piping. Such events are expected to be sporadic; therefore, the original evaluation would be equally applicable to optimized SCR operation.

Given these conclusions, the overall groundwater resource impacts of optimizing operation of plant SCR units are expected to be insignificant. Furthermore, the effect of ammoniated ash leachate seepage via groundwater to Jacobs Creek would be negligible compared with permitted pond effluent ammonia loadings.

TRANSPORTATION

Affected Environment

Under existing conditions, the affected plants (COF, CUF, KIF, PAF, and WCF) all currently receive ammonia via truck or rail delivery. Table 9 contains the method of delivery and the delivery frequency.

Table 9. Current Ammonia Deliveries

Plant	Current Slip Rate (2 ppm)	
	Deliveries per Week	Weeks for Each Delivery
*COF	0.03	38.9
*WCF	0.05	20.1
**CUF	0.04	28.1
**KIF	0.02	48.7
**PAF	0.03	32.9

* Receives ammonia deliveries via truck
** Receives ammonia deliveries via train

The table above demonstrates that the delivery frequencies vary between plants and vary from once every 20 weeks (WCF, truck delivery) to once every 48.7 weeks (KIF, rail delivery).

Environmental Consequences

The No Action Alternative

Under the No Action Alternative, the 2-ppm slip level commitment would be maintained at all five SCRs. To coordinate catalyst replacement with routine outages, a catalyst might have to be replaced before its useful life ended. Most plants would not be able to increase NOx reduction at the design level under the No Action Alternative. If this alternative were pursued, there would be no impacts to the existing transportation network.

Action Alternative – Extend the Catalyst Life by Increasing Slip

The proposed changes in this alternative would increase ammonia slip. This would allow some SCR units to optimize operations, both by extending catalyst life and allowing NOx reduction to be sustained at the design level. Increasing slip would likely only be possible at plants that burn low sulfur coal (KIF and COF Unit 5). CUF, WCF Units 7 and 8, and PAF, which burn higher sulfur coal, may not be able to tolerate an increase in ammonia slip in the SCR much beyond 2-ppm due to the potential for APH fouling from formation of ammonium bisulfate. FGD systems will be added to KIF and COF Unit 5. After these additions, higher sulfur fuel could be used at these plants. Nonetheless, the analysis for this alternative assumes that slip would be increased at all five plants.

This alternative would increase the number of ammonia deliveries to each plant site, increasing truck or train traffic. As seen in Table 10, the additional truck deliveries would be more frequent (every five to 10 weeks for WCF and COF) as would the additional rail deliveries (every seven to 12 weeks for the three remaining plants). Although the increase in deliveries would be more frequent for the larger slip increase, this increase would be transparent to the motoring public, causing no impacts to the level of service of the transportation facilities.

Table 10. Increased Ammonia Deliveries per Increase in Ammonia Slip

Plant	Increase Ammonia Slip to 10 ppm	
	Additional Deliveries per Week	Weeks for ONE additional Delivery
*COF	0.10	9.7
*WCF	0.20	5.0
**CUF	0.14	7.0
**KIF	0.08	12.2
**PAF	0.12	8.2

* Receives ammonia deliveries via truck
** Receives ammonia deliveries via train

Regardless of the alternative selected, there would be no adverse changes to the transportation network based on these data.

MITIGATION MEASURES

COMMITMENTS

Ammoniated Discharge Management

To ensure compliance, TVA would commit to analyzing the COF Ash Pond 5 Outfall DSN 010, CUF Ash Pond Outfall IMP 001, KIF Ash Pond Outfall 001, PAF JCAP Outfall DSN 001, and WCF Ash Pond Outfall 001 and FGD Settling Pond Outfall 008 discharge for NH_3-N (a) as required by the NPDES permit for these outfalls; (b) as required by the NPDES permit for other outfalls at these plants (e.g., apply COF DSN 001 ammonia monitoring to COF DSN 010; apply WCF Outfall 001 requirements for ammonia monitoring to WCF Outfall 008); or (c) if (a) or (b) is not applicable, once per month. In addition, TVA could utilize one of the following measures as needed:

1. Utilize a pH control system at the ash pond and/or FGD (WCF) pond to decrease the pH of the discharge.

2. Ensure APH washes do not coincide with rainfall/runoff events for dry stacking operations (COF and CUF).

3. During wet sluicing of fly ash at CUF, ensure as much of the dry stack active area is covered as is practicable.

4. At PAF, route bottom ash pond discharges (DSN 002) to the JCAP—DSN 002 discharges typically have lower ammonia concentrations, lower pH levels, and higher temperatures than DSN 001.

5. At WCF, route ammoniated fly ash wastewater through the ash pond.

6. Increase pond retention time and mixing by use of baffles or other mechanical devices.

7. Phase catalyst management so that the maximum slip does not occur for more than one unit at a time (plants with SCRs on more than one unit).

8. Replace or rejuvenate used SCR catalyst to limit ammonia slip.

9. Reduce the amount of ammonia being injected into the SCR systems, thereby reducing the ammonia slip.

10. Utilize other treatment systems to control ammonia concentrations such as biological degradation, air stripping, recirculating sand filters, etc.

11. Employ a combination of these measures.

Specific commitments for PAF and WCF would be as follows:

Paradise Fossil Plant

TVA would begin monitoring every other week for ammonia in the inflow from the FGD pond and outflow of the JCAP. Monitoring would continue until seasonal trends can be established for the higher ammonia injection levels. Frequency and location of sampling could be modified as results warrant. Any unacceptable ammonia concentrations (toxicity and/or nutrient additions) would be mitigated by one or a combination of the measures listed under "Ammoniated Discharge Management."

Widows Creek Fossil Plant

TVA would begin monitoring every other week for ammonia in the inflow and outflow of the FGD Settling Pond Outfall 008. Monitoring would continue until seasonal trends can be established for the higher ammonia injection levels. (At 92 mg NH_3-N/kg, the discharge concentration is estimated to be 3.2 mg N/L, which is equal to the CMC at the maximum pH [8.5] measured at DSN 008.) Frequency and location of sampling could be modified as results warrant. Any unacceptable ammonia concentrations (toxicity and/or nutrient additions) would be mitigated by one or a combination of the measures listed under "Ammoniated Discharge Management."

APH Wastewater Management

TVA would commit to containing the APH wash water in a pond or other containment and analyzing the wastewater for NH_3-N concentration and pH prior to discharging the wash water to an ash pond. Upon evaluation of the data, the wastewater would be managed in one of the following ways so as not to exceed the "trigger point" for the listed mussels at COF, the NPDES permit action levels for ammonia at CUF and KIF, the CMC/CCC, and/or other future NPDES permit requirements:

1. If no treatment is warranted, release to the ash pond and discharge without treatment.

2. Stage release by slowly releasing the wastewater from the holding pond or containment to the ash pond over a number of days.

3. Reduce the pH of the wastewater to meet CMC/CCC limits.

4. Employ other treatment measures such as biological degradation, air stripping, recirculating sand filters, etc.

5. Employ a combination of these measures.

PREFERRED ALTERNATIVE

TVA's proposed action is the preferred alternative: Extend the catalyst life by increasing slip up to values that do not violate opacity standards, water quality criteria, NPDES action levels, or toxicity reference values as appropriate based on constraints at individual facilities. This would allow some SCR units to optimize operations, both by extending catalyst life and by allowing NOx reduction to be sustained at the design level.

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