

Document Type: EA-Administrative Record
Index Field: Final Environmental Document
Project Name: NOxOUT Selective Noncatalytic
Reduction Demonstration, Unit 1
Shawnee Fossil Plant
Project Number: 2005-44

FINAL ENVIRONMENTAL ASSESSMENT

NOxOUT SELECTIVE NONCATALYTIC REDUCTION DEMONSTRATION SHAWNEE FOSSIL PLANT - UNIT 1 West Paducah, Kentucky

TENNESSEE VALLEY AUTHORITY

APRIL 2005

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Shawnee Fossil Plant – Unit 1
West Paducah, Kentucky

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Abstract: Tennessee Valley Authority (TVA) is proposing to install and evaluate equipment for removal of nitrogen oxides (NOx) from coal combustion flue gas, utilizing selective noncatalytic reduction on Unit 1 at Shawnee Fossil Plant. This action would help TVA meet its systemwide goal of reducing NOx emissions by over 78 percent. NOx emissions are a major factor in causing air pollution, including acid rain and high ground-level ozone concentrations. Reductions of NOx emissions are necessary to meet air regulatory requirements under Section 110 of the Clean Air Act.

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CHAPTER 1

1. PURPOSE OF AND NEED FOR ACTION

1.1. The Decision

Tennessee Valley Authority (TVA) is proposing to install and evaluate equipment for removal of nitrogen oxides (NO_x) from coal combustion flue gas, utilizing selective noncatalytic reduction (SNCR) on Unit 1 at Shawnee Fossil Plant (SHF). This action would help TVA meet its systemwide goal of reducing NO_x emissions by over 78 percent. NO_x emissions are a major factor in causing air pollution, including acid rain and high ground-level ozone concentrations. Reductions of NO_x emissions are necessary to meet air regulatory requirements under Section 110 of the Clean Air Act.

1.2. Background

1.2.1. NO_xOUT SNCR – General Description of Process

NO_xOUT SNCR is a patented, urea-based NO_x reduction technology that is derived from research conducted in the early 1970s by the Electric Power Research Institute. NO_xOUT SNCR is an in-furnace, post-combustion NO_x reduction technology that relies on the finely controlled distribution of urea to effect a selective reaction of gas-phase ammonia with NO_x within a specific temperature region in the upper furnace. For this application, the urea is delivered and stored as a 40 to 50 percent aqueous solution that is continuously circulated through the SNCR system-piping loop. Using plant raw water, a metering module further dilutes the reagent to a predetermined concentration and precisely controls the flow of diluted reagent to distribution modules. The distribution modules provide the final control of diluted reagent and atomizing/cooling (plant) air being delivered to each injector into the boiler, where droplet size and trajectory for each injector have been determined through advanced computer modeling. The final spray characteristics and flow rate of diluted reagent for each injector are fine-tuned during system optimization and startup to correspond to specific boiler operating loads and NO_x concentration. Figure 1-1 shows a typical conceptual layout for a multiple-level SNCR system installed on a single boiler.

SNCR is an in-furnace NO_x reduction process that has been applied to a variety of boiler and furnace types burning a wide range of fuels. Because SNCR is a post-combustion NO_x reduction technology, the type of furnace and fuel being burned are much less critical than the flue gas composition, temperature downstream of the combustion zone, and other operating conditions. In a coal-fired application, the important process design parameters, beyond temperature and residence time, are the carbon monoxide concentration in the upper furnace region and the sulfur trioxide (SO₃) concentration at the air preheater (APH) inlet. All of these factors must be taken into account in the final SNCR system design.

1.2.2. Site Description

SHF is located on 2,696 acres about 10 miles northwest of Paducah, Kentucky, on the Ohio River. The plant has ten generating units with a combined capacity of 1,369 megawatts. Plant construction began in January 1951. The first generating unit went into operation in April 1953. By October 1956, all ten of the plant's coal units were generating power. SHF consumes some 9,600 tons of coal per day and generates about 7.5 billion kilowatt-hours

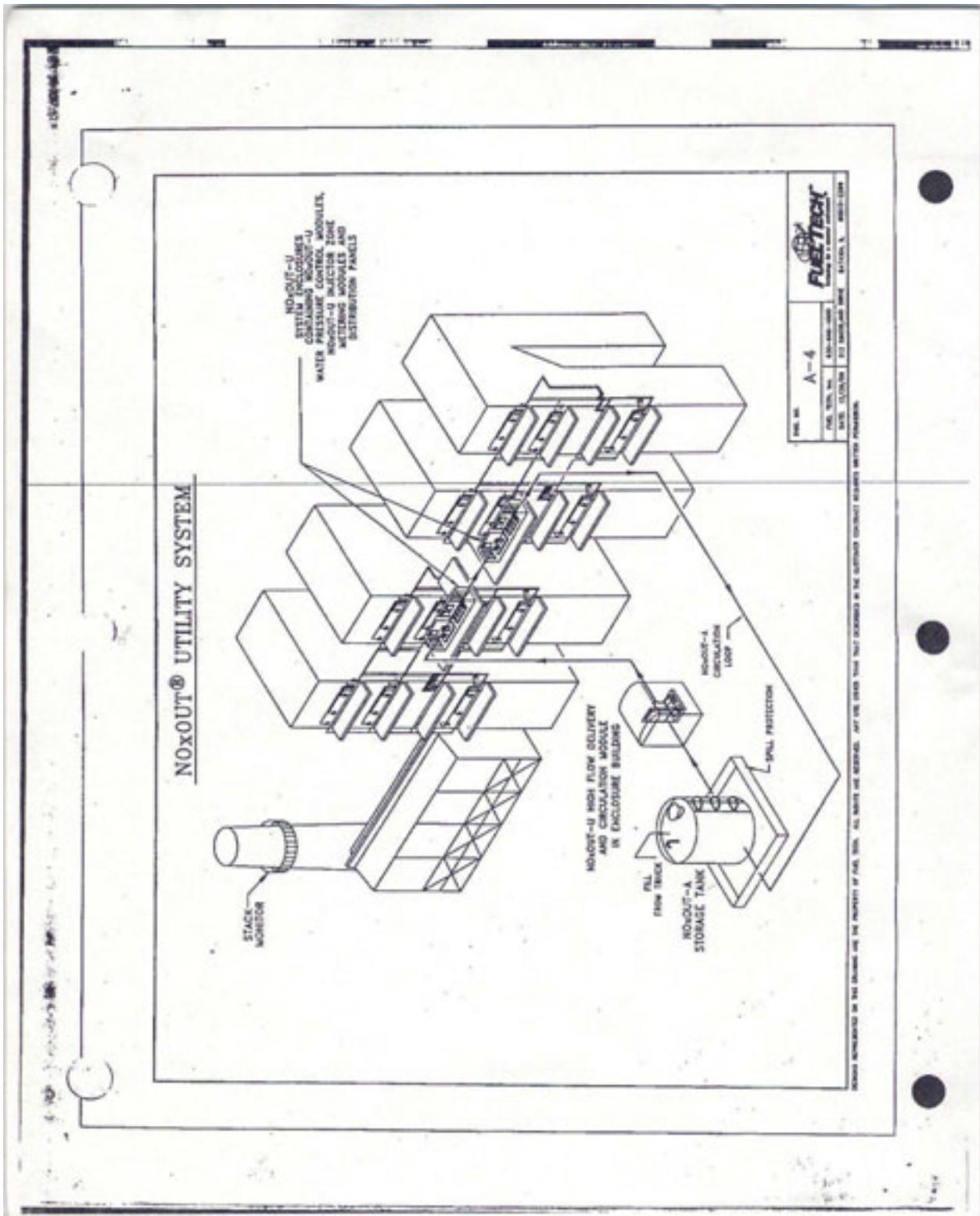


Figure 1-1. Typical Conceptual Layout for a Multiple-Level Selective Noncatalytic Reduction System Installed on a Single Boiler

of electricity a year, enough to supply 550,000 homes. SHF Unit 10 is the site of the nation's first demonstration of a commercial-scale atmospheric fluidized bed combustion (AFBC) boiler for using high-sulfur coal. See Figure 1-2 for site map.

1.3. Other Pertinent Environmental Reviews or Documentation

National Environmental Policy Act documents prepared by TVA related to the SHF and/or SNCR system operation are listed below.

Tennessee Valley Authority. 1984. Atmospheric Fluidized Bed Combustion 160-Megawatt Add-On Boiler, Shawnee Steam Plant Environmental Assessment. May 1984.

Tennessee Valley Authority. 1995. Energy Vision 2020 - Integrated Resource Plan Environmental Impact Statement. December 1995.

Tennessee Valley Authority. 2005. NOxOUT Selective Noncatalytic Reduction Demonstration, Johnsonville Fossil Plant Environmental Assessment. April 2005.

1.4. The Scoping Process

A TVA interdisciplinary team reviewed the proposed project for potential direct, indirect, and cumulative effects of Alternative A, the No Action Alternative, and Alternative B, Demonstration of NOxOUT SNCR System on SHF Unit 1. Potentially affected resources include air, water (industrial wastewater, surface water, and groundwater), solid waste, and aquatic resources.

1.5. Necessary Federal Permits, Licenses, or Notifications

Action Alternative B would require the following to be obtained:

- An asbestos removal notification would be obtained for boiler penetration work.
- A National Pollutant Discharge Elimination System (NPDES) permit modification may be necessary for ammoniated wastewater discharge from Outfall 001.

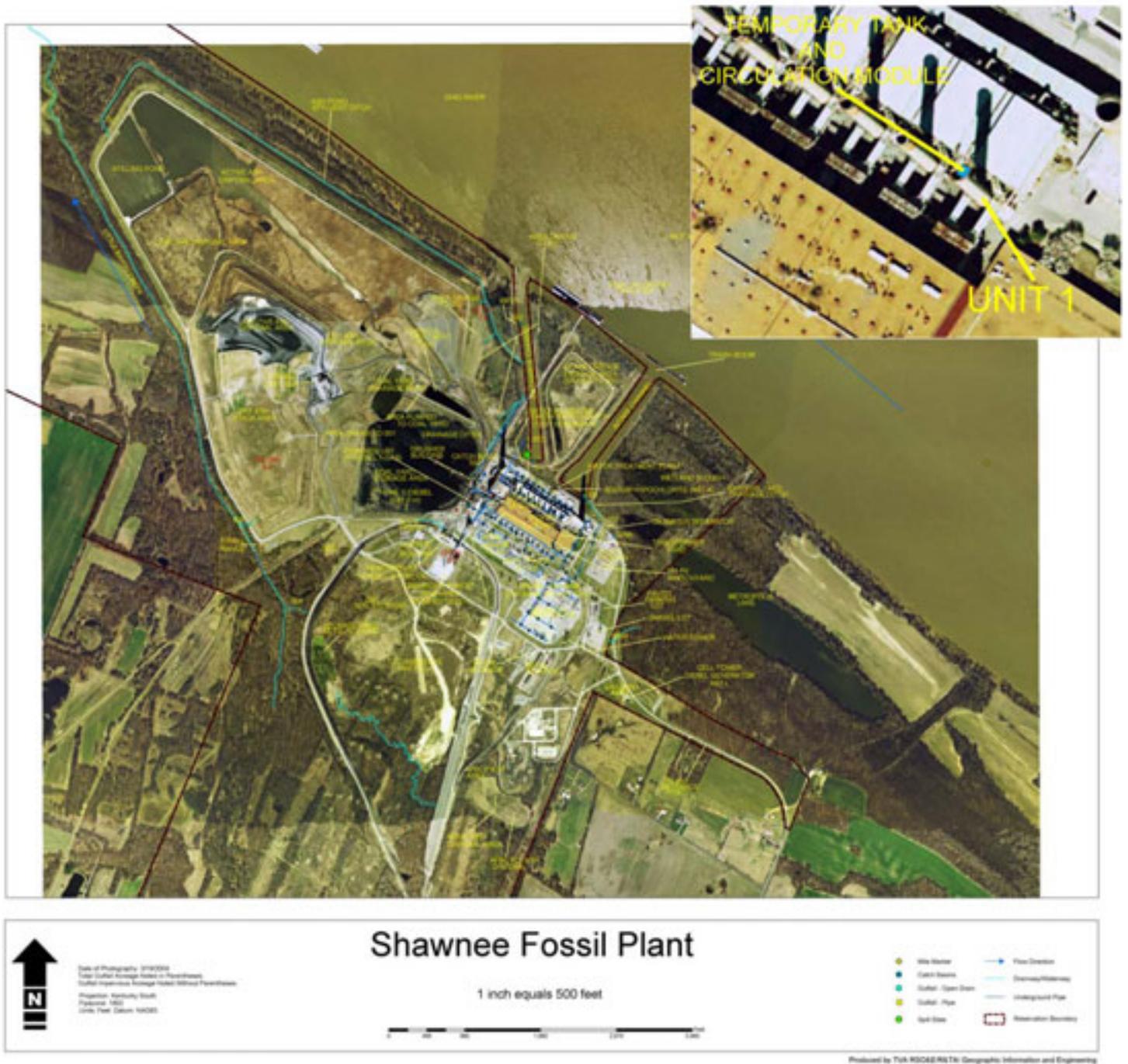


Figure 1-2. Shawnee Fossil Plant Site Map With Expansion of Unit 1 and Area for the Proposed Location of the Temporary Frac Tank and Circulation Module

CHAPTER 2

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the No Action and Action Alternatives and discusses the environmental consequences of each.

2.1. Alternatives

This Environmental Assessment (EA) evaluated two alternatives: Alternative A, the No Action Alternative, and Alternative B (the Action Alternative), Demonstration of NO_xOUT SNCR System on SHF Unit 1.

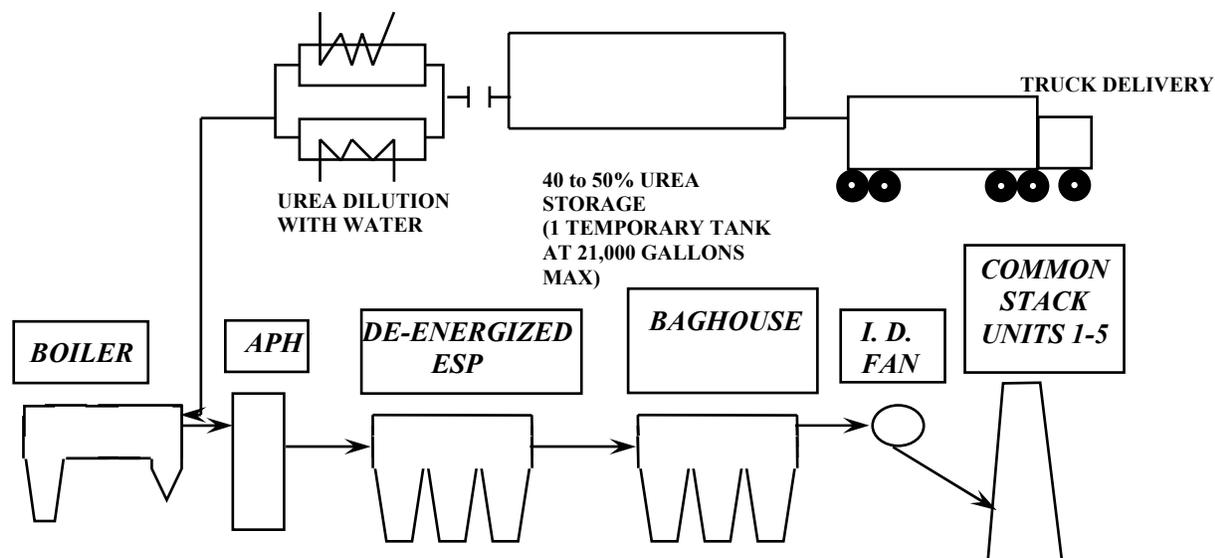
2.1.1. *Alternative A – The No Action Alternative*

Under Alternative A, the plant would not install and demonstrate the NO_xOUT SNCR system on Unit 1 at SHF. Under Alternative A, there would be no physical or operational changes to SHF.

2.1.2. *Alternative B – Demonstration of NO_xOUT SNCR System on SHF Unit 1*

Under Alternative B, the plant would install and demonstrate the NO_xOUT SNCR system. This demonstration would be conducted on SHF's Unit 1 during 2005 and 2006. If the demonstration proved successful, another environmental review would be conducted to determine if SNCR could be placed on additional units at SHF.

Under Alternative B, there would be minor physical additions outside and inside the powerhouse. Alternative B would add a temporary 21,000-gallon frac tank to store the 40 to 50 percent urea solution (see Appendix A for the Material Safety Data Sheets for urea), a circulating module inside an enclosed modular building, and associated piping outside the powerhouse on the south side of the baghouse next to the Unit 1 stack at SHF. The metering module (elevation 374 between Units 1 and 2), the distribution modules (2 east of the boiler and 2 west of the boiler, elevation 374), and the 22 injectors (8 injectors [6 back and 1 on each side] on elevation 364.5, 6 injectors [front] on elevation 366.5, and 8 [6 in front and 1 on each side] on elevation 378) would be located inside the powerhouse. See Figure 1-1 for a visual description of equipment. See Figure 2-1 for a proposed SNCR treatment train for SHF Unit 1. The general SNCR process is described under Section 1.2 of this EA.



% = Percent
 APH = Air Preheater
 ESP = Electrostatic Precipitator
 I.D. Fan = Induced Draft Fan
 Max = Maximum

Figure 2-1. Proposed Selective Noncatalytic Reduction Treatment Train at Shawnee Fossil Plant Unit 1

2.2. Comparison of Alternatives

For a comparison of environmental impacts under each alternative, see Table 2-1.

Table 2-1. Comparison of Potential Environmental Impacts

Resource Area or Environmental Issue	Alternative A No Action	Alternative B Demonstration of NOxOUT SNCR System on SHF Unit 1
Air	None	<ul style="list-style-type: none"> • Transient air pollutant emissions would occur during the construction phase of this project. • Land clearing, site preparation, and vehicular traffic over unpaved roads and construction sites would result in the emission of fugitive dust particulate matter (PM) during site preparation and active construction periods. • Combustion of gasoline and diesel fuel by

Resource Area or Environmental Issue	Alternative A No Action	Alternative B Demonstration of NOxOUT SNCR System on SHF Unit 1
		<p>internal combustion engines (vehicles, generators, construction equipment, etc.) would generate local emissions of PM, NOx, carbon monoxide, volatile organic compounds (VOCs), and sulfur dioxide (SO₂) throughout the site preparation and construction period.</p> <ul style="list-style-type: none"> • There would be the possibility of slight increases in ammonia concentrations downwind of the plant site. • The overall effect of the change in ambient ozone concentration (or the frequency of that change) at a specific place due to NOx emission reductions at SHF during operation would be to reduce the amount of ozone produced in the atmosphere. • Allowing ammonia to slip through the system without reacting could lead to the formation of particulate, which could lead to a slight increase in the atmospheric particulate burden.
Wastewater	None	<ul style="list-style-type: none"> • Ammoniated runoff rate from the dry ash stacking area for the 10-year, 24-hour, 5-inch rainfall event is estimated to be approximately (~) 1.32x10⁵ cubic feet per day (cfd). • The worst-case ammonia content of the mixed fly ash from Units 1-9 is estimated to be 233 milligrams ammonia per kilogram ash (mg NH₃/kg) based on the ammonia slip rate of 20 parts per million by volume (ppmv), 80 percent partitioning of ammonia to fly ash, 10 percent fugitive emission losses, and the ash production rates. • The worst-case estimated NH₃ concentration at the ash pond discharge is estimated to be 0.29 mg ammonia nitrogen per liter (NH₃-N/L), which is 4.5 times less than the lowest criterion maximum concentration (CMC) for the 6.0 to 9.0 standard units (s.u.) pH range allowed by the current SHF Kentucky Pollutant Discharge Elimination System (KPDES) permit.

Resource Area or Environmental Issue	Alternative A No Action	Alternative B Demonstration of NOxOUT SNCR System on SHF Unit 1
<p align="center">Surface Water</p>	<p align="center">None</p>	<ul style="list-style-type: none"> • Construction impacts, temporary erosion and sedimentation, would be minimized by implementing best management practices (BMPs) to control erosion during construction, stabilizing disturbed areas after completion of construction, and routing surface runoff to existing treatment facilities that meet regulatory requirements. • The projected ammonia concentration in the Ohio River for worst-case conditions was calculated to be no greater than 0.09 mg NH₃-N/L, which would be below the chronic criterion concentration (CCC) for the extreme conditions of pH 9.0 and temperatures greater than 86 degrees Fahrenheit (°F). • Other sources of ammonia to the Ohio River from SHF would be ammonia-laden storm water runoff from the dry stack area, and leachate seepage from the dry stack area directly to the Ohio River and via Little Bayou Creek (LBC) to the Ohio River. Assuming storm water runoff from a 10-year, 24-hour, 5-inch rainfall event and ammonia content in the mixed ash on the dry stack of 48 mg NH₃-N/kg (based on 5 ppmv NH₃ slip), the combined loading to the Ohio River from these sources would be approximately 62 kg NH₃-N/day. • Based on the Ohio River 7Q10 low flow rate of 46,300 cubic feet per second (cfs), the added NH₃-N concentration in the river from all the ammonia sources would remain at 0.09 milligrams per liter (mg/L), which is below the CCC for expected conditions.
<p align="center">Groundwater</p>	<p align="center">None</p>	<ul style="list-style-type: none"> • The NH₃-N content of the mixed fly ash from Units 1-9 would be 48 mg/kg (based on 5ppmv NH₃ slip). • The worst-case NH₃-N concentration of the leachate emerging from the base of the ash stack is estimated to be ~114 mg/L. • The NH₃-N loading to LBC would be ~0.29 kg/day assuming no transformation or attenuation of ammonia during groundwater transport. • Bounding estimates of the NH₃-N concentration in LBC under low flow conditions of 0.12 to 0.31 mg/L are

Resource Area or Environmental Issue	Alternative A No Action	Alternative B Demonstration of NO _x OUT SNCR System on SHF Unit 1
		<p>obtained assuming complete mixing of the NH₃-N load (0.29 kg/day) with the reported Lindquist et al. (1992) and USGS low flows, respectively.</p> <ul style="list-style-type: none"> The NH₃-N loading to the Ohio River would be ~1.5 kg/day assuming no transformation or attenuation of ammonia during groundwater transport. Impacts would be negligible due to the high dilution capacity of the river.
Solid Waste	None	<ul style="list-style-type: none"> Ash from Unit 1 would be mixed with ash from other units to ensure that the ammonia content of the mixed ash is less than 100 parts per million (ppm) to prevent a detectable odor. Ammoniated ash greater than 50 ppm would not be marketable.
Aquatic Ecology	None	<ul style="list-style-type: none"> The storage, handling, and use of urea solutions for the proposed NO_xOUT SNCR system would result in the potential for ammonia or other nitrogenous compound contamination of surface water and impacts to aquatic life. One pathway for impacts would be a direct accidental release of urea to surface water. The engineered features of the urea storage system include a retention basin for spills to minimize this risk. Management of water treatment system flows and other appropriate mitigation measures, as necessary, would maintain discharge ammonia concentrations at levels that would safeguard water quality and protect aquatic life.
Protected Aquatic Species	None	<ul style="list-style-type: none"> Due to the possibility for release ammonia to surface waters or through groundwater migration to the Ohio River or LBC, there exists a potential for impact to aquatic resources. However, with mitigation safeguards to minimize ammonia in the discharge, there would be no impacts to listed aquatic species.

2.3. The Preferred Alternative

TVA's preferred alternative is Alternative B, Installation and Demonstration of the NO_xOUT SNCR System on SHF's Unit 1.

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CHAPTER 3

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

SHF staff conducted a preliminary examination of the scope of this project and discussed issues of environmental concern. There were several media and resource areas that were determined to have no impacts, i.e., archeology, terrestrial ecology, visual, and noise impacts. However, there were a few media and resource areas that had uncertainties regarding the potential for impacts. The SHF staff determined that these areas needed a greater degree of evaluation. Subsequently, an EA was initiated. The media and resource areas evaluated and discussed in this EA are air, water (industrial wastewater, surface water, and groundwater), solid waste, aquatic ecology, and protected aquatic species.

3.1. Air

3.1.1. *Affected Environment*

The air quality in the vicinity of SHF is generally good, with the area in compliance with all air quality standards. Regionally, air quality is also generally good. The new 8-hour ozone standard promulgated by the United States Environmental Protection Agency (USEPA) in 1997 is more stringent than the old ozone standard, and many areas are having difficulty meeting attainment of the new standard. In addition, some areas, including McCracken County, could experience periods when fine particulate concentrations will be above the recently adopted annual PM_{2.5} standard.

3.1.2. *Environmental Consequences*

3.1.2.1. **Alternative A - No Action**

Under the No Action Alternative, current air quality in the vicinity of SHF is expected to continue.

3.1.2.2. **Alternative B - Demonstration of NOxOUT SNCR System on SHF Unit 1**

Construction Impacts

Under Alternative B, transient air pollutant emissions would occur during the construction phase of this project. Since the SHF site has already been developed as an industrial site, construction-related emissions would be relatively less than for a new site. Construction-related air quality impacts are primarily related to land clearing, site preparation, and the operation of internal combustion engines.

Vehicle Emissions and Excavation Dust

Land clearing, site preparation, and vehicular traffic over unpaved roads and construction sites would result in the emission of fugitive dust PM during site preparation and active construction periods. The largest-size fraction (greater than 95 percent by weight) of fugitive dust emissions would be deposited within the construction site boundaries. The remaining fraction of PM would be subject to longer-range transport. As necessary, appropriate BMPs would be utilized (i.e. water suppression) to control fugitive dust emissions in open construction areas and on unpaved roads.

Combustion of gasoline and diesel fuel by internal combustion engines (vehicles, generators, construction equipment, etc.) would generate local emissions of PM, NO_x, carbon monoxide, VOCs, and SO₂ throughout the site preparation and construction period. The total amount of these emissions would be small and would result in minimal off-site impacts.

Air quality impacts from construction activities would be temporary and dependent on both man-made factors (e.g., intensity of activity, control measures, etc.) and natural factors (e.g., wind speed, wind direction, soil moisture, etc.). However, even under unusually adverse conditions, these emissions would have, at most, a minor, transient impact on off-site air quality that would not exceed or violate any applicable ambient air quality standard. Overall, the air quality impact of construction-related activities for the project would not be significant.

Operational Impacts

Alternative B operational impacts would not adversely impact local air quality. There would be the possibility of slight increases in ammonia concentrations downwind of the plant site. This possibility is discussed below. Overall, operational impacts would improve air quality.

Ozone-Scavenging Losses

Ozone concentrations below background levels occur immediately downwind of NO_x sources, such as power plants, due to ozone scavenging, i.e., nitric oxide emissions consuming ozone. Significant ozone production does not occur until 20 to 80 kilometers (km) downwind of the NO_x source. The proposed SNCR reduction of NO_x emissions might reduce the size of the area in which ozone scavenging occurs. While ozone concentrations might increase slightly in areas previously affected by ozone scavenging, they would not be expected to increase above background ozone levels.

Plume Opacity and Plume Blight

Plume opacity is determined by the amount of nitrogen dioxide and PM emitted. Due to the optical properties of nitrogen dioxide, it tends to give a plume a slight reddish-brown color when viewed against a clear sky. Since Alternative B would greatly reduce NO_x emissions, it would also be expected to reduce plume opacity and plume blight.

Regional Impacts

The primary purpose of Alternative B would be to reduce emissions of NO_x, a pollutant that can, in combination with VOCs and sunlight, lead to the production of ozone. The purpose of this section is to describe the nature of ozone and the impacts that reducing NO_x emissions from SHF would have on ambient ozone levels. In addition, the potential impact of Alternative B on secondary particulate formation and regional haze is described.

Ozone

Ozone forms in the atmosphere as a result of a mixture of NO_x and VOCs being exposed to sunlight. Both NO_x and VOCs have natural and anthropogenic (man-made) emissions' sources. For example, isoprene (a VOC important in ozone formation) is primarily emitted from trees and crops. Other VOCs, however, are emitted into the atmosphere as the consequence of human activity, such as the use of solvents or the operation of motor vehicles. While there are also natural sources of NO_x, they are relatively small compared to the NO_x emitted from motor vehicles and other forms of fuel combustion. Since large

utility boilers burn large quantities of fossil fuel, they are a major source of the NO_x emitted into the atmosphere.

Ozone levels in the TVA region have historically been less than the National Ambient Air Quality Standards (with the exception of a few urban centers). With the recent revision of the ozone standard from a 1-hour average concentration of 120 parts per billion (ppb) to an 8-hour average concentration of 80 ppb, more areas in the TVA region are expected to experience ozone concentrations exceeding the standard. Furthermore, it is anticipated that a number of urban areas and even some remote, rural areas in the Appalachian Mountains, which barely met the former 1-hour standard, will experience ozone concentrations above the 8-hour standard.

Although it is not possible to quantify the change in ambient ozone concentration (or the frequency of that change) at a specific place due to NO_x emission reductions at SHF, it is known from previous modeling and air quality research that the overall effect would be to reduce the amount of ozone produced in the atmosphere. It is also known that the area that would benefit the most would be the area within about 150 km downwind from SHF.

Secondary Particulate and PM₁₀/PM_{2.5}

Although almost all of the urea would be chemically converted to nitrogen and water in the reactions that would be responsible for the reduction in NO_x emissions, there would be a possibility that some ammonia would be emitted from the stack. Since ammonia is associated with the formation of particulate in the atmosphere, any ammonia that would be emitted has the potential to result in the formation of additional atmospheric particulate. Therefore, allowing ammonia to slip through the system without reacting could lead to the formation of particulate, which could lead to a slight increase in the atmospheric particulate burden. However, the bag filter control device would be very effective (99.8 percent control efficiency) in removing ammonia and its reaction products.

3.2. Industrial Wastewater

3.2.1. Affected Environment

Existing Coal Combustion Byproducts Wastewater Treatment Facilities

SHF Unit 1 produces 27,199 tons of fly ash and 4,000 tons of bottom ash per year, on a dry basis. The fly ash is handled in a dry ash collection system from which it can either be loaded dry into pneumatic trucks for use in concrete products or it can be conditioned with 15-20 percent moisture and hauled to an ash stacking area for disposal. The bottom ash is wet-slucied to the ash pond. The ash handling system at SHF does not retain the ability to wet sluice fly ash

As described in the following paragraphs, the coal combustion byproducts handling system at SHF includes the ash pond (Outfall 001); the chemical treatment pond (Outfall 004), which is pumped to the coal yard drainage basin then pumped to the ash pond; and the dry ash stack area, which drains to the ash pond.

Ash Pond

The ash pond is permitted to receive combined wastewaters of ash sluice water, water treatment plant wastes, dry fly ash and limestone handling facilities' wastes, station sump discharges, effluent from the chemical treatment pond, APH washing wastes, and storm water runoff. The ash pond inflow sources and flow rates are listed in Table 3-1. The ash

pond effluent is discharged to the discharge channel, which also receives the condenser cooling water flow (1,463 million gallons per day [mgd]), as well as other lesser flows.

The ash pond receives wet-sluciced bottom ash only; SHF has no capability to wet-slucice fly ash to the ash pond (personal communication, Traci Thompson, TVA SHF, January 14, 2005). The bottom ash collects in the bottom of the boiler and is washed from the boiler bottoms with jets of water and sluciced to a bottom ash dewatering area within the ash pond system. The bottom ash slucice water is discharged to the ash pond at a rate of 19.44 mgd.

The APHs are washed during the outages, typically once every 3 years. The wastewater from the cleaning of the APHs is discharged to the ash pond. In addition, the APHs are steam cleaned weekly, removing an estimated 10 percent of the waste that is collected on the interior surfaces. The wastes from the weekly steam cleaning are disposed of at the dry ash stack area. Storm water runoff from the dry ash stack area flows to the ash pond.

According to the current Kentucky Pollutant Discharge Elimination System (KPDES) permit, TVA is required to meet the ash pond effluent limits presented in Table 3-2. These requirements do not include limitations for ammonia concentrations in the discharge, but do include limits for acute toxicity. The ash pond is equipped with a carbon dioxide system used to regulate pH conditions at the discharge to maintain compliance with the KPDES permit requirements.

Table 3-1. Inflow Sources to Ash Pond

Source	Inflow to Ash Pond (mgd)
Ash slucice water	19.44
Coal yard drainage basin (receives effluent from the chemical treatment pond and station sumps)	5.7105
Inactive and active ash disposal areas, dry ash stacking areas, coal/ash dredge cell	0.4101
Limestone storage area and sump	0.0084
Air preheater washing wastes	0.0040
Pressure washing waste, water treatment plant waste	0.1501
Portable hand wash stations	0.0001
Precipitation	0.1709
Ash pond seepage	- 0.017
Evaporation	- 0.1226
Total	25.7545

Source: March 2002 Wastewater Flow Schematic KPDES Permit Number KY0004219

Table 3-2. Discharge Serial Number 001 Discharge Requirements

Effluent Characteristics	Effluent Limitations				Monitoring Requirements	
	Monthly Average		Daily Maximum		Measurement Frequency	Sample Type
	Average Concentration	Average Amount	Average Concentration	Average Amount		
	(mg/L)	(lb/day)	(mg/L)	(lb/day)		
Flow	Report (mgd)		Report (mgd)		1/Week	Weir
pH	Range 6.0 – 9.0 (s.u.)				1/Week	Grab
Total Suspended Solids	30	--	67	--	1/Month	Grab
Oil and Grease	10.2	--	10.2	--	1/Month	Grab
Hardness (as mg/L of CaCO ₃)	Report	--	Report	--	1/Week	Grab
Chromium (total)	Report	--	Report	--	1/Quarter	Grab
Copper (total)	Report	--	Report	--	1/Quarter	Grab
Zinc (total)	Report	--	Report	--	1/Quarter	Grab
Acute Toxicity*	N/A	--	1.00 TU _a	--	1/Quarter	Grab

Source: KPDES Permit Number KY0004219 effective October 1, 1997

mg/L = milligrams per liter lb/day = pounds per day mgd = million gallons per day s.u. = standard units

CaCO₃ = Calcium Carbonate

*TU_a = acute toxicity unit; quarterly tests conducted the first year of the permit with annual tests in subsequent years

Chemical Treatment Pond

The chemical treatment pond receives chemical boiler cleaning wastes and other metal cleaning wastes with or without chemical cleaning compounds, including boiler tube cleaning, boiler fireside cleaning, and APH cleaning. The chemical treatment pond has discharge limitations for total copper and total iron and requirements for reporting flow and pH measurements for each batch. The volume of the chemical treatment pond is 4.225 million gallons (personal communication, Traci Thompson, TVA SHF, January 19, 2005). The chemical treatment pond is pumped to the coal yard drainage basin and then pumped from the coal yard drainage basin to the ash pond.

Dry Ash Stacking Area

The fly ash handling system at SHF is a dry ash handling system. Dry fly ash is disposed of on the dry ash stack. The maximum active area of exposed dry fly ash at the dry fly ash stacking area is 10 acres or less. As stacking areas become inactive, they are stabilized with an interim cover, such as soil or bottom ash, for fugitive emission controls. Fugitive emission controls are required on the unexposed or stabilized areas. The dry fly ash stack is graded at the end of each day to limit ponding and encourage sheet flow runoff. Runoff from the active dry fly ash stacking area flows to the ash pond.

3.2.2. Environmental Consequences

3.2.2.1. Alternative A - No Action

TVA would continue to operate SHF without the NO_xOUT SNCR demonstration on Unit 1, and no impacts to industrial wastewater are anticipated beyond the effects of existing and future activities associated with routine operation of the plant.

3.2.2.2. Alternative B - Demonstration of NOxOUT SNCR System on SHF Unit 1

Operational Impacts

Ammonia Slip

As stated in Section 1.2, the NOxOUT SNCR system is an in-furnace, post-combustion NOx reduction technology that relies on the finely controlled distribution of urea to effect a selective reaction of gas-phase ammonia with NOx. Ammonia slip, the emission of unreacted ammonia (NH₃), is caused by the incomplete reaction of the ammonia with NOx present in the flue gas. The unreacted NH₃ could react with available gaseous sulfuric acid to form ammonium bisulfate (NH₄HSO₄), which is a very sticky substance. Ammonia slip tends to adhere to or commingle with the fly ash and/or build up on the APH interior surfaces. Formation of NH₄HSO₄ could accelerate the buildup inside the APHs and make the periodic cleaning of the APHs more difficult.



European experience with selective catalytic reduction (SCR) NOx control systems at facilities using low-sulfur coals led to a recent study conducted by ABB Environmental. The study concluded that about 20 percent of the NH₃ slip adhered to the heating surfaces in the APH, and about 80 percent adhered to the fly ash (ABB Environmental, 2000). No known ammonia partitioning study for SNCRs has been performed. This EA assumes that the partitioning would be similar to the ABB SCR study. Until there is further experience with United States coal types, the partitioning of ammonia slip between fly ash and APH heating surfaces will be based on professional judgments.

The amount of ammonia slip would depend on unit operation. The ammonia slip rate would vary during the demonstration to determine the optimum operational settings. Since there would be no catalyst subjected to fouling, the slip rate would be assumed to be constant during SNCR operations, unless the urea injection rate changed. Initially the expected slip rate would be 5 ppmv, but could be 20 ppmv or higher. For this EA, slip rates of 5 ppmv and 20 ppmv will be discussed to provide information to determine the significance of environmental impacts.

Air Preheater Cleaning

The Unit 1 APHs are steam cleaned weekly while the units are online. The ammonia removed during the steam cleaning would be estimated to be 10 percent of the ammonia accumulated in the APHs. The APH steam-cleaning waste is disposed of at the dry ash stack area, which drains to the ash pond.

About once every 3 years, the two Unit 1 APHs are thoroughly washed during the Unit 1 outages. Approximately 100,000 gallons of water is used to clean the APHs during a 24-hour period (personal communication, Traci Thompson, TVA SHF, January 4, 2005). Formation of ammonium bisulfate due to ammonia reacting with sulfuric acid in the flue gas could build up on the interior surfaces of the APHs. Additional wash water might be required to remove the sticky ammonium bisulfate and eliminate plugging. For the purposes of this EA, the volume of water needed to clean the Unit 1 APHs is assumed to be 100,000 gallons, which provides the least amount of dilution. For the worst-case scenario analyzed for this EA, the SNCR would operate continuously during a portion of the ozone season in 2005 (July through October), and before, during, and after the ozone season in 2006 (mid-April through October). The Unit 1 APH cleaning is assumed to occur after the 2-year demonstration, which provides the worst-case condition for buildup of ammoniated

material on the APHs. Currently, the APH wash wastewater is discharged directly to the ash pond.

Bottom Ash

Bottom ash sluice water, which is the largest inflow to the ash pond, would not be anticipated to be affected by ammonia slip. The SNCR operation is an in-furnace, post-combustion NO_x reduction technology where the urea is injected into the flue gas. The bottom ash is collected in the bottom of the boiler prior to the point where the urea would be injected. Therefore, any ammonia slip would be entrained in the flue gas and would have no contact with the bottom ash. The ammonia slip would be accounted for on the fly ash and on the interior surfaces of the APHs, presumably 80 percent with the fly ash and 20 percent with the APHs (ABB Environmental, 2000).

Ammonia Loading to the Ash Pond

Ammonia Criteria

The current SHF KPDES permit requirements for the Outfall 001 discharge do not include limitations for ammonia concentrations; however, limits for acute toxicity are included and there are existing water quality criteria for ammonia. The acute criterion (criterion maximum concentration or CMC) for protection of aquatic life ammonia toxicity is defined as the 1-hour average concentration of total ammonia nitrogen (in mg N/L) that should not be exceeded more than once every 3 years on average. The CMC is not affected by temperature but does vary with pH. As the pH increases, the CMC decreases (Table 3-3). The CMC for ammonia must be met at the Outfall 001 discharge point in accordance with regulations and KPDES permit requirements.

Table 3-3. Maximum Allowable Ammonia Concentrations to Protect Aquatic Life From Acute Effects at Typical pH Levels

Acute Criterion (mg NH ₃ -N/L)						
pH 6.0	pH 6.5	pH 7.0	pH 7.5	pH 8.0	pH 8.5	pH 9.0
54.99	48.83	36.09	19.89	8.41	3.20	1.32

Note: Assumes salmonids are absent

Similarly, the CCC for ammonia must be met in the receiving stream to protect the aquatic biota of the Ohio River. The CCC is defined as the 30-day average concentration not to be exceeded more than once every 3 years. In addition, the highest 4-day average within the 30-day period should not exceed 2.5 times the CCC. The CCC is dependent on both temperature and pH. As temperature and/or pH increases, the CCC decreases (Table 3-4).

Table 3-4. Thirty-Day Average Allowable Ammonia Concentrations to Protect Aquatic Life From Chronic Effects at Selected pH Levels

Chronic Criterion Concentration (CCC) (mg NH ₃ -N/L)				
Temperature (°F)	pH 7.5	pH 8.0	pH 8.5	pH 9.0
70	2.85	1.59	0.71	0.32
75	2.38	1.33	0.6	0.27
80	1.99	1.11	0.5	0.22
82	1.86	1.03	0.46	0.21
84	1.73	0.96	0.43	0.19
86	1.61	0.90	0.4	0.18

Note: Assumes salmonids are absent

Storm Water Runoff Loading

The 10-year, 24-hour, 5-inch rainfall event would produce the worst-case ammonia mass loading to the ash pond from the dry ash stack area runoff. Total runoff from the dry stack for this event is estimated to be approximately 1.21×10^6 cfd (Petty, 1987). The ammoniated runoff rate from the active area is estimated at approximately 1.32×10^5 cfd. Transfer of ammonia from the ash surface to runoff was modeled using the physically based soil diffusion and runoff transport model of Wallach et al. (1988). The worst-case ammonia content of the mixed fly ash from Units 1-9 is estimated to be 233 mg-NH₃/kg ash based on the ammonia slip rate of 20 ppmv (17.76 lb/hour), 80 percent partitioning of ammonia to fly ash, 10 percent fugitive emission losses, and the ash production rates presented in Section 3.5. Other parameters applied in the model are presented in Table 3-5. The runoff is assumed to mix completely with the ash pond inflow and, due to short-circuiting, mix with only 50 percent of the ash pond free water volume. In addition, no volatilization, chemical degradation, or biological uptake of the ammonia is assumed for purposes of estimating the ammonia discharges. Results indicate the total ammonia mass loading to the ash pond from the dry stack runoff generated by the 24-hour storm event is approximately 73 kg. Under these conditions, the estimated ammonia concentration at the ash pond discharge (Outfall 001) is 0.29 mg NH₃-N/L, which is 4.5 times less than the lowest CMC for the 6.0 to 9.0 s.u. pH range allowed by the current SHF KPDES permit (Table 3-3). The impact of the ammoniated discharge produced by storm water runoff alone is determined to be insignificant only if the ammonia concentration discharged from Outfall 001 remains at or below the CMC.

Table 3-5. Parameters Applied in the Ammonia Runoff Model

Parameter	Units	Value
Ash Porosity	(dimensionless)	0.51
Ash Density	kg/L	1.21
NH ₃ Diffusion Coefficient	m ² /s	1.78x10 ⁻⁹
Kinematic Viscosity	m ² /s	1.02x10 ⁻⁶
Friction Factor	(dimensionless)	0.02
Surface Slope	m/m	0.03
Characteristic Length	m	60

kg/L = kilograms per liter
m²/s = square meters per second
m/m = meters per meter
m = meter

Outfall 001 effluent flows to the discharge channel prior to entering the Ohio River. Complete mixing can be assumed in the discharge channel considering the turbulent conditions and the fact that the ash pond effluent enters the discharge channel approximately 1,270 feet upstream of the Ohio River. If the ammonia concentration at the Outfall 001 discharge is 0.29 mg NH₃-N/L due to storm water runoff, after mixing with the discharge channel flow (average flow: 1,490 mgd) and the Ohio River (7Q10 flow: 29,910 mgd according to SHF KPDES Permit Number KY0004219), the concentration would be reduced to 0.0005 mg NH₃-N/L. For all allowable pH levels at Outfall 002 (6.0 to 9.0 s.u.) and for very high water temperatures, the ammonia concentration at the Ohio River is less than the CCC (Table 3-4). Therefore, the worst-case ammonia loading from storm water runoff alone is expected to have an insignificant toxicity impact to the receiving stream.

APH Cleaning Wastewater Loading

The largest ammonia loading to the ash pond would occur during the Unit 1 APH cleaning, assuming the wastewater would be discharged directly to the ash pond, as is the current procedure. The Unit 1 APH wash scenario analyzed for this EA assumes that there would be an 11-month buildup of ammonia on the APH surfaces (from the 2-year SNCR demonstration) prior to being washed. This buildup would result in ammonia loading of approximately 2,932 to 11,728 kg, assuming ammonia slip rate of 5 to 20 ppmv, respectively. Steady release of the ammoniated material is assumed throughout the washing process; although, it is likely that a more concentrated release would occur over a shorter time span at the beginning of the washing process.

Like the storm water runoff, the Unit 1 APH cleaning waste is assumed to mix completely with the ash pond inflow and, due to short-circuiting, mix with only 50 percent of the ash pond free water volume. In addition, no volatilization, chemical degradation, or biological uptake of the ammonia is assumed for purposes of estimating the ammonia discharges. Complete mixing of the Outfall 001 effluent is assumed in the discharge channel considering the turbulent conditions and the fact that the ash pond effluent enters the discharge channel approximately 1,270 feet upstream of the Ohio River.

As presented in Table 3-6, under these conditions for the direct release of the Unit 1 APH wash wastewater to the ash pond, the CMC is met only within specific pH ranges at Outfall 001 for both slip rates evaluated. For the 5-ppmv slip rate, the pH must be less than 8.0 to ensure the CMC is not exceeded, and for the 20-ppmv slip rate, the pH would have to be

less than 6.5 not to exceed the CMC at Outfall 001 (Table 3-3). Over the past 2 years at SHF, the measured pH levels at Outfall 001 ranged from 7.16 to 8.70 s.u. Although the ash pond does have a pH control system, under all operating conditions, the pH might not be able to be maintained below 8.0 s.u., much less be lowered to pH levels below 6.5 s.u. as needed during the Unit 1 APH cleaning. If a storm event occurred during the Unit 1 APH washing, runoff could contribute additional ammonia loading from the dry stack to the ash pond. Therefore, the Unit 1 APH wash wastewater should be contained (in a pond, frac tanks, etc.), the ammonia concentration should be determined, then the waste could be released over a number of days to ensure that the ammonia concentration at the Outfall 001 discharge remains at or below the CMC. Staging releases from the containment could also eliminate any risks of significant levels of ammonia being leached from the ash pond to LBC via groundwater flows. If the Unit 1 APH wash wastewater is contained then released in stages to ensure the effluent ammonia concentration remains at or below the CMC, no significant toxicity impacts are expected at the Outfall 001 discharge.

The ammonia concentration of the Unit 1 APH wash wastewater after mixing with the discharge channel flow and the Ohio River is very low for both slip rates evaluated (Table 3-6). For all allowable pH levels at Outfall 002 (6.0 to 9.0 s.u.), and for very high water temperatures (greater than 86°F), the ammonia concentration at the Ohio River is less than the CCC (Table 3-4). Over the past 2 years at SHF, the maximum water temperature at the intake was 84°F. Therefore, the Unit 1 APH wash wastewater being discharged directly to the ash pond is expected to have an insignificant toxicity impact to the receiving stream.

Table 3-6 Unit 1 Air Preheater Wash Wastewater Ammonia Concentrations

Ammonia Slip Rate (ppmv)	Ammonia Concentration Outfall 001 (mg NH₃-N/L)	Ammonia Concentration Outfall 002 at the Ohio River (mg NH₃-N/L)
5	12.80	0.02
20	51.21	0.09

Monitoring

As compounds containing ammonia dissolve, and as natural microbial and algal processes for assimilating ammonia proceed, pH changes can occur. To ensure that the ash pond discharge would meet the KPDES permit limits for both pH and acute toxicity, and to ensure that the effluent being discharged to the Ohio River would not exceed the CCC for ammonia, the existing CO₂ system would be utilized to control the pH.

TVA would monitor the ammonia concentration at the ash pond inflow, midpoint, and discharge during the Unit 1 APH staged release; in the Unit 1 fly ash; and in storm water runoff from the dry ash stacking area. TVA would ensure that all KPDES permit and other regulatory requirements for Outfalls 001 and 002 are met. As necessary, mitigation measures like staging releases or ensuring pond mixing would be activated to ensure that any ammonia released through Outfall 001 would remain below the CMC.

Staging Releases of the Unit 1 APH Wash Wastewater to the Ash Pond

To reduce the NH₃-N concentration at the ash pond discharge (Outfall 001), the Unit 1 APH cleaning waste would be retained in a pond (such as the chemical treatment pond), basin, frac tanks, or other containment. The ammonia concentration would be measured, and based on concentration results, the containment would be slowly released to the ash pond.

The number of days required for the staged release would depend on the ammonia concentration of the Unit 1 APH wash wastewater. The higher the ammonia concentration, more days would be required to meter the waste to ensure the ammonia concentration at the Outfall 001 discharge remained below the CMC. Staged releases from the chemical treatment pond would also eliminate any risks of significant levels of ammonia being leached from the ash pond to LBC via groundwater flows.

If utilized, the containment pond/basin should be checked to ensure there was enough free volume to accept the Unit 1 APH cleaning waste. If needed, the pond/basin would be pumped prior to receiving the waste. Pumps would be utilized to achieve mixing of the APH wastewater in the containment pond/basin.

Mixing of the ash pond inflow

If monitoring results for ammonia were trending toward the CMC limits for Outfall 001, installation of baffles could be utilized in the ash pond to improve mixing of the ash pond inflow with the free water volume of the pond. Baffling the ash pond would improve mixing to at least 75 percent and up to 100 percent. Baffling would also increase the retention time of the water, which would allow more time for chemical degradation and/or biological uptake of the ammonia.

Whenever needed, a combination of the above mitigation methods (monitoring, staging release, and mixing of the pond inflow) could be used to effectively control the ammonia concentrations at Outfall 001. There are also other mitigation options (listed here but not explained in detail) that could be utilized to control the ammonia concentrations at Outfall 001. These options are passive treatment systems such as constructed wetlands, addition of media for enhancing growth of nitrifying microorganisms in the ash pond, installation of aeration devices to improve dissolved oxygen concentrations to enhance aerobic microbial degradation of ammonia, installation of conventional treatment systems such as air stripping, trickling filters, recirculation sand filters, or biological treatment systems.

3.3. Surface Water

3.3.1. Affected Environment

The SHF site is located in West Paducah, McCracken County, Kentucky, on the Ohio River 35 miles upstream of its confluence with the Mississippi River (Ohio River Mile 946). The plant is bordered by the Ohio River and LBC, which are both classified as warm water aquatic habitats. The 7Q10 flow at the SHF discharge points on the Ohio River is 46,300 cfs, and on the LBC is 0 cfs (KPDES permit number KY0004219).

No reaches of the Ohio River fully support all uses. All of the river miles only partially support the fish consumption use because of limited fish consumption advisories for polychlorinated biphenyls (PCBs) and dioxin. For streams in the vicinity of SHF, drinking water use is fully supported (Kentucky 305(b) Report, 2004). According to the 2002 303(d) List for Kentucky (Kentucky Division of Water, 2003), the Ohio River from river mile 934.5 to 981.0 is on the second priority listing. This reach of the Ohio River partially supports both fish consumption and swimming. The pollutants of concern are PCBs, mercury, and pathogens. The suspected sources of the pollutants are combined sewer overflows, urban runoff/storm sewers, land disposal, agriculture, municipal point sources, industrial point sources, and contaminated sediments.

Besides the state of Kentucky's statewide fish consumption advisory for mercury, long-standing fish consumption advisories remain in effect in the 6.5 miles of LBC. LBC is identified as not supporting warm water aquatic habitat, and only partially supporting fish consumption (Kentucky 305(b) Report, 2002/2004). According to the 2002 303(d) List for Kentucky (Kentucky Division of Water, 2003), the LBC is on the first priority listing. The impaired uses identified are nonsupport for aquatic life and fish consumption. The pollutants of concern are PCBs, metals, and radiation. The suspected sources of the pollutants are industrial point sources and land disposal.

3.3.2. Environmental Consequences

3.3.2.1. Alternative A - No Action

TVA would continue to operate SHF without the NOxOUT SNCR demonstration on Unit 1, and no impacts to surface water are anticipated beyond the effects of existing and future activities associated with routine operation of the plant.

3.3.2.2. Alternative B - Demonstration of NOxOUT SNCR System on SHF Unit 1

Construction Impacts

No impacts to surface water would be expected from construction and installation of the SNCR system. All construction activities would be within the existing plant site. SHF is an industrial facility with existing BMPs in place. Any additional BMPs to prevent erosion and the discharge of sediment or other pollution materials to surface waters would be implemented in the SHF Integrated Pollution Prevention Plan as needed to ensure that potential effects would be minimized. Appropriate BMPs would be implemented, and all construction activities would be conducted to ensure that waste materials are contained and that no pollution materials are introduced into receiving waters.

Construction Workforce Domestic Sewage Disposal

Portable toilets or existing facilities would be made available to the construction workforce. Portable toilets would be pumped out regularly, and the sewage would be transported by tanker truck to a publicly owned treatment works.

Operational Impacts

No significant impacts to surface waters would be anticipated due to spills or leaks. The urea storage tank (maximum tank size would be 21,000 gallons) would be placed within a partial secondary containment. During the transfer of urea from tanker truck to holding tank, all normal BMPs would be applied to the unloading operation. All area storm drains would be blocked, containers would be placed under all connections, and all Department of Transportation requirements would be followed; the driver would be within 25 feet of the truck, awake, have an unobstructed view of the tanker, and be able to move the tanker should an emergency situation require it to be moved.

Leaks or spills from the piping inside the powerhouse would be routed to the ash pond via the station sump where the urea could be contained and cleaned up. The outside piping between the tank and the powerhouse would be a short section, which would minimize the risk for leaks to occur there. To reduce the risk of a leak in the outside piping further, the piping would be welded. Depending on the location and route of the piping, diversionary containment would be required.

No significant impacts on the water quality of the Ohio River would be anticipated from post-combustion ammoniated waste discharged from the SHF site. The worst-case condition evaluated for ammonia discharge via Outfall 001 was the Unit 1 APH wash wastewater being discharged directly to the ash pond assuming a 20-ppmv ammonia slip rate, an 11-month buildup of ammoniated material on the Unit 1 APH, and the 7Q10 low flow rate in the Ohio River of 46,300 cfs. The projected ammonia concentration in the Ohio River for these conditions was calculated to be no greater than 0.09 mg NH₃-N/L, which would be below the CCC for the extreme conditions of pH 9.0 and temperatures greater than 86°F (Table 3-4). This worst-case scenario assumes the Unit 1 APH wash wastewater would be discharged directly to the ash pond, yet there would be a commitment to contain the Unit 1 APH wash wastewater and slowly release it to the ash pond over a number of days to prevent potential impacts at Outfalls 001 and 002. Therefore, the ammonia concentration discharged to the Ohio River during the Unit 1 APH cleaning operation would be expected to be even lower (Section 3.2).

Other sources of ammonia to the Ohio River from SHF would be ammonia-laden storm water runoff from the dry stack area, and leachate seepage from the dry stack area directly to the Ohio River and via LBC to the Ohio River. Assuming storm water runoff from a 10-year, 24-hour, 5-inch rainfall event (Section 3.2) and ammonia content in the mixed ash on the dry stack of 48 mg NH₃-N/kg (Section 3.4), the combined loading to the Ohio River from these sources would be approximately 62 kg NH₃-N/day. The total ammonia loading from the dry stack area and the worst-case ammonia loading from the Unit 1 APH wash wastewater discharge (discussed in the previous paragraph) would be approximately 9,722 kg NH₃-N/day. Based on the Ohio River 7Q10 low flow rate of 46,300 cfs, the added NH₃-N concentration in the river from all the ammonia sources would remain at 0.09 mg/L, which is below the CCC for expected conditions.

No significant impacts on the water quality of the LBC would be anticipated from post-combustion ammoniated waste discharged from the SHF site. Although, limited physical/chemical measurements made in 1978 and 1988 in LBC showed one pH and temperature combination that resulted in a CCC of 0.10 (i.e., not protective since it is lower than the predicted worst case NH₃-N concentration in LBC of 0.12 to 0.31 mg/L), it is likely that the 30-day average concentration in this case would have been within the acceptable range since measurements in both the preceding and the following months resulted in CCCs higher than the predicted concentrations. Additional factors supporting the conclusion that the 2-year, one-unit SNCR test should not result in significant impacts in LBC include the following:

- The worst-case NH₃-N loading to LBC assumed no transformation or attenuation of ammonia during groundwater transport.
- No allowance was made for dilution of leachate seepage as it mixed with ambient groundwater during transport to LBC.
- During low flow stream conditions, the rate of leachate seepage would also be lower than average, since both stream flow and leachate generation are precipitation dependent.
- Biological activity in LBC would be expected to remove some portion of the NH₃-N, especially during warmer months when exceedances of criteria would be most likely.

3.4. Groundwater

3.4.1. Affected Environment

SHF lies at the northwestern limit of the Mississippi Embayment and within the Gulf Coastal Plain Physiographic Province. The predominant natural physiographic features of the site, most evident prior to plant construction, are the recent floodplain of the Ohio River and the low upland terrace developed on loess deposits (Kellberg, 1951). The floodplain along the south bank of the river averages about 2,000 feet in width and generally lies at or above approximately 320 feet mean sea level (msl). The floodplain is characterized by a natural levee immediately adjacent to the river and a lower, locally swampy area, extending south of the levee to the base of the upland terrace. At the southern margin of the floodplain, the topography rises some 20 to 30 feet to a relatively flat upland terrace bench. Most of the plant facilities are situated on this terrace.

The plant site is underlain by more than 300 feet of unconsolidated deposits of clay, silt, sand, and gravel, ranging from Cretaceous to Holocene in age. These deposits include, in descending stratigraphic order, Holocene alluvium within the floodplains of the Ohio River, Little Bayou, and Bayou Creeks; Pleistocene loess occupying the upland terrace region; Plio-Pleistocene alluvial terrace deposits; the McNairy formation (Upper Cretaceous); and the Tuscaloosa formation (Upper Cretaceous). Bedrock at the site consists of the Warsaw limestone (Mississippian) and lies at approximate elevation 6 feet msl (Kellberg, 1951). Bedrock surface dips to the southwest toward the axis of the Mississippi Embayment (Davis et al., 1973).

Because the dry ash stacking area is the primary focus of groundwater quality impacts presented later in the section, the remainder of the site description focuses on the hydrogeologic conditions in this region of the plant site.

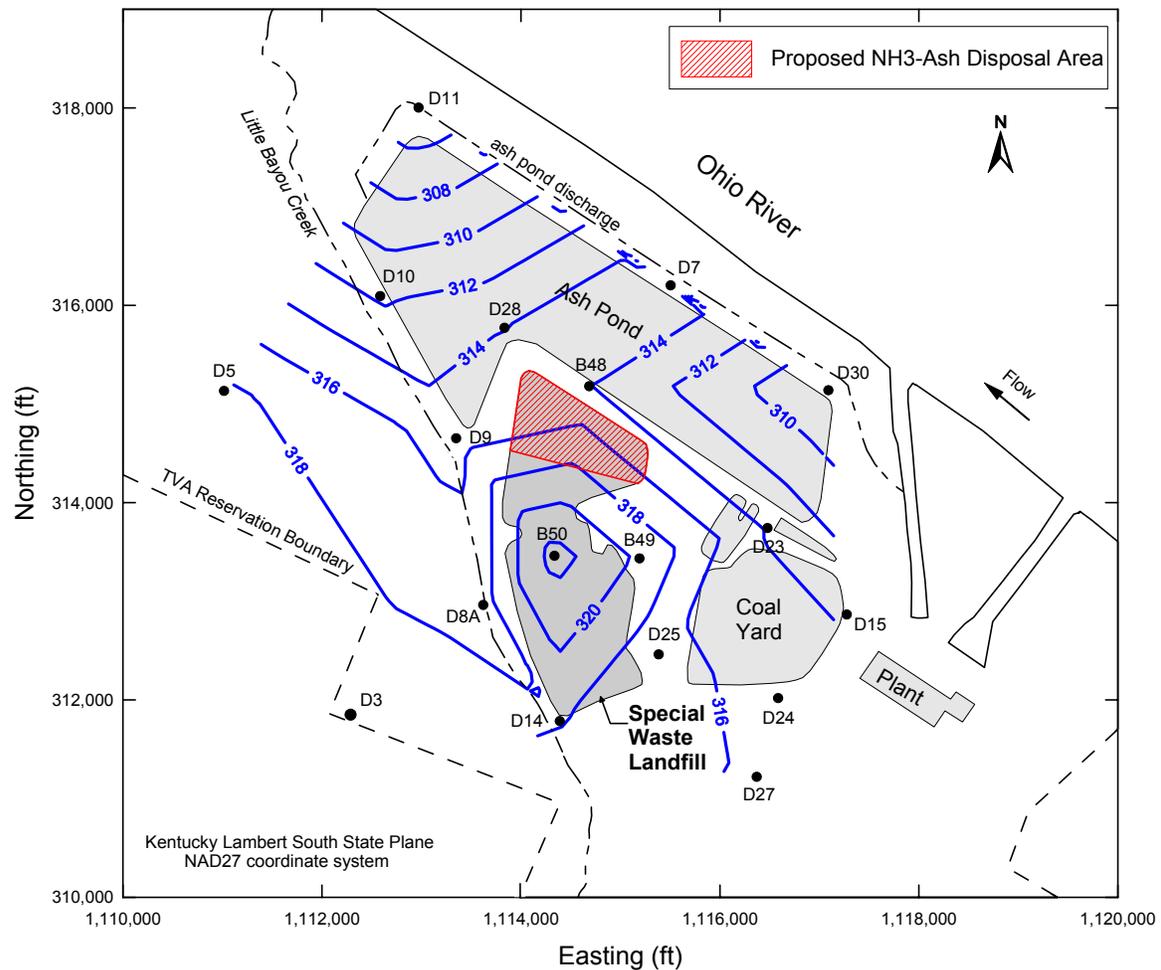
Plio-Pleistocene-age alluvial terrace deposits lie directly below the ash and fill deposits over a large portion of the site, including the dry ash stacking facility (Figure 3-1). Most if not all of the loess originally present above the terrace deposits is believed to have been removed during construction of the former ash pond. The upper portion of the terrace deposits are characteristically fine-grained and lenticular, consisting of variable mixtures of clay, silt, and fine sand. Thickness of the upper terrace sediments ranges from 4 to 25 feet and averages 9 feet in the landfill area. These sediments are distinct from the lower part of the terrace deposit, which is composed predominantly of rounded quartz (chert) gravel with sand and very minor amounts of clay and silt. Occasional sand lenses occur within the gravel unit, and fairly continuous micaceous sand was encountered below the gravel layer at most borings. The lower gravel unit and associated sand layers are commonly referred to as the Regional Gravel Aquifer (RGA), the principal aquifer in the site region. Recent borings in the landfill area indicate RGA thicknesses of 30 to 65 feet, with an average thickness of 47 feet. Regionally, the RGA is thinnest near the Ohio River, with thickness increasing with distance from the river (Boggs and Lindquist, 2000).

The McNairy formation was encountered below the RGA at all of the recent borings in the dry stack area although penetration depths were 10 feet or less. The McNairy consists of lenticular deposits of green-to-gray sandy clay and fine micaceous sand.

The first occurrence of groundwater below the vicinity of the dry ash stack is within the basal ash fill deposits of the former ash pond. Boring data suggest that isolated regions of saturated ash form in areas where infiltrating water accumulates above an underlying clay

or silt layer. These perched groundwater zones do not appear to be laterally continuous and do not constitute usable aquifers.

The RGA represents the shallowest aquifer beneath the site. Groundwater potentiometric levels measured on June 27, 2000, are shown on Figure 3-1. This plan view of the potentiometric surface based primarily on wells completed in the upper RGA indicates mounding of the potentiometric surface in the dry stack area. Potentiometric levels range from about 316 to 317 feet msl at the perimeter of the landfill to a maximum of approximately 323 feet msl near its center. The roughly circular-shaped potentiometric contours centered on the landfill indicate that the horizontal component of groundwater movement in the upper RGA is radially away from the center of the ashfill. The overall potentiometric surface configuration suggests that groundwater originating within the limits of the dry ash stack ultimately discharges to LBC and to the Ohio River. One can also infer from the V-shaped potentiometric contours centered on LBC between Wells D-9 and D-14 that the stream is gaining along this reach (Boggs and Lindquist, 2000).



Contours in feet-msl

Figure 3-1. Groundwater Potentiometric Surface of Upper Regional Gravel Aquifer Measured June 27, 2000

3.4.2. Environmental Consequences

3.4.2.1. Alternative A - No Action

Construction Impacts

There would be no groundwater resource impacts associated with this alternative.

Operational Impacts

There would be no groundwater resource impacts beyond the current local impairment of shallow groundwater quality beneath the ash disposal and coal storage areas.

3.4.2.2. Alternative B - Demonstration of NOxOUT SNCR System on SHF Unit 1

Construction Impacts

Construction of the NOxOUT SNCR system on Unit 1 would require no excavation or other activities that could potentially affect local groundwater resources.

Operational Impacts

Ammonia-laden leachate from dry stacked ash generated during Unit 1 SNCR testing represents a potential source of groundwater contamination. Dry ammoniated ash from Unit 1 would be mixed in pug mills with ash from Units 2-9 and deposited on the north end of the dry ash stacking area. The total surface area covered by ammoniated ash during the demonstration would be ~15 acres. The ammonia content of the mixed ash is estimated to be 48.6 mg NH₃-N/kg ash based on the expected ammonia slip rate of 5 ppmv (4.40 lb/hour), 80 percent partitioning of ammonia to fly ash, 10 percent fugitive emission losses, and the ash production rates presented in Section 3.5. Of the ~15-acre total surface area, no more than about 10 acres of dry ash would be exposed at any given time during the stacking process. Interim cover consisting of bottom ash or vegetated soil would be applied to inactive stack surfaces to control dust. The ash stack would ultimately be capped and closed in accordance with facility permit requirements.

A hydrologic water budget analysis of the SHF dry ash stacking area reported by Lindquist et al. (1992) indicates that from 7-8 percent of precipitation contacting the stack surface would be expected to form leachate. Ammoniated leachate would seep downward through the partially saturated ash, exit through the base of the stack, and enter older saturated ash deposits associated with a former ash pond. Once in the shallow saturated ash, Lindquist et al. (1992) indicate that part of the leachate would migrate horizontally with ambient groundwater flow to LBC, while the remaining leachate would be transported downward to the RGA where it would then migrate to the Ohio River. Ammoniated leachate migrating from the disposal site would not traverse private property regardless of whether flow is to LBC or the Ohio River. Consequently, there would be no impacts to existing or future groundwater users in the site vicinity.

Geochemical and hydrological studies of Lindquist et al. (1989 and 1992), Fryar et al. (2000), LaSage (2004), and Mukherjee (2003) indicate that the reach of LBC adjacent to the dry ash stack and ash pond areas receives shallow groundwater recharge from at least portions of the ash disposal areas. The estimated rate of ammoniated leachate seepage from the 15-acre disposal area to LBC is 2.5 cubic meters (m³)/day based on groundwater flow modeling predictions of Lindquist et al. (1992). Assuming complete leaching of ammonia from the mixed ash by infiltrating precipitation, the NH₃-N concentration of the

leachate would be approximately 114 mg/L. (This estimate assumes complete leaching of ammonia from a unit volume of ash by one pore volume of infiltrating precipitation, i.e., pore water $\text{NH}_3\text{-N}$ concentration is equal to the ash $\text{NH}_3\text{-N}$ content of 48.6 mg/kg multiplied by ash density of 1.21 kg/L divided by ash porosity of 0.51.) The ammonia loading to LBC would be approximately 0.29 kg/day assuming no transformation or attenuation of ammonia during groundwater transport.

Historical stream flow data for LBC are available for a United States Geological Survey (USGS) gauge located approximately 1.5 miles upstream of the proposed ammoniated-ash disposal site. Unfortunately, these data fail to account for substantial influx of groundwater and spring water along the gaining reach of LBC downstream of the gauge. Additional stream flow measurements are reported by Lindquist et al. (1992) for a gauging site (LBC-1) situated about 0.5 mile downstream of the proposed disposal site. The minimum daily flow reported at the USGS gauge is 930 m^3/day ; whereas, Lindquist et al. (1992) measured flows of approximately 2,400 m^3/day during "low flow conditions." Bounding estimates of the $\text{NH}_3\text{-N}$ concentration in LBC under low flow conditions of 0.12 to 0.31 mg/L are obtained assuming complete mixing of the $\text{NH}_3\text{-N}$ loading (0.29 kg/day) with the reported Lindquist et al. (1992) and USGS low flows, respectively. Concentration estimates are considered conservative because no allowance is made for dilution of leachate seepage as it mixes with ambient groundwater during transport to LBC. Furthermore, the analysis assumes the average daily ammonia load entering LBC is mixed with stream flow during low flow conditions. Under low stream flow conditions, the rate of leachate seepage into LBC would also be lower than average, since both stream flow and leachate generation rates respond similarly to periods of reduced precipitation. To ensure the CCC limits would be met in LBC, samples of the dry stack area would be taken to verify the ash $\text{NH}_3\text{-N}$ content was not greater than 48 mg/kg.

The quantity of ammoniated ash leachate migrating to the Ohio River via groundwater is estimated from modeling results reported by Lindquist et al. (1992). Their water budget analysis of the dry stack indicates that the total rate of leachate generation for the 15-acre ammoniated ash disposal area would average $\sim 15.3 \text{ m}^3/\text{day}$. Subtracting the portion of leachate transported to LBC (i.e., $2.5 \text{ m}^3/\text{day}$) from the total leaves approximately $12.8 \text{ m}^3/\text{day}$ of leachate that would ultimately discharge into the Ohio River. Assuming an $\text{NH}_3\text{-N}$ concentration of 114 mg/L as before, the estimated average $\text{NH}_3\text{-N}$ loading to the Ohio River would be approximately 1.5 kg/day. Impacts would be negligible due to the high dilution capacity of the river. Potential aquatic impacts of ammoniated-ash leachate seepage into local streams are discussed in Sections 3.3 and 3.6.

3.5. Solid Waste

3.5.1. Affected Environment

Coal Combustion Byproduct Generation, Marketing, and Handling

SHF operates nine conventional pulverized pulverized coal combustion units and one AFBC unit. The pulverized coal combustion units, Units 1-9, are expected to burn between 4.09 and 4.32 million tons of coal annually through at least 2015. These units burn various percentages of Powder River Basin (PRB) subbituminous coal and Colorado bituminous coal. The PRB coal ash content averages about 5.6 percent ash, and the Colorado coal averages about 8.7 percent ash. The coals, blended on site, have ranged from 17-30 percent PRB and 70-83 percent Colorado bituminous coal from 2001-2004. Since the predominant coal source is bituminous coal, the fly ash produced from the blending of these

coals is still classified as a Class "F" coal ash. However, the presence of the PRB coal does cause the fly ash to contain more calcium than most ash produced solely from the combustion of bituminous coal. Therefore, the resulting fly ash will tend to have a more alkaline pH than bituminous coal ash.

Total pulverized coal ash production has ranged from approximately 296,000 to 310,000 tons of ash per year from 2001-2004. The ash is collected as either fly ash, which is fine enough and light enough to be carried with the flue gas stream exiting the boiler, or as bottom ash, which is coarser and heavier and falls to the bottom of the boiler. The fly ash/bottom ash split is about 80 percent fly ash and 20 percent bottom ash. The 4-year average fly ash production for each individual unit at SHF is approximately 27,199 tons per year.

Prior to 1988, all fly ash was sluiced to ash ponds on the plant site and dredged to dredge cells. In 1988, SHF converted to dry fly ash collection, but because the fly ash contains high levels of unburned carbon, the material is not suitable for most market uses like ready-mix cement. However, in 2004, TVA entered into an agreement to supply dry fly ash to a nearby cement kiln for use as raw material in cement manufacturing. This kiln uses about 100,000 tons per year of dry fly ash from SHF as raw feed.

Fly ash that is not sold or used is conditioned to about 18 percent moisture in pug mills and hauled to a fly ash stacking area for disposal. Rainfall runoff from the dry fly ash stacking area is routed to the coal pile runoff pond and then pumped to the ash pond. This discharge flows through the ash pond and ultimately discharges to a ditch that flows into the Ohio River.

As of April 2004, the existing dry fly ash stacking area had about 2.0 million cubic yards of remaining disposal capacity. If no fly ash were marketed, this would be enough disposal capacity for about 4 years (2008). If current marketing levels can be sustained, the life of the disposal facility would be about 5 years (to 2009). Extending the life of the fly ash disposal area defers the date when additional disposal areas would need to be developed. At the time when need for additional disposal capacity is established, an environmental review would be undertaken to evaluate the use of alternative sites for disposal.

All bottom ash produced at SHF is currently sluiced to the active ash pond. Bottom ash is reclaimed there for use in dike construction, roadways on the plant reservation, or for community projects like walking tracks and parking lots. Between 59,000 and 62,000 tons of bottom ash are handled in this manner annually (based on data from 2001-2004). Markets for bottom ash are currently being explored. Increasing the marketability of bottom ash would require a pyrite separation system as part of the bottom ash handling equipment at the plant. Pyrites and mill rejects would be segregated from the bottom ash and handled separately if a pyrite separation system were installed. This system is not part of the current project and an appropriate environmental review would be performed at the time a specific project is proposed.

In addition to the pulverized coal combustion units at SHF, Unit 10 is an AFBC unit that burns crushed coal with limestone in a "self-scrubbing" process to reduce sulfur emissions from the unit. This unit produces two products, char/fly ash, which is the finest fraction (equivalent to fly ash from Units 1-9), and a spent bed material (SBM), which is a coarser, heavier material (equivalent to Units 1-9 bottom ash). Both the char/fly ash and SBM are collected dry in silos at the plant. Because these materials are self-cementing, small

amounts of dry char/fly ash and SBM are sold for use in nonhazardous waste stabilization to local municipal landfill operations. Char/fly ash and SBM that are not sold or used are conditioned to about 18 percent moisture in pug mills and hauled to the fly ash stacking area for codisposal with the fly ash. Unit 10 has produced from 260,000 to 360,000 tons of char/fly ash and SBM annually for the years 2001-2004.

3.5.2. Environmental Consequences

3.5.2.1. Alternative A - No Action

TVA would continue to operate SHF without the NO_xOUT SNCR demonstration on Unit 1, and no impacts to solid waste are anticipated beyond the effects of existing and future activities associated with routine operation of the plant.

3.5.2.2. Alternative B - Demonstration of NO_xOUT SNCR System on SHF Unit 1

Fly Ash

Potential impacts of “ammonia slip” or excess unreacted ammonia as a result of the demonstration of SNCR on Unit 1 at SHF include undesirable levels of ammonia being deposited on the dry fly ash. Dry fly ash at SHF is currently being used as raw feed in cement kilns, in cement replacement, and certain other uses. If this fly ash contained ammonia, it could cause ammonia releases from the cement kiln or from the cement products when mixed with water or when the concrete products were placed in damp environments like basements or other enclosed areas. If anticipated ammonia levels are high enough, the ammonia could be irritating to eyes and nasal passages. In order to retain the marketability of fly ash, the fly ash marketed would need to have low levels of ammonia (less than 50 ppm). Fly ash that would not meet this specification would be disposed of in the dry fly ash stacking area. In order to obtain more precise information on SNCR impacts, during the demonstration of the technology on Unit 1, fly ash samples would be collected from the baghouse hoppers and from the ash silo system to determine actual ammonia levels on the fly ash.

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, especially under alkaline conditions. SHF has alkaline conditions. The AFBC materials, combustion of coal and limestone, are highly alkaline exhibiting pH measurements above 10. Currently, the AFBC materials from Unit 10 and the dry fly ash from Units 1-9 are not necessarily segregated in the dry stacking area. Therefore, any ammoniated fly ash from the SNCR demonstration on Unit 1 would be exposed to high pH levels during or immediately after disposal on the dry stack. Generally, at levels below 100 ppm, fly ash would not have any detectable odor problems. However, based on studies conducted by TVA at John Sevier Fossil Plant for installation of similar systems (TVA, 2005), the ammonia level on the fly ash could be up to 500 ppm deposited on the fly ash. This ammonia level and the existing alkaline conditions could cause ammonia to be evolved from the fly ash into the atmosphere, which could affect worker safety and could be an odor problem for nearby neighbors. These concentrations of ammonia are only expected on Unit 1. During this demonstration, ash from Unit 1 would be mixed with the ash from Units 2-9. The quantity of ammoniated fly ash from Unit 1 when mixed with the nonammoniated fly ash from Units 2-9 would be estimated to be 48.6 mg NH₃-N/kg ash (as stated in Section 3.4). This level is below the 100-ppm level for detectable odors. Therefore, for the demonstration, the ammonia odor levels would be considered insignificant.

Bottom Ash

Bottom ash use is not expected to be impacted by the SNCR demonstration at SHF, since the bottom ash is collected in the boiler prior to urea injection.

3.6. Aquatic Ecology

3.6.1. Affected Environment

Little Bayou Creek

Discharge points and groundwater from the ash pond at SHF can affect water quality in LBC. LBC and Big Bayou Creek have been the subject of biological monitoring from 1987 through 1999 because they border the Paducah Gaseous Diffusion Plant (PGDP). This monitoring was conducted by the University of Kentucky (1987-1989), and Oak Ridge National Laboratories Environmental Sciences Division (ORNL-ESD) staff (1990-1999). These investigations are detailed in a series of reports prepared by the ORNL-ESD staff (Kszos, 1994; Kszos et al., 1994; Kszos, 1996a; 1996b; 1997; Kszos et al., 1998; 1999a; 1999b; Phipps and Kszos, 1996; Roy et al., 1996). With the exception of toxicity testing, a comprehensive BMP was not required in either the Agreed Order or the KPDES permit; however, biological monitoring of the Department of Energy facilities at PGDP was conducted to satisfy requirements of Department of Energy Order 5400.1. As discussed in Section 3.3 of this document, LBC is on the Kentucky 303(d) list for pollutant causes identified as metals, PCBs, and radiation. Its designated uses are aquatic life and fish consumption. However, according to Kentucky's 1996 305(b) report, fish consumption advisories were in effect for LBC because of PCB contamination.

Benthic invertebrate diversity and abundance and fish diversity (15-20 species) and abundance at the monitoring site on LBC downstream of PGDP were comparable to the diversities and densities measured in two reference streams (Big Bayou Creek above PGDP mile 12.5 and on Massac Creek mile 13.8). A slight trend toward lower species diversity and in LBC indicates "slight but noticeable" degradation downstream of PGDP. This stream does have periods of near-zero flow, and the diversity and density of fish and benthic macroinvertebrate communities may be affected by these extremely low flow conditions in LBC.

Ohio River

Discharge and groundwater flow from the SHF ash pond may also influence the Ohio River. Ohio River Valley Water Sanitation Commission has conducted fish sampling in Ohio River adjacent to SHF. Data from fish sampling conducted from 1987-1992 are summarized in Table 3-6. These surveys indicate that the Ohio River supports a relatively diverse fish community in the area (56 species), including several state-listed fish species. The entire length (664 miles) of the Ohio River bordering Kentucky has been posted with fish consumption advisories because of PCB and chlordane contamination. The Ohio River advisories were specifically for the consumption of channel catfish, carp, white bass, paddlefish, and paddlefish eggs.

3.6.2. Environmental Consequences

3.6.2.1. Alternative A - No Action

Under the No Action Alternative, no NOx emissions reduction equipment would be installed or operated, so no impacts to aquatic life would result.

3.6.2.2. Alternative B - Demonstration of NOxOUT SNCR System on SHF Unit 1

Installation and operation of the proposed NOx emissions reduction systems could potentially impact aquatic communities in the Ohio River or LBC. However, appropriate mitigation measures such as those described in Section 3.2 would make these potential impacts insignificant.

Construction Impacts

Under Alternative B, potential construction impacts to the Ohio River and LBC would include temporary erosion and siltation resulting from construction of the NOxOUT SNCR system. These areas have previously been disturbed by plant construction and modification activities. Construction impacts would be minimized by implementing BMPs to control erosion during construction, stabilizing disturbed areas after completion of construction, and routing surface runoff to existing treatment facilities that meet regulatory requirements. Implementation of these measures would substantially reduce the potential impacts in the Ohio River or LBC to the point of causing only minor and temporary effects on fish and other aquatic life.

Table 3-7. Number and Relative Abundance of Fish Species Collected From the Ohio River Near Shawnee Fossil Plant - 1987-1992

<i>Fish Species</i>	1987		1988		1989		1990		1991		1992	
	#	%	#	%	#	%	#	%	#	%	#	%
Silver lamprey	--	--	--	--	--	--	--	--	--	--	1	<0.1
Paddlefish	--	--	1	<0.1	--	--	--	--	1	<0.1	1	<0.1
Shovelnose sturgeon	1	<0.1	--	--	--	--	--	--	--	--	--	--
Lepisosteus sp.	--	--	1	<0.1	1	<0.1	--	--	--	--	10	0.2
Spotted gar	--	--	--	--	3	0.1	7	<0.1	4	0.1	--	--
Longnose gar	19	0.2	4	<0.1	15	0.3	24	0.3	7	0.1	17	0.3
Shortnose gar	68	0.9	94	1	146	2.8	106	1.4	133	2	236	4.1
Bowfin	6	0.1	7	0.1	18	0.4	4	<0.1	6	0.1	5	0.1
American eel	3	<0.1	--	--	4	0.1	--	--	--	--	--	--
Clupeidae	4	<0.1	--	--	--	--	--	--	--	--	--	--
Skipjack herring	370	4.7	277	2.8	40	0.8	55	0.7	205	3.1	23	0.4
Gizzard shad	1589	20.4	2379	23.9	1588	30.9	2659	35.4	783	11.8	1672	28.9
Threadfin shad	1523	19.6	3692	37.1	478	9.3	2216	29.5	980	14.8	1679	29
Gizzard x Threadfin shad	1	<0.1	--	--	--	--	--	--	--	--	--	--
Goldeye	212	2.7	191	1.9	19	0.4	58	0.8	147	2.2	42	0.7
Mooneye	20	0.3	72	0.7	14	0.3	13	0.2	17	0.3	4	0.1
Hiodon sp.	--	--	--	--	--	--	--	--	1	<0.1	--	--
Cyprinidae	--	--	--	--	--	--	--	--	--	--	5	0.1
Grass carp	--	--	--	--	--	--	--	--	1	<0.1	3	0.1
Common carp	95	1.2	97	1	97	1.9	49	0.7	27	0.4	30	0.5
Carp x Goldfish	--	--	--	--	--	--	8	0.1	--	--	--	--
Mississippi silvery minnow	--	--	--	--	--	--	23	0.3	298	4.5	2	<0.1
Hybognathus sp.	--	--	--	--	--	--	--	--	250	3.8	--	--
Chubs	--	--	1	<0.1	--	--	--	--	--	--	--	--

<i>Fish Species</i>	1987		1988		1989		1990		1991		1992	
	#	%	#	%	#	%	#	%	#	%	#	%
Speckled chub	--	--	5	<0.1	3	0.1	1	<0.1	4	0.1	1	<0.1
Silver chub	17	0.2	18	0.2	36	0.7	32	0.4	22	0.3	14	0.2
Golden shiner	--	--	--	--	--	--	1	<0.1	--	--	--	--
Emerald shiner	1995	25.6	1207	12.1	407	7.9	313	4.2	747	11.3	190	3.3
River shiner	311	4	211	2.1	326	6.3	55	0.7	259	3.9	162	2.8
Striped shiner	1	<0.1	--	--	--	--	1	<0.1	--	--	--	--
Red shiner	61	0.8	8	0.1	1	<0.1	--	--	7	0.1	1	<0.1
Silverband shiner	105	1.4	--	--	3	0.1	--	--	66	1	78	1.3
Spotfin shiner	33	0.4	46	0.4	110	2.1	--	--	157	2.4	15	0.3
Spotfin x Red shiner	--	--	--	--	--	--	--	--	--	--	1	<0.1
Sand shiner	4	0.1	--	--	6	0.1	1	<0.1	--	--	--	--
Redfin shiner	--	--	--	--	1	<0.1	--	--	--	--	--	--
Steelcolor shiner	--	--	--	--	--	--	--	--	--	--	1	<0.1
Channel shiner	17	0.2	11	0.1	16	0.3	3	<0.1	45	0.7	40	0.7
Suckermouth minnow	--	--	1	<0.1	--	--	1	<0.1	2	<0.1	--	--
Bluntnose minnow	6	0.1	1	<0.1	4	0.1	1	<0.1	1	<0.1	2	<0.1
Bullhead minnow	73	0.9	55	0.6	15	0.3	4	<0.1	133	2	32	0.6
Blue sucker	--	--	1	<0.1	--	--	--	--	--	--	--	--
Ictiobinae	22	0.3	179	1.8	86	1.7	2	<0.1	--	--	--	--
Carpoides sp.	--	--	51	0.5	7	0.1	1	<0.1	1	<0.1	54	0.9
River carpsucker	86	1.1	57	0.6	141	2.7	52	0.7	26	0.4	136	2.4
Quillback	--	--	1	<0.1	18	0.4	10	0.1	6	0.1	7	0.1
Highfin carpsucker	--	--	--	--	2	<0.1	9	0.1	--	--	--	--
Ictiobus sp.	--	--	--	--	2	<0.1	--	--	--	--	--	--
Smallmouth buffalo	3	<0.1	3	<0.1	7	0.1	14	0.2	16	0.2	19	0.3
Bigmouth buffalo	5	0.1	3	<0.1	2	<0.1	1	<0.1	3	<0.1	4	0.1

<i>Fish Species</i>	1987		1988		1989		1990		1991		1992	
	#	%	#	%	#	%	#	%	#	%	#	%
Black buffalo	--	--	--	--	--	--	--	--	2	<0.1	--	--
Golden redhorse	--	--	--	--	--	--	--	--	--	--	2	<0.1
Shorthead redhorse	--	--	--	--	--	--	--	--	2	<0.1	1	<0.1
Ictaluridae	--	--	--	--	--	--	--	--	--	--	4	0.1
Blue catfish	71	0.9	20	0.2	31	0.6	20	0.3	13	0.2	10	0.2
Channel catfish	208	2.7	237	2.4	355	6.9	447	6	235	3.6	154	2.7
Northern madtom	--	--	1	<0.1	--	--	--	--	--	--	--	--
Flathead catfish	31	0.4	16	0.2	69	1.3	57	0.8	18	0.3	14	0.2
Blackspotted topminnow	1	<0.1	1	<0.1	4	0.1	--	--	7	0.1	--	--
Mosquitofish	2	<0.1	7	0.1	25	0.5	4	<0.1	40	0.6	3	0.1
Brook silverside	3	<0.1	8	0.1	54	1.1	19	0.3	37	0.6	1	<0.1
Inland silverside	--	--	--	--	59	1.2	86	1.1	419	6.3	30	0.5
Atherinidae	--	--	--	--	--	--	--	--	232	3.5	--	--
Morone sp.	37	0.5	50	0.5	13	0.3	18	0.2	23	0.3	153	2.6
White bass	149	1.9	152	1.5	129	2.5	38	0.5	44	0.7	12	0.2
Yellow bass	33	0.4	8	0.1	191	3.7	35	0.5	240	3.6	182	3.1
Striped bass	--	--	36	0.4	150	3.4	9	0.1	121	1.8	7	0.1
Striped x White bass	3	<0.1	29	0.3	6	0.1	2	<0.1	71	1.1	52	0.9
Sunfishes	--	--	6	0.1	31	0.6	6	<0.1	--	--	--	--
Lepomis hybrid	2	<0.1	--	--	--	--	1	<0.1	9	0.1	2	<0.1
Green sunfish	1	<0.1	3	<0.1	3	0.1	1	<0.1	1	<0.1	--	--
Warmouth	1	<0.1	1	<0.1	--	--	--	--	--	--	--	--
Orangespotted sunfish	2	<0.1	3	<0.1	--	--	--	--	6	0.1	3	0.1
Bluegill	279	3.6	88	0.9	45	0.9	30	0.4	240	3.6	68	1.2
Longear sunfish	26	0.3	96	1	67	1.3	24	0.3	31	0.5	26	0.4
Redear sunfish	--	--	1	<0.1	2	<0.1	--	--	4	0.1	--	--

<i>Fish Species</i>	1987		1988		1989		1990		1991		1992	
	#	%	#	%	#	%	#	%	#	%	#	%
Lepomis sp.	--	--	--	--	--	--	--	--	20	0.3	1	<0.1
Smallmouth bass	3	<0.1	1	<0.1	--	--	1	<0.1	4	0.1	2	<0.1
Spotted bass	9	0.1	12	0.1	4	0.1	9	0.1	10	0.2	2	<0.1
Largemouth bass	15	0.2	17	0.2	14	0.3	9	0.1	24	0.4	2	<0.1
Micropterus sp.	--	--	--	--	--	--	--	--	1	<0.1	--	--
White crappie	47	0.6	1	<0.1	28	0.5	19	0.3	25	0.4	4	0.1
Black crappie	13	0.2	6	<0.1	6	0.1	7	<0.1	26	0.4	7	0.1
Bluntnose darter	--	--	--	--	--	--	--	--	7	0.1	--	--
Perches	--	--	--	--	--	--	1	<0.1	--	--	--	--
Pike-Perches	4	0.1	--	--	--	--	--	--	--	--	--	--
Logperch	--	--	--	--	--	--	--	--	2	<0.1	1	<0.1
River darter	--	--	--	--	--	--	--	--	1	<0.1	1	<0.1
Sauger	11	0.1	2	<0.1	1	0.3	25	0.3	50	0.8	65	1.1
Walleye	3	<0.1	14	0.1	2	<0.1	--	--	--	--	--	--
Stizostedion sp.	--	--	--	--	--	--	--	--	2	<0.1	--	--
Freshwater drum	183	2.4	453	4.6	198	3.9	911	12.1	291	4.4	483	8.4
Striped mullet	--	--	--	--	2	<0.1	--	--	--	--	2	<0.1
Total Number	7,787		9,943		5,105		7,503		6,613		5,781	
Number of Taxa	49		50		51		49		57		53	
Number of Species	46		49		50		46		55		56	

= number % = percent < = less than sp = species -- = none found

Sources: EA Engineering, Science, and Technology, 1993; 1994; Environmental Science and Engineering, Inc., 1988; 1989; 1990; 1991.

Operational Impacts

The storage, handling, and use of urea solutions for the proposed NOxOUT SNCR system would result in the potential for ammonia or other nitrogenous compound contamination of surface water and impacts to aquatic life. One pathway for impacts would be a direct accidental release of urea to surface water. The engineered features of the urea storage system include a retention basin for spills to minimize this risk. Another pathway for surface water impacts would be ammonia contamination of combustion byproducts, such as fly ash. As discussed in Section 3.2, any ammonia accumulations from the APHs when washed would be expected to dissolve and increase ammonia concentrations in the ash pond. Similarly, storm water runoff from the active ash handling area on the dry ash stack would be expected to dissolve ammonia compounds from contaminated ash and carry this ammonia-contaminated water to the discharge of the dry stack stilling pond. In addition, precipitation would be expected to eventually seep through the dry ash stack and result in small quantities of ammonia being released to the Ohio River or LBC by groundwater seepage.

Ammonia Loading to the Ash Pond

Potential impacts to aquatic life in the Ohio River or LBC were examined by modeling the “worst-case scenario” for ammonia loading to the ash pond at SHF. The largest ammonia loading to the ash pond from runoff would occur during a 10-year, 24-hour, 5-inch rainfall event. Ammoniated runoff from the exposed area of the dry ash stack would flow to the ash pond. The estimated ammonia loading in the runoff from this type of rainfall event is estimated to be 185 kg.

As mentioned in Section 3.3, the projected ammonia concentration in the Ohio River for these conditions was calculated to be no greater than 0.09 mg NH₃-N/L, which would be below the CCC for the extreme conditions of pH 9.0 and temperatures greater than 86°F (Table 3-4). This worst-case scenario assumes the Unit 1 APH wash wastewater would be discharged directly to the ash pond, yet there would be a commitment to contain the Unit 1 APH wash wastewater and slowly release it to the ash pond over a number of days to prevent potential impacts at Outfalls 001 and 002. Therefore, the ammonia concentration discharged to the Ohio River during the Unit 1 APH cleaning operation would be expected to be even lower (Section 3.2). Also, no significant impacts on the water quality of the LBC would be anticipated from post-combustion ammoniated waste discharged from the SHF site. Factors supporting the conclusion that the 2-year, one-unit SNCR test should not result in significant impacts in LBC include the following:

- The worst-case NH₃-N loading to LBC assumed no transformation or attenuation of ammonia during groundwater transport.
- No allowance was made for dilution of leachate seepage as it mixed with ambient groundwater during transport to LBC.
- During low flow stream conditions, the rate of leachate seepage would also be lower than average, since both stream flow and leachate generation are precipitation dependent.
- Biological activity in LBC would be expected to remove some portion of the NH₃-N, especially during warmer months when exceedances of criteria would be most likely (Section 3.3).

If the worst-case rainfall event were the only source of ammonia to the ash pond, that is the Unit 1 APHs were not being cleaned during the rainfall event, the estimated ammonia concentration at Outfall 001 would be 0.74 mg NH₃-N/L, which is less than the CMC for all allowable pH conditions (Table 3-3). Since the ammonia concentration discharged from Outfall 001 would remain below the CMC, the impact of the ammoniated discharge was determined to be insignificant. Management of water treatment system flows and other appropriate mitigation measures, as necessary, would maintain discharge ammonia concentrations at levels that would safeguard water quality and protect aquatic life. Appropriate mitigation of ammonia concentrations in effluent water would result in insignificant impacts to aquatic life that uses adjacent areas of the Ohio River or LBC for spawning or feeding.

Groundwater Effects

As discussed in Section 3.4, some ammonia may be expected to enter the groundwater that travels from the ash pond to either LBC or the Ohio River. Any impacts to aquatic life in LBC or the Ohio River as a result of ammonia carried by groundwater would be insignificant, even when combined with the amount of ammonia potentially released from the permitted outfall.

3.7. Protected Aquatic Species

3.7.1. Affected Environment

Data from the TVA Natural Heritage database indicated that several state-listed and federally listed aquatic animal species are reported from the Ohio River and its tributaries in the vicinity of SHF (Table 3-8). The fish species reported in this table are mainly found in the main channel of the Ohio River but may occur at times in LBC. Neither of the two federally listed mussel species reported from the Ohio River is likely to occur in LBC because of extended periods of low or no flow in LBC. None of the listed mussel species have been reported from immediately adjacent to SHF, but are known from locations both upstream and downstream of the plant, and may be present in the Ohio River near the discharge outfall or in areas that may be influenced by groundwater infiltration from the ash pond.

3.7.2. Environmental Consequences

3.7.2.1. Alternative A - No Action

Under the No Action Alternative, no NO_x emissions reduction equipment would be installed or operated, so no impacts to aquatic life would result.

Table 3-8. Listed Aquatic Animals Reported From the Ohio River and its Tributaries in the Vicinity of Shawnee Fossil Plant

Scientific Name	Common Name	Federal Status	State Status
Fish			
<i>Hybognathus hayi</i>	Cypress minnow	-	Endangered
<i>Ichthyomyzon greeleyi</i>	Mountain brook lamprey	-	Threatened
<i>Menidia beryllina</i>	Inland silverside	-	Threatened
<i>Esox niger</i>	Chain pickerel	-	Special Concern
<i>Ictiobus niger</i>	Black buffalo	-	Special Concern
<i>Lepomis miniatus</i>	Redspotted sunfish	-	Threatened
<i>Notropis maculatus</i>	Taillight shiner	-	Threatened
<i>Noturus stigmosus</i>	Northern madtom	-	Special Concern
<i>Erimyzon sucetta</i>	Lake chubsucker	-	Threatened
<i>Ictiobus niger</i>	Black buffalo	-	Special Concern
<i>Atractosteus spatula</i>	Alligator gar		Endangered
Mussels			
<i>Plethobasus cooperianus</i>	Orange-foot pimpleback	Endangered	Endangered
<i>Potamilus capax</i>	Fat mucket	Endangered	Endangered
<i>Plethobasus cyphus</i>	Sheepnose	Candidate	Special Concern

3.7.2.2. Alternative B - Demonstration of NOxOUT SNCR System on SHF Unit 1

Installation and operation of the proposed NOx emissions reduction system could potentially impact individuals or populations of listed aquatic animal species in the Ohio River or LBC. As shown above in Table 3-8, three federally listed mussel species (two endangered and one candidate) are known from the Ohio River in the vicinity of SHF. Due to the possibility of the release of ammonia to surface waters or through groundwater migration to the Ohio River, there exists a potential that individuals or populations of state-listed or federally listed aquatic animals could be affected under the worst-case hypothetical scenario discussed in Section 3.2. However, with mitigation safeguards to minimize the presence of ammonia in the discharge, there would be no impacts to listed species.

Construction Impacts

Under Alternative B, potential construction impacts to the Ohio River and LBC would include temporary erosion and siltation resulting from construction of the NOxOUT SNCR system. These areas have previously been disturbed by plant construction and modification activities. These impacts would be minimized by implementation of BMPs to control erosion during construction and stabilize disturbed areas after construction is complete and by routing surface runoff to existing treatment facilities that meet regulatory requirements. These measures would substantially reduce the potential impacts in the Ohio River or LBC to the point of causing only minor and temporary effects on fish and other aquatic life. Construction impacts would likely cause no impacts to protected aquatic animals or their habitats in LBC or the Ohio River.

Operational Impacts

As described in Sections 3.2, 3.4, and 3.6 of this document, there would be a potential for impacts from ammonia to surface water and groundwater resources on or near SHF.

Conservative modeling estimates place both the potential ammonia discharge from the ash pond outfall and the potential groundwater effects of ammonia in LBC and the Ohio River below levels that would result in acute or chronic toxicity to aquatic animals. With mitigation safeguards to minimize the presence of ammonia in the discharge, there would be no direct or indirect impacts to orange-foot pimpleback, fat mucket, or sheepsnose or to any of the state-listed aquatic animals.

3.8. Cumulative Impacts

3.8.1. *Alternative A - No Action*

TVA would continue to operate SHF without the NO_xOUT SNCR demonstration on Unit 1, and TVA coal-fired power plant NO_x emissions would not be reduced by 75,000 tons during the ozone season (May to September) beginning in 2006. However, to meet Clean Air Act Title IV requirements, low-NO_x burners have already been installed on 34 TVA boilers; staged over-fire air has been installed on 6 units; and combustion optimization has been installed on an additional 18 units. If the SNCR demonstration does not take place, further reductions in NO_x would not be achieved.

3.8.2. *Alternative B - Demonstration of NO_xOUT SNCR System on SHF Unit 1*

TVA's Proposed NO_x Control Strategy

TVA has installed, is in the process of installing, or is considering the installation of additional NO_x controls, using SCR, SNCR, or other NO_x reduction technologies, at up to nine other coal-fired power plants (Allen, Bull Run, Colbert, Cumberland, John Sevier, Johnsonville, Kingston, Paradise, and Widows Creek). Table 3-9 lists all units being considered including the proposed action at SHF. This strategy would reduce TVA coal-fired power plant NO_x emissions by 75,000 tons during the ozone season (May to September) beginning in 2006. When combined with other controls already planned to meet the acid rain requirements under the Clean Air Act Title IV, the total NO_x reduction during the 2006 ozone season would be nearly 180,000 tons. The strategy identified above would reduce TVA's seasonal NO_x emissions roughly 80 percent below 1995 levels.

The new controls would help reduce local and regional ozone levels and would help prevent violations of the new more stringent 8-hour ozone standard that was promulgated by USEPA in 1997. The strategy is also consistent with the types of controls that would be needed to comply with USEPA's proposed rule for ozone transport, known as the Ozone Transport State Implementation Plan call.

NO_x emitted into the atmosphere leads to the formation of ozone and fine particulate and contributes to increased acidity of precipitation. Thus, the cumulative impact on air quality (due to a reduction in NO_x emissions) would be beneficial.

Table 3-9. TVA Fossil Plant Units With SCR Systems or Other NOx Reduction Technologies Installed or Planned for Installation

Unit	State	Generation Capacity (megawatts)	Year Installed or Estimated to be Completed
Paradise 2	Kentucky	704	2000
Paradise 1	Kentucky	704	2001
Paradise 3	Kentucky	1,050	2003
Allen 2	Tennessee	330	2002
Allen 3	Tennessee	330	2002
Allen 1	Tennessee	330	2003
Widows Creek 7	Alabama	575	2003
Widows Creek 8	Alabama	550	2004
Cumberland 2	Tennessee	1,300	2004
Cumberland 1	Tennessee	1,300	2003
Bull Run	Tennessee	950	2003
Kingston 1-4, 7-8	Tennessee	1,300	2004
Kingston 5-6	Tennessee	400	2005
Colbert 5	Alabama	500	2004
Colbert 1-4	Alabama	800	2011
John Sevier 1-4	Tennessee	800	2008
Johnsonville 1	Tennessee	125	2005
Shawnee 1	Kentucky	175	2005

Ozone Reduction

Precise quantification of ozone changes due to the proposed action is not practical or possible due to daily variations in meteorology and operating conditions. It is possible, however, to assess the overall impact of the proposed action in combination with anticipated NOx reductions at other TVA fossil plants. This assessment is possible by comparing the results of photochemical modeling performed with and without consideration of TVA's overall NOx reduction strategy. Specifically, modeling was performed as part of the effort of the Ozone Transport Assessment Group's work that considered the NOx and VOC emissions in the eastern half of the United States projected to the year 2007. Photochemical modeling was performed with the Ozone Transport Assessment Group's emissions databases modified to reflect the effect of TVA's NOx strategy. Although modeling was limited to a single 10-day episode in 1995, the results are illustrative of the effect of TVA's NOx reduction strategy on atmospheric ozone. Within Alabama, Kentucky, and Tennessee, the modeling indicated that TVA's NOx reduction strategy would decrease the overall peak 1-hour ozone in the ambient atmosphere by 2, 4, and 4 percent, respectively, and the peak 8-hour ozone burden would be decreased by 2, 3, and 4 percent, respectively. This modeling did not include the additional NOx emission reductions that would occur at John Sevier Fossil Plant, Johnsonville Fossil Plant, and SHF, since the modeling was performed prior to consideration of installing NOx reduction equipment at these three plants. In addition, it is important to note that the modeling did not account for additional NOx emission reductions that are likely to occur from other utilities as a

consequence of recent USEPA action establishing statewide NO_x budgets in the eastern states.

3.9. Summary of TVA Commitments

3.9.1. Routine and Compliance Measures

- Construction impacts to the air and surface water would be minimized by implementing BMPs as necessary to control erosion and fugitive dust during construction, to stabilize disturbed areas after completion of construction, and to route surface runoff to existing treatment facilities that meet regulatory requirements. These BMPs would be implemented per the SHF Integrated Pollution Prevention Plan.
- The urea storage tank (maximum tank size would be 21,000 gallons) would be placed within a partial secondary containment to contain overflow spills. During the transfer of urea from tanker truck to holding tank, all area storm drains would be blocked, and containers placed under all connections. All Department of Transportation requirements would be followed. The driver would be within 25 feet of the truck, awake, have an unobstructed view of the tanker, and be able to move the tanker should an emergency situation require it to be moved.

3.9.2. Special Mitigation Measures

- To ensure that the ammonia concentration at the Outfall 001 discharge remained at or below the CMC (Table 3-3) and CCC (Table 3-4) limitations that would safeguard water quality, protect aquatic life, and ensure there were no impacts to listed species, the Unit 1 APH cleaning waste would be retained in a pond (such as the chemical treatment pond), basin, frac tanks, or other containment, the ammonia concentration would be determined, and then the water would be slowly released to the ash pond to ensure adequate pond mixing. The number of days required for the staged release would depend on the ammonia concentration of the Unit 1 APH wash wastewater.
- In order to obtain more precise information on SNCR impacts, during the demonstration of the technology on Unit 1, and to safeguard water quality, protect aquatic life, and ensure there were no impacts to listed species, TVA would monitor the ammonia concentration in:
 1. The ash pond inflow, midpoint, and discharge during the Unit 1 APH staged releases.
 2. The Unit 1 fly ash:
 - a. At the ash silo system to ensure the dry stack ash NH₃-N content was not greater than 48 mg/kg (for LBC CCC limits).
 - b. Discharged into the baghouse hoppers.
 3. Storm water runoff from the dry ash stacking area.

- To ensure that the KPDES permit limits for both pH and acute toxicity are met, and to ensure that the effluent being discharged to the Ohio River would not exceed the CCC [Table 3-4] for ammonia, the existing CO₂ system would be utilized to control pH.

CHAPTER 4

4. LIST OF PREPARERS

Preparer	Contribution
Anne Aiken	Surface Water and Industrial Wastewater
Barry Barnard	Air Quality
John (Bo) Baxter	Aquatic Ecology
Mark Boggs	Groundwater
Stephanie Chance	Protected Aquatic Animals
Don Kachelman	Air Quality and Cumulative Impacts
Darlene Keller	NEPA Advisor, Environmental Affairs
Cheri Miller	Solid Waste
Jennifer Moses	Toxicity (Wastewater Section)
Diedre Nida	NEPA Advisor, EA Project Management
Rusty Smith	Project Coordinator, Resource Stewardship
Traci Thompson	Technical Advisor, Shawnee Fossil Plant
Robert Wilson	Site Map

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CHAPTER 5

5. LIST OF AGENCIES CONSULTED

Federal Agency

U.S. Fish and Wildlife Services
Frankfort, Kentucky

State Agency

Kentucky Department of Environmental Protection
Water Division
Frankfort, Kentucky

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CHAPTER 6

6. SUPPORTING INFORMATION

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6.2. Abbreviations, Acronyms, and Symbols

~	Approximately
°F	Degree Fahrenheit
7Q10	The minimum 7-day low flow that occurs once in 10 years
AFBC	Atmospheric Fluidized Bed Combustion
APH	Air Preheater
BMP	Best Management Practice
CCC	Chronic Criterion Concentration
cfD	Cubic Feet per Day
cfs	Cubic Feet per Second
CMC	Criterion Maximum Concentration
EA	Environmental Assessment
et al.	Latin term, et alii (masculine), et aliae (feminine), or et alia (neutral) meaning "and others"
H₂O	Water
i.e.	Latin term, id est, meaning "that is"
kg	Kilogram
km	Kilometer
KPDES	Kentucky Pollutant Discharge Elimination System
L	Liter

lb	Pound
LBC	Little Bayou Creek
m³	Cubic Meter
mg	Milligram
mgd	Million Gallons per Day
mg/L	Milligrams per Liter
msl	Mean Sea Level
NH₃	Ammonia
NH₃-N	Ammonia Nitrogen
NH₄HSO₄	Ammonium Bisulfate
NOx	Nitrogen Oxide
ORNL-ESD	Oak Ridge National Laboratories Environmental Sciences Division
PCB	Polychlorinated Biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PM	Particulate Matter
PM_{2.5}	Particulate Matter With a Diameter Less Than or Equal to 2.5 Micrometers
PM₁₀	Particulate Matter With a Diameter Less Than or Equal to 10 Micrometers
ppb	Parts per Billion
ppm	Parts per Million
ppmv	Parts per Million by Volume
PRB	Powder River Basin
RGA	Regional Gravel Aquifer
SBM	Spent Bed Material
SCR	Selective Catalytic Reduction
SHF	Shawnee Fossil Plant
SNCR	Selective Noncatalytic Reduction
SO₂	Sulfur Dioxide
SO₃	Sulfur Trioxide
s.u.	Standard Unit
TVA	Tennessee Valley Authority
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound

APPENDIX A – MATERIAL SAFETY DATA SHEETS FOR NO_xOUT

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MATERIAL SAFETY DATA SHEET

PRODUCT
NOxOUT® A

Emergency Telephone Number
CHEMTREC - 1.800.424.9300 (24 hours)

SECTION 1 - PRODUCT IDENTIFICATION

Trade Name: NOxOUT® A

Description: An aqueous solution of an amide

NFPA 704M/HMIS Rating: 1/1 Health 0/0 Flammability 0/0 Reactivity 0/Other
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 2 - COMPOSITION / INGREDIENT INFORMATION

Our hazard evaluation of the ingredient(s) under OSHA's Hazard Communication Rule, 29 CFR 1910.1200 has found none of the ingredient(s) hazardous.

SECTION 3 - HAZARD IDENTIFICATION

EMERGENCY OVERVIEW:

Caution: May cause irritation to skin and eyes. Avoid contact with skin, eyes, and clothing. Avoid prolonged or repeated breathing of vapor. Use with adequate ventilation. Do not take internally.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

Primary Route(s) of Exposure: Eye, Skin, Inhalation

Eye Contact: Can cause mild, short-lasting irritation.

Skin Contact: May cause irritation with prolonged contact.

Inhalation: May cause irritation to the respiratory tract and lungs.

SYMPTOMS OF EXPOSURE:

A review of available data does not identify any symptoms from exposure not previously mentioned.

Aggravation of Existing Conditions: A review of available data does not identify any worsening of existing conditions.

SECTION 4 - FIRST AID INFORMATION

Eyes: Flush with water for 15 minutes. Call a physician.

Skin: Wash thoroughly with soap and rinse with water. Call a physician.

Ingestion: Do not induce vomiting. Give water. Call a physician.

Inhalation: Remove to fresh air. Treat symptoms. Call a physician.

Note To Physician: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

Caution: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water.

SECTION 5 - FIRE FIGHTING

Flash Point: None

Extinguishing Media: This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use water to cool containers exposed to fire.

Unusual Fire and Explosion Hazard: May evolve CO, CO₂, NO_x, ammonia, and cyanuric acid under fire conditions.



MATERIAL SAFETY DATA SHEET

PRODUCT
NOxOUT® A

Emergency Telephone Number
CHEMTREC - 1.800.424.9300 [24 hours]

SECTION 6 - ACCIDENTAL RELEASE MEASURES

In case of transportation accidents, call the following 24-hour telephone number: 1.800.424.9300 (CHEMTREC).

SPILL CONTROL AND RECOVERY:

Small Liquid Spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 15.

Large Liquid Spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA in Section 15.

SECTION 7 - HANDLING AND STORAGE

Storage: Keep container closed when not in use.

SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

Respiratory Protection: Respiratory protection not normally needed. If significant dusting occurs, wear a NIOSH approved or equivalent dust respirator.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

Ventilation: General ventilation is recommended.

Protective Equipment: Use impermeable gloves and chemical splash goggles when attaching feeding equipment, doing maintenance or handling product. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural rubber, viton and butyl (compatibility studies havenot been performed).

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

Human Exposure Characterization: Based on Fuel Tech's recommended product application and our recommended personal protective equipment, the potential human exposure is: LOW.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Color:	Clear golden	
Form:	Liquid	
Density:	9.5 lbs/gal.	
Specific Gravity:	1.14 @ 77 Degrees F	ASTM D-1298
Ph (NEAT) =	9.5	ASTM E-70
Viscosity:	4 cps @ 72 Degrees F	ASTM D-2983
Flash Point:	None	
Crystallization Point:	60 Degrees F	

Note: These physical properties are typical values for this product.



MATERIAL SAFETY DATA SHEET

PRODUCT
NO_xOUT® A

Emergency Telephone Number
CHEMTREC - 1.800.424.9300 (24 hours)

SECTION 10 - STABILITY AND REACTIVITY

Incompatibility: Avoid contact with strong oxidizers (eg. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

Thermal Decomposition Products: In the event of combustion CO, CO₂, NO_x, ammonia, and cyanuric acid may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

SECTION 11 - TOXICOLOGICAL INFORMATION

Toxicity Studies: No toxicity studies have been conducted on this product.

Human Hazard Characterization: Based on our hazard characterization, the potential human hazard is: LOW

SECTION 12 - ECOLOGICAL INFORMATION

If released into the environment, see CERCLA in Section 15.

Environmental Hazard and Exposure Characterization: Based on our Hazard Characterization, the potential environmental hazard is: MODERATE. Based on Fuel Tech's recommended product application and the product's characteristics, the potential environmental exposure is: LOW.

SECTION 13 - DISPOSAL CONSIDERATIONS

Disposal: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be incinerated in accordance with local, state and federal regulations.

SECTION 14 - TRANSPORTATION INFORMATION

Proper shipping name/hazard class may vary by packaging, properties, and mode of transportation. Typical proper shipping names for this product are:

All Transportation Modes: Product is not regulated during transportation.

SECTION 15 - REGULATORY INFORMATION

The following regulations apply to this product.

FEDERAL REGULATIONS:

OSHA Hazard Communication Rule, 29 CFR 1910.1200:

Based on our hazard evaluation, none of the ingredients in this product are hazardous.

CERCLA/Superfund, 40 CFR 117, 302:

Notification of spills of this product is not required.

SARA/Superfund Amendments and Reauthorization Act of 1986 (Title III) - Sections 302, 311, 312 and 313:

Section 302 - Extremely Hazardous Substances (40 CFR 355):

This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

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FUEL TECH, INC. ♦ 512 KINGSLAND DR. ♦ BATAVIA, ILLINOIS 60510-2299
630.845.4500 or 800.666.9688



MATERIAL SAFETY DATA SHEET

PRODUCT
NOxOUT® A

Emergency Telephone Number
CHEMTREC - 1.800.424.9300 [24 hours]

Sections 311 and 312 - Material Safety Data Sheet Requirements (40 CFR 370):

Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200. Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

Section 313 - List of Toxic Chemicals (40 CFR 372):

This product does not contain ingredients on the List of Toxic Chemicals.

Toxic Substances Control Act (TSCA):

The chemical ingredients in this product are on the 8(b) Inventory List (40 CFR 710).

Resource Conservation and Recovery Act (RCRA), 40 CFR 261 Subpart C & D:

Consult Section 13 for RCRA classification.

Federal Water Pollution Control Act, Clean Water Act, 40 CFR 401.15 / Formerly Sec. 307, 40 CFR 116 / Formerly Sec. 311:

None of the ingredients are specifically listed.

Clean Air Act, Sec. 111 (40 CFR 60), Sec. 112 (40 CFR 61, 1990 Amendments), Sec. 611 (40 CFR 82, Class I and II Ozone Depleting Substances):

This product contains the following ingredients covered by the Clean Air Act: Urea - Section 111

STATE REGULATIONS:

California Proposition 65:

This product does not contain any chemicals which require warning under California Proposition 65.

Michigan Critical Materials:

This product does not contain ingredients listed on the Michigan Critical Materials Register.

State Right to Know Laws:

This product does not contain ingredients listed by State Right To Know Laws.

SECTION 16 - RISK CHARACTERIZATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

* The human risk is: LOW.

* The environmental risk is: LOW.

Any use inconsistent with Fuel Tech's recommendations may affect our risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.



MATERIAL SAFETY DATA SHEET

PRODUCT
NOxOUT® A

Emergency Telephone Number
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SECTION 17 - REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (CD-ROM version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (CD-ROM version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA).

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, Ohio (CD-ROM version), Micromedex, Inc., Englewood, CO.

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Suspect Chemicals Sourcebook (a guide to industrial chemicals covered under major regulatory and advisory programs), Roytech Publications (a Division of Ariel Corporation), Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, Washington (CD-ROM version), Micromedex, Inc., Englewood, CO.

REVISED: 03/15/00



MATERIAL SAFETY DATA SHEET
PRODUCT
NOxOUT® HP

Emergency Telephone Number:
CHEMTREC - 1.800.424.9300 [24 hours]

SECTION 1 - PRODUCT IDENTIFICATION

Trade Name: NOXOUT HP

Description: An aqueous solution of an amide

NFPA 704M/HMIS Rating: 1/1 Health 0/0 Flammability 0/0 Reactivity 0/Other
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 2 - COMPOSITION/INGREDIENT INFORMATION

Our hazard evaluation of the ingredient(s) under OSHA's Hazard Communication Rule, 29 CFR 1910.1200 has found none of the ingredient(s) hazardous.

SECTION 3 - HAZARD IDENTIFICATION

EMERGENCY OVERVIEW:

Caution: May cause irritation to skin and eyes. Avoid contact with skin, eyes, and clothing. Avoid prolonged or repeated breathing of vapor. Use with adequate ventilation. Do not take internally.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

Primary Route(s) of Exposure: Eye, Skin, Inhalation

Eye Contact: Can cause mild, short-lasting irritation

Skin Contact: May cause irritation with prolonged contact

Inhalation: May cause irritation to the respiratory tract and lungs

SYMPTOMS OF EXPOSURE:

A review of available data does not identify any symptoms from exposure not previously mentioned.

Aggravation of Existing Conditions: A review of available data does not identify any worsening of existing conditions.

SECTION 4 - FIRST AID INFORMATION

Eyes: Flush with water for 15 minutes. Call a physician.

Skin: Wash thoroughly with soap and rinse with water. Call a physician.

Ingestion: Do not induce vomiting. Give water. Call a physician.

Inhalation: Remove to fresh air. Treat symptoms. Call a physician.

Note To Physician: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

Caution: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water.

SECTION 5 - FIRE FIGHTING

Flash Point: None

Extinguishing Media: This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use water to cool containers exposed to fire.

Unusual Fire and Explosion Hazard: May evolve CO, CO₂, NO_x, ammonia, and cyanuric acid under fire conditions.



MATERIAL SAFETY DATA SHEET

PRODUCT
NOxOUT® HP

Emergency Telephone Number
CHEMTREC - 1.800.424.9300 (24 hours)

SECTION 6 - ACCIDENTAL RELEASE MEASURES

In case of transportation accidents, call the following 24-hour telephone number: 1.800.424.9300 (CHEMTREC).

SPILL CONTROL AND RECOVERY:

Small Liquid Spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 15.

Large Liquid Spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA in Section 15.

SECTION 7 - HANDLING AND STORAGE

Handling: Avoid contact with skin, eyes, and clothing.

Storage: Keep container closed when not in use.

SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

Respiratory Protection: Respiratory protection is not normally needed since the volatility and toxicity are low. If significant mists are generated, use either chemical cartridge respirator with a dust/mist prefilter or supplied air.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

Ventilation: General ventilation is recommended.

Protective Equipment: Use impermeable gloves and chemical splash goggles when attaching feeding equipment, doing maintenance or handling product. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural rubber, viton and butyl (compatibility studies have not been performed).

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Color:	Clear, colorless	
Form:	Liquid	
Density:	9.5 lbs/gal.	
Specific Gravity:	1.14 @ 77 Degrees F	ASTM D-1298
Ph (NEAT) =	9.7	ASTM E-70
Viscosity:	3 cps @ 72 Degrees F	ASTM D-2983
Flash Point:	None	
Crystallization Point:	60 Degrees F	

Note: These physical properties are typical values for this product.



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SECTION 10 - STABILITY AND REACTIVITY

Incompatibility: Avoid contact with strong oxidizers (eg. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

Thermal Decomposition Products: In the event of combustion CO, CO₂, NO_x, ammonia, and cyanuric acid may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

SECTION 11 - TOXICOLOGICAL INFORMATION

Toxicity Studies: No toxicity studies have been conducted on this product.

SECTION 12 - ECOLOGICAL INFORMATION

If released into the environment, see CERCLA in Section 15.

SECTION 13 - DISPOSAL CONSIDERATIONS

Disposal: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be incinerated in accordance with local, state and federal regulations.

SECTION 14 - TRANSPORTATION INFORMATION

Proper shipping name/hazard class may vary by packaging, properties, and mode of transportation. Typical proper shipping names for this product are:

All Transportation Modes: product is not regulated during transportation.

SECTION 15 - REGULATORY INFORMATION

The following regulations apply to this product.

FEDERAL REGULATIONS:

OSHA Hazard Communication Rule, 29 CFR 1910.1200:

Based on our hazard evaluation, none of the ingredients in this product are hazardous.

CERCLA/Superfund, 40 CFR 117, 302:

Notification of spills of this product is not required.

Sara/Superfund Amendments and Reauthorization Act of 1986 (Title III) - Sections 302, 311, 312 and 313:

Section 302 - Extremely Hazardous Substances (40 CFR 355):

This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

Sections 311 and 312 - Material Safety Data Sheet Requirements (40 CFR 370):

Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.



MATERIAL SAFETY DATA SHEET

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NO_xOUT[®] HP

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This product contains the following ingredients covered by the Clean Air Act:

Urea - Section 111

STATE REGULATIONS:

California Proposition 65:

This product does not contain any chemicals which require warning under California Proposition 65.

Michigan Critical Materials:

This product does not contain ingredients listed on the Michigan Critical Materials Register.

State Right to Know Laws:

This product does not contain ingredients listed by State Right To Know Laws.

International Regulations:

This is not a WHMIS controlled product under The House of Commons of Canada Bill C-70.

SECTION 16 - RISK CHARACTERIZATION

Our Risk Characterization is being determined.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

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