Appendix E

Applicant's Environmental Report

Operating License Renewal Stage

Arkansas Nuclear One – Unit 2

Introduction

Entergy Operations submits this Environmental Report in conjunction with the application to the U.S. Nuclear Regulatory Commission to renew the operating license for ANO-2 for twenty years beyond the end of the current license. In compliance with applicable NRC requirements, this ER analyzes potential environmental impacts associated with renewal of the ANO-2 operating license. This ER is designed to assist the NRC staff with the preparation of the ANO-2 specific Supplemental Environmental Impact Statement required for license renewal.

The ANO-2 ER is provided in accordance with 10CFR54.23, which requires license renewal applicants to submit a supplement to the ER that complies with the requirements of Subpart A of 10CFR Part 51. This report also addresses the more detailed requirements of NRC environmental regulations in 10CFR51.45 and 10CFR51.53, as well as the underlying intent of the National Environmental Policy Act, 42 U.S.C. §4321 *et seq*. For major federal actions, the NEPA requires federal agencies to prepare a detailed statement that addresses significant environmental impacts, adverse environmental effects that cannot be avoided if the proposal is implemented, alternatives to the proposed action, and irreversible and irretrievable commitments of resources associated with implementation of the proposed action.

Supplement 1 to Regulatory Guide 4.2 - Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses was used as guidance on the format and content of this ER. The level of information provided on the various topics and issues in this ER are commensurate with the extent of the analysis provided for the particular topic or issue.

Based upon the evaluations discussed in this ER, Entergy Operations concludes that no significant environmental impacts are associated with the renewal of the ANO-2 operating license. No major plant refurbishment activities have been identified as necessary to support the continued operation of ANO-2 beyond the end of the existing operating license term. Although normal plant maintenance activities may later be performed for economic and operational reasons, no significant environmental impacts associated with such refurbishments are expected.

The application to renew the operating license of ANO-2 assumes that licensed activities are now conducted, and will continue to be conducted, in accordance with the facility's current licensing basis (e.g., use of low enriched uranium fuel only). Changes made to the current licensing basis of ANO-2 during the staff review of this application are to be made in accordance with the Atomic Energy Act of 1954, as amended, and in accordance with Commission regulations.

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Acronyms and Abbreviations

AC	alternating current
ADEQ	Arkansas Department of Environmental Quality
ADH	Arkansas Department of Health
AEC	U. S. Atomic Energy Commission
AFW	auxiliary feedwater
AGFC	Arkansas Game and Fish Commission
AHTD	Arkansas Highway and Transportation Department
ALARA	as low as reasonably achievable
ANHC	Arkansas Natural Heritage Commission
ANO	Arkansas Nuclear One
ANO-1	Arkansas Nuclear One – Unit 1
ANO-2	Arkansas Nuclear One – Unit 2
ASP	Arkansas State Police
ASWCC	Arkansas Soil and Water Conservation Commission
ATWS	Anticipated Transient without Scram
BG&E	Baltimore Gas and Electric Company
BMS	boron management system
BTU	British thermal unit
BW	borated water
BWR	boiling water reactor
CAST	Center for Advanced Spatial Technology
CCW	component cooling water
CDF	Core Damage Frequency
CE	Combustion Engineering
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CILRWC	Central Interstate Low-Level Radioactive Waste Commission
CO	carbon monoxide
CO2	carbon dioxide
CoE	U. S. Army Corps of Engineers
COE	cost of enhancement
COMSORS	Core Melt Source Reduction System
CSS	containment spray system
DAW	dry active waste
DC	direct current
DOE	U. S. Department of Energy
DOT	U. S. Department of Transportation

Acronyms and Abbreviations (continued)

ECCS	emergency core cooling system
EDG	emergency diesel generator
EEI	Edison Electric Institute
EFW	emergency feedwater
EOI	Entergy Operations, Incorporated
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ER	environmental report
ESFAS	engineered safety features actuation system
FES	Final Environmental Statement
ft	feet
ft^3	cubic feet
GEIS	Generic Environmental Impact Statement
GIS	geographic information system
gpm	gallons per minute
GWPS	gaseous waste processing system
HEPA	high-efficiency particulate air
HPSI	high pressure safety injection
HSAW	high specific activity waste
HVAC	heating, ventilation, and air conditioning
IPE	individual plant examination
IPEEE	individual plant evaluation of external events
ISFSI	independent spent fuel storage installation
ISLOCA	interfacing system LOCA
J	joules
kV	kilovolts
LBLOCA	large break loss of coolant accident
LOCA	loss of coolant accident
LOOP	loss of off-site power
LPSI	low pressure safety injection
m^3	cubic meters
mA	milliamps
MACCS2	Melcor accident consequences code system
MFW	main feedwater
mg/l	milligram per liter

Acronyms and Abbreviations (continued)

mGy	milligray
ml	milliliter
MOV	motor-operated valve
mrad	millirad
mrem	millirem
MSL	mean sea level
mSv	millisievert
MT	metric ton
MWD/MTU	megawatt day/metric ton uranium
MWe	megawatts, electric
MWh	megawatt hour
MWt	megawatts, thermal
NA	not applicable
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESC	National Electric Safety Cod
NHL	National Historic Landmark
NOx	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NRC	U.S. Nuclear Regulatory Commission
NRR	(Office of) Nuclear Reactor Regulation
NUREG	U. S. Nuclear Regulatory Commission Document
ODCM	Offsite Dose Calculation Manual
PDS	plant damage state
PM2.5	particulate matter (particulate matter with a nominal size of less than 2.5 microns)
PM10	particulate matter (particulate matter with a nominal size of less than 10 microns)
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
PV	solar photovoltaic
PWR	pressurized water reactor
RAI	request for additional information
RAS	recirculation actuation system
RCRA	Resource Conservation and Recovery Act
RCS	reactor coolant system
rem	roentgen
RWT	refueling water tank
rx-yr	years of reactor operation

Acronyms and Abbreviations (continued)

SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternative
SBO	station blackout
SCDHEC	South Carolina Department of Health and Environmental Control
SCR	selective catalytic reduction
SEIS	Supplemental Environmental Impact Statement
SGTR	steam generator tube rupture
SHPO	State Historic Preservation Office
SOx	sulfur oxide(s)
SO2	sulfur dioxide
SRWP	solid radioactive waste program
SW	service water
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
UALR	University of Arkansas at Little Rock
UDEQ	Utah Department of Environmental Quality
USCB	U. S. States Census Bureau
USDA	U. S. Department of Agriculture
USGS	U. S. Geological Survey
USFWS	U. S. Fish and Wildlife Service
USWAG	Utility Solid Waste Activities Group
WMS	waste management system
ºC	degrees centigrade
ºF	degrees Fahrenheit

1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

For license renewal, the NRC has adopted the following definition of purpose and need, stated in Section 1.3 of the NRC Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants, NUREG-1437: "The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized Federal (other than NRC) decision makers."

Nuclear power plants are licensed by the NRC to operate up to 40 years, and the licenses may be renewed [10CFR50.51] for periods up to 20 years. 10CFR54.17(c) states that "[a]n application for a renewed license may not be submitted to the Commission earlier than 20 years before the expiration of the operating license currently in effect."

The proposed action is to extend the operating license for ANO-2 for a period of twenty (20) years beyond the current operating license expiration date. For ANO-2 (Facility Operating License NPF-6), the requested renewal would extend the existing license expiration date from midnight July 17, 2018 until midnight July 17, 2038.

2.0 SITE AND ENVIRONMENTAL INTERFACES

2.1 Location and Features

Arkansas Nuclear One, Unit 2 is located near Interstate 40 on a peninsula formed by Lake Dardanelle in southwestern Pope County, Arkansas, approximately 68 miles east of Fort Smith, Arkansas, and about 57 miles northwest of Little Rock, Arkansas. The town of Russellville, Arkansas is about 6 miles east-southeast of the site. The site is in the west-central part of the State, approximately 70 miles east of the Oklahoma border and the same distance south from the Missouri border. The location of the site is shown on Figures 2-1 and 2-2.

Access to the site is available by road or from Lake Dardanelle. Land access is provided by two roads, state Highway 333 and May Road. South of the discharge canal is a barge landing providing lake access to the site. The landing is used for delivery of large equipment or large structural assemblies. In addition, there is also a public boat landing further south of the discharge canal near May Cemetery for public use. However, this landing does not provide access to the site and would be under the control of the facility in the event of an emergency.

The industrial facility encompasses approximately 1,164 acres in a rural part of west-central Arkansas. The site is surrounded by a 0.65-mile radius exclusion area as shown in Figure 2-3. The nearest residences lie outside the site boundary to the south-southwest and west-southwest at 0.7 miles [EOI 2001b, Table 2.1]. Entergy owns most of the property on the peninsula. The property that is not owned by Entergy is privately owned and the U. S. Army Corps of Engineers owns the shoreline around Lake Dardanelle.

ANO-2 features include the containment building, an auxiliary building, a turbine building shared with Arkansas Nuclear One – Unit 1, an intake structure, a discharge structure shared with ANO-1, a cooling tower, a switchyard shared with ANO-1, and associated transmission line. Figure 3-1 shows the general features of the ANO site. Section 3.2 describes key features of ANO, including reactor and containment systems, cooling and auxiliary water systems, and transmission facilities.

The nearest major population center is Little Rock, Arkansas. The region within six miles of the site includes the town of Russellville, the nearest urbanized area. Outside the ANO property line on the southern end of the peninsula, the majority of the land area is forest and residential development. Pasture and cropland are insignificant on the peninsula.

There are no Native American lands within a 50-mile radius of ANO. State and federal lands within a 6-mile and a 50-mile radius of ANO are shown in Figures 2-4 and 2-5.

2.2 Aquatic and Riparian Ecological Communities

Lake Dardanelle is a man-made lake upstream of the Dardanelle Lock and Dam on the Arkansas River. The river was impounded and the lake formed in 1967. In addition to providing water for ANO, Lake Dardanelle serves a variety of other uses. The lake is designated as suitable for propagation of fish and wildlife, recreation, and public and industrial water supply.

The water quality of Lake Dardanelle is monitored by the Arkansas Department of Environmental Quality. Water-based recreation activities, such as boating and fishing, are a focal point of interest. Additionally, the environs of the lake are used for camping, picnicking, sightseeing, photography, and nature studies. The lake has a commercial fishing industry [NRC 2001, Section 2.2.5].

Lake Dardanelle is over 60 feet deep at its lower end, with an average depth of 10 feet [NRC 2001, Section 2.1]. Since Lake Dardanelle is relatively shallow and average retention period of water in the lake is about seven days, it has the characteristics of a flow-through lake rather than a storage reservoir [AEC 1973, Section 2.5].

Water temperatures in the vicinity of ANO show typical annual cycles for shallow reservoirs in the southeastern United States. The highest surface temperatures typically occur in August when temperature values exceed 90ºF. The lowest water temperatures during the winter are typically above freezing, although significant ice has occurred across the main channel of Lake Dardanelle. Few areas exhibit significant thermal stratification [Texas Instruments 1975].

The water quality of Lake Dardanelle and the Arkansas River is monitored routinely by the ADEQ. Since 1991, a decline in the minimum dissolved oxygen concentration has occurred in the Arkansas River, during low flow periods from July through October. The greatest number of low dissolved oxygen readings is occurring on portions of the Arkansas River which receive heavy loading from the urban and suburban areas of Fort Smith, approximately 100 river miles upstream of ANO. Lake Dardanelle is located above the Dardanelle Lock and Dam. Water releases from the dam for hydropower, occurring from a deeper portion of the lake, may account for low dissolved oxygen values below the Dardanelle Lock and Dam during the summer period. While ADEQ monitoring has identified occasional low dissolved oxygen readings, it has not changed the designated uses of the lake [ADEQ 2000].

2.2.1 Phytoplankton, Zooplankton and Benthic Communities

The various trophic communities of Lake Dardanelle have been surveyed and monitored. Phytoplankton populations are diverse and fluctuate seasonally. Green algae (*Chlorophyta*) is the dominant algal group throughout the year. Diatoms (*Chrysophyta*) are secondary in abundance and the bluegreens (*Cyanophyta*) and dinoflagellates (*Pyrrhopyta*) are minor constituents. Zooplankton vary seasonally. Rotifers dominate during the early summer. Other zooplankton species occurring at Lake Dardanelle include *Kellicottia bostoniensis, Platyias patulus, Brachionus spp., Keratela cochlearis, Polyarthra* sp., and *Leptodora kindti.* The benthic community includes *Chironomidae*, *Oligochaeta*, and *Spheriidae*. Additional benthic organisms in Lake Dardanelle include the *Corbicula fluminea* and *Dreissena polymorpha* [NRC 2001, Section 2.2.5].

2.2.2 Fish Community

The fish community of the area varies with the current. Flathead catfish (*Pylodictis olivaris*), channel catfish (*Ictalurus punctatus*), and blue catfish (*I. furcatus*) occur in areas with a current. Largemouth bass (*Micropterus salmoides*), spotted bass (*M. punctulatus*), green sunfish

(*Lepomis cyanellus*), bluegill sunfish (*L. macrochirus*), black crappie (*Pomoxis nigromaculatus*), white crappie (*P. annularis*), and warmouth (*L. gulosus*) are in slack water areas and in the Illinois Bayou embayment [NRC 2001, Section 2.2.5].

The fish community near ANO also changes seasonally. Striped bass (*Morone saxatilis*), and white bass (*M. chrysops*) are generally more abundant in the spring. Rough or commercial fish are generally abundant throughout the year. These fish include European carp (*Cyprinus carpio*), bigmouth buffalo (*Ictiobus cyprinellus*), black buffalo (*I. niger*), smallmouth buffalo (*I. bubalus*), carpsuckers (*Carpiodes spp.*), freshwater drum (*Aplodinotus grunniens*), and redhorses (*Moxostoma spp*.). The most important forage fish species in the lake are gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*) [NRC 2001, Section 2.2.5].

2.2.3 Summary

The importance of ANO to the aquatic resources of the region is illustrated by the consideration of ANO as beneficial to fish and wildlife of the region. The ANO site provides a number of diverse habitats such as fields, hardwood stands, conifer stands, and wetlands. There are numerous transitional areas or edge communities resulting in high-quality habitats for species diversity. The cooling water intake canal provides habitat for numerous species of fish. During warm months, the intake flow mixes warm, less oxygenated surface water with cool, more highly oxygenated Illinois Bayou channel water. This provides a highly productive habitat within the canal. Numerous species of fish and waterfowl utilize the warm water effluent during cold water conditions. A small, inundated wetland south of the effluent bay provides habitat for mammals, fish, reptiles, amphibians and waterfowl. The aquatic environment at ANO provides habitat for fish and wildlife, thus providing fishing, hunting, and other recreational opportunities for the public throughout the area [NRC 2001, Section 2.2.5].

2.3 Groundwater Resources

In the ANO area, Pennsylvanian McAlester formation shale bedrock is overlaid with clay and silt-clay deposits. The thickness of this clay overlay varies from about 13 to 24 feet. The bedrock sequence forms the trough of the east-west trending Scranton syncline. Hard, fine grained sandstone of the Harthshorne formation was encountered during drilling at a depth of about 150 feet [EOI 2001a, Section 2.5.1]. The piezometric surface slopes about 24 feet per mile southwest toward the lake. Therefore, groundwater from the ANO area migrates slowly through relatively impermeable clay toward the lake [EOI 2001a, Section 2.5.2].

Good groundwater bearing zones are not present in the overburden material at or near the site [EOI 2001a, Section 2.5.3]. As a result, no groundwater wells are located on the ANO site. Potable water used for domestic and industrial purposes within a 10-mile radius of ANO is from subsurface and surface sources. The area has six public water systems (see Table 2-6) that serve the incorporated towns and rural areas [Yusuf 2002]. There is no current or proposed major groundwater use in the vicinity of the site.

2.4 Critical and Important Terrestrial Habitats

ANO and its associated transmission line right-of-way lies within the oak-hickory biome of the eastern deciduous forest. This biome ranges from dense forests of oaks (*Quercus spp.*) and hickory (*Carya spp.*) to more open savanna habitat. Eastern red cedar (*Juniperus virginiana*) and short-leaf pine (*Pinus echinata*) are common in the open habitats [NRC 2001, Section 2.2.6].

Land cover at the ANO site includes mixed pine and hardwood forest and disturbed, early successional habitat (Table 2-1). Approximately 5 acres of wetlands are present on the site. The transmission line right-of-way crosses the Arkansas River, a number of small streams, wetlands, forests, savanna and farmland.

Table 2-1
Land Cover at ANO

Land Cover Class	Area (acres)	Percentage of Site
Mixed pine-hardwood forest	461	40
Early successional habitats	485	41
Developed areas	180	15
Open water	30	3
Wetlands	5	<1
Source: NRC 2001, Table 2-2		

Mammals at the ANO site and the transmission line right-of-way include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), red and grey fox (*Vulpes fulva* and *Urocyon cinereoargenteus*), eastern gray and fox squirrels (*Sciurus carolinensis* and *niger*), eastern chipmunk (*Tamias striatus*), and a variety of mice and voles. White-tailed deer are the most important game mammal [NRC 2001, Section 2.2.6].

The open water of Lake Dardanelle and emergent wetland habitat support a number of migrant waterfowl species, including common mergansers (*Mergus merganser*) and double-crested cormorants (*Phalacrocorax auritus*). Osprey (*Pandion haliaetus*) use the lake areas near the ANO site. American white pelicans (*Pelecanus erythrorhynchos*) use the open water habitats of the reservoir. Great blue herons (*Ardea herodias*) nest in trees near the ANO site [NRC 2001, Section 2.2.6].

The Arkansas Natural Heritage Commission was contacted regarding rare or special species and habitats within the ANO site and its associated transmission line right-of-way [see Attachment A]. The ANHC identified two species and three habitat areas of interest within the

corridor (Table 2-2). A field survey concluded that none of the species are likely to be affected by continued operation of ANO-2 or the transmission line right-of-way. Also, the presence of ANO-2 and the transmission line right-of-way does not pose a threat to the value of the three habitats of interest. The transmission corridor does not cross state or federal parks, wildlife refuges or wildlife management areas.

Table 2-2
Rare Species and Elements of Special Concern Within ANO and Transmission Line Right-of-Way

Species or Habitat	Common Name	Federal Status	State Status	Reason for ANHC Listing
Philadelphus hirsutus	Mock orange	None	None	Uncommon in State; disjunct from eastern range
Castanea pumila var. *ozarkensis*	Ozark chinquapin	None	None	Declining numbers due to chestnut blight
Illinois Bayou	--	None	Extraordinary Resource Water	Limitations on new impacts
Cadron Creek	--	None	Extraordinary Resource Water	Limitations on new impacts
Goose Pond Natural Area	--	None	Natural Area	Conservation easement to ANHC

2.5 Threatened or Endangered Species

One mammal, one fish and two bird species currently protected under the Endangered Species Act have geographic ranges that may include the ANO site area. These species are bald eagle (*Haliaeetus leucocephalus*), interior least tern (*Sterna antillarum*), gray bat (*Myotis grisescens*) and Arkansas River shiner (*Notropis girardi*). The bald eagle and Arkansas River shiner are currently listed as threatened and the remaining species are listed as endangered.

The bald eagle is a winter transient to the Lake Dardanelle area, where birds forage during colder periods of the winter months. Nest sites have been reported at several localities on Lake Dardanelle, but none are within 10 miles of ANO and none are within the transmission line right-of-way. Suitable habitat for the interior least tern and gray bat is not found within or near the ANO site area and these species have not been observed within the area. The Arkansas River shiner has not been observed within the ANO site area. No federally-listed reptiles, amphibians, or invertebrate species or appropriate habitats for them have been identified within the ANO site area. In addition, no federally-listed plant species have been identified within the ANO site area.

The interior least tern (*Sterna antillarum*) requires exacting sand bar conditions, i.e., sand bars with very low vegetation cover and affording some protection from predators and flooding. These conditions are not present within the site area [EOI 1999, Section 4.6.5.1]. The interior least tern breeds on sandbars in the Arkansas River near Atkins and Clarksville, Arkansas [NRC 2001, Section 4.6]. However, these nesting locations are beyond a 10-mile radius from the ANO facility and the transmission line right-of-way.

The gray bat *(Myotis grisescens)* is known to occur near ANO, where it resides in caves upstream of the Dardanelle Lock and Dam. However, these caves are 10 miles from the ANO facility and 2 miles from the transmission line right-of-way [NRC 2001, Section 4.6].

The Arkansas River shiner (*Notropis girardi*) is known to occur along portions of the Arkansas River. However, none have been observed in the vicinity of ANO or the transmission line right-of-way [see Attachment B].

Critical habitat has not been designated in Arkansas by the U.S. Fish and Wildlife Service or the Arkansas Game and Fish Commission for these species. In addition, no new federally-listed species along the transmission line constructed to support ANO-2 was identified [see Attachments B and C].

2.6 Regional Demography

2.6.1 Regional Population

The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* presents a population characterization method that is based on two factors: "sparseness" and "proximity" [NRC 1996, Section C.1.4]. "Sparseness" measures population density and city size within 20 miles of a site and categorizes the demographic information as follows.

Demographic Categories Based on Sparseness

		Category
Most sparse	1.	Less than 40 persons per square mile and no community with 25,000 or more persons within 20 miles
	2.	40 to 60 persons per square mile and no community with 25,000 or more persons within 20 miles
	3.	60 to 120 persons per square mile or less than 60 persons per square mile with at least one community with 25,000 or more persons within 20 miles
Least sparse	4.	Greater than or equal to 120 persons per square mile within 20 miles

Source: NRC 1996

"Proximity" measures population density and city size within 50 miles and categorizes the demographic information as follows.

Demographic Categories Based on Proximity

		Category
Not in close proximity	1.	No city with 100,000 or more persons and less than 50 persons per square mile within 50 miles
	2.	No city with 100,000 or more persons and between 50 and 190 persons per square mile within 50 miles
	3.	One or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles
In close proximity	4.	Greater than or equal to 190 persons per square mile within 50 miles

Source: NRC 1996

The GEIS then uses the following matrix to rank the population in the vicinity of the plant as low, medium, or high.

GEIS Sparseness and Proximity Matrix

		Proximity			
		1	2	3	4
Sparseness	1	1.1	1.2	1.3	1.4
	2	2.1	2.2	2.3	2.4
	3	3.1	3.2	3.3	3.4
	4	4.1	4.2	4.3	4.4

Low Population Area (grey: 1.1, 1.2, 2.1) | Medium Population Area (white) | High Population Area (black: 3.4, 4.3, 4.4)

Source: NRC 1996

Entergy used 2000 census data from the Arkansas State Census Data Center [UALR 2002a] and Geographical Information System software (ArcView®) to determine demographic characteristics in the ANO vicinity.

The 2000 census data indicates that 87,468 people live within 20 miles of ANO, which equates to a population density of 70 persons per square mile. According to the GEIS sparseness index, ANO is classified as Category 3 sparseness (having 60 to 120 persons per square mile within 20 miles).

The census data indicates that 267,664 people live within 50 miles of ANO, which equates to a population density of 34 persons per square mile. According to the GEIS proximity index, ANO is classified as Category 1 proximity (no city with 100,000 or more persons and less than 50 persons per square mile within 50 miles).

According to the GEIS sparseness and proximity matrix, the combination of sparseness Category 3 and proximity Category 1 results in the conclusion that ANO is located in a "medium" population area.

All or parts of 19 Arkansas counties (Figure 2-1) are located within 50 miles of ANO. Nearby towns include Russellville (Pope County), Clarksville (Johnson County) and Dardanelle (Yell

County). Pope, Johnson and Yell Counties have a combined total population of approximately 98,389 [USCB 2000a, USCB 2000b & USCB 2000c]. From 1990 to 2000, Pope County had an annual growth rate of 1.9 percent, Johnson County had an annual growth rate of 2.5 percent, and Yell County had an annual growth rate of 1.9 percent. All three counties had a faster growth rate than that of Arkansas as a whole during this same time period. From 1990 to 2000, Arkansas' annual population growth rate was 1.3 percent [USCB 2000d].

Table 2-3 shows estimated populations and annual growth rates through 2040 for the three counties with the greatest potential to be socioeconomically affected by license renewal activities. The license renewal term is through 2038.

Table 2-3
Population Growth in Pope, Johnson and Yell Counties, Arkansas, 1970 – 2040

Pope			Johnson		Yell	
Date	**Population**	**Annual Growth %**	**Population**	**Annual Growth %**	**Population**	**Annual Growth %**
1970[a]	28,607	--	13,630	--	14,208	--
1980[a]	38,964	3.6	17,423	2.8	17,026	2.0
1990[a]	45,883	1.8	18,221	0.5	17,759	0.4
2000[b]	54,469	1.9	22,781	2.5	21,139	1.9
2010[c]	61,899	1.4	23,418	0.3	23,620	1.2
2020[c]	69,014	1.1	24,040	0.3	25,997	1.0
2030[c]	76,057	1.0	24,655	0.3	28,350	0.9
2040[c]	83,100	0.9	25,270	0.2	30,703	0.8

a. NRC 2001, Table 2-6.
b. USCB 2000a, USCB 2000b & USCB 2000c.
c. UALR 2002b.

2.6.2 Minority and Low-Income Populations

2.6.2.1 Background

The NRC performs environmental justice analyses utilizing a 50-mile radius around the plant as the environmental impact site and the state as the geographic area for comparative analysis. Entergy has adopted this approach for identifying the minority and low-income populations that could be affected by ANO-2 operations.

NRC guidance suggests using the most recent U.S. Census Bureau decennial census data. Entergy used 2000 census data from the Arkansas State Census Data Center [UALR 2002a] to identify minority populations within 50 miles of ANO.

ARCVIEWtm GIS software (version 8.1) was used to identify the census block groups within the 50-mile radius, compile the minority and low-income population data, and produce maps showing the geographic location of minority and low-income populations in relation to ANO. The information for these block groups was then reviewed with respect to the Nuclear Reactor Regulation criteria [NRC 1999] for minority and low-income populations.

2.6.2.2 Minority Populations

The NRC Procedural Guidance for Performing Environmental Assessments and Considering Environmental Issues defines a "minority" population as American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic [NRC 1999]. The guidance indicates that a minority population exists if either of the two following conditions exist:

Exceeds 50 Percent – the minority population of the environmental impact site exceeds 50 percent or

More than 20 Percent Greater – the minority population percentage of the environmental impact site is significantly greater (typically at least 20 percent) than the minority population percentage in the geographic area chosen for comparative analysis.

The 2000 census data indicates that 21.4% of the population in Arkansas was composed of minorities [UALR 2002a]. Therefore, a block group within a 50-mile radius of ANO with minority citizens equal to or greater than 41.4% of the total block group population would be a "minority population."

Overall, minority populations within the 50-mile radius impact site were small and well dispersed. Based on the "exceeds 50 percent" and "more than 20 percent greater" criteria, minority populations existed in only 4 of the 218 block groups. The locations of these block groups are shown in Figure 2-6. These block groups are located in the communities of Dardanelle, Morrilton and Conway. The nearest minority population to ANO was in census block group 952300-3 located approximately 8 miles southeast of the plant.

Labels in Figure 2-6 refer to the census tract and block group number. These block groups had population totals that ranged from 600 to 1600 persons. The composition of minorities in these block groups ranged from 42% to 62%.

2.6.2.3 Low-Income Populations

NRC guidance defines "low-income" using USCB statistical poverty thresholds [NRC 1999]. The guidance identifies an area as a low-income population area if the percentage of households below the poverty level is significantly greater (typically at least 20 percent) than the low-income household percentage in the area chosen for comparative analysis.

The 2000 census data indicates that 15.8% of the state-wide population was living below the poverty level [UALR 2002a]. Therefore, census block groups within a 50-mile radius of ANO

with 35.8% or more of the total population below the poverty level would be a "low-income population."

Overall, low-income populations within the 50-mile radius impact site were small and well dispersed. Based on the NRC's criterion (at least 20 percent), low-income populations existed in only 7 of the 218 block groups. The geographic locations of the low-income populations are shown in Figure 2-7. The majority of these block groups are located in the communities of Clarksville, Russellville and Conway. The nearest low-income population to ANO was in census block group 951400-2 located approximately 5 miles east of the plant.

Labels in Figure 2-7 refer to the census tract and block group number. These block groups had population totals that ranged from 682 to 2285 persons. The percentage of the total block group population below the poverty level ranged from 40% to 63%. One block group (Census tract 030700, Group 3) was also defined as a minority population in Section 2.6.2.2 above. This block group is located approximately 49 miles east-southeast of ANO.

2.7 Taxes

The continued availability of ANO and the associated tax base is an important feature in Pope County's ability to continue to invest in infrastructure and to draw industry and new residents. In 2002, Entergy paid approximately $8.5 million in property taxes for ANO, making Entergy the largest industrial tax payer in the county. Table 2-4 identifies the distribution of these taxes within the four principle Pope County tax units. Based on this table, taxes associated with ANO make up approximately 43%, 55% and 43% of the locally generated property tax revenues for the county general, county roads and county library budgets, respectively. The majority of Entergy's property taxes for ANO are allocated to the Russellville School District. In 2002, Entergy's taxes made up about 49% of the locally generated property tax revenues for the school district.

Table 2-4
Entergy Property Tax Distribution for 2002 [a]

Taxing Unit	2002 Approved Budget [a]	County Revenue from Property Taxes [a]	Entergy Tax Distribution [c]	% of County Property Tax Revenue from Entergy
County General	7,236,541	508,722	220,893	43
County Roads	3,798,811	999,579	549,167	55
County Library	809,932	508,722	220,893	43
Russellville School District	28,685,177 [b]	14,413,959	7,090,478	49

a. Lutrel 2003.
b. RSD 2003.
c. McAlister 2003

2.8 Land Use Planning

Land use planning focuses on Pope County since the continued availability of ANO and the associated tax base is an important feature in the county's ability to invest in infrastructure and to draw industry and new residents. In Johnson and Yell County, continued presence of the plant has less influence on land use because the plant does not directly contribute to the tax base of these counties.

2.8.1 Existing Land Use Trends

Pope County occupies roughly 822 square miles (526,080 acres) and consists of approximately 68.5% forest, 25.5% agriculture (crops & pasture), 2.6% water and 2.5% urban (residential & commercial/industrial) [CAST 2002]. About 60% of the county is mountainous or hilly with elevations ranging from approximately 450 feet to approximately 2100 feet above MSL. Most of this area is too steep for intensive use so it is used mainly for woodland and pasture. Some of the less sloping areas are suitable for improved pasture and truck crops. About 40% of Pope County is level to gently sloping hilltops, valley fill and alluvial fill. Bottom lands along the Arkansas River are intensively farmed. The main crops include soy beans, rice, wheat, and grain sorghum. Acreage in crops and pasture has been declining in the Pope County area as more land is used for urban development [USDA 1981].

The ANO site is centrally situated on a peninsula which extends into Lake Dardanelle (see Figure 2-2). Outside the site boundary, the majority of the area is forested with small areas of open grassland and residential development, which is typical of land near Lake Dardanelle. Much of the property along the shoreline of Lake Dardanelle is owned by the CoE and maintained in a natural condition.

2.8.2 Future Land Use Trends

Residential development is expected to continue around Lake Dardanelle because of the availability of desirable lakefront property. Pope County has experienced moderate population growth and moderate land-use changes in the last 10 years. Future lakefront development would be facilitated by the presence of roads and water service, which are an indirect impact of the ANO site. Tax receipts from ANO keep Pope County's tax rates lower than would otherwise be needed to fund the county government's current high level of public infrastructure and services. This enhances the county's attractiveness as a place to live and may tend to accelerate the conversion of open space to residential and commercial uses [NRC 2001, Section 4.4.3].

2.9 Housing

Between 1970 and 2000, total housing units in Pope County increased from 9,882 to 22,851 [USCB 2000a]. As of October 2002, a total of 976 ANO employees lived in Pope County, 99 lived in Johnson County, and 111 lived in Yell County (see Table 3-1). Information is not available for the individual ANO units, but only for the entire facility. Roughly half of plant employee and resource use is associated with ANO-2.

Since 2000, the Pope County population has continued to increase from 45,883 at the 1990 Census to 54,469 in 2000 (see Table 2-3). Johnson County increased in population from about 18,221 in 1990 to 22,781 in 2000, and Yell County increased from about 17,759 in 1990 to 21,139 in 2000 (see Table 2-3). In 2000, Pope County employed 4,834 in major manufacturing facilities, compared with 3,040 in Johnson County and 2,936 in Yell County [USCB 2000e, USCB 2000f & USCB 2000g]. Housing availability in the tri-county area is not limited by growth-control measures. The number of occupied housing units in Pope and Johnson Counties has more than doubled since 1970 (see Table 2-5).

Table 2-5
Housing Units and Housing Units Vacant (Available) by County, 1970 – 2000

	1970[a]	**1980**[a]	**1990**[a]	**2000**[b]
Pope County				
Housing Units	9,882	14,903	18,430	22,851
Occupied Units	9,014	13,615	16,828	20,701
Vacant Units	868	1,288	1,602	2,150
Johnson County				
Housing Units	5,278	7,179	7,984	9,926
Occupied Units	4,761	6,395	7,059	8,738
Vacant Units	517	784	925	1,188
Yell County				
Housing Units	5,361	6,877	7,868	9,157
Occupied Units	4,725	6,219	6,907	7,922
Vacant Units	636	658	961	1,235

a. NRC 2001, Table 2-7.
b. USCB 2002a, USCB2002b & USCB 2002c.

2.10 <u>Social Services and Public Facilities</u>

2.10.1 Public Water Supply

Public water systems within a 10-mile radius of ANO use either groundwater or surface water sources. The area has six public water systems that serve the incorporated towns and rural areas. The West Crow Mountain Water Association previously reported in the *Generic*

Environmental Impact Statement for License Renewal of Nuclear Plants" Arkansas Nuclear One, Unit 1, NUREG-1437, Supplement 3, has merged with the Tri-County Regional Water District [Yusuf 2002]. Table 2-6 shows source and capacity information on selected water supply systems in communities near ANO and the area served by each [Yusuf 2002]. Russellville, Dover, and London are primarily served with surface water from the Illinois Bayou. Large areas of rural Pope County are not served by public water supplies.

Table 2-6
Major Public Water Supply Systems Within 10-Mile Radius of ANO, 2002

Water System	Source	Average Demand (GPD)	Maximum Demand (GPD)	Maximum Capacity (GPD)	Area Served	Population Served	Storage Capacity (gallons)
City Corporation	100% surface from Illinois Bayou	6,780,000	11,510,000	18,500,000	City of Russellville	43,683	4,075,000
Dardanelle Waterworks	80% groundwater 20% surface	450,000	622,000	2,458,000	City of Dardanelle	10,775	900,000
Dover Waterworks	100% surface from City Corporation (Illinois Bayou)	159,000	269,000	288,000	City of Dover and surrounding rural areas	1,746	197,899
London Waterworks	100% surface from City Corporation (Illinois Bayou)	97,000	143,000	216,000	City of London and surrounding rural areas	1,170	100,000
Northeast Yell County Water Association, Inc.	67% surface 33% groundwater from Danville Water Department (Cedar Piney Reservoir)	614,000	873,000	1,333,000	Rural Yell, Conway, and Perry Counties	7,805	1,467,174
Tri-County Regional Water Distribution District	100% surface from City Corporation (Illinois Bayou) and Atkins Water Department (Galla Lake)	1,020,000	2,600,000	4,500,000	Rural Pope County from north of London east to Conway County line	14,581	2,674,000
Source: Arkansas Department of Health, Facsimile Correspondence dated September 25, 2002.							

In 1997, the city of Russellville completed the construction of a new water supply source, the Huckleberry Creek Reservoir (City Corporation Water System source). The new reservoir significantly increased the system capacity, and provides residential and industrial customers in the area with a reliable supply of high-quality potable water for the future.

ANO and City Corporation have also worked together to make several changes in the water system near the plant. Additional water storage and pumping stations have been added to reduce short-term surges that occurred in the past. According to City Corporation, ANO does not cause capacity or flow concerns for the system, and the system should be able to meet the ANO water demand in the foreseeable future [Church 2002].

Availability of wastewater collection is currently adequate. In 1990, public wastewater collection was provided for 51 percent of Pope County residents while 49 percent used private means of disposal. Public wastewater collection was provided for only 35 percent of the residents of Johnson County and 39 percent of the residents of Yell County [NRC 2001, Section 2.2.8.2].

2.10.2 Transportation

2.10.2.1 Pope County

Pope County is on the north side of the Arkansas River and is served by Interstate 40, which runs east and west through the southern part of the county (see Figures 2-1 and 2-2). In addition, two-lane U.S. Highway 64 runs parallel to I-40. The primary state highways in Pope County are Highways 7 and 27. Highway 7 is a federal scenic byway and Highway 27 is a state scenic highway. Secondary state highways in Pope County are Highways 124, 164 and 333. Highway 333 provides access to the ANO site from two intersections with U.S. Highway 64.

The Arkansas Highway and Transportation Department was contacted for information regarding highway traffic counts near ANO [Boyles 2002]. A summary of AHTD traffic count information is in Table 2-7.

Table 2-7
AHTD Traffic Counts (Cars/Day) for Highways near ANO [a]

Location	1999	2000	2001
State Hwy 333 near the east intersection with U.S. Hwy 64	--	2,700	2,400
State Hwy 333 near the west intersection with U.S. Hwy 64	--	--	1,400
U.S. Hwy 64 west of London	--	2,900	2,500
U.S. Hwy 64 near Mill Creek	6,900	9,500	7,000

[a] Boyles 2002

2.10.2.2 Johnson and Yell Counties

Yell County is not served by the interstate highway system, but has ready access to the Interstate 40 corridor via Arkansas Scenic Highways 10, 22, 27 and 154. State Highways 60 and 247 complete the major road network in the county.

Johnson County is served by the Interstate 40 corridor, as well as U.S. Highway 64 and State Highways 21, 103 and 123 [NRC 2001, Section 2.2.8.2].

2.11 Meteorological and Air Quality

ANO is in west-central Arkansas, approximately mid-way between Fort Smith and Little Rock. It is on Lake Dardanelle, part of the Arkansas River, at an elevation of about 400 feet above MSL. To the north of the site are the Boston Mountains and the Ouachita Mountains are to the south [NRC 2001, Section 2.2.4].

Pope County is hot in the summer and moderately cool in the winter, and has fairly heavy rainfall well distributed throughout the year. Climatological records for Russellville, Arkansas show normal daily maximum temperatures ranging from about 51ºF in January to about 93ºF in July. Normal daily minimum temperatures range from about 27ºF in January to about 69ºF in July. Precipitation averages about 49 inches per year, with an average of about 3 inches of snow per year. Statistics for the 30-year period from 1954 through 1983 estimate the probability of a tornado striking the site is approximately 3×10^{-4} per year [NRC 2001, Section 2.2.4].

Arkansas is in **attainment** of the National Ambient Air Quality Standards (40CFR81.304). The nearest nonattainment areas to ANO are the Dallas/Ft. Worth, Texas metropolitan area, over 300 miles southwest of the site, and the Memphis, Tennessee metropolitan area, approximately 200 miles east of the site.

The Caney Creek and Upper Buffalo Wilderness Areas are the closest wilderness areas to ANO. These areas are designated in 40CFR81.404 as mandatory Class I Federal areas in which visibility is an important value. The Caney Creek Wilderness Area is more than 100 miles from the ANO site and the Upper Buffalo Wilderness Area is within 50 miles of the site [NRC 2001, Section 2.2.4].

ANO has several diesel generators and boilers. Emissions from these generators and boilers are covered by an air permit issued by the ADEQ under the Clean Air Act. The permit limits the fuel usage and hours of operation of these emission sources.

2.12 Historic and Archaeological Resources

2.12.1 Cultural Background

2.12.1.1 Prehistoric Era

The area around the ANO site is rich in prehistoric and historic Native American and historic Euroamerican resources. This part of west-central Arkansas has an archaeological sequence that extends back about 12,000 years. As in many of the surrounding states, archaeological periods for this part of Arkansas fall into several sequential cultural periods of Native American occupation: the Paleo-Indian era (about 9500 B.C. to 8000 B.C.), the Archaic era (8000 B.C. to 500 B.C.), the Woodland era (500 B.C. to A.D. 900), the Mississippian era (A.D. 900 to A.D. 1541), and the Historic era, initiated by the arrival of Spanish explorers (A.D. 1541 to A.D. 1850) [NRC 2001, Section 2.2.9.1].

The prehistoric periods were marked by initial reliance on big game hunting subsistence, followed by increased use of smaller game animals and plant foods in the Archaic era. Trends toward more sedentary villages with greater reliance on cultivated crops began late in the Woodland era and increased in importance in the following Mississippian era. In Arkansas, the Mississippian cultures were largely focused in the eastern part of the state, along the Mississippi River valley. In the region of western Arkansas including the Arkansas River valley, contemporaneous cultures included the Caddoan groups who grew cultivated crops, but continued to rely heavily on hunting, fishing and gathering of wild plants [NRC 2001, Section 2.2.9.1].

2.12.1.2 Historic-era

Following arrival of the Spanish, and later Euroamerican settlers, the Native American Historic-era in the vicinity of ANO was marked by nearly continual occupation and visits by several tribes as they coped with the Euroamerican expansion into their former homelands. Before a large land cession in 1808, the region north of the Arkansas River was primarily occupied by the Osage, while the area south of the river was occupied by the Quapaw until that land was ceded to the United States in 1818. Other tribes that either visited or occupied smaller areas during this time included the Caddo, Tunica, Shawnee and Delaware [NRC 2001, Section 2.2.9.1].

Beginning immediately after the 1808 Osage cession, the Arkansas River valley was occupied by the Cherokees, who had begun to be pushed out of their traditional homelands in the Carolinas. Known as the "Arkansas Cherokees", the Cherokees occupied the Arkansas River corridor from Little Rock to Fort Smith between 1809 and 1828. In 1817, a reservation was set aside for the Arkansas Cherokees on the north side of the river that included the ANO site. Soon after, additional Cherokees immigrated into the area from the Southern Appalachian area, bringing the population of Cherokees in the Arkansas River valley to 5,000. Increasing pressure from white settlers brought about another land cession by the Arkansas Cherokees, and in 1828 they once again moved westward to the Oklahoma Territory, marking the end of Native American occupation in the project area [NRC 2001, Section 2.2.9.1].

Though relatively brief, the Cherokee occupation of the area including the ANO site left a lasting mark in the archaeological and historic records. The primary historic site associated with this period is the Dwight Mission, a Presbyterian mission to the Cherokees, established in 1820 on the west bank of Illinois Bayou, about 1.5 miles east of the ANO property line. When the Cherokees were forced out of the area a few years later, the mission relocated to Oklahoma as well. Lake Dardanelle inundated some of the original mission compound in the 1960s. The archaeological record from the Cherokee villages and home sites in the area outside the ANO property line is relatively unknown, but recent investigations indicate that the local archaeological remains hold great promise for significant research potential [NRC 2001, Section 2.2.9.1].

Following Cherokee removal, the area including the ANO property, was immediately taken up by Euroamerican settlers. The May and Rye families settled the land in the immediate vicinity of the ANO site in the 1830s. Although early Euroamerican use of the land within the ANO property was primarily agricultural, numerous important Historic-era resources exist a short distance north of the site. Completed in 1823, a military road passed through the river valley just north of ANO, connecting Memphis, Little Rock, Fort Smith and the Oklahoma Territory. In 1838-39, this road was used as part of the final Cherokee removal from the Southern Appalachians and northern Georgia, along the infamous "Trail of Tears." The area just northwest of the plant site had a population of 65 people in 1832, and was incorporated as the town of London in 1882, with a population of 119. Three cotton gins were in the vicinity of London at one time. One of these was built in 1847 on the Rye farm, located just west of the plant on ANO property. The gin was torn down in 1902 [NRC 2001, Section 2.2.9.1].

2.12.1.3 Trail of Tears

Two routes of the 1838 Trail of Tears passed the present-day ANO site. The first was the water route that in part followed the Arkansas River into Indian Territory. In the summer of 1838, three detachments of Cherokees followed the water route to Fort Smith, west of Russellville, then into their new homelands. The second route was used by a detachment of 600-700 Cherokees, led by John A. Bell, who followed the land route along the north side of the Arkansas River. The water route passed along the southern boundary of the ANO site, using the now submerged Arkansas River waterway, and the land route passed just to the north, along the military road [NRC 2001, Section 2.2.9.1].

The Trail of Tears was designated a National Historic Trail by Congress in 1987, and granted additional protection under the National Trails System Act of 1990. The legislatively-designated historic trail includes only the water route. Bell's route was not formally included, although its designation as part of the national trail system is still under study [NRC 2001, Section 2.2.9.1].

2.12.1.4 Late Historic

Several historic transportation and communication features occur in the area. Just north of the ANO property, the Fort Smith and Little Rock Railroad was constructed in 1873; later, it was the Iron Mountain Railroad; currently, it is the Union-Pacific line. Telephone service to the area began about 1900 and U.S. Highway 64 was constructed in 1921. The Arkansas-Louisiana gas

main was completed in 1928 and electrical power became available in the late 1930s [NRC 2001, Section 2.2.9.1].

2.12.2 Historic and Archaeological Resources

2.12.2.1 Prehistoric

Construction of the ANO-1 plant within the 1164-acre site began in 1968. In 1969, the Arkansas Archaeological Society conducted a reconnaissance field survey of the lands within the site that were not within the construction zone and which were not heavily vegetated. From the report, it is not possible to define the actual acreage examined, although it is important to note that the goal of the fieldwork was only to identify and record Native American archaeological properties [NRC 2001, Section 2.2.9.2].

A site-file search of the archaeological records of the State Archeologist, State Historic Preservation Officer, and the Arkansas Archaeological Society Research Station of Arkansas Tech University in Russellville, revealed 18 prehistoric archaeological sites within one mile of the ANO site boundary [Klinger 2001].

These results, along with the reconnaissance-level survey conducted in 1969, indicate a potential for the existence of additional prehistoric Native American sites on ANO property.

A site-file search for five transmission line rights-of-way emanating from ANO that were either already constructed, under construction, or proposed for construction revealed little data of past archaeological surveys or known archaeological sites along the transmission line rights-of-way [Klinger 2001]. There is no record that archaeological fieldwork was ever conducted along the ANO transmission line rights-of-way beyond the site-file search.

2.12.2.2 Historic

As noted above, the 1969 archaeological survey of the ANO site only focused on potential Native American properties, even though Historic-era Euroamerican sites were present. Consequently, none of the Historic-era properties have been recorded or evaluated for National Register of Historic Places eligibility [NRC 2001, Section 2.2.9.2].

Review of Historic-era records and maps has revealed several Historic-era properties existed within the ANO property boundaries, dating from approximately 1830 to 1967, when the property was acquired by the Arkansas Power and Light Company. A site-file search of the historic records of the State Archeologist, State Historic Preservation Officer, and the Arkansas Archaeological Society Research Station of Arkansas Tech University in Russellville, revealed numerous historic sites for the ANO area [Klinger 2001]. The 1936 General Highway and Transportation map indicates 16 structures and the 1940 Arkansas River and Tributary map shows 66 structures within the site boundary. The General Land Office surveyor records also show 3 fields and 1 road in the area.

No standing structures remain at these former historic sites except a few storm shelter/storage cellars. They exist as unrecorded and unevaluated Historic-era archaeological sites that exhibit house and outbuilding foundations, artifact scatters, trash dumps, and buried features, along with the historic roads and trails that linked the farming community [NRC 2001, Section 2.2.9.2].

In addition to the farms, one Historic-era cemetery, the May Cemetery, is on ANO property, about one-half mile south of the plant. The cemetery is protected by a chain link fence and is well maintained. There are 106 marked and named graves in the cemetery, along with a number of unnamed graves, both marked and unmarked. The cemetery was established in 1885. Two other historic cemeteries exist in proximity to the ANO site: the Swan (Finchum) Cemetery, about 0.5 miles west of the northwest corner of the ANO boundary, and the Crain Cemetery, immediately north of State Highway 333, between the plant entrance and London, and about 200 yards from the ANO property line. The Crain Cemetery does not appear on ANO or U.S. Geological Survey base maps, but includes some 32 marked graves dating back to 1865 [NRC 2001, Section 2.2.9.2].

2.12.3 National Register of Historic Places and National Historic Landmark Resources

Arkansas has more than 1500 properties listed on the National Register of Historic Places, but has only 12 National Historic Landmarks [Klinger 2001]. Pope County has 24 NRHP sites, most of which are in the city of Russellville and are associated with Arkansas Tech University. Only one NHL site (in Fort Smith) is in the general west-central area of the state. Therefore, no NRHP or NHL sites are within the vicinity of the ANO site.

The Arkansas State Historic Preservation Office was contacted regarding historical and archaeological sites on the ANO site and the associated ANO-2 transmission line. Based on previous consultation with SHPO during the ANO-1 license renewal process and recent consultation during 2002, no additional cultural resources were recorded for the ANO site. For the ANO-2 transmission line, SHPO did identify nineteen recorded sites in or adjacent to the existing transmission line. However, these recorded sites have not been evaluated for eligibility for inclusion in the NRHP. Eligibility for inclusion into the NRHP would only have to be made should Entergy propose any new construction in or adjacent to the transmission right-of-way [see Attachment D].

2.13 Related Federal Project Activities

Entergy did not identify any known or reasonably foreseeable federal or non-federal projects or other activities that may contribute to the cumulative environmental impacts of license renewal.

Figure 2-1, Location of ANO

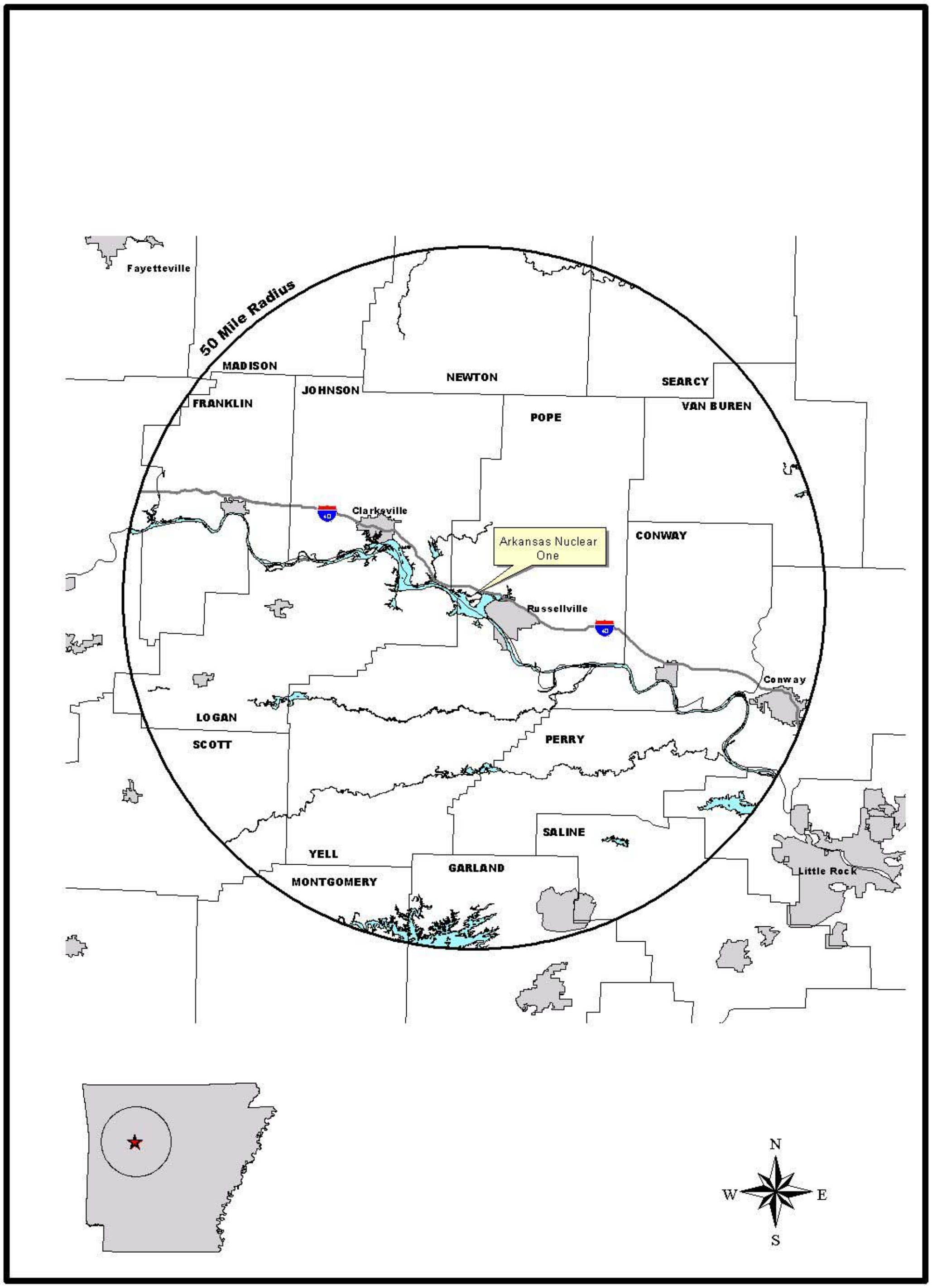


Figure 2-2, General Area Near ANO

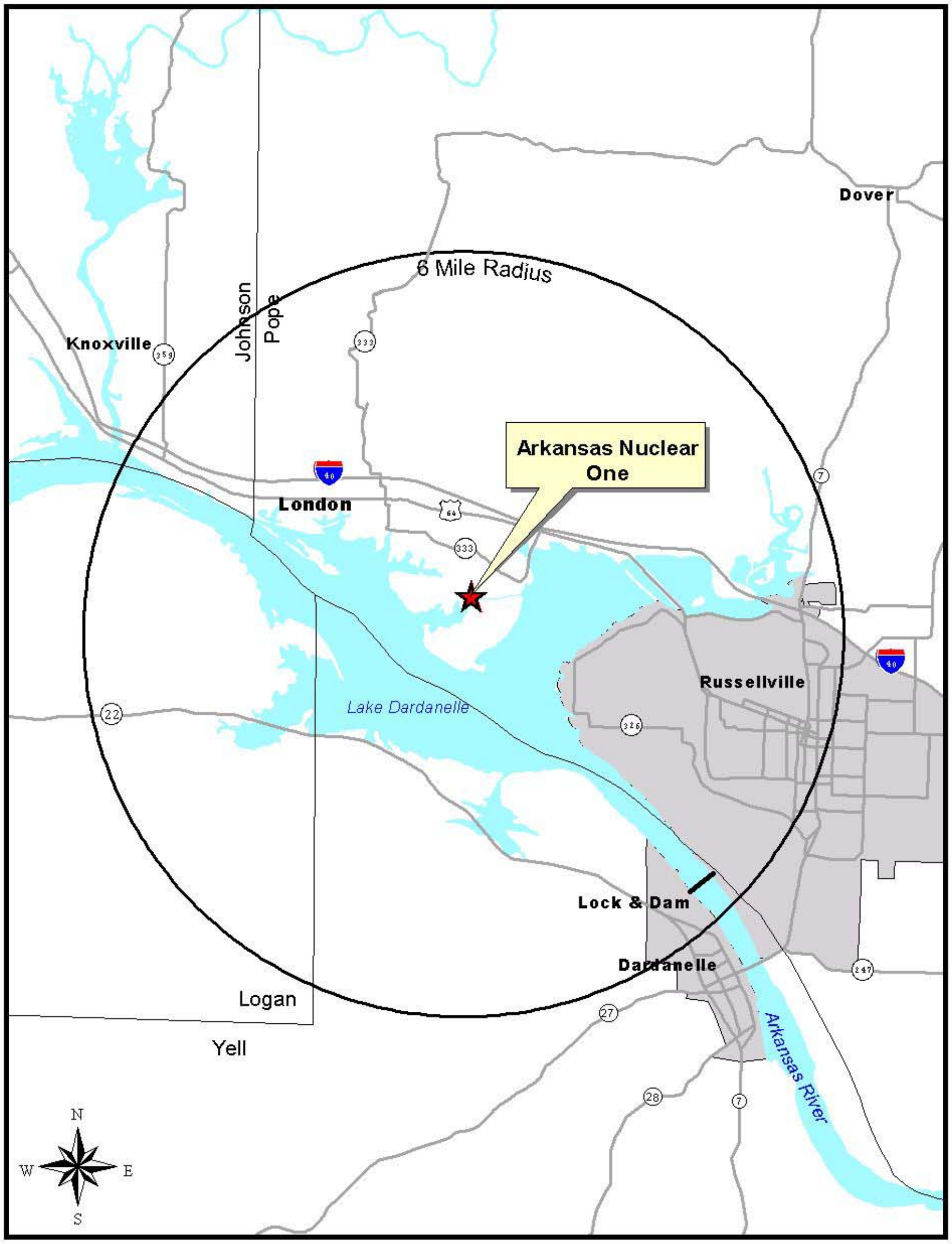


Figure 2-3, ANO Exclusion Zone and Features

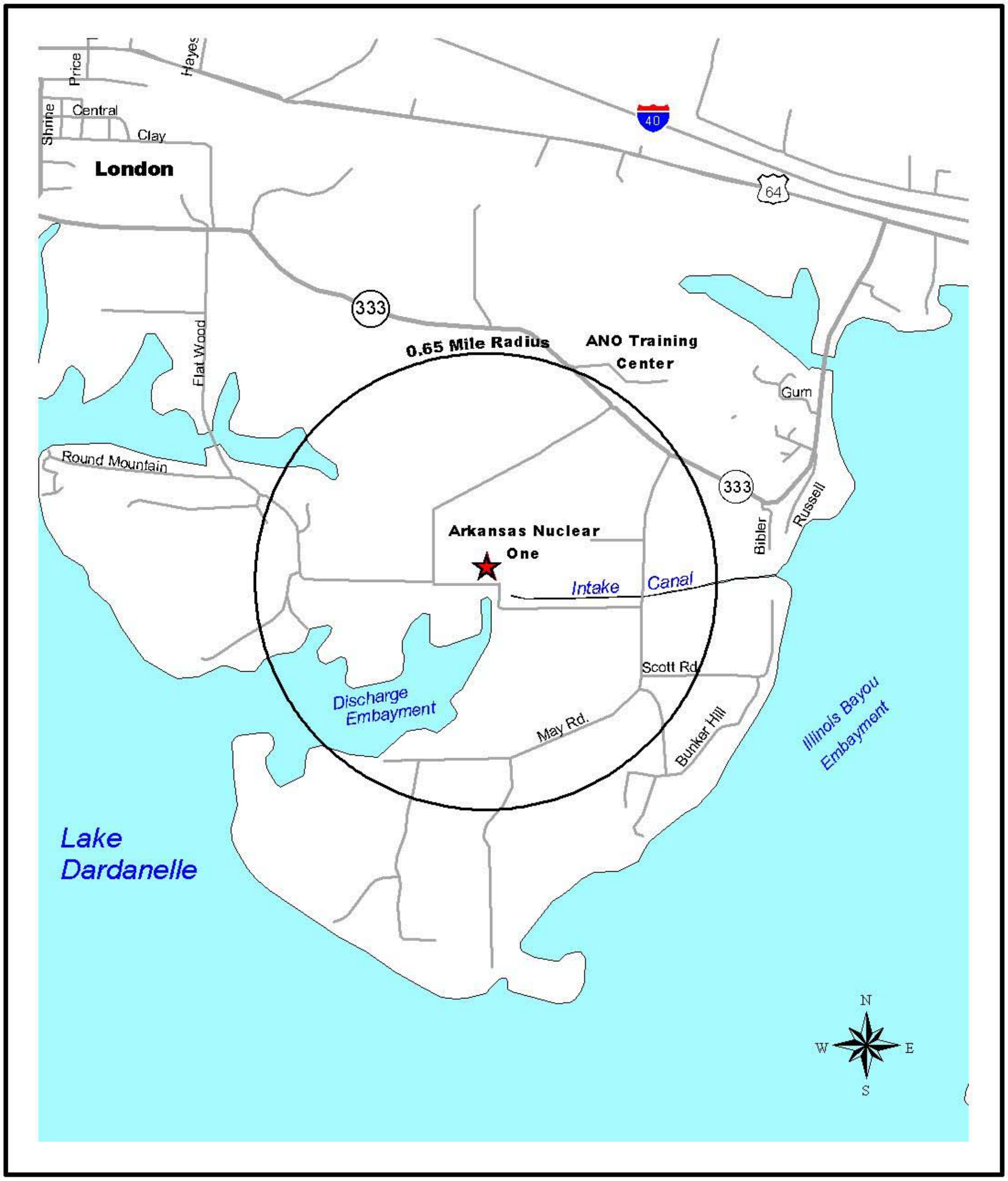


Figure 2-4, State and Federal Lands – 50-Mile Radius

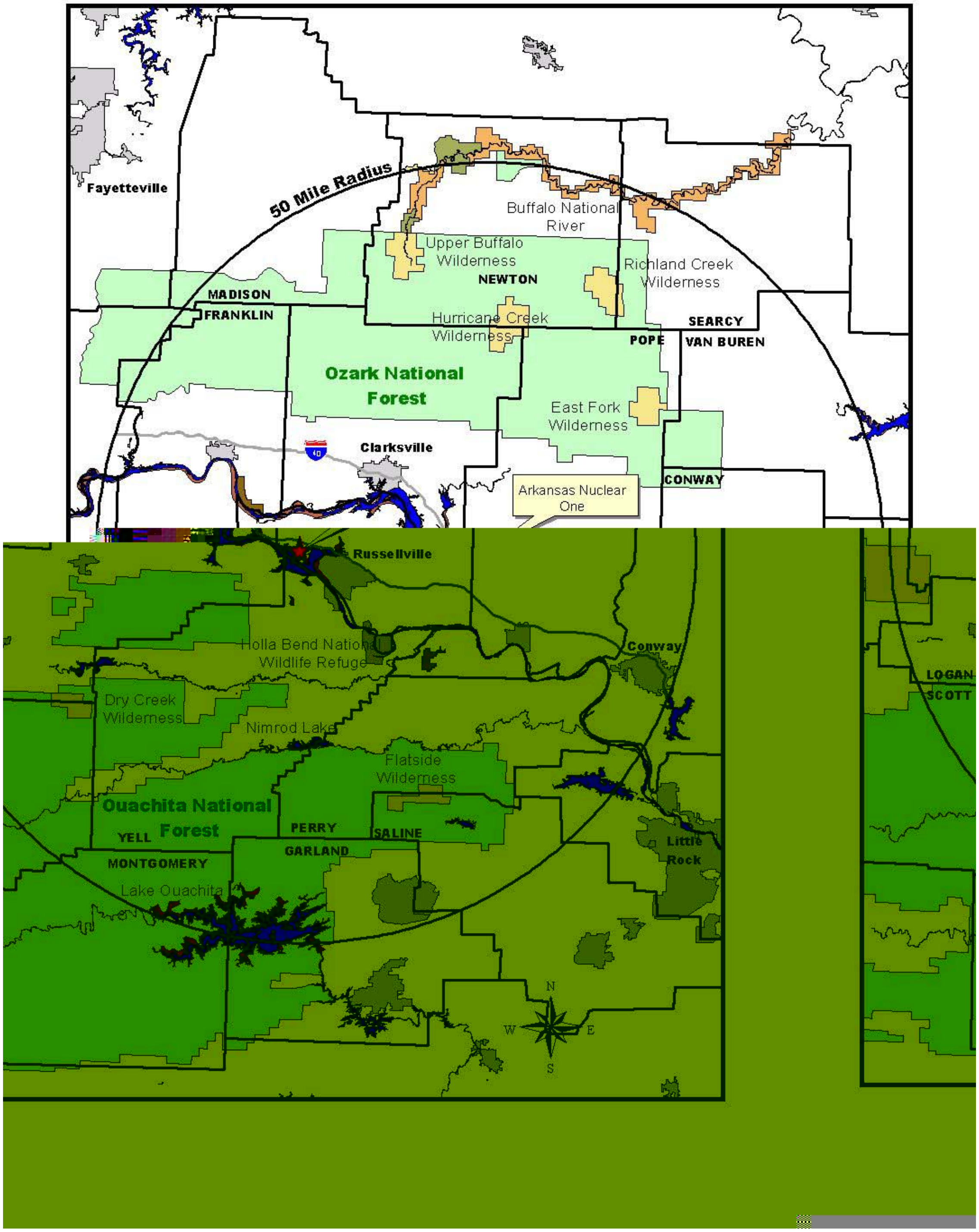


Figure 2-5, State and Federal Lands – 6-Mile Radius

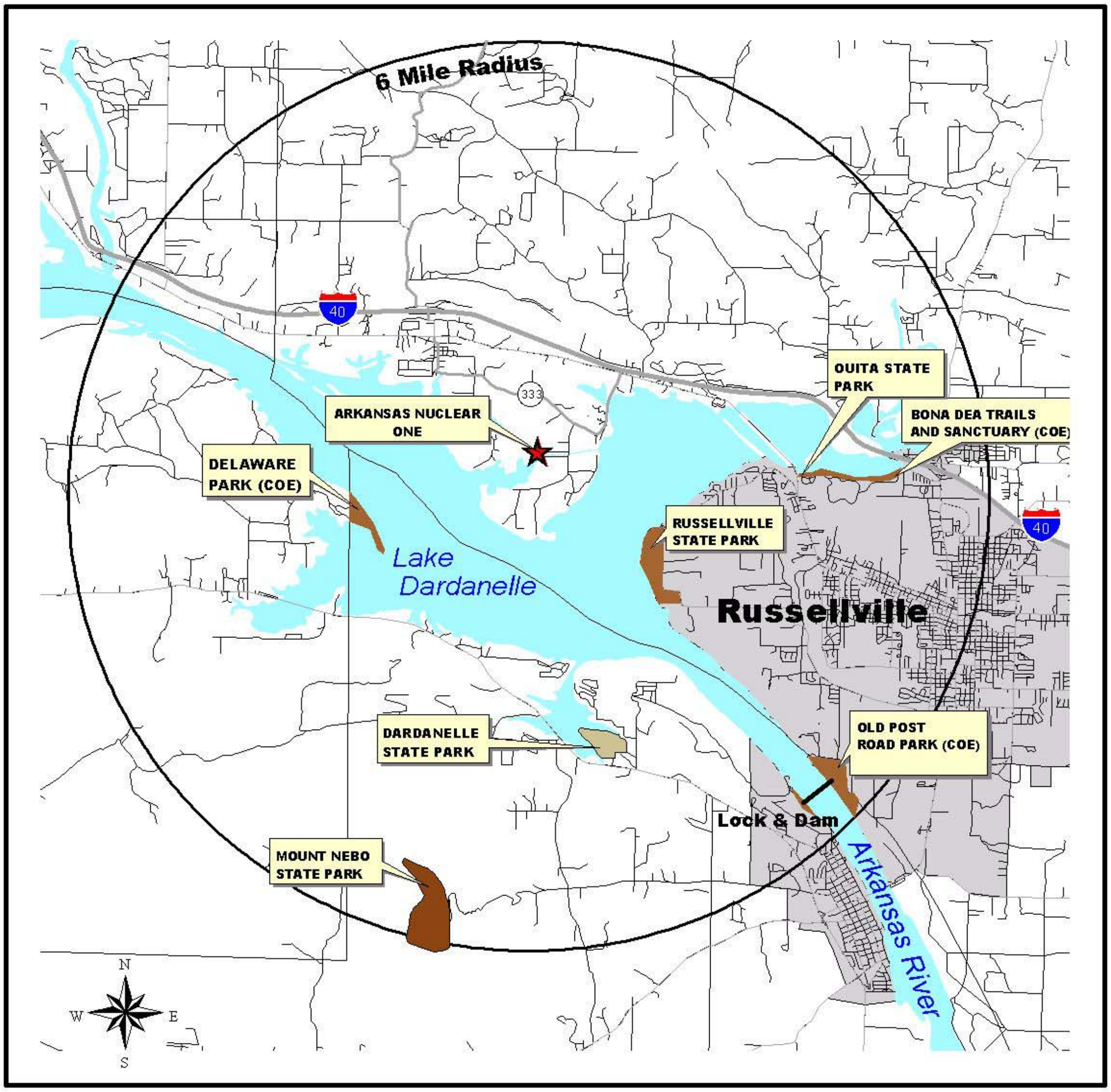


Figure 2-6, Census Block Groups – Minority Population Review

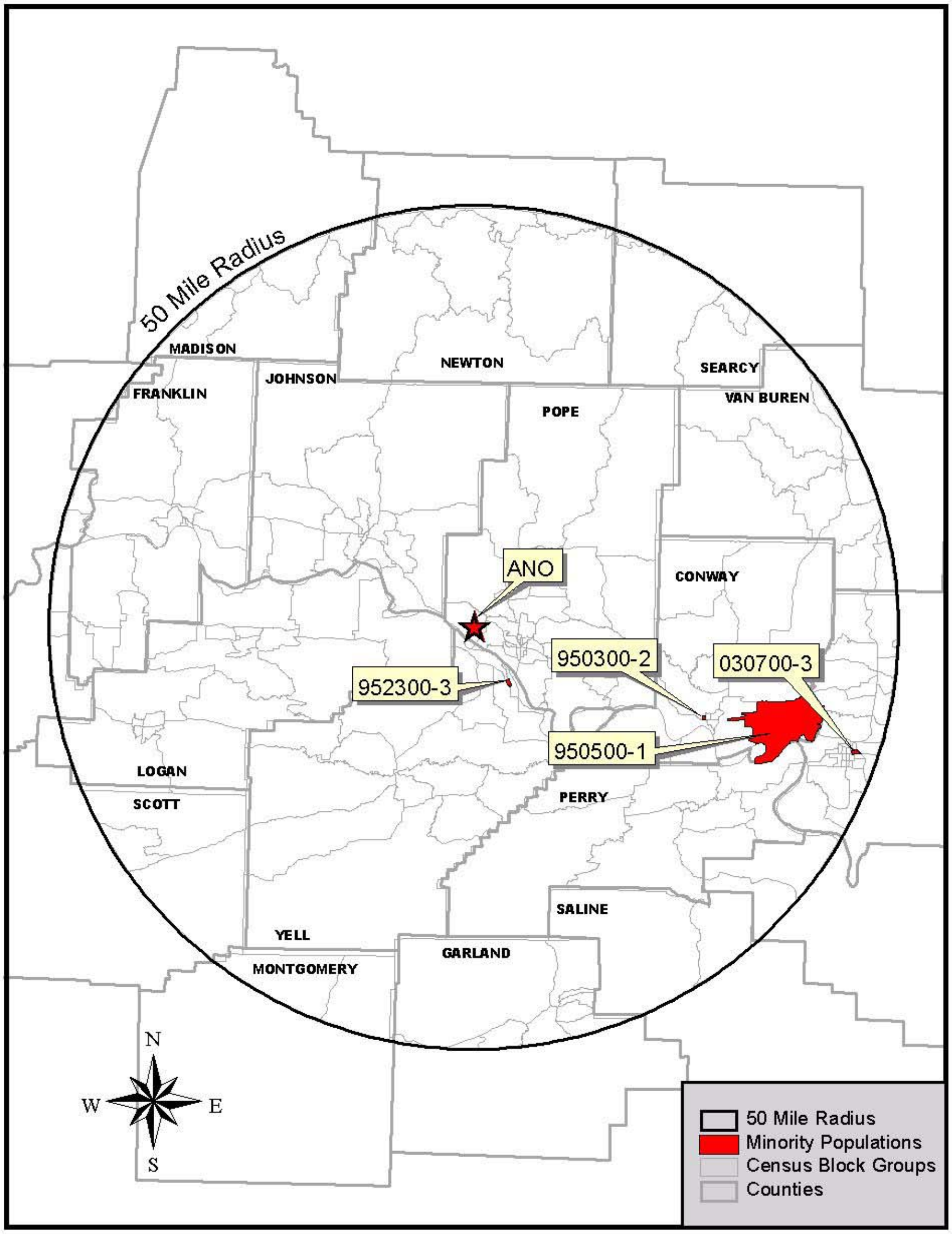
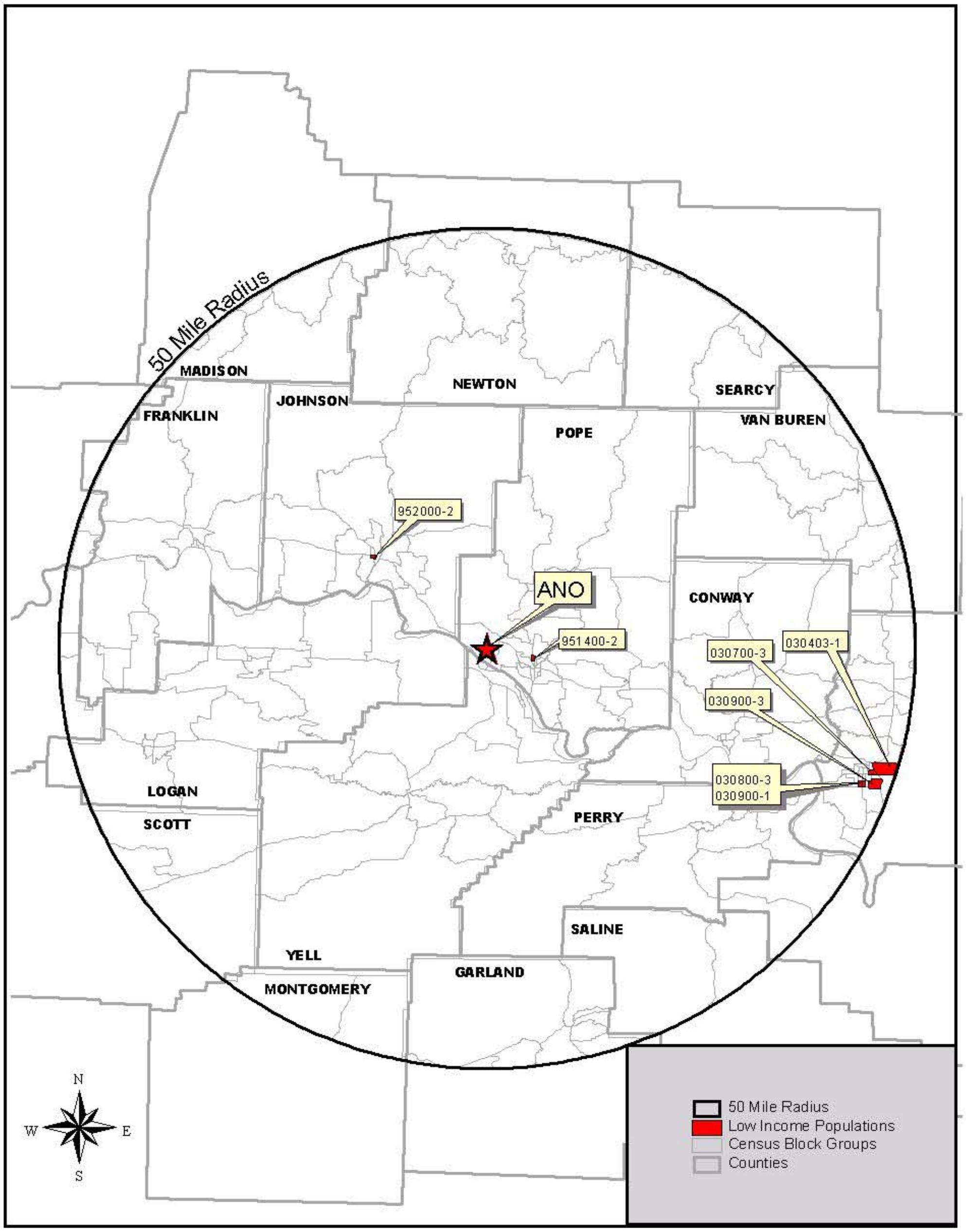


Figure 2-7, Census Block Groups – Low-Income Household Review



2.14 References

AEC (U. S. Atomic Energy Commission). 1973. *Final Environmental Statement Related to the Arkansas Nuclear One Unit 1*, Arkansas Power & Light Company, Docket No. 50-313, Unites States Atomic Energy Commission, Directorate of Licensing, February 1973.

ADEQ (Arkansas Department of Environmental Quality). 2000. *Arkansas Water Quality Inventory Report*, 2000.

Boyles, M. 2002. Traffic count data provided by Planning and Research Section, Arkansas Highway and Transportation Department. Personal communication with S. Holbrook, FTN Associates, September 27, 2002.

CAST (Center for Advanced Spatial Technology). 2002. *Pope County Land Use and Land Cover Summary - summer 1999*, Center for Advanced Spatial Technology, University of Arkansas, Fayetteville, Arkansas. Data available at http://titan.cast.uark.edu.

Church, L. 2002. Water system capacity data provided by City Corporation. Personal communication with Bob West, FTN Associates, September 25, 2002.

EOI (Entergy Operations, Inc.). 1999. Applicant's Environmental Report – Operating License Renewal Stage, Arkansas Nuclear One - Unit 1, December 1999.

EOI (Entergy Operations, Inc.). 2001a. Arkansas Nuclear One - Unit 1, Safety Analysis Report, Amendment 17.

EOI (Entergy Operations, Inc.). 2001b. Arkansas Nuclear One - Units 1 and 2, Docket Nos. 50-313 and 50-368 License Nos. DPR-51 and NPF-6, 2001 Annual Radiological Environmental Operating Report.

Klinger, T. C. 2001. Report entitled Entergy Arkansas Nuclear One Cultural Resources Records Review. Report prepared for ANO, June 2001.

Lutrel, G. 2003. Budget and county property tax data provided by Pope County Treasurer. Telephone conversation with B. West, FTN Associates, June 10, 2003.

McAlister, B. 2003. Entergy property tax data provided by Pope County Tax Collector. Telephone conversation with B. West, FTN Associates, June 10, 2003.

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)*, Volumes 1 and 2, NUREG-1437, Washington, DC.

NRC (U.S. Nuclear Regulatory Commission). 1999. Office of Nuclear Reactor Regulation, NRR Office Letter No. 906, Revision 2, *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues*, dated September 21, 1999.

NRC (U.S. Nuclear Regulatory Commission). 2001. *Generic Environmental Impact Statement for License Renewal of Nuclear Plant, Arkansas Nuclear One, Unit 1*, NUREG-1437, Supplement 3, Office of Nuclear Reactor Regulation, Washington, D.C., April 2001.

RSD (Russellville School District). 2003. Operating budget data provided by Russellville School District. Telephone conversation with B. West, FTN Associates, June 2003.

Texas Instruments. 1975. *Evaluation of the Potential Impact of Impingement on Fisheries Resources and Dissolved Oxygen for Dardanelle Reservoir* (Report prepared for Arkansas Power & Light Company, January 1975).

UALR (University of Arkansas at Little Rock). 2002a. University of Arkansas at Little Rock, Little Rock, Arkansas, Arkansas Census Data Center.

UALR (University of Arkansas at Little Rock). 2002b. University of Arkansas at Little Rock, Little Rock, Arkansas, Arkansas Census Data Center. Email communication between Dr. Greg Hamilton and Bob West, FTN Associates, December 10, 2002.

USCB (U. S. Census Bureau). 2000a. State and County Quick Facts: Pope County, Arkansas. Available at http://quickfacts.census.gov/qfd/states/05/05115.html.

USCB (U. S. Census Bureau). 2000b. State and County Quick Facts: Johnson County, Arkansas. Available at http://quickfacts.census.gov/qfd/states/05/05071.html.

USCB (U. S. Census Bureau). 2000c. State and County Quick Facts: Yell County, Arkansas. Available at http://quickfacts.census.gov/qfd/states/05/05149.html.

USCB (U. S. Census Bureau). 2000d. State and County Quick Facts: Arkansas. Available at http://quickfacts.census.gov/qfd/states/05000.html.

USCB (U. S. Census Bureau). 2000e. Table DP-1, Profile of General Demographic Characteristics: 2000, Geographic area: Pope County, Arkansas. Available at http://censtats.census.gov/data/AR/05005115.pdf#page=3.

USCB (U. S. Census Bureau). 2000f. Table DP-1, Profile of General Demographic Characteristics: 2000, Geographic area: Johnson County, Arkansas. Available at http://censtats.census.gov/data/AR/05005071.pdf#page=3.

USCB (U. S. Census Bureau). 2000g. Table DP-1, Profile of General Demographic Characteristics: 2000, Geographic area: Yell County, Arkansas. Available at http://censtats.census.gov/data/AR/05005149.pdf#page=3.

USDA (U. S. Department of Agriculture). 1981. *Soil Survey of Pope County Arkansas*, United States Department of Agriculture, Forest Service, and Soil Conservation Service in Cooperation with the Arkansas Agricultural Experiment Station.

Yusuf, M. 2002. Water system data provided by Arkansas Department of Health. Personal communication with Bob West, FTN Associates, September 24, 2002.

3.0 THE PROPOSED ACTION

3.1 Description of the Proposed Action

The proposed action is to renew the facility operating license for ANO-2 for an additional twenty (20) years beyond the expiration of the current operating license. For ANO-2 (Facility Operating License NPF-6), the requested renewal would extend the license expiration date from midnight July 17, 2018 to midnight July 17, 2038.

There are no changes related to license renewal with respect to operation of ANO-2 that would significantly affect the environment during the period of extended operation. The application to renew the operating license of ANO-2 assumes that licensed activities are now conducted, and would continue to be conducted, in accordance with the facility's current licensing bases (e.g., use of low enriched uranium fuel only). Changes made to the current licensing basis of ANO-2 during the staff review of this application would be made in accordance with the Atomic Energy Act of 1954, as amended, and in accordance with Commission regulations.

3.2 General Plant Information

ANO-2 consists of a containment building, an auxiliary building and a turbine building shared with ANO-1. The reactor and nuclear steam supply system for ANO-2 are in the containment building. Mechanical and electrical systems required for the safe operation of ANO-2 are primarily located in the auxiliary and containment buildings. Figure 3-1 shows the general features of the ANO site. Figure 2-3 shows the 0.65-mile radius exclusion zone. No residences are permitted within this exclusion zone.

3.2.1 Reactor and Containment Systems

ANO-2 utilizes a pressurized water reactor in the nuclear steam supply system, and a two-loop reactor coolant system. Combustion Engineering supplied the nuclear steam supply system. The unit was originally licensed for an output of 2,815 megawatts-thermal. However, approval was obtained from the NRC in 2002 to increase the maximum reactor core power level from 2,815 MWt to 3,026 MWt. The gross electrical output corresponding to 3,026 MWt is 1,048 megawatts-electric (MWe) [NRC 2002]. ANO-2 achieved commercial operation in 1980.

ANO-2 fuel is made of low enrichment uranium oxide and is stacked in pre-pressurized tubes made from zircaloy, which form sealed enclosures [EOI 2002a, Section 1.0]. ANO-2 can operate with an individual rod average fuel burnup (burnup averaged over the length of a fuel rod) not to exceed 60,000 MWD/MTU. Sufficient margin is provided to ensure that peak burnups are within acceptable limits [EOI 2002, Section 4.1].

The ANO-2 containment structure is designed to withstand an internal pressure of 59 pounds per square inch above atmospheric pressure and act as a radioactive materials barrier [EOI 2002, Section 3.1.5]. The containment structure is designed with engineered safety features to protect the public and plant personnel from an accidental release of radioactive fission products, particularly in the unlikely event of a loss of coolant accident. These safety features function to

localize, control, mitigate, and terminate such events to limit exposure levels below applicable dose guidelines.

3.2.2 Cooling and Auxiliary Water Systems

ANO-2 utilizes a closed-cycle cooling system equipped with a natural-draft cooling tower to dissipate waste heat to the atmosphere. After moving through the condenser, circulating water rejects waste heat to the atmosphere utilizing the natural-draft cooling tower. Evaporation in the cooling tower occurs at an average rate of approximately 9,900 gpm (22 cfs) with the maximum evaporation rate expected to be approximately 11,900 gpm (27 cfs) [NRC 1977, Section 5.3.4]. Remaining waste heat is discharged in the form of blowdown from the circulating water system to a 520-ft long canal discharging into Lake Dardanelle. This blowdown is mixed with the ANO-1 circulating water system discharge.

For the ANO-2 service water system, water is drawn from the Illinois Bayou arm of Lake Dardanelle through a 4400-ft long canal to the ANO-2 intake structure at an average rate of approximately 16,000 gpm (36 cfs) [NRC 1977, Section 5.3.4]. As the water enters the intake structure at an average velocity of approximately 0.34 feet per second [NRC 1977, Section 3.2.3], it passes through bar racks and traveling screens designed to intercept debris. After passing through the traveling screens, the water enters the service water pumps where it is pumped to the service water system. There are three pumps with a rated capacity of 20,000 gpm each. Normally, two of the three pumps are running with the third pump in standby. The ANO-2 service water system supplies water to the closed-loop component cooling water system, cooling tower make-up, and if necessary, the emergency cooling pond.

Continuous chlorination of the ANO-2 service water system can be used to control nuisance biological organisms. However, free available oxidants in the cooling tower blowdown are limited to a maximum daily concentration of 0.5 mg/l and an average monthly concentration of 0.2 mg/l [EOI 2002b].

3.2.3 Radioactive Waste Treatment Processes (Gaseous, Liquid and Solid)

ANO uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials that are produced as a by-product of plant operations. Radioactive materials in liquid and gaseous effluents are reduced to levels as low as reasonably achievable. Radionuclides removed from the liquid and gaseous effluents are converted to a solid waste form for eventual disposal with other solid radioactive wastes in a licensed disposal facility [NRC 2001, Section 2.1.4].

The ANO-2 waste processing systems meet the design objectives of 10CFR Part 50, Appendix I, and control the processing, disposal, and release of radioactive liquid, gaseous, and solid wastes. Radioactive material in the reactor coolant is the source of most gaseous, liquid, and solid radioactive wastes in light water reactors. Radioactive fission products build up within the fuel as a consequence of the fission process. The fission products are contained within the sealed fuel rods; however, small quantities of radioactive materials may be transferred from the

fuel elements to the reactor coolant under normal operating conditions. Neutron activation of materials in the primary coolant system also contributes to radionuclides in the coolant.

Solid wastes, other than fuel, result from treating gaseous and liquid effluents to remove radionuclides. Contaminated spent resins and filters generated during the treatment processes are dewatered, packaged, stored, and ultimately shipped off-site for further treatment or disposal. Other types of solid waste consist of contaminated materials removed from various reactor areas, including hardware components, equipment, tools, protective clothing, rags, paper, and other trash generated during plant modifications or maintenance activities. Some types of waste may be shredded or compacted to reduce their final disposal volume [NRC 2001, Section 2.1.4].

Reactor fuel assemblies that have exhausted a certain percentage of their fissile uranium content are referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced by fresh fuel during routine refueling outages, typically every 18 months. The spent fuel assemblies are then stored for a period of time in the spent fuel pool in the auxiliary building and may later be transferred to dry storage at the onsite independent spent fuel storage installation. ANO also provides for temporary onsite storage of mixed wastes, which contain both radioactive and chemically hazardous materials. Storage of radioactive materials is regulated by the NRC under the Atomic Energy Act of 1954, and storage of hazardous wastes is regulated by the U.S. Environmental Protection Agency under the Resource Conservation and Recovery Act of 1976 [NRC 2001, Section 2.1.4].

Systems used at ANO-2 to process liquid, gaseous, and solid radioactive wastes are described in the following sections.

3.2.3.1 Liquid Waste Processing Systems and Effluent Controls

Radioactive liquid waste generated from the operation of ANO-2 may be released to the Dardanelle Reservoir in accordance with limits specified in the ANO Offsite Dose Calculation Manual. Liquid wastes enter the reservoir through the discharge canal [NRC 2001, Section 2.1.4.1].

ANO liquid waste is processed by two major systems: (1) the boron management system, which processes liquids from reactor coolant system bleed valves and drains, reactor coolant auxiliary system relief valves and drains, and radwaste system relief valves and drains, and (2) the waste management system, which processes waste from various floor drains and sumps. The liquid radwaste system is used to reduce the radioactive material concentrations in liquid wastes before discharge to ensure that they are consistent with limits specified in the ODCM [NRC 2001, Section 2.1.4.1].

Controls for limiting the release of radiological liquid effluents are described in the ODCM. Controls are based on (1) concentrations of radioactive materials in liquid effluents and projected dose or (2) dose commitment to a hypothetical member of the public. Concentrations of radioactive material that may be released in liquid effluents to unrestricted areas are limited to the concentration specified in 10CFR Part 20, Appendix B, Table 2, Column 2, for

radionuclides other than dissolved or entrained noble gases. The total concentration of dissolved or entrained noble gases in liquid releases is limited to 2 x 10 -4 microcurie/ml. The ODCM dose limits during a calendar quarter are ≤0.015 millisievert (1.5 mrem) to the total body and ≤0.05 mSv (5 mrem) to a critical organ. During the calendar year, the ODCM dose limits are ≤0.03 mSv (3 mrem) to the total body and ≤0.10 mSv (10 mrem) to a critical organ. Radioactive liquid wastes are subject to the sampling and analysis program described in the ODCM [NRC 2001, Section 2.1.4.1].

Liquids entering the BMS are degasified to remove hydrogen and fission product gases. The liquid wastes are then transferred to receiver tanks that provide temporary storage to allow for radioactive decay. This maintains releases to the environment ALARA, as well as ensuring that the concentrations in effluent are below the ODCM limits. [NRC 2001, Section 2.1.4.1] The contents of the receiver tanks are normally processed through either the vendor processing skid or the installed pre-concentrator filter and pre-concentrator ion exchanger to the waste condensate tanks or the boric acid condensate tank. If necessary, a holdup tank may be recirculated for processing prior to transfer. Sampling and release of liquid waste from the monitor tank is performed on a batch basis rather than a continuous basis to provide better control over effluent discharge. If the activity level in the monitor tank is within discharge limits, the liquid may be released in a controlled, monitored fashion to meet the administrative limits in the ODCM. If radionuclide levels in the liquids exceed the discharge limits, they are returned to the receiver tank for additional time to decay and for treatment [NRC 2001, Section 2.1.4.1].

Liquids entering the WMS are expected to contain lower levels of activity than those in the BMS and are collected in one of two sections of a drain tank. When sufficient volume in the on-line waste tank is collected, the contents are transferred to a BMS holdup tank for subsequent processing with collected BMS waste or processed directly via the vendor processing skid to a waste condensate tank or a boric acid condensate tank. [NRC 2001, Section 2.1.4.1] If desired, the waste collection tank can be recirculated for sampling prior to transfer or processing. If radionuclide concentrations in the filtered waste tank exceed discharge limits, the wastes are transferred to the clean liquid radwaste system for additional treatment [NRC 2001, Section 2.1.4.1].

Liquid effluents are monitored continuously as wastes are discharged, and effluent release is automatically discontinued if monitors indicate that radionuclide concentrations in the wastes exceed permitted levels. Waste tanks are vented to a gas collection header and are purged with nitrogen to remove accumulated gases [NRC 2001, Section 2.1.4.1].

3.2.3.2 Gaseous Waste Processing Systems and Effluent Controls

Radioactive gases generated by fission and neutron activation of materials in the plant are managed by the Gaseous Waste Processing System. Radioactive constituents in gaseous effluents include noble gases, iodine, tritium, and fine particulate materials. Radioactive gaseous effluents generated from operation of ANO-2 are released to the atmosphere through the main vent stacks or the turbine building ventilation exhaust. Smaller, intermittent releases may also occur through the emergency air lock, the plant compressed air system, the main

steam line penetrations, the containment equipment hatch, and the auxiliary feedwater pumps [NRC 2001, Section 2.1.4.2].

The GWPS collects, stores, and disposes of gases from the liquid radwaste vacuum degasifiers, the volume control tanks, and other miscellaneous hydrogenated sources associated with the primary reactor cooling system. During normal operation, the GWPS is designed to store gases to allow for radioactive decay before release. The GWPS consists of a surge tank, two compressors, waste gas decay tanks, and several filter systems. Each of the filter systems contains a roughing filter, a high-efficiency particulate air filter, and a charcoal adsorber. The gas storage tanks are sampled before release via the gaseous waste discharge header. Both activity and flow rates in the discharge stream are continuously monitored to ensure that the effluents comply with discharge limits [NRC 2001, Section 2.1.4.2].

The GWPS also processes effluents from the auxiliary system equipment and tanks, the spent fuel storage area ventilation, and the radwaste area ventilation. These effluents contain air and are kept separate from the hydrogenated primary system effluents to minimize the potential for explosion. These effluents typically contain low levels of activity and are released directly to the station vent plenum through a filter system. These effluents are continuously monitored as they are released and are diverted to the GWPS surge tank for additional storage and decay if they exceed discharge limits [NRC 2001, Section 2.1.4.2].

ANO maintains gaseous releases within ODCM limits. The GWPS is used to reduce radioactive materials in gaseous effluents before discharge to meet the dose design objectives in 10CFR Part 50, Appendix I. In addition, the limits in the ODCM are designed to provide reasonable assurance that radioactive material discharged in gaseous effluents would not result in the exposure of a member of the public in an unrestricted area in excess of the limits specified in 10CFR Part 20, Appendix B [NRC 2001, Section 2.1.4.2].

The quantities of gaseous effluents released from ANO-2 are controlled by the administrative limits defined in the ODCM. The controls are specified for dose rate, dose due to noble gases, and dose due to radioiodine and radionuclides in particulate form. [NRC 2001, Section 2.1.4.2] For noble gases, the dose rate limit at or beyond the site boundary is ≤5 mSv/yr (500 mrem/yr) to the total body, and ≤30 mSv/yr (3000 mrem/yr) to the skin. For iodine and particulates with half-lives greater than 8 days, the limit is ≤15 mSv/yr (1500 mrem/yr) to an organ. The limit for air dose due to noble gases released in gaseous effluents to areas at or beyond the site boundary during a calendar quarter is ≤0.05 milligray (5 mrad) for gamma radiation and ≤0.1 mGy (10 mrad) for beta radiation. For a calendar year, the limit is ≤0.1 mGy (10 mrad) for gamma radiation and ≤0.2 mGy (20 mrad) for beta radiation. The radioactive gaseous waste sampling and analysis program specifications provided in the ODCM address the gaseous release type, sampling frequency, minimum analysis frequency, type of activity analysis, and lower limit of detection [NRC 2001, Section 2.1.4.2].

3.2.3.3 Solid Waste Processing

The ANO Solid Radioactive Waste Program provides the capabilities for solidification, stabilization, encapsulation, and packaging of wastes. The SRWP processes wastes from the

liquid and gaseous effluent treatment systems, as well as other miscellaneous solid wastes generated during plant operation and maintenance. Solid waste is packaged in containers to meet the applicable requirements of 10CFR Parts 61 and 71 for transportation and disposal. The SRWP provides the capability for preparing solid waste for shipment to an offsite treatment or disposal facility. The system is designed to maintain radiation exposure ALARA for personnel who handle solid wastes and to minimize the quantities of solid waste generated at the plant [NRC 2001, Section 2.1.4.3].

The SRWP manages high specific activity wastes from the liquid and gaseous effluent treatment systems, which consists mainly of spent ion exchange resin and filter cartridges. Spent resin is transferred to a storage tank where it is held for radioactive decay. The resins are dewatered or solidified before offsite shipment for disposal. Radioactive filters are transported from each filter housing to the waste disposal area. Packaging of other dry active wastes is performed in a low-level waste work area. Volume-reduction treatments, such as shredding or compaction, may be used where appropriate. Solid wastes are packaged in containers suitable for transfer to an offsite treatment or disposal facility [NRC 2001, Section 2.1.4.3].

ANO stores both HSAW and DAW in an onsite low level radioactive waste storage building in preparation for shipment to offsite treatment or disposal facilities. The storage facility is designed to accommodate more than 5 years of waste expected to be generated at ANO based on normal operations. The functions of the facility include interim storage of HSAW, DAW, and other radioactively contaminated materials; receiving, sorting, compacting, packaging, and shipment of DAW; and office space for radwaste management activities. The HSAW storage area is shielded to minimize doses to nearby workers. Dose rates within the facility are continuously monitored. The facility ventilation system operates at negative pressure, and effluents are continuously monitored after passing through a HEPA filter to remove particulates. A separate shielded facility is available for temporary storage of radioactively contaminated, but reusable, tools and equipment [NRC 2001, Section 2.1.4.3].

3.2.4 Transportation of Radioactive Materials

ANO radioactive waste shipments are packaged in accordance with NRC and U.S. Department of Transportation requirements. The type and quantities of solid radioactive waste generated and shipped at ANO vary from year to year, depending on plant activities. ANO currently transports radioactive waste to a licensed disposal facility in Oak Ridge, Tennessee. ANO may also transport material from an offsite processing facility to a disposal site or back to the plant site for reuse or storage [NRC 2001, Section 2.1.4.3].

3.2.5 Nonradioactive Waste Systems

Nonradioactive waste is produced from plant maintenance and cleaning processes. Most of these wastes are from boiler blowdown (as impurities are purged from plant boilers), water treatment sludges and other wastes, boiler metal cleaning wastes, floor and yard drains, and stormwater runoff. Chemical and biocide wastes are produced from processes used to control the pH in the coolant, to control scale, to control corrosion, to regenerate resins, and to clean

and defoul the condenser. Waste liquids are typically combined with cooling water discharges. Sanitary waste water is treated at an onsite facility before discharge under a permit from the ADEQ [NRC 2001, Section 2.1.5].

Non-radioactive gaseous effluents result from operation of the oil-fired boilers used to heat the plant and from testing of the emergency diesel generators. Discharge of regulated pollutants is minimized by use of low-sulfur fuels and is within Arkansas air quality standards [NRC 2001, Section 2.1.5].

3.2.6 Maintenance, Inspection and Refueling Activities

Various programs and activities currently exist at ANO-2 to maintain, inspect, test, and monitor the performance of plant equipment. These programs and activities include, but are not limited to those implemented to:

- meet the requirements of 10CFR Part 50, Appendix B (Quality Assurance), Appendix R (Fire Protection), Appendices G and H, Reactor Vessel Materials;
- meet the requirements of 10CFR50.55a, American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section XI, Inservice Inspection and Testing requirements;
- meet the requirements of 10CFR50.65, the maintenance rule, including the Structures Monitoring Program; and
- maintain water chemistry in accordance with EPRI guidelines.

Additional programs include those implemented to meet Technical Specification surveillance requirements, those implemented in response to NRC generic communications, and various periodic maintenance, testing, and inspection procedures. Certain program activities are performed during the operation of the unit. Others are performed during scheduled refueling outages.

3.2.7 Power Transmission Systems

One 500 kV line was required to connect ANO-2 to the electric grid. This line involves approximately 91 miles of a single circuit 500 kV transmission line from the existing ANO 500 kV station switchyard, southeasterly via the Mayflower substation (southwest of Mayflower) to the Mabelvale substation (southwest of Little Rock). Figure 3-2 shows the transmission system of interest.

The transmission corridor for this line crosses lands that consist of rural property, forestland and to a limited degree agricultural and timber production operations [NRC 1977, Section 5.2]. The vegetation management method used along the Entergy transmission line rights-of-way is mechanical clearing only. No herbicide application is utilized along this corridor. Semiannually, an aerial survey of the transmission corridor isperformed to identify issues that would cause potential operational problems (i.e., erosion, vegetation control, equipment maintenance).

This 500 kV line has operated at the same voltage levels since ANO-2 was placed into service. If ANO-2 was removed from service, this 500 kV line would remain in service to provide power for area transmission loads. Area loads have grown significantly since the construction of ANO-2 and the 500 kV line must remain in service to supply these loads.

3.3 Refurbishment Activities

10CFR51.53(c)(2) requires that a license renewal applicant's environmental report contain:

"a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with Section 54.21 of this chapter. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment."

The objective of the review required by 10CFR54.21 is to determine whether the detrimental effects of plant aging could preclude certain ANO-2 systems, structures, and components from performing in accordance with the current licensing basis, during the additional 20 years of operation requested in the license renewal application.

The evaluation of structures and components as required by 10CFR54.21 has been completed and is described in the body of the ANO-2 License Renewal Application. This evaluation did not identify the need for refurbishment of structures or components related to license renewal.

Routine replacement of certain components during the period of extended operation is expected to occur within the bounds of normal plant maintenance. Modifications to improve operation of plant systems, structures, or components are reviewed for environmental impact by station personnel during the planning stage for the modification. These reviews are controlled by site procedures.

3.4 Programs and Activities for Managing the Effects of Aging

The programs for managing aging of systems and equipment at ANO-2 are described in the body of the ANO-2 license renewal application. The evaluation of structures and components required by 10CFR54.21 identified some new inspection activities necessary to continue operation of ANO-2 during the additional 20 years beyond the initial license term. These activities are described in the body of the ANO-2 license renewal application. The additional inspection activities are consistent with normal plant component inspections, and therefore, are not expected to cause significant environmental impact. The majority of the aging management programs are existing programs or modest modifications of existing programs.

3.5 Employment

The non-outage work force at ANO consists of approximately 1,258 persons. There are 1,071 Entergy employees normally on-site. The remaining 187 persons are baseline contractor employees. Table 3-1 shows employee residences by county and city. The GEIS estimated that an additional 60 employees would be necessary for operation during the period of extended

operation. Since there will not be significant new aging management programs added at ANO, Entergy Operations believes that it will be able to manage the necessary programs with existing staff. Therefore, Entergy Operations has no plans to add non-outage employees to support plant operations during the extended license period.

Refueling and maintenance outages typically last approximately 30 days. Depending on the scope of these outages, an additional 1,300 to 1,400 workers are typically on-site. The number of workers required on-site for normal plant outages during the period of extended operation is expected to be consistent with the number of additional workers used for past outages at ANO.

Table 3-1
Employee Residence Information, ANO Units 1 and 2, October 2002

County and City	Employees (Entergy and Baseline Contractors)
CONWAY COUNTY	**16**
Hattieville	1
Morrilton	12
Springfield	3
CRAWFORD COUNTY	**3**
Alma	3
FAULKNER COUNTY	**18**
Conway	17
Greenbrier	1
FRANKLIN COUNTY	**2**
Alix	1
Ozark	1
GARLAND COUNTY	**1**
Hot Springs	1
JEFFERSON COUNTY	**1**
Union Church	1
JOHNSON COUNTY	**99**
Clarksville	38
Coal Hill	2
Hagerville	1
Hartman	8
Knoxville	10
Lamar	38

Table 3-1, Employee Residence Information (continued)	
County and City	**Employees (Entergy and Baseline Contractors)**
Oark	1
Ozone	1
LOGAN COUNTY	**12**
New Blaine	1
Paris	1
Scranton	7
Subiaco	3
LONOKE COUNTY	**2**
Austin	1
Cabot	1
NEWTON COUNTY	**2**
Pelsor	2
PERRY COUNTY	**4**
Adona	1
Bigelow	2
Perryville	1
POLK COUNTY	**1**
Mena	1
POPE COUNTY	**976**
Atkins	40
Dover	112
Hector	9
Jerusalem	1
Lamar	4
London	59
Pottsville	28
Russellville	722

Table 3-1, Employee Residence Information (continued)	
County and City	**Employees (Entergy and Baseline Contractors)**
Tilly	1
PULASKI COUNTY	**8**
Jacksonville	1
Little Rock	2
Maumelle	2
North Little Rock	2
Sherwood	1
SEARCY COUNTY	**1**
Witt Springs	1
ST. FRANCIS COUNTY	**1**
Madison	1
YELL COUNTY	**111**
Belleville	6
Buckville	1
Casa	2
Danville	6
Dardanelle	70
Delaware	2
Havana	10
Ola	10
Plainview	3
Waveland	1
Total:	**1,258**

Figure 3-1, ANO Plant Features

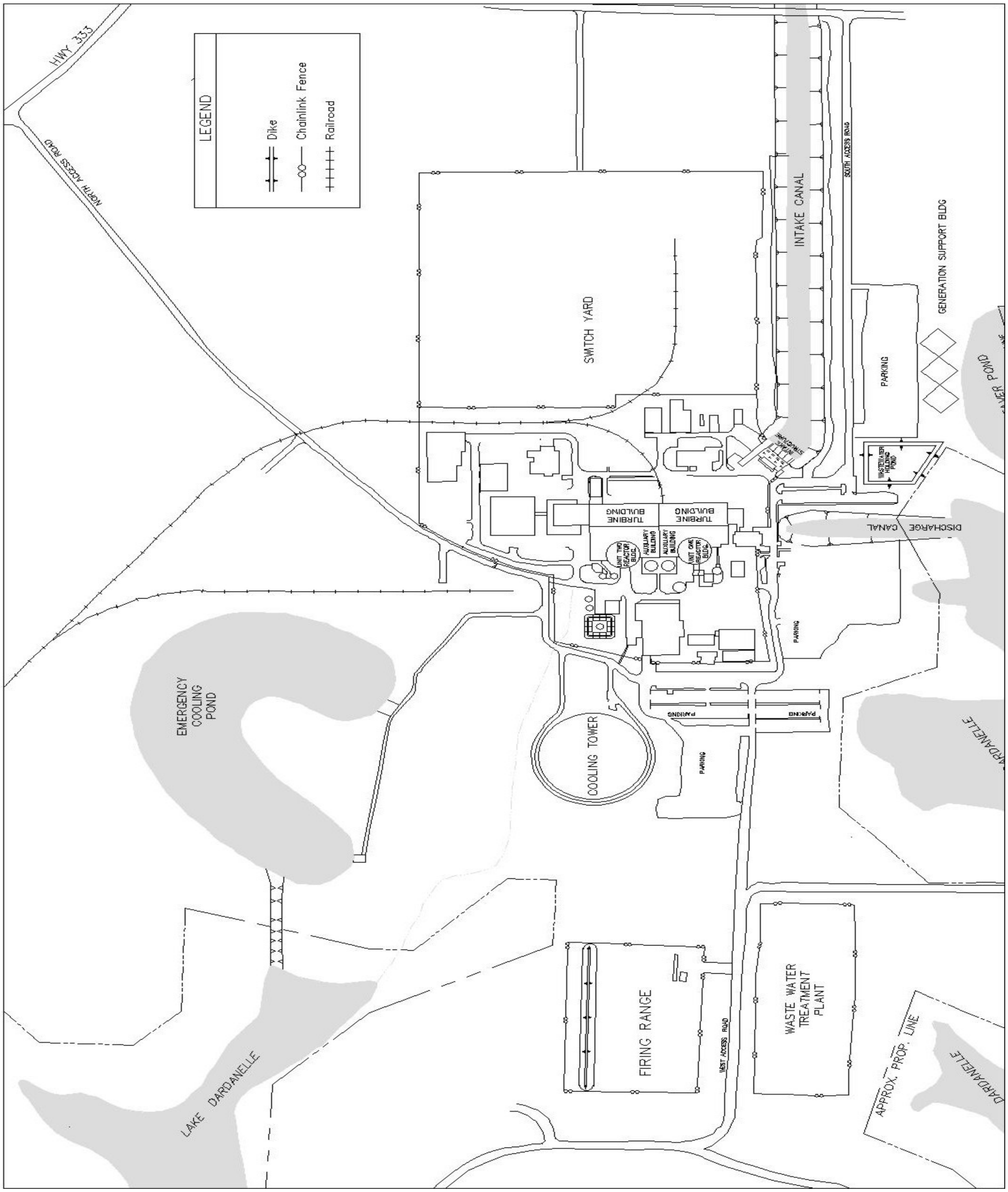
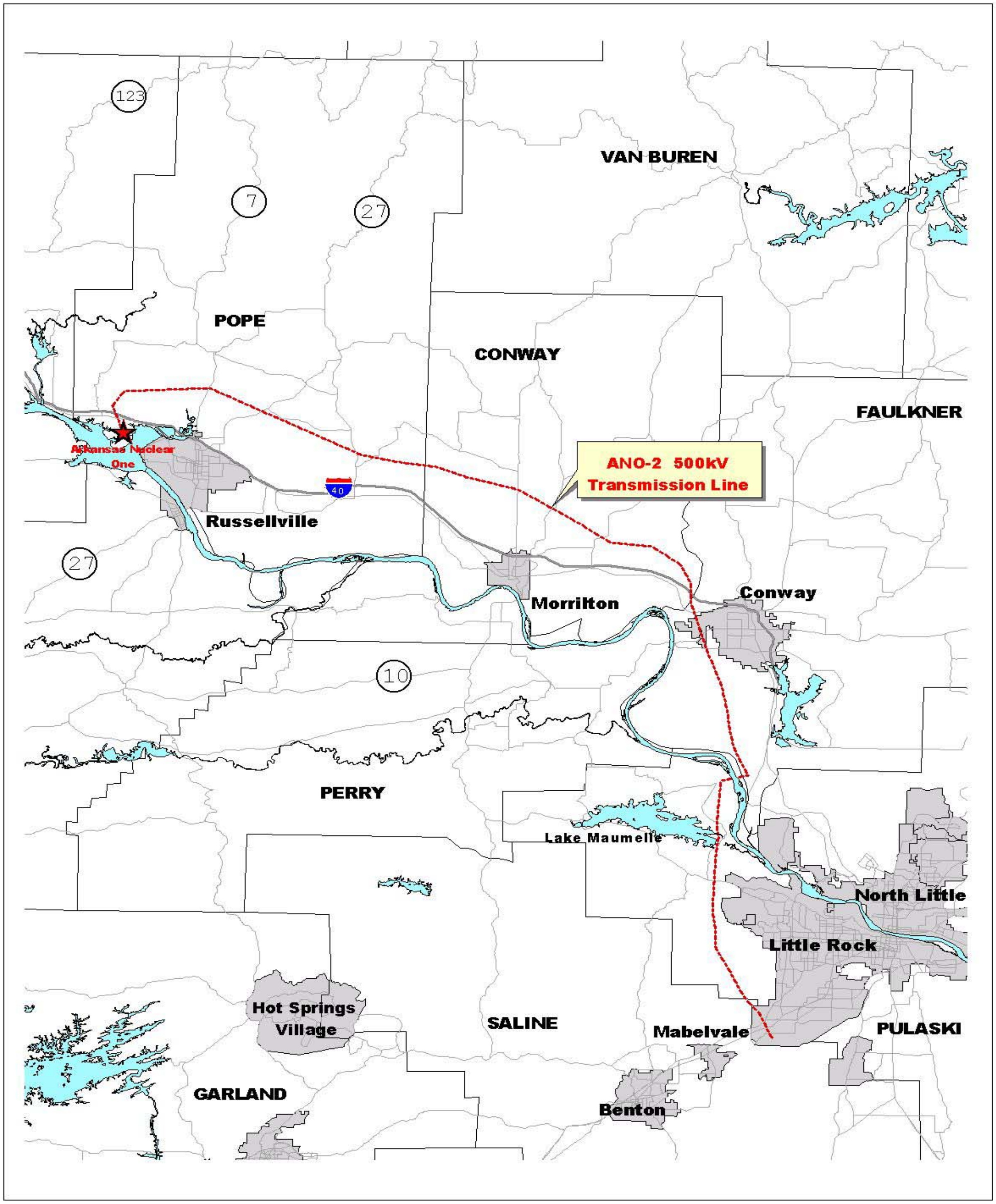


Figure 3-2, ANO-2 Transmission Line



3.6 References

EOI (Entergy Operations, Inc.). 2002. Arkansas Nuclear One - Unit 2, Safety Analysis Report, Amendment 17.

EOI (Entergy Operations, Inc.). 2002a. Arkansas Nuclear One, Unit 2 System Training Manual, Reactor Vessels and Internals, STM-2-01, Revision 6.

EOI (Entergy Operations, Inc.). 2002b. Arkansas Nuclear One, National Pollutant Discharge Elimination System Permit AR0001392.

NRC (U. S. Nuclear Regulatory Commission). 1977. *Final Environmental Statement Related to Operation of Arkansas Nuclear One Unit 2*, Arkansas Power & Light Company, Docket No. 50-368, Unites States Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, June 1977

NRC (U.S. Nuclear Regulatory Commission). 2001. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants" Arkansas Nuclear One, Unit 1.* NUREG-1437, Supplement 3. Office of Nuclear Reactor Regulation, Washington, D.C. April 2001.

NRC (U.S. Nuclear Regulatory Commission). 2002. *Arkansas Nuclear One, Unit 2 – Draft Environmental Assessment and Finding of No Significant Impact Related to a Proposed License Amendment to Increase the Licensed Power Level* (TAC NO. MB0789)

4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

Discussion of GEIS Categories for Environmental Issues

The NRC has identified and analyzed 92 environmental issues that it considers to be associated with nuclear power plant license renewal and has designated the issues as Category 1, Category 2, or NA (not applicable). NRC designated an issue as Category 1 if the following criteria were met:

- the environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;
- a single significance level (i.e., small, moderate, or large) has been assigned to the impacts that would occur at any plant, regardless of which plant is being evaluated (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent-fuel disposal); and
- mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely to be not sufficiently beneficial to warrant implementation.

If the NRC concluded that one or more of the Category 1 criteria could not be met, NRC designated the issue Category 2. NRC requires plant-specific analysis for Category 2 issues. NRC designated two issues as NA, signifying that the categorization and impact definitions do not apply to these issues. NRC rules do not require analyses of Category 1 issues that NRC resolved using generic findings (10CFR51, Appendix B, Table B-1) as described in the GEIS [NRC 1996]. An applicant may reference the generic findings or GEIS analyses for Category 1 issues.

Category 1 License Renewal Issues

Entergy has determined that, of the 69 Category 1 issues, 7 do not apply to ANO-2 because they apply to design or operational features that do not exist at the facility. In addition, because Entergy does not plan to conduct refurbishment activities, the NRC findings for the 7 Category 1 issues that apply only to refurbishment do not apply. Table 4-1 lists these 14 issues and explains why these issues are not applicable to ANO-2. Table 4-2 lists the 55 Category 1 issues applicable to ANO-2. Entergy reviewed the NRC findings on these 55 issues and identified no new and significant information that would invalidate the findings for ANO-2. Therefore, Entergy adopts by reference the NRC findings for these Category 1 issues.

Table 4-1
Category 1 Issues Not Applicable to ANO-2

Surface Water Quality, Hydrology, and Use (for all plants)	
Impacts of refurbishment on surface water quality	No refurbishment activities planned.
Impacts of refurbishment on surface water use	No refurbishment activities planned.
Altered salinity gradients	ANO located on freshwater lake.
Water use conflicts (plants with once-through cooling systems)	ANO-2 utilizes cooling tower system.
Aquatic Ecology (for all plants)	
Refurbishment	No refurbishment activities planned.
Groundwater Use and Quality	
Impacts of refurbishment on groundwater use and quality	No refurbishment activities planned.
Ground-water use conflicts (potable and service water; plants that use <100 gpm)	ANO does not use groundwater.
Ground-water quality degradation (Ranney Wells)	ANO does not use Ranney wells.
Ground-water quality degradation (saltwater intrusion)	ANO located on freshwater lake.
Ground-water quality degradation (cooling ponds in salt marshes)	ANO located on freshwater lake.
Human Health	
Radiation exposures to the public during refurbishment	No refurbishment activities planned.
Occupational radiation exposures during refurbishment	No refurbishment activities planned.
Terrestrial Resources	
Cooling pond impacts on terrestrial resources	ANO-2 does not use cooling ponds.
Socioeconomics	
Aesthetic impacts (refurbishment)	No refurbishment activities planned.

Table 4-2
Category 1 Issues Applicable to ANO-2

Surface Water Quality, Hydrology, and Use (for all plants)
Altered current patterns at intake and discharge structures
Altered thermal stratification of lakes
Temperature effects on sediment transport capacity
Scouring caused by discharged cooling water
Eutrophication
Discharge of chlorine or other biocides
Discharge of sanitary wastes and minor chemical spills
Discharge of other metals in waste water
Aquatic Ecology (for all plants)
Accumulation of contaminants in sediments or biota
Entrainment of phytoplankton and zooplankton
Cold Shock
Thermal plume barrier to migrating fish
Distribution of aquatic organisms
Premature emergence of aquatic insects
Gas supersaturation (gas bubble disease)
Low dissolved oxygen in the discharge
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses
Stimulation of nuisance organisms (e.g., shipworms)
Aquatic Ecology (for plants with cooling tower based heat dissipation systems)
Entrainment of fish and shellfish in early life stages
Impingement of fish and shellfish
Heat Shock

Table 4-2, Category 1 Issues Applicable to ANO-2 (continued)
Terrestrial Resources
Cooling tower impacts on crops and ornamental vegetation
Cooling tower impacts on native plants
Bird collisions with cooling towers
Power line right-of-way management (cutting and herbicide application)
Bird collision with power lines
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)
Floodplains and wetland on power line right of way
Air Quality
Air quality effects of transmission lines
Land Use
Land Use (license renewal period)
Power line right of way
Human Health
Microbiological organisms (occupational health)
Noise
Radiation exposures to public (license renewal term)
Occupational radiation exposures (license renewal term)
Socioeconomics
Public services: public safety, social services, and tourism and recreation
Public services, education (license renewal term)
Aesthetic impacts (license renewal term)
Aesthetic impacts of transmission lines (license renewal term)
Postulated Accidents
Design basis accidents

Table 4-2, Category 1 Issues Applicable to ANO-2 (continued)
Uranium Fuel Cycle and Waste Management
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste)
Offsite radiological impacts (collective effects)
Offsite radiological impacts (spent fuel and high level waste disposal)
Non-radiological impacts of the uranium fuel cycle
Low-level waste storage and disposal
Mixed waste storage and disposal
On-site spent fuel
Nonradiological waste
Transportation
Decommissioning
Radiation doses
Waste management
Air quality
Water quality
Ecological resources
Socioeconomic impacts

Category 2 License Renewal Issues

NRC designated 21 issues as Category 2. Sections 4.1 through 4.20 address the Category 2 issues, beginning with a statement of the issue. As is the case with Category 1 issues, some Category 2 issues (6) apply to operational features that ANO-2 does not have. In addition, some Category 2 issues (4) apply only to refurbishment activities. If the issue does not apply to ANO-2, the section explains the basis.

For the 11 Category 2 issues applicable to ANO-2, the corresponding sections contain the required analyses. These analyses include conclusions regarding the significance of the impacts relative to renewal of the operating license for ANO-2 and, when applicable, discuss potential mitigative alternatives to the extent required. Entergy has identified the significance of the impacts associated with each issue as SMALL, MODERATE or LARGE consistent with the criteria that NRC established in 10CFR51, Appendix B, Table B-1, Footnote 3 as follows.

- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

- MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attributes of the resource.

- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

In accordance with NEPA practice, Entergy considered ongoing and potential additional mitigation in proportion to the significance of the impact to be addressed (i.e., impacts that are small receive less mitigative consideration than impacts that are large).

"NA" License Renewal Issues

NRC determined that its categorization and impact-finding definitions did not apply to electromagnetic fields (chronic effect) and environmental justice. NRC noted that applicants currently do not need to submit information on chronic effects from electromagnetic fields (10CFR51, Appendix B, Table B-1, Footnote 5). For environmental justice, NRC does not require information from applicants, but noted that it would be addressed in individual license renewal reviews (10CFR51, Appendix B, Table B-1, Footnote 6). Entergy has included environmental justice demographic information in Section 2.6.2.

Format of Category 2 Issue Review

The review and analysis for the Category 2 issues and environmental justice are found in Sections 4.1 through 4.21. The format for the review of the Category 2 issues is described below:

- **Issue** – a brief statement of the issue.

- **Description of Issue** – a brief description of the issue.

- **Findings from Table B-1, Appendix B to Subpart A** - The findings for the issue from Table B-1 - Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Appendix B to Subpart A, are presented.

- **Requirement** - The requirement from 10CFR51.53(c)(3)(ii) is restated.

- **Background** – For issues applicable to ANO-2, a background excerpt from the applicable section of the GEIS is provided. The specific section of the GEIS is referenced for the convenience of the reader. In most cases, background information is not provided for issues that are not applicable to ANO-2.

- **Analysis of Environmental Impact** - An analysis of the environmental impact as required by 10CFR51.53(c)(3)(ii) is provided, taking into account information provided in the GEIS, Appendix B to Subpart A of Part 51, as well as current ANO-2 specific information.

- **Conclusion** – For issues applicable to ANO-2, the conclusion of the analysis is presented along with the consideration of mitigation alternatives as required by 10CFR51.45(c) and 10CFR51.53(c)(3)(iii).

4.1 Water Use Conflicts

4.1.1 Description of Issue

Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)

4.1.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See 10CFR51.53(c)(3)(ii)(A).

4.1.3 Requirement [10CFR51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15 x 10^{12} ft^3/year (9 x 10^{10} m^3/year), an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided. The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow.

4.1.4 Background

Consultation with regulatory and resource agencies indicates that water use conflicts are already a concern at two closed-cycle nuclear power plants (Limerick and Palo Verde) and may be a problem in the future at Byron Station and the Duane Arnold Energy Center. Because water use conflicts may be small or moderate during the license renewal period, this a Category 2 issue for nuclear plants with closed-cycle cooling systems. Related to this, the effects of consumptive water use on in-stream and riparian communities could also be small or moderate, depending on the plant [NRC 1996, Section 4.3.2.1].

4.1.5 Analysis of Environmental Impact

Two factors may cause water-use and water-availability issues to become important for facilities that use cooling towers. First, the relatively small rate of water withdrawal and discharge allowed some plants with cooling towers to be located on small rivers that are susceptible to

droughts or competing water uses. Second, cooling towers evaporate cooling water, and consumptive water losses may represent a substantial portion of the flow in a small river. Entergy does not believe that these factors apply to ANO-2 because the plant is located on a lake formed from an impounded river.

However, to assist the NRC staff in addressing this issue for license renewal, Entergy provides the following information.

4.1.5.1 Hydrology

ANO is located on Lake Dardanelle, an impoundment created by the construction of Dardanelle Lock and Dam on the Arkansas River at river mile 205.5. The lake was created in the late 1960's as part of the McClelland-Kerr Arkansas River Navigation Project constructed by the CoE. The Arkansas River basin upstream of Dardanelle Lock and Dam is over 150,000 square miles in area. Lake Dardanelle is one of the largest reservoirs in Arkansas with a surface area of approximately 34,300 acres and a shoreline of over 300 miles. Based on a period from 1969 through 1994, the lake has an average annual flow of 41,790 cfs (1.32×10^{12} ft^3/year) at the Dardanelle Lock and Dam [USGS 1995]. The surface elevation of the lake is maintained between 336.0 and 338.2 feet above MSL [CoE 2002].

ANO-2 withdraws cooling water from Lake Dardanelle at an average rate of approximately 36 cfs. Approximately 75% of this flow is evaporated in the natural draft cooling tower and the remaining amount is returned to the lake. Therefore, consumptive water loss due to the operation of ANO-2 is approximately 27 cfs or 0.06% of the Lake Dardanelle (Arkansas River) average daily flow rate. This loss of instream flow has an insignificant impact on the overall flow of the Arkansas River through Lake Dardanelle.

4.1.5.2 Riparian Uses

The demand for Lake Dardanelle water from other downstream users is low and there is no reported water availability problem on the lake. Other than ANO, there are only three registered off-stream users of water from the lake. In 2000, approximately 5 cfs was diverted from the lake for irrigation, mining and water supply uses [ASWCC 2002].

Although relatively small, the consumptive loss of water at ANO-2 removes water from potential hydropower uses downstream. Entergy, therefore, annually pays the CoE for the loss of water that would otherwise be used for hydropower generation at Dardanelle Lock and Dam. Compensation in the amount of approximately $11,000/year is made for combined evaporative water losses from both ANO generating units.

4.1.5.3 Instream Ecological Uses

The various ecological communities of Lake Dardanelle are described in Section 2.2. Because ANO-2 is located on a river impoundment and there are no water availability problems in Lake Dardanelle, the relatively small consumptive water loss from ANO-2 does not have a significant

adverse impact on instream ecological communities. Resource agencies have concurred with this assessment [AGFC 1995 & AGFC 2000].

4.1.6 Conclusion

Section 5.3.4 of the *Final Environmental Statement Related to Operation of Arkansas Nuclear One Unit 2,* [NRC 1977] concluded that the operation of ANO-2 would not result in a water use conflict on Lake Dardanelle. For extended operation, ANO-2 will also not result in a water use conflict on Lake Dardanelle. Cooling water makeup at ANO-2 is a very small percentage of the overall flow of the Arkansas River through Lake Dardanelle. Since the plant became operational in 1980, water withdrawal has caused no water availability concerns for the lake, conflicts with other off-stream users, or adverse impacts on riparian or instream ecological communities.

Therefore, Entergy concludes that environmental impact of water use conflicts from license renewal would be SMALL and does not warrant mitigation.

4.2 <u>Entrainment of Fish and Shellfish in Early Life Stages</u>

4.2.1 Description of Issue

Entrainment of fish and shellfish in early life stages (for all plants with once-through and cooling pond heat dissipation systems)

4.2.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See 10CFR51.53(c)(3)(ii)(B).

4.2.3 Requirement [10CFR51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations and, if necessary, a 316(a) variance in accordance with 40CFR Part 125, or equivalent state permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock and impingement and entrainment.

4.2.4 Analysis of Environmental Impact

ANO-2 utilizes a cooling tower heat dissipation system. Therefore, this issue is not applicable to ANO-2 and analysis is not required.

4.3 Impingement of Fish and Shellfish

4.3.1 Description of Issue

Impingement of fish and shellfish (for all plants with once-through and cooling pond heat dissipation systems)

4.3.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See 10CFR51.53(c)(3)(ii)(B).

4.3.3 Requirement [10CFR51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations and, if necessary, a 316(a) variance in accordance with 40CFR Part 125, or equivalent state permits and supporting documentation. If the applicant can not provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock and impingement and entrainment.

4.3.4 Analysis of Environmental Impact

ANO-2 utilizes a cooling tower heat dissipation system. Therefore, this issue is not applicable to ANO-2 and analysis is not required.

4.4 Heat Shock

4.4.1 Description of Issue

Heat shock (for all plants with once-through and cooling pond heat dissipation systems)

4.4.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See 10CFR51.53(c)(3)(ii)(B).

4.4.3 Requirement [10CFR51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(a) determinations and variance in accordance with 40CFR Part 125, or equivalent state permits and supporting

documentation. If the applicant can not provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock.

4.4.4 Analysis of Environmental Impact

ANO-2 utilizes a cooling tower heat dissipation system. Therefore, this issue is not applicable to ANO-2 and analysis is not required.

4.5 Groundwater Use Conflicts (Plants Using >100 gpm of Groundwater)

4.5.1 Description of Issue

Groundwater use conflicts (potable and service water, and dewatering: plants that use >100 gpm)

4.5.2 Findings from Table B-1, Subpart A, Appendix A

SMALL, MODERATE, or LARGE. Plants that use more than 100 gpm may cause groundwater use conflicts with nearby groundwater users. See 10CFR51.53(c)(3)(ii)(C).

4.5.3 Requirement [10CFR51.53(c)(3)(ii)(C)]

If the applicant's plant uses Ranney wells or pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater use must be provided.

4.5.4 Analysis of Environmental Impact

There are no groundwater wells on the ANO site. Drinking water is supplied by the City of Russellville and service water is taken from Lake Dardanelle. Therefore, this issue is not applicable to ANO and analysis is not required.

4.6 Groundwater Use Conflicts (Plants Using Cooling Towers Withdrawing Make-Up Water from a Small River)

4.6.1 Description of Issue

Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)

4.6.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other groundwater or upstream surface water users come on line before the time of license renewal. See 10CFR51.53(c)(3)(ii)(A).

4.6.3 Requirement [10CFR51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15 x 1012 ft3/year (9 x 1010 m3/year), an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided. The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow.

4.6.4 Background

Consultation with regulatory and resource agencies indicates that water use conflicts are already a concern at two closed-cycle nuclear power plants (Limerick and Palo Verde) and may be a problem in the future at Byron Station and the Duane Arnold Energy Center. Because water use conflicts may be small or moderate during the license renewal period, this a Category 2 issue for nuclear plants with closed-cycle cooling systems [NRC 1996, Section 4.3.2.1].

4.6.5 Analysis of Environmental Impact

As discussed in Section 4.1.5, Entergy does not believe that this issue applies to ANO-2 because the plant is located on a lake formed from an impounded river. However, to assist the NRC staff in addressing this issue for license renewal, Entergy provides the information below.

ANO is located on Lake Dardanelle, an impoundment created by the construction of Dardanelle Lock and Dam on the Arkansas River at river mile 205.5. The lake was created in the late 1960's as part of the McClelland-Kerr Arkansas River Navigation Project constructed by the U.S. Army Corps of Engineers. The Arkansas River basin upstream of Dardanelle Lock and Dam is over 150,000 square miles in area. Lake Dardanelle is one of the largest reservoirs in Arkansas with a surface area of approximately 34,300 acres and a shoreline of over 300 miles. Based on a period from 1969 through 1994, the lake has an average annual through flow of 41,790 cubic feet/second (1.32×10^{12} ft^3/year) at Dardanelle Lock and Dam [USGS 1995]. The surface elevation of the lake is maintained between 336.0 and 338.2 feet above MSL [CoE 2002]. Since the lake elevation remains constant, aquifer elevation and recharge rates also remain relatively constant.

ANO-2 withdraws cooling water from Lake Dardanelle at an average rate of approximately 36 cubic feet/second. Approximately 75% of this flow is evaporated in the natural draft cooling tower and the remaining amount is returned to the lake. Consumptive water loss due to the operation of ANO-2, therefore, is approximately 27 cfs or 0.06% of the Lake Dardanelle (Arkansas River) average daily flow rate. This loss of instream flow has an insignificant impact on the overall flow of the Arkansas River through Lake Dardanelle.

The demand for Lake Dardanelle water from other downstream users is low and there is no reported water availability problem on the lake. Other than ANO, there are only three registered off-stream users of water from the lake. In 2000, approximately 5 cfs was diverted from the lake for irrigation, mining and water supply uses [ASWCC 2002].

4.6.6 Conclusion

Section 5.3.4 of the *Final Environmental Statement Related to Operation of Arkansas Nuclear One Unit 2,* [NRC 1977] concluded that the operation of ANO-2 would not result in water use conflicts on Lake Dardanelle. For extended operation, ANO-2 will not result in a water use conflict on Lake Dardanelle. Cooling water makeup at ANO-2 is a very small percentage of the overall flow of the Arkansas River through Lake Dardanelle and does not affect lake or aquifer elevation, or aquifer recharge rates. Since the plant became operational in 1980, water withdrawal has caused no water availability concerns for the lake or conflicts with other off-stream users.

Therefore, Entergy concludes that water use conflict from license renewal would be SMALL and does not warrant mitigation.

4.7 <u>Groundwater Use Conflicts (Plants Using Ranney Wells)</u>

4.7.1 Description of Issue

Groundwater use conflicts (plants using Ranney wells)

4.7.2 Findings from Table B-1, Subpart A, Appendix A

SMALL, MODERATE, or LARGE. Ranney wells can result in potential groundwater depression beyond the site boundary. Impacts of large groundwater withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See 10CFR51.53(c)(3)(ii)(C).

4.7.3 Requirement [10CFR51.53(c)(3)(ii)(C)]

If the applicant's plant uses Ranney wells or pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater use must be provided.

4.7.4 Analysis of Environmental Impact

ANO does not utilize Ranney wells. Drinking water is supplied by the City of Russellville and service water is taken from Lake Dardanelle. Therefore, this issue is not applicable to ANO and analysis is not required.

4.8 <u>Degradation of Groundwater Quality</u>

4.8.1 Description of Issue

Groundwater quality degradation (cooling ponds at inland sites).

4.8.2 Findings from Table B-1, Subpart A, Appendix A

SMALL, MODERATE, or LARGE. Sites with closed-cycle cooling ponds may degrade groundwater quality. For plants located inland, the quality of the groundwater in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See 10CFR51.53(c)(3)(ii)(D).

4.8.3 Requirement [10CFR51.53(c)(3)(ii)(D)]

If the applicant's plant is located at an inland site and utilizes cooling ponds, an assessment of the impact of the proposed action on groundwater quality must be provided.

4.8.4 Analysis of Environmental Impact

ANO does not utilize cooling ponds. ANO-2 uses a cooling tower heat dissipation system. Therefore, this issue is not applicable to ANO-2 and analysis is not required.

4.9 Impacts of Refurbishment on Terrestrial Resources

4.9.1 Description of Issue

Refurbishment impacts - Terrestrial Resources

4.9.2 Findings from Table B-1, Subpart A, Appendix A

SMALL MODERATE, or LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See 10CFR51.53(c)(3)(ii)(E).

4.9.3 Requirement [10CFR51.53(c)(3)(ii)(E)]

All license renewal applicants shall assess the impact of refurbishment and other license renewal related construction activities on important plant and animal habitats.

4.9.4 Analysis of Environmental Impact

As noted in Section 3.3, no refurbishment activities are required for ANO-2 license renewal. Therefore this issue is not applicable to ANO-2 and no analysis is required.

4.10 Threatened or Endangered Species

4.10.1 Description of Issue

Impacts from refurbishment and continued operations on threatened or endangered species.

4.10.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See 10CFR51.53(c)(3)(ii)(E).

4.10.3 Requirement [10CFR51.53(c)(3)(ii)(E)]

All license renewal applicants shall assess the impact of refurbishment and other license renewal related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act.

4.10.4 Background

It is not possible to reach a conclusion about the significance of potential impacts to threatened and endangered species at this time because (1) the significance of impacts on such species cannot be assessed without site- and project-specific information that will not be available until the time of license renewal and (2) additional species that are threatened with extinction and that may be adversely affected by plant operations may be identified between the present and the time of license renewal [NRC 1996, Section 3.9].

4.10.5 Analysis of Environmental Impacts

Section 2.5 of this ER discusses threatened or endangered species that occur within the vicinity of the ANO-2 site and transmission line. Entergy is not aware of concerns regarding threatened or endangered terrestrial species that could occur at ANO or along the associated transmission corridor. Current operations of ANO-2 and Entergy vegetation management practices along transmission line rights-of-way do not adversely affect a listed terrestrial species or its habitat. Furthermore, station operations and transmission line maintenance practices are not expected to change significantly during the license renewal term. Therefore, no adverse impacts to threatened or endangered terrestrial species from current or future operations are anticipated.

Entergy contacted the ANHC, USFWS and AGFC requesting information on listed species or critical habitats that might exist on the ANO site or along the associated transmission corridor, with particular emphasis on species that might be adversely affected by continued operation over the license renewal period. No concerns were identified by these agencies during the consultation process [see Attachments A, B and C].

As discussed in Section 3.3, Entergy has no plans to conduct refurbishment or construction activities at ANO during the period of extended operation. Therefore, there would be no refurbishment-related impacts to special-status species and no further analysis of refurbishment-related impacts is applicable.

4.10.6 Conclusion

No major refurbishment activities are required for ANO-2 license renewal. Therefore, there will be no impact to threatened or endangered species from refurbishment activities.

The continued operation of ANO-2 and its associated transmission line should not impact threatened or endangered species because no federally-listed threatened or endangered species are known to exist at the site or along the transmission line right-of-way. Although the ANHC identified two species and three habitat areas within the transmission line corridor that are of interest (see Table 2-2), Entergy conducted a field survey of these habitats and concluded that none of the species are likely to be affected.

Therefore, Entergy concludes that impact to threatened or endangered species from license renewal would be SMALL and does not warrant further mitigation.

4.11 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)

4.11.1 Description of Issue

Air quality during refurbishment (nonattainment and maintenance areas).

4.11.2 Findings from Table B-1, Subpart A, Appendix A

SMALL, MODERATE, or LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the number of workers expected to be employed during the outage. See 10CFR51.53(c)(3)(ii)(F).

4.11.3 Requirement [10CFR51.53(c)(3)(ii)(F)]

If the applicant's plant is located in or near a nonattainment or maintenance area, an assessment of vehicle exhaust emissions anticipated at the time of peak refurbishment workforce must be provided in accordance with the Clean Air Act as amended.

4.11.4 Analysis of Environmental Impact

As discussed in Section 3.3, Entergy has no plans for refurbishment related to license renewal at ANO-2. In addition, as discussed in Section 2.11, ANO is not located in, or near, a nonattainment or maintenance area for air pollutants. The nearest nonattainment areas to ANO are the Dallas/Ft. Worth, Texas metropolitan area, over 300 miles southwest of the site, and the Memphis, Tennessee metropolitan area, approximately 200 miles east of the site. Therefore, this issue is not applicable to ANO-2 and analysis is not required.

4.12 Impact on Public Health of Microbiological Organisms

4.12.1 Description of Issue

Microbiological organisms (public health) (plants using lakes or canals, or cooling towers, or cooling ponds that discharge to a small river).

4.12.2 Finding from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See 10CFR51.53(c)(3)(ii)(G).

4.12.3 Requirement [10CFR51.53(c)(3)(ii)(G)]

If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river having an annual average flow rate of less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided.

4.12.4 Background

Public health questions require additional consideration for the 25 plants using cooling ponds, lakes, canals, or small rivers because the operation of these plants may significantly enhance the presence of thermophilic organisms. The data for these sites are not now at hand and it is impossible to predict the level of thermophilic organism enhancement at a given site with current knowledge. Thus, the impacts are not known and are site-specific. Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of N. fowleri cannot be determined generically [NRC 1996, Section 4.3.6].

4.12.5 Analysis of Environmental Impact

During 1981, 11 nuclear plants took part in a study to determine if thermophilic pathogens existed in cooling water systems. ANO was one of 10 plants in the study that had thermophilic free-living amoebae in cooling water samples. However, the amoebae were not pathogenic. *Naegleria* sp., which is pathogenic, was not detected in the water or sediment samples from the ANO intake canal or discharge embayment. *Legionella* was detected in water samples collected in Lake Dardanelle at ANO, but the concentrations were similar to the concentrations in local surface-water control sources [NRC 2001, Section 4.1.4].

Studies on thermophilic pathogens at ANO have concluded that risk of infection from aerosols containing *Legionella* sp. is not a public health risk, but rather, a potential industrial hygiene concern that is managed through appropriate industrial hygiene practices [NRC 2001, Section 4.1.4].

The ADH was contacted to determine whether it had concerns regarding thermophilic pathogens in Lake Dardanelle or the Arkansas River. The ADH had no information indicating that a human-health exposure problem exists with thermophilic pathogens in Lake Dardanelle or the Arkansas River [McGrew 2003 & Meyers 2003].

4.12.6 Conclusion

There has been no known impact of ANO-2 operation on public health related to thermophilic microorganisms. Although there is a potential for deleterious thermophilic microorganisms associated with cooling systems, the actual hazard to public health has not been documented or substantiated. ANO's analyses and evaluations, including consultation with the ADH, indicate that the impact of deleterious microbiological organism from plant operations during the period of extended operation is expected to be SMALL and mitigation is not warranted.

4.13 Electromagnetic Fields –Acute Effects

4.13.1 Description of Issue

Electromagnetic fields, acute effects (electric shock)

4.13.2 Findings from Table B-1, Subpart A, Appendix A

SMALL, MODERATE or LARGE. Electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been a problem at most operating plants and generally is not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electrical shock potential at the site. See 10CFR51.53(c)(3)(ii)(H).

4.13.3 Requirements [10CFR51.53(c)3)(ii)(H)]

If the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the National Electric Safety Code for preventing electric shock from induced currents, an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines must be provided.

4.13.4 Background

The transmission line of concern is that between the plant switchyard and the intertie to the transmission system. With respect to shock safety issues and license renewal, three points must be made. First, in the licensing process for the earlier licensed nuclear plants, the issue of electrical shock safety was not addressed. Second, some plants that received operating licenses with a stated transmission line voltage may have chosen to upgrade the line voltage for reasons of efficiency, possibly without reanalysis of induction effects. Third, since the initial NEPA review for those utilities that evaluated potential shock situations under the provision of the NESC, land use may have changed, resulting in the need for reevaluation of this issue.

The electrical shock issue, which is generic to all types of electrical generating stations, including nuclear power plants, is of small significance for transmission lines that are operated in adherence with NESC. Without review of each nuclear plant's transmission line conformance with NESC criteria, it is not possible to determine the significance of the electrical shock potential [NRC 1996, Sections 4.5.4 and 4.5.4.1].

4.13.5 Analysis of Environmental Impact

One transmission line was constructed to connect ANO-2 to the electric grid. This line involves approximately 91 miles of a single circuit 500 kV transmission line from the existing ANO 500 kV station switchyard, southeasterly via the Mayflower substation (southwest of Mayflower) to the Mabelvale substation (southwest of Little Rock). This line is shown in Figure 3-2 and is listed in Table 4-3.

Table 4-3
Transmission Line Built for Operation of ANO-2

Line Description	Voltage	Distance (Miles)	Year Line Was Energized
ANO to Mayflower	500 kV	61.03	1971
Mayflower to Mabelvale	500 kV	30.05	1973

The transmission line in Table 4-3 has remained at the same operating voltage since ANO-2 was placed into service and has not been moved since installation. The clearances along this transmission line were initially established for most land uses (i.e., county roads, farm machinery, etc.). Since Entergy Arkansas holds easements to the land beneath the transmission line and monitors the line by aerial surveillance during the year, Entergy controls the land use. If ANO-2 was removed from service, this transmission line would remain in service to provide power for the area transmission loads due to the significant increase in area loads since the construction of ANO-2.

To safeguard persons in close proximity to electric power lines, the NESC identifies minimum vertical clearances for electric lines operating at various voltage levels. Regulatory bodies usually require that utilities construct transmission lines according to either the latest edition of the NESC or to a specific edition adopted by the body. However, they do not require that existing transmission lines be upgraded to meet revisions of the code. In addition, the NESC does not require maintenance replacements to comply with the latest code, unless a structure is replaced.

The 500 kV transmission line meets the 1997 NESC clearance of 28.35 feet at a maximum operating temperature of 212°F.

The earlier standards, to which the transmission line was constructed, did not specifically address electric shock that could be experienced by a person contacting a large vehicle parked under the transmission line. This was added to more recent NESC editions which state that for voltages exceeding 98 kV to ground (169.7 kV phase to phase), either the clearance must be increased or the effects thereof shall be reduced by other means, as required, to limit the steady-state current due to electrostatic effects to 5 mA (root-mean-square), if the largest anticipated truck, vehicle, or equipment under the transmission line were short-circuited to ground. The size of the anticipated truck, vehicle, or equipment used to determine the clearances may be less than, but need not be greater than, that limited by federal, state, or local regulations governing the area under the transmission line. For this determination, the conductors shall be at a final unloaded sag of 50°C (120°F).

EPRI has published a reference book [EPRI 1987] and developed a computer code called ENVIRO [EPRI 1992], that are used to calculate steady-state current from transmission lines. The calculation is a two-step process in which the analyst calculates average field strength at one meter (3.28 feet) above the ground beneath the minimum line clearance, and then calculates steady-state current.

The largest vehicle anticipated under the 500 kV transmission line is a tractor-trailer (75 feet long, 8.5 feet wide and 13.5 feet high) parked on or alongside the roadway.

The transmission line clearance, together with transmission line characteristics such as voltage and conductor position, was entered into the ENVIRO code to obtain electric field strengths at one-foot intervals one meter above the ground. The maximum calculated average field strength was determined (in kV per meter) assuming a 75-foot object under and perpendicular to the transmission line (representing a large tractor-trailer rig). Using the maximum average field strength, in accordance with the EPRI reference book, the steady-state current for a tractor trailer 75 feet long, 8.5 feet wide and 13.5 feet high at the road crossings under the 500 kV transmission line was calculated. The resultant value was greater than the 5 mA limit established by the NESC for two of the sixteen major road crossings. The highest current appeared at a 500 kV crossing with a 35.8 feet clearance at 120°F. However, mitigating measures are not necessary for these road crossings for the following reasons.

- The likelihood is small that a large truck would park in perfect orientation directly under one of the sixteen major road crossings of the 500 kV transmission line.

- Although the 1997 NESC uses 5 mA as a limit, this value would not actually flow through a person touching such a vehicle. The actual flow of current would be a small fraction of the 5 mA limit and would not result in a safety concern for an adult or a child. The 5 mA value could only occur when the vehicle is perfectly insulated and the person is perfectly grounded. Research has shown [EPRI 1987] that for a large school bus, the median value of short-circuit current through a body touching the school bus is only 1 to 4 percent of the calculated short-circuit level. Thus, if 5 mA was calculated (a value conservatively used as a let-go current level for children), the average person would only have 0.05 to 0.2 mA flowing through his body. This 0.05 to 0.2 mA value is not perceptible to the average adult and would at most be "perceptible without shock" to a child. As is stated in this reference, "if

the line is designed according to code (i.e., within the 5 mA. short-circuit limit), short-circuit currents to a person would be below minimum perception levels." Therefore, modification of the 500 kV transmission line (at the two crossings that exceed the 5 mA limit by at most 10.8 percent) is not necessary since contact with this large vehicle would result in a barely perceptible shock.

- Without a transmission line change or planned modification to the transmission line as specified within the NESC Code, it is not normally the policy to reconstruct existing facilities (that were initially built to applicable code standards) in order to meet later or more restrictive code standards. The NESC does not require utilities to modify existing facilities to comply with later revisions of the code as long as those facilities complied with prior editions of the code, except as required by the administrative authority.

The minimum off-the-road clearance for the 500 kV transmission line was found to be 35 feet at 120°F. At the maximum operating transmission line temperature of 212°F, this clearance would meet the NESC requirement of 28.35 feet. In addition, a very large school bus (40 feet long by 11 feet high by 8 feet wide) was analyzed at an off-road location to simulate the largest possible vehicle or agriculture combine that might be located in a field. The resultant calculations determined that the short-circuit current for this large school bus was 3.95 mA, which is less than the 5 mA 1997 NESC limit.

ANO-2 is located in close proximity to the ANO switchyard, where the above transmission line is terminated. A 500 kV transmission line connects the ANO-2 generator to the switchyard. This transmission line is very short, less than 1600 feet, and meets the 1997 NESC requirements for clearance and electric shock for large vehicles.

4.13.6 Conclusion

Based on the above information, the impact of the potential for electric shock is SMALL. Since the transmission line would remain in-service regardless of license renewal, license renewal will have no impact on shock hazard. Further, the potential for shock hazard is not significant and mitigation is not warranted.

4.14 Housing Impacts

4.14.1 Description of Issue

Housing Impacts

4.14.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely

populated areas or in areas with growth control measures that limit housing development. See 10CFR51.53(c)(3)(ii)(I).

4.14.3 Requirement [10CFR51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on housing availability… within the vicinity of the plant must be provided.

4.14.4 Background

The impacts on housing are considered to be of small significance when a small and not easily discernible change in housing availability occurs, generally as a result of a very small demand increase or a very large housing market. Increases in rental rates or housing values in these areas would be expected to equal or slightly exceed the statewide inflation rate. No extraordinary construction or conversion of housing would occur where small impacts are foreseen.

The impacts on housing are considered to be of moderate significance when there is a discernible but short-lived reduction in available housing units because of project-induced in-migration. The impacts on housing are considered to be of large significance when project-related demand for housing units would result in very limited housing availability and would increase rental rates and housing values well above normal inflationary increases in the state.

Moderate and large impacts are possible at sites located in rural and remote areas, at sites located in areas that have experienced extremely slow population growth (and thus slow or no growth in housing), or where growth control measures that limit housing development are in existence or have been recently lifted. [NRC 1996, Section 3.7.2].

4.14.5 Analysis of Environmental Impact

ANO is located in southwestern Pope County, approximately 6 miles west-northwest of Russellville, Arkansas. As described in Section 2.6.1, ANO is located in a medium population area. There are no growth-control measures limiting housing within Pope, Johnson and Yell Counties.

Supplement 1 to Regulatory Guide 4.2, provides the following guidance:

Section 4.14.1 states that: "If there will be no refurbishment or if refurbishment involves no additional workers then there will be no impact on housing and no further analysis is required."

Section 4.14.2 states that: "If additional workers are not anticipated there will be no impact on housing and no further analysis is required."

The ANO site has approximately 1,258 full time workers (Entergy employees and baseline contractors) during normal plant operations. As noted in Section 3.3, there are no major refurbishment activities required for ANO-2license renewal. Additionally, Entergy does not

anticipate a need for additional full time workers during the license renewal period. Therefore, no analysis is required for this issue.

4.14.6 Conclusion

Entergy concludes that the impact on housing from the continued operation of ANO-2 will be SMALL and that no mitigation is required. This conclusion is based on the following:

- Entergy does not anticipate an increase in employment during the license renewal period.
- As noted in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal. Therefore, there will not be an increase in the number of workers required for plant outages. Likewise, there will not be an increase in the length of a typical plant outage.
- The number of ANO employees will continue to be a small percentage of the population in the adjacent counties during the period of extended operation.

4.15 Public Utilities: Public Water Supply Availability

4.15.1 Description of Issue

Public Services (public utilities)

4.15.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See 10CFR51.53(c)(3)(ii)(I).

4.15.3 Requirement [10CFR51.53(c)(3)(ii)(I)]

The applicant shall provide an assessment of the impact of population increases attributable to the proposed project on the public water supply.

4.15.4 Public Water Supply - Background

Impacts on public utility services are considered small if little or no change occurs in the utility's ability to respond to the level of demand and thus there is no need to add capital facilities. Impacts are considered moderate if overtaxing of facilities during peak demand periods occurs. Impacts are considered large if existing service levels (such as the quality of water and sewage treatment) are substantially degraded and additional capacity is needed to meet ongoing demands for services.

In general, small to moderate impacts to public utilities were observed as a result of the original construction of the case study plants. While most locales experienced an increase in the level

of demand for services, they were able to accommodate this demand without significant disruption. Water service seems to have been the most affected public utility.

Public utility impacts at the case study sites during refurbishment are projected to range from small to moderate. The potentially small to moderate impact at Diablo Canyon is related to water availability (not processing capacity) and would occur only if a water shortage occurs at refurbishment time.

Because the case studies indicate that some public utilities may be overtaxed during peak periods, the impacts to public utilities would be moderate in some cases, although most sites would experience only small impacts [NRC 1996, Section 3.7.4.5].

4.15.5 Analysis of Environmental Impact

As noted in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal. Therefore, there will be no impact to public utilities from refurbishment activities. In addition, Entergy does not anticipate a need for additional workers during the period of extended operation. Therefore, there will be no impact to public utilities from additional plant workers.

Plant operations during the period of extended operation are not projected to cause a noticeable effect on the local water supply. In 1997, City Corporation (City of Russellville) completed the construction of a new water supply source, the Huckleberry Creek Reservoir, which significantly increased the system capacity, and provides residential and industrial customers in the area with a reliable supply of high-quality potable water for the future.

According to City Corporation, ANO does not cause capacity or flow concerns for the system, and the system should be able to meet the ANO water demand in the foreseeable future [Church 2002].

In addition, ANO and City Corporation have worked together to upgrade the water system near the plant. A 1,000,000 gallon storage tank was installed just north of the facility. Eighty percent of the capacity of the tank is reserved for ANO with the remaining amount assigned to meet the needs of the City of London, Arkansas [EOI 1999, Section 4.10.3].

4.15.6 Conclusion

License renewal operations will not cause appreciable increased demand on the public water supply system. As noted in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal. Entergy also does not anticipate a need for additional workers during the period of extended operation. In addition, as shown in Table 2-6, public water systems near ANO have excess capacity and can meet the demand of residential and industrial customers in the area. Therefore, impacts to public water supplies will continue to be SMALL and no evaluation of mitigation measures is warranted.

4.16 Education Impacts from Refurbishment

4.16.1 Description of Issue

Public Services (effects of refurbishment activities upon local educational system)

4.16.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors. See 10CFR51.53(c)(3)(ii)(I).

4.16.3 Requirement [10CFR51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on public schools (impacts from refurbishment activities only) within the vicinity of the plant must be provided.

4.16.4 Analysis of Environmental Impact

As noted in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal. Therefore this issue is not applicable to ANO-2 and no analysis is required.

4.17 Offsite Land Use

4.17.1 Offsite Land Use - Refurbishment

4.17.1.1 Description of Issue

Offsite Land Use (effects of refurbishment activities)

4.17.1.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. Impacts may be of moderate significance at plants in low population areas. See 10CFR51.53(c)(3)(ii)(I).

4.17.1.3 Requirement [10CFR51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on… land-use…within the vicinity of the plant must be provided.

4.17.1.4 Analysis of Environmental Impact

As noted in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal. Therefore, there will be no impacts from refurbishment activities and no analysis is required.

4.17.2 Offsite Land Use – License Renewal Term

4.17.2.1 Description of Issue

Offsite Land Use (effects of license renewal)

4.17.2.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. Significant changes in land-use may be associated with population and tax revenue changes resulting from license renewal. See 10CFR51.53(c)(3)(ii)(I).

4.17.2.3 Requirement [10CFR51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on …land-use…within the vicinity of the plant must be provided.

4.17.2.4 Background

During the license renewal term, new land use impacts could result from plant-related population growth or from the use of tax payments from the plant by local government to provide public services that encourage development.

However, as noted in Regulatory Guide 4.2, Section 4.17.2, Table B-1 of 10CFR Part 51 partially misstates the conclusion reached in Section 4.7.4.2 of NUREG-1437. NUREG-1437, Section 4.7.4.2 concludes that "population-driven land use changes during the license renewal term at all nuclear plants will be small." Regulatory Guide 4.2 further states that "Until Table B-1 is changed, applicants only need cite NUREG-1437 to address population-induced land-use change during the license renewal term." Therefore, the discussion will be limited to the land use changes that may result from tax payments made by the plant to local governments.

The assessment of new tax-driven land use impacts in the GEIS considered the following:

1) the size of the plant's tax payments relative to the community's total revenues,

2) the nature of the community's existing land use pattern, and

3) the extent to which the community already has public services in place to support and guide development.

In general, if the plant's tax payments are projected to be small relative to the community's total revenue, new tax-driven land use changes during the plant's license renewal term would be small, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land use changes would be moderate.

This is most likely to be true where the community has no pre-established patterns of development (i.e., land use plans or controls) or has not provided adequate public services to support and guide development in the past, especially infrastructure that would allow industrial development. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land use changes would be large. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development in the past.

Based on predictions for the case study plants, it is projected that all new population-driven land use changes during the license renewal term at all nuclear plants will be small because population growth caused by license renewal will represent a much smaller percentage of the local area's total population than has operations-related growth. Also, any conflicts between offsite land use and nuclear plant operations are expected to be small. In contrast, it is projected that new tax-driven land use changes may be moderate at a number of sites and large at some others. Because land use changes may be perceived by some community members as adverse and by others as beneficial, the staff is unable to assess generically the potential significance of site-specific off-site land use impacts [NRC 1996, Section 4.7.4.2].

4.17.2.5 Analysis of Environmental Impact

The environmental impacts from this issue are from population-driven land use changes and from tax-driven land use changes.

Population-Driven Land Use Changes

Entergy agrees with the GEIS conclusion that new population-driven land use changes at ANO during the license renewal term will be SMALL [NRC 1996, Section 4.7.4.2]. Entergy does not anticipate that additional workers will be employed at ANO during the period of extended operations. Therefore, there will be no adverse impact to the offsite land use from plant-related population growth.

Tax-Driven Land Use Changes

Pope County is the only jurisdiction that taxes ANO directly, and it is the principal jurisdiction that receives direct tax revenue as a result of ANO's presence. Because there are no major refurbishment activities and no new construction as a result of the license renewal, no new sources of plant-related tax payments are expected that could significantly influence land use in Pope County. During the period of extended operation, new land-use impacts could result from the use by local governments of the tax revenue paid by Entergy for the entire ANO plant site. As discussed in Section 2.7 of this report, Entergy paid Pope County $8.5 million in property taxes for ANO in 2002 [McAlister 2003].

Residential development is expected to continue around Lake Dardanelle because of the availability of desirable lakefront property. Pope County has experienced moderate population growth and moderate land use changes in the last 10 years. Future lakefront development would be facilitated by the presence of roads and water service, which are an indirect impact of

the ANO site. Tax receipts from ANO keep Pope County's tax rates lower than would otherwise be needed to fund the county government's current level of public infrastructure and services. This enhances the county's attractiveness as a place to live and may tend to accelerate the conversion of open space to residential and commercial uses.

The ANO plant site was one of the case studies examined in the GEIS [NRC 1996, Section C.4.1.5]. Section C.4.1.5.2 of the GEIS concluded that the indirect land use impacts associated with the license renewal term are expected to be MODERATE. The GEIS case study, however, assumed a certain level of refurbishment activity. As discussed in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal.

Although the property tax paid by ANO represents greater than 10% of Pope County's total property tax revenue, the impacts from tax driven off-site land use changes is expected to be SMALL because the area around ANO has:

- pre-established land use patterns of development that are anticipated to continue during the period of extended operation, and
- public services in place to support and guide development.

4.17.2.6 Conclusion

Entergy agrees with the GEIS conclusion that new population-driven land use changes at ANO during the license renewal term will be SMALL. Entergy does not anticipate that additional workers will be employed at ANO during the period of extended operation. Therefore, there will be no adverse impact to the offsite land use from additional plant workers.

In addition, the impact to tax-driven land use changes from the continued payment of property taxes at ANO is expected to be SMALL and no mitigation is required.

4.18 Transportation

4.18.1 Description of Issue

Public services, Transportation

4.18.2 Finding from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See 10CFR51.53(c)(3)(ii)(J).

4.18.3 Requirement [10CFR51.53(c)(3)(ii)(J)]

All applicants shall assess the impact of the proposed project on local transportation during periods of license renewal refurbishment activities and during the term of the renewed license.

4.18.4 Background

Impacts to transportation during the license renewal term would be similar to those experienced during current operations and would be driven mainly by the workers involved in current plant operations.

Based on past and projected impacts at the case study sites, transportation impacts would continue to be of small significance at all sites during operations and would be of small or moderate significance during scheduled refueling and maintenance outages. Because impacts are determined primarily by road conditions existing at the time of the project and cannot be easily forecast, a site specific review will be necessary to determine whether impacts are likely to be small or moderate and whether mitigation measures may be warranted [NRC 1996, Section 4.7.3.2].

4.18.5 Analysis of Environmental Impact

The transportation infrastructure appears to adequately serve the residents living in the area around ANO. However, two traffic issues were identified from interviews with the AHTD and local law enforcement agencies. One issue is occasional congestion at the east intersection of State Highway 333 and U.S. Highway 64, which serves as a major ingress and egress point for ANO traffic (see Table 2-7). Congestion at this intersection has been reduced by using staggered work schedules and shift changes at ANO. According to the Arkansas State Police, only one recorded accident occurred at this intersection in 2001 [ASP 2002].

The other issue is the potential for an I-40 east-bound on-ramp between London and Lake Dardanelle. There are currently east-bound-off and west-bound-on ramps at this location. The addition of an east-bound on-ramp would reduce local traffic congestion caused by ANO workers on U.S. Highways 7 and 64 and local streets in Russellville.

4.18.6 Conclusion

As noted in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal. Additionally, as noted in Section 3.5, there are no expected increases in the total number of employees that will be on-site during the period of extended operation. Therefore, impacts on local traffic will be SMALL and no mitigation measures are warranted.

4.19 Historic and Archaeological Properties

4.19.1 Description of Issue

Historic and Archaeological Resources

4.19.2 Finding from Table B-1, Appendix B to Subpart A

SMALL, MODERATE or LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See 10CFR51.53(c)(3)(ii)(K).

4.19.3 Requirement [10CFR51.53(c)(3)(ii)(K)]

All applicants shall assess whether any historic or archaeological properties will be affected by the proposed project.

4.19.4 Background

It is unlikely that moderate or large impacts to historic resources occur at any site unless new facilities or service roads are constructed or new transmission lines are established.

However, the identification of historic resources and determination of possible impact to them must be done on a site-specific basis through consultation with the SHPO. The site-specific nature of historic resources and the mandatory National Historic Preservation Act consultation process mean that the significance of impacts to historic resources and the appropriate mitigation measures to address those impacts cannot be determined generically [NRC 1996, Section 3.7.7].

4.19.5 Analysis of Environmental Impact

Entergy consulted with the Arkansas SHPO regarding this issue. The SHPO concluded that continued operation of ANO-2 and the 500 kV transmission line is not likely to affect historic and archeological resources, and that no further activity is required to comply with Section 106 of the National Historic Preservation Act [see Attachment D]. The SHPO made the same conclusion during preparation of the ANO-1 license renewal application environmental report in 1999 [EOI 1999, Section 4.12.4].

In addition, no refurbishment activities have been identified to support continued operation of ANO-2 beyond the end of the existing operating license. Therefore, there will be no impact on historic or archeological properties from refurbishment activities. An ANO administrative procedure ensures protection for archeological and cultural resources that may be encountered during land disturbing activities on-site. The procedure requires the assessment of potential historical and archeological sites prior to work in previously undisturbed areas. The procedure also requires, when applicable, consultation with the SHPO and implementation of management controls to protect historical and archeological sites on the ANO property [EOI 2000].

4.19.6 Conclusion

As noted in Section 3.3, there are no major refurbishment activities required for ANO-2 license renewal. Therefore, there will be no impact on historic or archeological properties from refurbishment activities.

Because control procedures are used during normal ANO operations to protect historical and archeological resources, the current level of impact is SMALL. Therefore, the impact of continued operation of ANO-2 during the period of the renewed license on historic or archeological resources will also be SMALL and evaluation of mitigation measures is not warranted.

4.20 Severe Accident Mitigation Alternatives

4.20.1 Description of Issue

Severe accidents

4.20.2 Finding from Table B-1, Appendix B to Subpart A

SMALL. The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See 10CFR51.53(c)(3)(ii)(L).

4.20.3 Requirement [10CFR51.53(c)(3)(ii)(L)]

If the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided.

4.20.4 Background

The staff concluded that the generic analysis summarized in the GEIS applies to all plants and that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants. However, not all plants have performed a site-specific analysis of measures that could mitigate severe accidents. Consequently, severe accidents are a Category 2 issue for plants that have not performed a site-specific consideration of severe accident mitigation and submitted that analysis for Commission review [NRC 1996, Section 5.5.2.5].

4.20.5 Analysis of Environmental Impact

The method used to perform the Severe Accident Mitigation Alternative analysis was based on the handbook used by the NRC to analyze benefits and costs of its regulatory activities, [NRC 1997].

Environmental impact statements and environmental reports are prepared using a sliding scale in which impacts of greater concern and mitigation measures of greater potential value receive more detailed analysis than impacts of less concern and mitigation measures of less potential value. Accordingly, Entergy Operations used less detailed feasibility investigation and cost estimation techniques for SAMA candidates having disproportionately high costs and low benefits and more detailed evaluations for the most viable candidates.

The following is a brief outline of the approach taken in the SAMA analysis.

(1) <u>Establish the Baseline Impacts of a Severe Accident</u>

Severe accident impacts were evaluated in four areas:

- Off-site exposure costs – Monetary value of consequences (dose) to off-site population.

  The Probabilistic Safety Assessment model was used to determine total accident frequency (core damage frequency and containment release frequency). The Melcor Accident Consequences Code System was used to convert release input to public dose. Dose was converted to present worth dollars (based on a valuation of $2,000 per person-rem and a present worth discount factor of 7%).

- Off-site economic costs – Monetary value of damage to off-site property.

  The PSA model was used to determine total accident frequency (core damage frequency and containment release frequency). MACCS2 was used to convert release input to off-site property damage. Off-site property damage was converted to present worth dollars.

- On-site exposure costs – Monetary value of dose to workers.

  Best estimate occupational dose values were used for immediate and long-term dose. Dose was converted to present worth dollars (based on a valuation of $2,000 per person-rem and a present worth discount factor of 7%).

- On-site economic costs – Monetary value of damage to on-site property.

  Best estimate cleanup and decontamination costs were used. On-site property damage estimates were converted to present worth dollars. It was assumed that, subsequent to a severe accident, the plant would be decommissioned rather than

restored. Therefore replacement/refurbishment costs were not included in on-site costs. Replacement power costs were considered.

(2) Identify SAMA Candidates

Potential SAMA candidates were identified from the following sources, (see Attachment E for reference details):

- Severe Accident Mitigation Design Alternative analyses submitted in support of original licensing activities for other operating nuclear power plants and advanced light water reactor plants;
- SAMA analyses for other CE plants, including the evolutionary Westinghouse-CE System 80+ design;
- the ANO-1 SAMA evaluation;
- NRC and industry documentation discussing potential plant improvements;
- documented insights provided by the ANO-2 staff; and
- the PSA model top 100 cut sets.

(3) Preliminary Screening

Potential SAMA candidates were screened out if they modified features not applicable to ANO-2, if they had already been implemented at ANO-2, or if they were similar in nature and could be combined with another SAMA candidate to develop a more comprehensive or plant-specific SAMA candidate.

(4) Final Screening

Using cost-benefit analysis, SAMA candidates were screened out if their implementation would require extensive plant reconstruction, or the cost of implementing the SAMA candidate would exceed the maximum possible benefit.

The remaining SAMA candidates were evaluated individually to determine the benefits and costs of implementation, as follows.

- Benefits estimate – The total benefit of implementing a SAMA candidate was estimated.
  - The baseline PSA model was modified to reflect the maximum benefit of the improvement, resulting in a revised accident frequency. Generally, the maximum benefit of a SAMA candidate was determined with a bounding modeling assumption. For example, if the objective of the SAMA candidate was to reduce

the likelihood of a certain failure mode, then eliminating the failure mode from the PSA bounded the benefit, even though the SAMA candidate would not be expected to be 100% effective in eliminating the failure.

- ➢ Using the revised accident frequency and the method previously described for the four baseline severe accident impacts, the revised impacts following implementation of the SAMA candidate were estimated.
- ➢ The benefits for each SAMA candidate were estimated in terms of averted consequences. Averted consequences are the arithmetic differences between the estimated impacts for the baseline and the revised impacts following implementation of each individual SAMA candidate.

- Cost estimate – The cost of implementing a SAMA was estimated by one of the following methods.
  - ➢ An estimate for a similar modification considered in a previously performed SAMA or SAMDA analysis was used.
  - ➢ These estimates are conservative for comparison against an estimated benefit at ANO-2 since they were developed in the past and no credit was taken for inflation when applying them to ANO-2. In addition, several of them were developed from SAMDA analysis (i.e., during the design phase of the plant), and therefore, did not consider the additional costs associated with performing design modifications to an existing plant (i.e., reduced efficiency, minimizing dose, disposal of contaminated material, etc.).
  - ➢ Engineering judgment was applied to formulate a conclusion regarding the economic viability of the SAMA candidate.
  - ➢ The detail of the cost estimate was commensurate with the benefit. If the benefit was low, it was not necessary to perform a detailed cost estimate to determine if the SAMA was cost beneficial.

(5) Sensitivity Analyses

Several sensitivity analyses were conducted to gauge the impact of assumptions upon the analysis.

The SAMA analysis for ANO-2 is presented in the following sections. These sections provide a more detailed discussion of the process presented above.

4.20.5.1 Establish the Baseline Impacts of a Severe Accident

A baseline was established to enable estimation of the risk reductions attributable to implementation of potential SAMA candidates. This severe accident risk was estimated using the PSA model and the MACCS2 model.

4.20.5.1.1 The PSA Model – Level 1 and Level 2 Analysis

The PSA model used for the SAMA analysis was the most recent internal events risk model (Revision 3p2) which is an updated version of the model used in the individual plant examination, [EOI 1994]. The PSA model describes the results of the first two levels of the PSA for ANO-2. Level 1 determines core damage frequencies based on system analyses and human-factor evaluations; and Level 2 uses the physical and chemical phenomena that affect the performance of containment and other radiological release mitigation features to quantify accident behavior and release of fission products to the environment.

The PSA model has been updated several times since the IPE due to the following.

- Equipment performance – As data collection progresses, estimated failure rates and system unavailability data change.

- Plant configuration changes – Plant configuration changes are incorporated into the PSA model.

- Modeling changes – The PSA model is refined to incorporate the latest state of knowledge and recommendations of industry peer reviews.

The PSA model used for the SAMA analysis (Revision 3p2) reflects the ANO-2 configuration as of December 10, 2000, uses failure and unavailability data current as of the same date, and resolves industry peer review comments on a previous revision of the model.

The PSA model contains the sequences leading to core damage listed in Table 4-4, with baseline frequencies listed and descriptions to follow.

Table 4-4
ANO-2 PSA Model CDF Results by Accident Sequence

Accident Sequence	CDF (/rx-yr)
TQX	1.537E-06
TBF	1.316E-06
SX	8.998E-07
SU	6.013E-07
TBX	5.059E-07
TQU	4.059E-07
ISL	3.270E-07
RVR	2.700E-07
AX	1.581E-07
MX	1.537E-07
TQBF	1.326E-07
RBF	9.613E-08
AU	6.692E-08
SBF	1.987E-08
MU	1.183E-08
RBX	3.979E-09
RX	2.039E-09
RU	6.969E-10
RBU	1.659E-10
SBX	1.188E-11
SBU	0
TQBU	0
TQBX	0

The following paragraphs summarize the important aspects of the sequences that lead to core damage.

AU - This sequence represents a large-break loss of coolant accident with failure of low pressure safety injection, high pressure safety injection, or safety injection tanks. This sequence results in early core damage and is assumed to occur very fast such that no operator recoveries are credited.

AX - This sequence represents a large-break LOCA with failure of HPSI or the containment cooling function during recirculation -- after the refueling water tank is emptied. Due to the break size, the large flow rate required of LPSI coupled with containment spray actuation, results in rapid depletion of the RWT inventory. Therefore, failure of recirculation following a large-break LOCA has been conservatively assumed to result in early core damage.

ISL - Interfacing system LOCAs are events that occur at the pressure boundary of the reactor coolant system and a system to which it is connected. Typically, the interfacing system of concern is the LPSI system, since the failure of the pressure boundary is postulated to result in a large-break LOCA, and a failure of the LPSI system that is required for mitigation of the LOCA. This core damage scenario results in a containment bypass situation where coolant inventory does not collect in the sump for recirculation and fission products can directly escape containment. Core damage scenarios have also been identified involving failure of tubing in heat exchangers for high pressure RCS coolant and low pressure cooling systems, with subsequent failure to interrupt the leak path prior to exhaustion of the injection inventory.

MU - This sequence represents a medium-break LOCA with failure of HPSI to replace inventory lost out the break. This event leads to early core damage.

MX - This sequence represents a medium-break LOCA with successful RCS inventory control and subsequent failure of HPSI or containment spray during recirculation (after the RWT inventory is exhausted). This leads to late core damage.

RBF - This sequence represents a steam generator tube rupture followed by success of RCS inventory control and loss of the core-heat removal function. This results in RCS pressurization above the HPSI shutoff head. When once-through-cooling is not successfully initiated, boil-off of RCS inventory through the primary safety valves results in a high RCS pressure and early core damage.

RBU - This sequence represents the case where a SGTR occurs followed by loss of RCS and core heat removal. This requires once-through-cooling, which subsequently fails. This sequence results in high RCS pressure and early core damage.

RBX - This sequence represents the case where a SGTR occurs followed by loss of RCS and core heat removal. This requires once-through-cooling, and requires that all decay heat be removed via the containment spray system during recirculation. If the flow path from the affected steam generator is not isolated prior to the RWT inventory being exhausted from the sump, inventory control will be lost, leading to eventual core uncovering and late core damage.

RU - This sequence represents a SGTR followed by failure of the operators to use the unaffected steam generator to depressurize the RCS below the affected steam generator pressure (i.e., failure to terminate the leak) and failure of the HPSI system to make-up inventory lost out the ruptured tube. Although this sequence is slow to progress, it has been conservatively assumed that this sequence results in early core damage.

RVR - Reactor vessel rupture is defined to be a breach of the primary system pressure boundary where the loss of primary coolant exceeds the capability of the emergency core cooling system. A reactor vessel rupture, as defined, cannot be mitigated and leads directly to core damage.

RX - This sequence represents the case when a SGTR occurs followed by successful reactor trip, primary-secondary heat removal, and inventory make-up. However, the RCS remains at high pressure and inventory is conservatively assumed to be lost through the steam generator. RCS inventory control will be lost when the RWT is depleted, and the recirculation actuation signal causes HPSI suction to be aligned to an empty containment sump. This sequence results in late core damage.

SBF - This sequence represents a small-break LOCA, failure of core heat removal through the steam generators and failure of once-through-cooling. This leads to re-pressurization of the RCS above the HPSI shutoff head and early core damage at high RCS pressure.

SBU - This sequence represents a small-break LOCA with failure of HPSI to replace inventory lost out the break. It also involves failure of the core heat removal function. Since this event is non-minimal when compared to sequence SU (below) it is bounded by and considered within SU. However, for completeness, this sequence was included. This event leads to early core damage.

SBX - This sequence represents a small-break LOCA with successful HPSI, but with initial failure of RCS and core heat removal and recovery via once-through-cooling. From this point on, this sequence is similar to SX (below) with a subsequent failure of the HPSI or CSS during recirculation (after the RWT inventory is exhausted). Since this event is non-minimal when compared to sequence SX (below) it is bounded by and considered within SX. However, for completeness, this sequence was included. This leads to late core damage.

SU - This sequence represents a small-break LOCA with failure of HPSI to replace inventory lost out the break. This event leads to early core damage.

SX - This sequence represents a small-break LOCA with successful RCS inventory control and RCS and core heat removal, with a subsequent failure of HPSI or the CSS during recirculation (after the RWT inventory is exhausted). This leads to late core damage.

TBF - This sequence involves transient initiating events with a subsequent loss of RCS and core heat removal [i.e. main feed water, emergency feed water, and auxiliary feed water failures] and failure of once-through-cooling [due to HPSI or emergency core cooling system vent and low temperature-over pressure vent valve failures]. This sequence leads to high RCS pressure early core damage.

TBX - This sequence represents a transient initiating event followed by failure of RCS and core heat removal, but successful once-through-cooling. This results in the depletion of the RWT inventory and a requirement for recirculation of the containment sump inventory, which subsequently fails. This sequence represents a transient-induced medium break LOCA. This sequence leads to late core damage.

TQBU - This sequence represents a transient initiating with subsequent failures resulting in a small break LOCA (such as primary safety valves failing to re-close or reactor coolant pump seal LOCAs) with a subsequent failure of primary to secondary heat transfer via the steam generators and failure of HPSI to inject when aligning once-through-cooling.

TQBF - This sequence represents a transient initiating with subsequent failures resulting in a small break LOCA (such as primary safety valves failing to re-close or reactor coolant pump seal LOCAs) with a subsequent failure of primary to secondary heat transfer via the steam generators and failure of once-through-cooling as a result of a failure to depressurize the RCS.

TQBX - This sequence represents a transient initiating with subsequent failures resulting in a small break LOCA (such as primary safety valves failing to re-close or reactor coolant pump seal LOCAs) with a subsequent failure of primary to secondary heat transfer via the steam generators and failure of long term containment heat removal during once-through-cooling.

TQU/TQX - These sequences represents transient initiating events with successful reactor trip and successful primary-to-secondary heat transfer via the steam generators. However, subsequent failures induce a small break LOCA (such as primary safety valves failing to re-close or reactor coolant pump seal LOCAs). This event is then treated by a transfer to the small break LOCA event tree where potential subsequent failures of HPSI during injection from the RWT and recirculation from the containment sump are modeled. TQU sequences lead to early core damage, while TQX sequences lead to late core damage.

The PSA model used for the SAMA analysis (Revision 3p2) is an internal events risk model and does not include external event risk modeling. The SAMA analysis considered that external events can lead to potentially significant risk contributions. For the SAMA analysis, it was assumed that the benefit from the external events contribution was equivalent to that of the internal events; therefore, the cost of SAMA implementation was compared with a benefit value of twice that estimated. This treatment of external events was considered adequate since not all potential enhancements would be impacted by an external event. In some cases an external event would only impose partial failure of systems or trains. For this reason, doubling the benefit to account for external events is conservative. In addition, the conservative nature of other assumptions within the cost-benefit model tends to overestimate the benefit associated with an individual SAMA candidate. Consequently, doubling the benefit to account for external events generated results that are conservative.

The Level 2 analysis involves two types of considerations: 1) a deterministic analysis of the physical processes for a spectrum of severe accident progressions, and 2) a probabilistic analysis component in which the likelihoods of the various outcomes are assessed. The deterministic analysis examines the response of the containment to the physical processes during a severe accident. This response is performed comparatively against existing reference plant analyses. The probabilistic analysis determines the likelihoods of the spectrum of severe accidents using event tree and fault tree methods. Severe accidents resulting in containment failure and a release of fission products to the environment are grouped according to the magnitude and timing of their release.

Containment system fault trees and support system logic developed in the Level 1 PSA (Revision 3p2) model were used to determine the plant damage state results.

The containment event tree branching logic from the IPE was used in the form of Level 2 top logic, combining the Level 1 and containment system fault trees and mapping these sequences to the plant damage bins. This logic was based on the use of reference plant severe accident analyses. The ANO-2 response was modeled by comparing its features with those of the reference plants and adjusting the reference plant results appropriately. The results of the containment event tree quantification consist of containment event tree endstates; each has a specific fission product release magnitude and timing (i.e., release category), and a likelihood given a PDS. The same Level 2 top logic was used in the risk impact assessment of the ANO-2 power uprate.

4.20.5.1.2 The MACCS2 Model – Level 3 Analysis

The MACCS2 Model estimated the hypothetical impacts of severe accidents on the surrounding environment and members of the public. The magnitude of the on-site impacts (in terms of clean up and decontamination costs and occupational dose) was based on information provided in the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997]. The principal phenomena analyzed were atmospheric transport of radionuclides, mitigation actions (i.e., evacuation, condemnation of contaminated crops and milk) based on dose projection, dose accumulation by a number of pathways, including food and water ingestion, and economic costs. Input for the Level 3 analysis included the core radionuclide inventory, source terms from the IPE, site meteorological data, projected population distribution (within 50-mile radius) for the year 2040, emergency response evacuation modeling, and economic data. The MACCS2 input data are described in Attachment E.

The Level 3 analysis looked at the source term for each of 51 different release modes associated with endstates of the containment event tree. Because the analysis was based on probabilistic risk input, the analytical results relate the frequency of an impact to the magnitude of the impact (i.e., frequency versus risk). In general, severe accidents having the greatest predicted impact had the lowest predicted probability of occurrence.

The result of the Level 3 model was a matrix of off-site exposure and off-site property costs associated with a postulated severe accident for each containment event tree endstate. This matrix is a function solely of the Level 3 modeling assumptions and did not change when modifications were made to the plant model. This matrix was combined with the results of the Level 2 model to yield the probabilistic off-site dose and probabilistic off-site economic losses.

4.20.5.1.3 Evaluation of Baseline Severe Accident Impacts Using the Regulatory Analysis Technical Evaluation Handbook Method [NRC 1997]

Off-site Exposure Costs

The Level 3 baseline analysis resulted in an annual off-site exposure risk of 0.172 person-rem. This value was converted to its monetary equivalent (dollars) via application of the $2,000 per person-rem conversion factor from the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997]. This monetary equivalent was then discounted to present value using the formula from the same source:

$$APE = \left(F_S D_{P_S} - F_A D_{P_A}\right) R \frac{1 - e^{-rt_f}}{r}$$

where,

APE = monetary value of accident risk avoided from population doses, after discounting

R = monetary equivalent of unit dose, ($/person-rem)

F = accident frequency (events/year)

D_P = population dose factor (person-rem/event)

S = status quo (current conditions)

A = after implementation of proposed action

r = discount rate (%)

t_f = years remaining until end of facility life (years)

Using a 35-year period for remaining plant life, a 7% discount rate, assuming F_A is zero, and the baseline core damage frequency of 7.17E-06/year resulted in the monetary equivalent value of $44,979. This value is presented in Table 4-5.

Off-site Economic Costs

The Level 3 analysis resulted in an annual off-site economic risk monetary equivalent of $3,385. This value was discounted in the same manner as the public health risks in accordance with the following equation:

$$AOC = \left(F_S P_{D_S} - F_A P_{D_A}\right) \frac{1 - e^{-rt_f}}{r}$$

where,

AOC = monetary value of risk avoided from off-site property damage, after discounting

P_D = off-site property loss factor ($/event)

F = accident frequency (events/year)

S = status quo (current conditions)

A = after implementation of proposed action

r =discount rate (%)

t_f = years remaining until end of facility life (years)

Using previously defined values, the resulting monetary equivalent is $44,188. This value is presented in Table 4-5.

On-site Exposure Costs

The values for occupational exposure associated with severe accidents were not derived from the PSA model, but from information in the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997]. The values for occupational exposure consist of "immediate dose" and "long-term dose." The best estimate value provided for immediate occupational dose is 3,300 person-rem, and long-term occupational dose is 20,000 person-rem (over a 10-year clean-up period). The following equations were used to estimate monetary equivalents.

Immediate Dose

$$W_{IO} = \left(F_S D_{IO_S} - F_A D_{IO_A}\right) R \frac{1 - e^{-rt_f}}{r} \qquad (1)$$

where,

W_{IO} = monetary value of accident risk avoided from immediate doses, after discounting

IO = immediate occupational dose

R = monetary equivalent of unit dose, ($/person-rem)

F = accident frequency (events/year)

D_{IO} = immediate occupational dose (person-rem/event)

S = status quo (current conditions)

A = after implementation of proposed action

r = discount rate (%)

t_f = years remaining until end of facility life (years)

The values used in the analysis were:

R = $2,000/person rem

r = 0.07

D_{IO} = 3,300 person-rem /accident

t_f = 35 years

For the basis discount rate, assuming F_A is zero, the bounding monetary value of the immediate dose associated with ANO-2's accident risk is:

$$W_{IO} = \left(F_S D_{IO_S}\right) R \frac{1 - e^{-rt_f}}{r}$$

$$W_{IO} = 3300 * F_S * \$2000 * \frac{1 - e^{-.07*35}}{.07}$$

W_{IO} = (\$8.61x10^7) F_S

For the baseline core damage frequency, 7.17x10^{-6}/year,

$$W_{IO} = \$618$$

Long-Term Dose

$$W_{LTO} = \left(F_S D_{LTO_S} - F_A D_{LTO_A}\right) R * \frac{1 - e^{-rt_f}}{r} * \frac{1 - e^{-rm}}{rm} \qquad (2)$$

where,

W_{LTO} = monetary value of accident risk avoided long-term doses, after discounting, (\$)

LTO = long-term occupational dose

m = years over which long-term doses accrue

R = monetary equivalent of unit dose, (\$/person-rem)

F = accident frequency (events/year)

D_{LTO} = long-term occupational dose (person-rem/event)

S = status quo (current conditions)

A = after implementation of proposed action

r = discount rate (%)

t_f = years remaining until end of facility life (years)

The values used in the analysis were:

R = $2,000/person rem

r = .07

D_{LTO} = 20,000 person-rem /accident

m = 10 years

t_f = 35 years

For the basis discount rate, assuming F_A is zero, the bounding monetary value of the long-term dose associated with ANO-2's accident risk is:

$$W_{LTO} = \left(F_S D_{LTO_S}\right) R * \frac{1-e^{-rt_f}}{r} * \frac{1-e^{-rm}}{rm}$$

$$W_{LTO} = \left(F_S \times 20000\right) \$2000 * \frac{1-e^{-.07*35}}{.07} * \frac{1-e^{-.07*10}}{.07*10}$$

W_{LTO} = (\$3.75x10^8) F_S

For the core damage frequency for the baseline, 7.17x10^{-6}/year,

$$W_{LTO} = \$2{,}691$$

Total Occupational Exposures

Combining equations (1) and (2) above, using delta (Δ) to signify the difference in accident frequency resulting from the proposed actions, and using the above numerical values, the long-term accident related on-site (occupational) exposure avoided is:

$$AOE = \Delta W_{IO} + \Delta W_{LTO} \text{ (\$)}$$

where,

AOE = on-site exposure avoided

The bounding value for occupational exposure (AOE_B) is:

$$AOE_B = W_{IO} + W_{LTO} = \$618 + \$2691 = \$3309$$

The resulting monetary equivalent of $3,309 is presented in Table 4-5.

<u>*On-site Economic Costs*</u>

Clean-up/Decontamination

The total cost of clean-up/decontamination of a power reactor facility subsequent to a severe accident is estimated in the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997] to be $1.5x10^9$; this same value was adopted for these analyses. Considering a 10-year cleanup period, the present value of this cost is:

$$PV_{CD} = \left(\frac{C_{CD}}{m}\right)\left(\frac{1-e^{-rm}}{r}\right)$$

where,

PV_{CD} = present value of the cost of cleanup/decontamination

CD = clean-up/decontamination

C_{CD} = total cost of the cleanup/decontamination effort, ($)

m = cleanup period (years)

r = discount rate (%)

Based upon the values previously assumed,

$$PV_{CD} = \left(\frac{\$1.5E+9}{10}\right)\left(\frac{1-e^{-.07*10}}{.07}\right)$$

$$PV_{CD} = \$1.08E+9$$

This cost is integrated over the term of the proposed license extension as follows:

$$U_{CD} = PV_{CD}\frac{1-e^{-rt_f}}{r}$$

where,

UCD = total cost of clean-up/decontamination over the life of the plant

Based upon the values previously assumed,

$$U_{CD} = \$1.41E+10$$

Replacement Power Costs

Replacement power costs were estimated in accordance with the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997]. Since replacement power will be needed for the time period following a severe accident, for the remainder of the expected generating plant life, long-term power replacement calculations have been used. The present value of replacement power was estimated as follows:

$$PV_{RP} = \left(\frac{\$1.2x10^8}{r}\right)\left(1 - e^{-rt_f}\right)^2$$

where,

PV_{RP} = present value of the cost of replacement power for a single event

t_f = years remaining until end of facility life

r = discount rate (%)

The $1.2x10^8$ value has no intrinsic meaning, but is a substitute for a string of non-constant replacement power costs that occur over the lifetime of a "generic" reactor after an event. This equation was developed in the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997] for discount rates between 5% and 10% only.

Based upon the values previously assumed:

$$PV_{RP} = \left(\frac{\$1.2x10^8}{r}\right)\left(1 - e^{-rt_f}\right)^2 = \left(\frac{\$1.2x10^8}{0.07}\right)\left(1 - e^{-(0.07)(35)}\right)^2 = \$1.43x10^9$$

To account for the entire lifetime of the facility, U_{RP} was then calculated from PV_{RP}, as follows:

$$U_{RP} = \left[\frac{PV_{RP}}{r}\right]\left(1 - e^{-rt_f}\right)^2$$

where,

U_{RP} = present value of the cost of replacement power over the remaining life

t_f = years remaining until end of facility life

r = discount rate (%)

Based upon the values previously assumed:

$$U_{RP} = \left(\frac{PV_{RP}}{r}\right)\left(1-e^{-rt_f}\right)^2 = \left(\frac{\$1.43x10^9}{0.07}\right)\left(1-e^{-(0.07)(35)}\right)^2 = \$1.71x10^{10}$$

Repair and Refurbishment

It was assumed that the plant would not be repaired. However, a sensitivity analysis was developed to model repair/refurbishment costs following a severe accident. Repair/refurbishment costs were estimated in accordance with the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997] as 20% of the cost of replacement power previously discussed. Sensitivity analysis results are discussed in Attachment E.

Total On-site Property Damage Costs

Combining the cleanup/decontamination and replacement power costs, using delta (ΔF) to signify the difference in accident frequency resulting from the proposed actions, and using the above numerical values, the best-estimate value of averted occupational exposure can be expressed as:

$$AOSC = \Delta F\left(U_{CD} + U_{RP}\right) = \Delta F\left(\$1.41x10^{10} + \$1.71x10^{10}\right) = \Delta F\left(\$3.12x10^{10}\right)$$

where,

ΔF = difference in annual accident frequency resulting from proposed action

For the core damage frequency for the baseline, $7.17x10^{-6}$/year,

$$AOSC = \$223{,}281$$

The resulting monetary equivalent of $223,281 is presented in Table 4-5.

4.20.5.2 Identify SAMA Candidates

A list of SAMA candidates was developed by reviewing industry documents and considering plant-specific enhancements not identified in published industry documents. Since ANO-2 is a conventional CE nuclear power reactor, considerable attention was paid to the SAMA candidates from SAMA analyses for other CE plants. Attention was also paid to the generation and screening of plant-specific enhancements documented in the ANO-1 SAMA evaluation. Attachment E lists the specific documents from which SAMA candidates were gathered.

In addition to SAMA candidates from review of industry documents, additional SAMA candidates were obtained from plant-specific sources, such as the ANO-2 individual plant examination and individual plant evaluation of external events. In both the IPE and IPEEE, several enhancements related to severe accident design performance were recommended. These nineteen enhancements were included in the comprehensive list of SAMA candidates and are listed in Section E.2.1 of Attachment E.

The current ANO-2 PSA model was also used to identify plant-specific modifications for inclusion in the comprehensive list of SAMA candidates. The top 100 cut sets from the PSA model were reviewed for patterns that could be addressed through a potential enhancement to the plant. Sixteen postulated modifications were developed, included in the list of SAMA candidates, and are listed in Section E.2.1 of Attachment E.

The comprehensive list contained a total of 192 SAMA candidates. The first step in the analysis of these candidates was to eliminate the non-viable SAMA candidates through preliminary screening.

4.20.5.3 Preliminary Screening

The purpose of the preliminary SAMA screening was to eliminate from further consideration enhancements that were not viable for implementation at ANO-2. Potential SAMA candidates were screened out if they modified features not applicable to ANO-2, if they had already been implemented at ANO-2, or if they were similar in nature and could be combined with another SAMA candidate to develop a more comprehensive or plant-specific SAMA candidate.

During this process, 99 of the 192 original SAMA candidates were eliminated, leaving 93 SAMA candidates for further analysis.

4.20.5.4 Final Screening

A benefits analysis was performed on the remaining SAMA candidates. The method for determining if a SAMA candidate is beneficial consists of determining whether the benefit provided by implementation of the SAMA candidate exceeds the expected cost of implementation. The benefit was defined as the sum of the dollar equivalents for each severe accident impact (off-site exposure, off-site economic costs, occupational exposure, and on-site economic costs). If the expected cost exceeded the estimated benefit, the SAMA was not considered cost-beneficial.

The result of implementation of each SAMA candidate would be a change in the severe accident risk (i.e., a change in frequency or consequence of severe accidents). The method of calculating the magnitude of these changes is straightforward. First, the severe accident risk after implementation of each SAMA candidate was estimated using the same method as for the baseline. The results of the Level 2 model were combined with the Level 3 model to calculate these post-SAMA risks. The results of the benefit analyses for the SAMA candidates are presented in Attachment E.

Each SAMA evaluation was performed in a bounding fashion. Bounding evaluations were performed to address the generic nature of the initial SAMA concepts. Such bounding calculations overestimate the benefit and thus are conservative calculations. For example, one SAMA dealt with installing digital large break LOCA protection; the bounding calculation to estimate the benefit of this improvement was total elimination of large breaks. Such a calculation obviously overestimated the benefit, but if the inflated benefit indicated that the SAMA is not cost-beneficial, then the purpose of the analysis was satisfied.

As described above for the baseline, values for avoided public and occupational health risk were converted to a monetary equivalent (dollars) via application of the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997] conversion factor of $2,000 per person-rem and discounted to present value. Values for avoided off-site economic costs were also discounted to present value. The formula for calculating net value for each SAMA was:

Net value = ($APE + $AOC + $AOE + $AOSC) – COE

where,

$APE = value of averted public exposure ($)

$AOC = value of averted off-site costs ($)

$AOE = value of averted occupational exposure ($)

$AOSC = value of averted on-site costs ($)

COE = cost of enhancement ($)

If the net value of a SAMA was negative, the cost of the enhancement was greater than the benefit and the SAMA was not cost beneficial.

The expected cost of implementation of each SAMA (COE) was established from existing estimates of similar modifications combined with engineering judgment. Most of the cost estimates were developed from similar modifications considered in previous performed SAMA and SAMDA analyses. In particular, these cost-estimates were derived from the three major sources including:

- Calvert Cliffs SAMA Analysis

- Westinghouse-CE System 80+ SAMDA Analysis
- ANO-1 SAMA Analysis

The cost estimates did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency costs associated with unforeseen implementation obstacles. Estimates based on modifications that were implemented or estimated in the past were presented in terms of dollar values at the time of implementation (or estimation), and were not adjusted to present-day dollars. In addition, several implementation costs were originally developed for SAMDA analyses (i.e., during the design phase of the plant), and therefore, do not capture the additional costs associated with performing design modifications to existing plants (i.e., reduced efficiency, minimizing dose, disposal of contaminated material, etc.). Therefore, the cost estimates were conservative.

As this analysis focuses on establishing the economic viability of potential plant enhancement when compared to attainable benefit, often detailed cost estimates were not required to make informed decisions regarding the economic viability of a particular modification. Several of the SAMA candidates were clearly in excess of the attainable benefit estimated from a particular analysis case. For less clear cases, engineering judgment was applied to determine if a more detailed cost estimate was necessary to formulate a conclusion regarding the economic viability of a particular SAMA. In most cases, more detailed cost estimates were not required, particularly if the SAMA called for the implementation of a hardware modification. Nonetheless, the cost of SAMA candidates was conceptually estimated to the point where conclusions regarding the economic viability of the proposed modification could be adequately gauged.

The cost-benefit comparison and disposition of each of the 93 SAMA candidates is presented in Attachment E.

4.20.5.5 Sensitivity Analyses

Several sensitivity analyses were conducted to gauge the impact of assumptions upon the analysis. A description of each follows:

Sensitivity Case #1: Repair/Refurbishment

The purpose of this sensitivity case was to investigate the impact of assuming damaged plant equipment is repaired and refurbished following an accident scenario, as opposed to automatically decommissioning the facility following the event. For the purpose of this analysis, the cost of repair and refurbishment over the lifetime of the plant was assumed to be equivalent to 20% of the replacement power cost in accordance with the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997].

Sensitivity Case #2: Conservative Discount Rate

The purpose of this sensitivity case was to investigate the sensitivity of each analysis case to the discount rate. The discount rate of 7.0% used in the base case analyses is conservative relative to corporate practices; nonetheless, a lower discount rate of 5.0% was assumed in this case.

Sensitivity Case #3: Best-Estimate Discount Rate

The purpose of this sensitivity case was to investigate the sensitivity of each analysis case to the discount rate. The discount rate of 7.0% used in the base case analyses is considered conservative; therefore, this analysis case uses a higher discount rate of 15%, as suggested by Entergy, as a best estimate rate to investigate the impact on each analysis case.

Sensitivity Case #4: High Estimated Dose (On-site)

The purpose of this sensitivity case was to investigate the sensitivity of each analysis case to the on-site dose estimates. For the base case analyses, the immediate and long-term on-site dose to plant personnel following a severe accident was assumed to be 3,300 and 20,000 rem respectively. This analysis case assumed high estimated dose values of 14,000 and 30,000 rem for immediate and long-term on-site dose, respectively, as suggested in the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997].

Sensitivity Case #5: High On-site Cleanup Cost

The purpose of this sensitivity case was to investigate the sensitivity of each analysis case to the total on-site cleanup cost. For the base case analyses, the total on-site cleanup cost following a severe accident was assumed to be $1,500,000. This analysis case assumed a high estimated on-site cleanup cost of $2,000,000 as suggested in the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997].

The benefits estimated for each of these sensitivities are presented in Attachment E.

Table 4-5
Estimated Present Dollar Value Equivalent for a Severe Accident at ANO-2

Parameter	Present Dollar Value ($)
Off-site population dose	$44,979
Off-site economic costs	$44,188
On-site dose	$3,309
On-site economic costs	$223,281
Total	$315,756
Total + External events	$631,513

4.20.6 Conclusion

Entergy Operations analyzed 192 conceptual alternatives for mitigating ANO-2 severe accident impacts. Preliminary screening eliminated 99 SAMA candidates from further consideration, based on inapplicability to ANO-2's design or features that have already been incorporated into ANO-2's current design or procedures and programs. During the final disposition, the 93 remaining SAMA candidates were eliminated because their cost was expected to exceed their benefit. Using the 7% real discount rate recommended by the *Regulatory Analysis Technical Evaluation Handbook* [NRC 1997], 93 SAMA candidates for which the evaluation was completed were determined not to be cost-beneficial. The sensitivities analyses indicated that the results of the analysis would not change for the conditions analyzed.

In summary, this analysis found no cost-beneficial Severe Accident Mitigation Alternatives.

4.21 Environmental Justice

4.21.1 Description of Issue

Environmental Justice

4.21.2 Finding from Table B-1, Appendix B to Subpart A

"The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews."

4.21.3 Requirement

Other than the above referenced finding, there is no requirement concerning environmental justice in 10CFR Part 51.

4.21.4 Background

The following background information is from the Regulatory Guide 4.2:

Environmental justice was not reviewed in NUREG-1437. Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations," issued on February 11, 1994, is designed to focus the attention of Federal agencies on the human health and environmental conditions in minority and low-income communities. The NRC Office of Nuclear Reactor Regulation is guided in its consideration of environmental justice by Attachment 4, "NRR Procedures for Environmental Justice Reviews," to NRR Office Letter No. 906, Revision 2, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues," September 21, 1999. NRR Office Letter No. 906 is revised periodically. The environmental justice review involves identifying off-site environmental impacts, their geographic locations, minority and low-income populations that may be affected, the significance of such effects and whether they are disproportionately high and adverse compared to the population at large within the geographic area, and if so, what mitigative measures are available, and which will be implemented. The NRC staff will perform the environmental justice review to determine whether there will be disproportionately high human heath and environmental effects on minority and low-income populations and report the review in its SEIS. The staff's review will be based on information provided in the ER and developed during the staff's site-specific scoping process.

The NRC's Office of Nuclear Reactor Regulation Office Letter No. 906, Revision 2 [NRC 1999] contains a procedure for incorporating environmental justice into the licensing process. Entergy used this process in conducting the review and analysis of this issue.

4.21.5 Analysis

The consideration of environmental justice is required to assure that federal programs and activities will not have "disproportionately high and adverse human health or environmental

effects…on minority populations and low income populations…" Entergy's analyses of the Category 2 issues defined in 10CFR51.53(c)(3)(ii) determined that there were no adverse impacts from the renewal of the ANO-2 license. Based on the review of these issues, no review for environmental justice is necessary. However, Entergy presents environmental justice demographic information in Section 2.6.2 of this ER to assist the NRC in its review.

4.21.6 Conclusion

As part of its environmental assessment of this proposed action, Entergy has determined that no significant off-site environmental impacts will be created by the renewal of the ANO-2 license. This conclusion is supported by the review performed of the Category 2 issues defined in 10CFR51.53(c)(3)(ii) presented in this ER.

As the NRR procedure recognizes, if no significant off-site impacts occur in connection with the proposed action, then no member of the public will be substantially affected. Therefore, there can be no disproportionately high and adverse impacts or effects on members of the public, including minority and low-income populations, resulting from the renewal of the ANO-2 license.

4.22 References

AGFC (Arkansas Game & Fish Commission). 1995. Letter from A. Carter, Chief Fisheries Division, Arkansas Game and Fish Commission, to Jerry Yelverton, Vice President, Entergy Operations, Inc., dated March 8, 1995

AGFC (Arkansas Game & Fish Commission). 2000. Letter from B. Limbird, Arkansas Game and Fish Commission to Lindsey Lewis, FTN Associates, dated March 14, 2000.

ASP (Arkansas State Police). 2002. Personal communication between Lt. Coffman, Arkansas State Police, Russellville, Arkansas and Shannon Holbrook, FTN Associates.

ASWCC (Arkansas Soil & Water Conservation Commission). 2002. Email message from Mike Guess, Water Resources Specialist, Arkansas Soil & Water Conservation Commission to Bob West, FTN Associates, December 16, 2002.

Church, L. 2002. Water system capacity data provided by City Corporation. Personal communication with Bob West, FTN Associates

CoE (U. S, Army Corps of Engineers). 2002. Letter dated October 4, 2002 from M. Miller, Chief, Operations Division COE, Little Rock District, to Bob West, FTN Associates.

EOI (Entergy Operations, Inc.). 1994. Individual Plant Examination (IPE), Arkansas Nuclear One - Unit 2, March 1994.

EOI (Entergy Operations, Inc.). 1999. Applicant's Environmental Report – Operating License Renewal Stage. Arkansas Nuclear One - Unit 1, December 1999.

EOI (Entergy Operations, Inc.). 2000. ANO Procedure 1000.167, ANO Historical and Archaeological Preservation Program.

EPRI (Electric Power Research Institute). 1987. "Transmission Line Reference Book, 345 kV and Above", Second Edition-Revised, Electric Power Research Institute, 1987.

EPRI (Electric Power Research Institute). 1992. Electromagnetic Workstation: ENVIRO Code, Electric Power Research Institute, Version 1.13, 1992.

McAlister, B. 2003. Property tax data provided by Pope County Tax Collector. Telephone conversation with B. West, FTN Associates, June 10, 2003.

McGrew, C. 2003. Personal communication between C. McGrew (Assistant Director), Arkansas Department of Health – Communicable Diseases, Little Rock, Arkansas and Bob West, FTN Associates, January 21, 2003.

Meyers, C. 2003. Personal communication between C. Meyers, Arkansas Department of Health, Russellville, Arkansas and Bob West, FTN Associates, January 21, 2003.

NRC (U. S. Nuclear Regulatory Commission). 1977. *Final Environmental Statement Related to Operation of Arkansas Nuclear One Unit 2,* Arkansas Power & Light Company, Docket No. 50-368, Unites States Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, June 1977

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS). Volumes 1 and 2. NUREG-1437, Washington, DC.

NRC (U.S. Nuclear Regulatory Commission). 1997. *Regulatory Analysis Technical Evaluation Handbook*, NUREG/BR-0184, Washington, DC, January 1997.

NRC (U.S. Nuclear Regulatory Commission). 1999. Office of Nuclear Reactor Regulation, NRR Office Letter No. 906, Revision 2, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues," dated September 21, 1999.

NRC (U.S. Nuclear Regulatory Commission). 2001. Generic Environmental Impact Statement for License Renewal of Nuclear Plants" Arkansas Nuclear One, Unit 1. NUREG-1437, Supplement 3. Office of Nuclear Reactor Regulation, Washington, D.C. April 2001.

USGS (United States Geological Survey). 1995. U.S. Geological Survey, Water Resources Division, Little Rock, AR. Water Data Report USGS-WDR-AR-94-1, March, 1995.

5.0 ASSESSMENT OF NEW AND SIGNIFICANT INFORMATION

"The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware." 10CFR51.53(c)(3)(iv)

The NRC has resolved most license renewal environmental issues generically and only requires an applicant to analyze those issues the NRC has not resolved generically. While NRC regulations do not require an applicant's environmental report to contain analyses of the impacts of those environmental issues that have been generically resolved [10CFR51.53(c)(3)(i)], the regulations do require that an applicant identify any new and significant information of which the applicant is aware [10CFR51.53(c)(3)(iv)].

Entergy performed an analysis to identify the following:

- Information that identifies a significant environmental issue not covered in NRC's GEIS and codified in the regulation, or
- Information not covered in the GEIS analyses that leads to an impact finding different from that codified in the regulation.

NRC does not specifically define the term "significant". For its review, Entergy used guidance available in Council on Environmental Quality regulations. The NEPA authorizes CEQ to establish implementing regulations for federal agency use. NRC requires license renewal applicants to provide NRC with input, in the form of an environmental report, that NRC will use to meet NEPA requirements as they apply to license renewal (10CFR51.10).

CEQ guidance provides that federal agencies should prepare environmental impact statements for actions that would significantly affect the environment (40CFR1502.3), focus on significant environmental issues (40CFR1502.1), and eliminate from detailed study issues that are not significant [40CFR1501.7(a)(3)]. The CEQ guidance includes a lengthy definition of "significantly" that requires consideration of the context of the action and the intensity or severity of the impact(s) (40CFR1508.27). Entergy expects that MODERATE or LARGE impacts, as defined by NRC, would be significant. Chapter 4 presents the NRC definitions of MODERATE and LARGE impacts.

Entergy reviewed SEIS's associated with other license renewal applications to determine if there were new issues identified for those plants that may be applicable to ANO-2. In addition, some regulatory agencies were randomly consulted regarding new and significant information. However, Entergy has an ongoing assessment process for identifying and evaluating new and significant information that may affect programs at the Entergy sites, including those related to license renewal matters. This process is directed by the nuclear corporate support group responsible for environmental matters, with assistance from environmental peer group members composed of technical personnel from the Entergy Nuclear South sites. A summary of this process is as follows:

- Issues relative to environmental matters are identified as follows:
  - Participation in industry utility groups (i.e., EEI, EPRI, NEI & USWAG).
  - Participation in non-utility groups (i.e., Institute of Hazardous Materials Management and National Registry of Environmental Professionals).
  - Periodic reviews of proposed regulatory changes.
  - Entergy Nuclear South Environmental Peer Group meetings.
- Environmental issues are reviewed and evaluated for applicability by the nuclear corporate support group. If the issue is applicable to Entergy, it is evaluated by the environmental peer group that consist of technical personnel involved in environmental compliance, environmental monitoring, environmental planning, natural resource management and health and safety issues. Necessary changes are made to the program and implemented in accordance with site and corporate procedures.

Additional actions incorporated into this assessment process specifically for ANO-2 license renewal include the following:

- Review of documents related to environmental issues at ANO-2.
- Review of internal procedures for reporting to the NRC events that could have environmental impacts.
- Credit for the oversight provided by inspections of plant facilities by state and federal regulatory agencies.

As a result of this assessment, Entergy is aware of no new and significant information regarding the environmental impacts of ANO-2 license renewal.

6.0 SUMMARY OF LICENSE RENEWAL IMPACTS AND MITIGATING ACTIONS

6.1 License Renewal Impacts

Entergy has reviewed the environmental impacts of renewing the ANO-2 operating license and has concluded that all impacts would be small and would not require mitigation. This environmental report documents the basis for Entergy's conclusion. Chapter 4 incorporates by reference NRC findings for the 55 Category 1 issues that apply to ANO-2 (and for the 2 "NA" issues for which NRC came to no generic conclusion), all of which have impacts that are small. The remainder of Chapter 4 analyzes Category 2 issues, all of which are either not applicable or have impacts that would be small. Table 6-1 identifies the impacts that ANO-2 license renewal would have on resources associated with Category 2 issues.

6.2 Mitigation

6.2.1 Requirement

"The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45 (c), for all Category 2 license renewal issues in Appendix B to subpart A of this part. No such consideration is required of Category 1 issues in Appendix B to subpart A of this part." [10CFR51.53 (c)(3)(iii)]

6.2.2 Entergy Response

As discussed in Supplement 1 to Regulatory Guide 4.2, Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses, when adverse environmental effects are identified, 10CFR51.45(c) requires consideration of alternatives available to reduce or avoid these adverse effects. Furthermore, Regulatory Guide 4.2 states that "Mitigation alternatives are to be considered no matter how small the adverse impact; however, the extent of the consideration should be proportional to the significance of the impact" [NRC 2000].

As described in Section 6.1 and as shown in Table 6-1, analysis of the Category 2 issues found the impacts to be small for the applicable issues. For these issues, the current permits, practices, and programs that mitigate the environmental impacts of plant operations are adequate. This ER finds that no additional mitigation measures are sufficiently beneficial as to be warranted.

Table 6-1
Environmental Impacts Related to License Renewal at ANO-2

Issue	Environmental Impact
Surface Water Quality, Hydrology and Use (for all plants)	
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow) 10CFR51.53(c)(3) (ii)(A)	**SMALL.** ANO-2 cooling water makeup is a very small percentage (0.06%) of the overall flow of the Arkansas River through Lake Dardanelle. Since 1980, water withdrawal has caused no water availability concerns for the lake, conflicts with other off-stream users, or adverse impacts on riparian or in-stream ecological communities. Consideration of mitigation is not required.
Aquatic Ecology (for all plants with once-through and cooling pond heat dissipation systems)	
Entrainment of fish and shellfish 10CFR51.53(c)(3)(ii)(B)	**NONE.** ANO-2 does not use a once-through cooling system or cooling pond heat dissipation systems. Consideration of mitigation is not required.
Impingement of fish and shellfish 10CFR51.53(c)(3)(ii)(B)	**NONE.** ANO-2 does not use a once-through cooling system or cooling pond heat dissipation systems. Consideration of mitigation is not required.
Heat shock 10CFR51.53(c)(3)(ii)(B)	**NONE.** ANO-2 does not use a once-through cooling system or cooling pond heat dissipation systems. Consideration of mitigation is not required.
Groundwater Use and Quality	
Groundwater use conflicts (plants using >100 gpm of ground-water) 10CFR51.53(c)(3)(ii)(C)	**NONE.** ANO does not use groundwater. Consideration of mitigation is not required.
Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river) 10CFR51.53(c)(3)(ii)(A)	**SMALL.** ANO-2 cooling water makeup is a very small percentage (0.06%) of the overall flow of the Arkansas River through Lake Dardanelle. Since the lake elevation remains constant, aquifer elevation and recharge rates also remain relatively constant. Since 1980, water withdrawal has caused no water availability concerns for the lake or conflicts with other off-stream users. Consideration of mitigation is not required.

Table 6-1 (continued)	
Issue	**Environmental Impact**
Groundwater Use and Quality (continued)	
Groundwater use conflicts (Ranney Wells) 10CFR51.53(c)(3)(ii)(C)	**NONE.** ANO does not use Ranney wells. Consideration of mitigation is not required.
Degradation of groundwater quality 10CFR51.53(c)(3)(ii)(D)	**NONE.** ANO does not use cooling ponds. Consideration of mitigation is not required.
Terrestrial Resources	
Refurbishment impacts on terrestrial resources 10CFR51.53(c)(3)(ii)(E)	**NONE.** No major refurbishment activities identified. Consideration of mitigation is not required.
Threatened or Endangered Species (for all plants)	
Threatened or endangered species 10CFR51.53(c)(3)(ii)(E)	**SMALL.** No major refurbishment activities identified. No threatened or endangered species impacted by continued operations of ANO-2. Consideration of mitigation is not required.
Air Quality	
Air quality during refurbishment 10CFR51.53(c)(3)(ii)(F)	**NONE.** No major refurbishment activities identified. ANO is not located in, or near, a nonattainment or maintenance area for air pollutants. Consideration of mitigation is not required.
Human Health	
Microbiological (Thermophilic) Organisms 10CFR51.53(c)(3)(ii)(G)	**SMALL.** ADH found that the risk to individuals utilizing Lake Dardanelle for recreational activities is extremely low. Consideration of mitigation is not required.
Electromagnetic fields – Acute effects 10CFR51.53(c)(3)(ii)(H)	**SMALL.** Potential for shock hazard is not significant and consideration of mitigation is not warranted. In addition, transmission line would remain in-service regardless of license renewal.

Table 6-1 (continued)	
Issue	**Environmental Impact**
Socioeconomics	
Housing impacts 10CFR51.53(c)(3)(ii)(I)	**SMALL.** No major refurbishment activities identified. Entergy does not anticipate an increase in employment during period of extended operation. Therefore, there no additional impacts to housing are expected due to continued operations of ANO-2. Consideration of mitigation is not required.
Public utilities: public water supply availability 10CFR51.53(c)(3)(ii)(I)	**SMALL.** No major refurbishment activities identified and no additional workers anticipated during the period of extended operation. Public water systems near ANO have excess system capacity and can meet demand of residential and industrial customers in the area. Consideration of mitigation is not required.
Education impacts from refurbishment 10CFR51.53(c)(3)(ii)(I)	**NONE.** No major refurbishment activities identified. Consideration of mitigation is not required.
Offsite land use (effects of refurbishment activities) 10CFR51.53(c)(3)(ii)(I)	**NONE.** No major refurbishment activities identified. Consideration of mitigation is not required.
Offsite land use (effects of license renewal) 10CFR51.53(c)(3)(ii)(I)	**SMALL.** Area around ANO has pre-established land patterns of development and has public services in place to support and guide development. No additional workers anticipated during the period of extended operation. Consideration of mitigation is not required.
Local transportation impacts 10CFR51.53(c)(3)(ii)(J)	**SMALL**. No major refurbishment activities identified and no increases in total number of employees during the period of extended operation. Consideration of mitigation is not required.
Historic and archaeological properties 10CFR51.53(c)(3)(ii)(K)	**SMALL**. No major refurbishment activities identified and site environmental work practices ensure protection for archeological and cultural resources that may be encountered during land disturbing activities on-site. Consideration of mitigation is not required.

Table 6-1 (continued)	
Issue	**Environmental Impact**
Postulated Accidents	
Severe accident mitigation alternatives 10CFR51.53(c)(3)(ii)(L)	**SMALL.** No impact from continued operation. No severe accident mitigation alternatives found to be cost effective.

6.3 Unavoidable Adverse Impacts

6.3.1 Requirement [10CFR51.45(b)(2)]

The applicant's report shall discuss any adverse environmental effects which cannot be avoided upon implementation of the proposed project.

6.3.2 Entergy Response

Section 4.0 of this ER report contains the results of Entergy's review and the analyses of the Category 2 issues as required by 10CFR51.53(c)(3)(ii). These reviews take into account the information that has been provided in the GEIS, Appendix B to Subpart A of Part 51, and information specific to ANO-2.

This review and analysis did not identify any significant adverse environmental impacts associated with the continued operation of ANO-2. The evaluation of structures and components required by 10CFR54.21 has been completed. No plant refurbishment activities, outside the bounds of normal plant component replacement and inspections, have been identified to support continued operation of ANO-2 beyond the end of the existing operating license. As a result of these reviews and analyses, Entergy is not aware of significant adverse environmental effects that cannot be avoided upon implementation of the proposed project.

6.4 Irreversible or Irretrievable Resource Commitments

6.4.1 Requirement [§51.45(b)(5)]

The applicant's report shall discuss any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

6.4.2 Entergy Response

The continued operation of ANO-2 for the period of extended operation will result in irreversible and irretrievable resource commitments, including the following:

- Nuclear fuel, which is consumed in the reactor and converted to radioactive waste

- The land required to dispose of spent nuclear fuel, low-level radioactive wastes generated as a result of plant operations, and sanitary wastes generated from normal industrial operations

- Elemental materials that will become radioactive

- Materials used for the normal industrial operations of ANO-2 that cannot be recovered or recycled or that are consumed or reduced to unrecoverable forms

Other than the above, there are no major refurbishment activities or changes in operation of ANO-2 during the period of extended operation that would irreversibly or irretrievably commit environmental components of land, water and air.

6.5 Short-term Use Versus Long-term Productivity

6.5.1 Requirement [10CFR51.45(b)(4)]

The applicant's report shall discuss the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.

6.5.2 Entergy Response

The *Final Environmental Statement Related to Operation of Arkansas Nuclear One Unit 2* evaluated the relationship between the short-term uses of the environment and the maintenance and enhancement of the long-term productivity associated with the construction and operation of ANO-2 [NRC 1977, Section 9.2]. The period of extended operation will not change the short-term uses of the environment from the uses previously evaluated in the FES. The period of extended operation will postpone the availability of the site resources (land, air, water). However, extending operations will not adversely affect the long-term uses of the site.

There are no major refurbishment activities or changes in operation of ANO-2 planned for the period of extended operation that would alter the evaluation of the FES for the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity of these resources.

6.6 References

NRC (U. S. Nuclear Regulatory Commission). 1977. *Final Environmental Statement Related to Operation of Arkansas Nuclear One Unit 2,* Arkansas Power & Light Company, Docket No. 50-368, Unites States Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, June 1977.

NRC (U.S. Nuclear Regulatory Commission). 2000. Supplement 1 to Regulatory Guide 4.2, Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses, September 2000.

7.0 ALTERNATIVES CONSIDERED

7.1 Introduction

NRC regulations require that an applicant's environmental report discuss alternatives to a proposed action [10CFR51.45(b)(3)]. The intent of this review is to enable the Commission to consider the relative environmental consequences of the proposed action as compared to the environmental consequences of other activities that also meet the purpose of the proposed action. In addition, this review addresses the environmental consequences of taking no action [NRC 1996]. For license renewal, there are only two alternatives that meet the purpose of the requirement: not renew the operating license or renew the operating license. The alternatives are discussed below.

7.2 Proposed Action

ANO-2 operated at a 2002 capacity factor of 106.5% and has a net electrical output of approximately 1023 MWe [EOI 2002, Section 1.1]. The proposed action is to renew the operating license for ANO-2. This action would provide the opportunity for Entergy to continue to operate ANO-2 through the period of extended operation.

The review of the environmental impacts required by 10CFR51.53(c)(3)(ii) is provided in Chapter 4.0 of this ER. Based on this review, Entergy concludes that there would be no adverse impact to the environment from the continued operation of ANO-2 through the period of extended operation.

7.3 No-Action Alternative

The no-action alternative to the proposed action is to not renew the operating license for ANO-2. In this alternative, it is expected that ANO-2 will continue to operate up to the end of the existing operating license, at which time plant operation would cease and decommissioning would begin. In an "obligation to serve" the regulated environment, a decision not to seek a renewal license would necessitate the replacement of approximately 1023 MWe with other sources of generation. The environmental impacts of the no-action alternative would be:

- the environmental impacts from decommissioning the ANO-2 unit, and

- the environmental impacts from a replacement power source.

Environmental impacts associated with decommissioning are discussed in Section 7.4.

The environmental impacts associated with a replacement power source would be the impacts from the construction and operation of a source of replacement power at a new location (greenfield) or at the ANO site (brownfield). The environmental impacts of these various types of replacement power are discussed in Chapter 8.0.

7.4 Decommissioning Impacts

A nuclear power plant licensee is required to submit decommissioning plans within two years following permanent cessation of operation of a unit or at least five years before expiration of the operating license, whichever occurs first, pursuant to the requirements of 10CFR50.54(b).

The environmental impacts of the termination of operations and decommissioning are addressed in Section 8.4 of the GEIS [NRC 1996]. The impacts of decommissioning would not be significantly different if decommissioning occurs after 40 years of operation or after 60 years of operation.

Entergy has reviewed the environmental impacts of decommissioning of ANO-2. These impacts are expected to be comparable to those environmental impacts described in the GEIS for impacts to: land use, water, air quality, ecological resources, human health, social and economic structure, waste management, aesthetics, and cultural resources. The following sections provide additional information on impacts to aquatic ecological resources and socioeconomics that would be associated with the termination of operations of ANO-2.

7.4.1 Aquatic Ecological Resources

The impact to aquatic resources resulting from cessation of ANO-2 operation would be elimination of water consumptive losses (e.g., evaporation associated with the cooling system). However, as noted in ER Sections 4.1 and 4.6, the impacts of operating ANO-2 were evaluated and found not to be detrimental to water consumptive losses.

7.4.2 Socioeconomics

When ANO-2 ceases operation, there will be a decrease in employment in the area. As noted in ER Section 3.5, the workforce employed at ANO resides primarily in the adjacent counties. The impacts associated with the loss of these jobs would be concentrated in the counties of Pope, Johnson and Yell. The loss of these jobs would be an adverse impact to the economies of these counties.

ANO employees also contribute time and resources in community activities, such as schools, churches, community groups and civic activities. The loss of jobs would have an adverse impact on involvement with these activities.

As discussed in ER Section 2.7, the property taxes paid by ANO represented approximately 43%, 55% and 43% of the locally generated tax revenues for the County General, County Roads and County Library 2002 budgets, respectively. The majority of Entergy's property taxes for ANO are allocated to the Russellville School District. In 2002, Entergy's taxes made up about 49% of the locally generated property tax revenues for the school district. The loss of the tax revenues would be an adverse impact to the economies of these counties.

7.5 Alternative Energy Sources

Nuclear power plants are commonly used for base-load generation. The GEIS states that coal-fired and gas-fired generation capacity are the feasible alternatives to nuclear power generating capacity, based on current (and expected) technological and cost factors. The following generation alternatives were considered in detail in this ER:

- Coal-fired generation at an alternate site (Section 8.1.1). Entergy did not consider coal-fired generation at the ANO site since it was concluded in the ANO-1 SEIS that there was not enough land to build a coal-fired unit and a coal yard [NRC 2001, Section 8.2].

- Natural gas-fired generation at the ANO site and at an alternate site (Section 8.1.2)

- Nuclear generation at the ANO site and at an alternate site (Section 8.1.3)

These alternatives are presented (Sections 8.1.1, 8.1.2 and 8.1.3, respectively) as if such plants were constructed at the ANO site, using the existing water intake and discharge structures, switchyard, and transmission lines, or at an alternate location that could be either a current industrial site or an undisturbed, pristine site requiring a new generating building and facilities, new switchyard, and at least some new transmission lines. In this ER, a "greenfield" site is assumed to be an undisturbed, pristine site.

Depending on the location of an alternative site, it might also be necessary to connect to the nearest gas pipeline (in the case of natural gas) or rail line (in the case of coal). The requirement for these additional facilities may increase the environmental impacts relative to those that would be experienced at the ANO site [NRC 2001, Section 8.2].

The potential for using imported power is discussed in Section 8.1.4. Imported power is considered feasible, but would result in the transfer of environmental impacts from the current region in Arkansas to some other location in Arkansas, another state, or Canadian province.

As stated in NUREG-1437, Vol. 1, Section 8.1, the "NRC has determined that a reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable" [NRC 1996]. Accordingly, the following alternatives were not considered as reasonable replacement power:

- wind
- solar
- hydropower
- geothermal
- wood energy
- municipal solid waste
- other biomass-derived fuels
- oil
- fuel cells

- delayed retirement
- utility-sponsored conservation
- combination of alternatives

These technologies were eliminated as possible replacement power alternatives for one or more of the following reasons:

- High land-use impacts — Some of the technologies listed above (wind, PV, solar, hydroelectric) would require a large area of land and would thus require a greenfield siting plan. This would result in a greater environmental impact than continued operation of ANO-2.

- Low capacity factors — Some of the technologies identified above (wind, PV, solar and hydroelectric) are not capable of producing the nearly 1023 MWe of power at high capacity factors. These generation technologies are used as peaking power sources, as opposed to base-load power sources, and for this reason are unlike resources.

- Geographic availability of the resource — Some of the technologies are not feasible because there is no feasible location in the Entergy Service area.

- Emerging technology — Some of the technologies have not been proven as reliable and cost effective replacements of a large generation facility. Therefore, these technologies are typically used with smaller (lower MWe) generation facilities.

- Availability — There is no assurance of the availability of imported power.

7.6 References

EOI (Entergy Operations, Inc.). 2002. Arkansas Nuclear One - Unit 2, Safety Analysis Report, Amendment 17.

NRC (U.S. Nuclear Regulatory Commission). 1996. NUREG-1437, Generic Environmental Statement for License Renewal of Nuclear Power Plants, Final Report, May 1996.

NRC (U.S. Nuclear Regulatory Commission). 2001. Generic Environmental Impact Statement for License Renewal of Nuclear Plants" Arkansas Nuclear One, Unit 1, NUREG-1437, Supplement 3, Office of Nuclear Reactor Regulation, Washington, D.C., April 2001.

8.0 COMPARISON OF IMPACTS

The following key assumptions have been made in the review of alternative energy sources. These key assumptions are intended to simplify the evaluation, yet still allow the no-action alternative review to meet the intent of NEPA requirements and NRC environmental regulations.

- The goal of the proposed action (license renewal) is the production of approximately 1000 MWe of base-load generation. Alternatives that do not meet the goal are not considered in detail.
- The time frame for the needed generation is 2018 through 2038.
- Purchased power is not considered a reasonable alternative because there is no assurance that the capacity or energy would be available. See Section 8.1.4.
- The annual capacity factor of ANO-2 in 2002 was 106.5%. The capacity factor is targeted to remain at or near this value throughout the plant's operating life.

8.1 Comparison of Environmental Impacts for Reasonable Alternatives

As stated in the GEIS, the "NRC has determined that a reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable" [NRC 1996, Section 8.1]. Below is a discussion of the supply side alternative energy technologies that Entergy could utilize if the license for ANO-2 is not renewed. These alternatives are within the range of alternatives capable of meeting the goal of approximately 1000 MWe as base-load generation (replacement power for ANO-2).

Conventional coal-fired, oil and natural gas-fired combined cycle, natural gas-fired combined cycle, and advanced light water reactor are currently available conventional base-load technologies considered to replace ANO-2 generation upon its termination of operation. These sources are considered viable alternatives based upon current Entergy planning strategies.

The environmental impacts discussed in this chapter are for the construction and operation of these generation facilities. Impacts are evaluated for a greenfield case (building on a new, pristine condition site) and a brownfield case (constructing new generation on the existing ANO site, with exception of coal-fired unit).

The continued operation of ANO-2 for the period of extended operation would result in less environmental impact than that of the replacement power that could be obtained from other reasonable generating sources, as described below.

8.1.1 Coal-Fired Generation

It was assumed that it would take about 1000 megawatt electric (MWe) of coal-fired generation capacity to replace the approximately 1023 MWe output of ANO-2. A comparison using a larger-sized coal-fired facility is appropriate considering the additional electrical usage necessary for pollution control and transporting coal or ash. The typical capacity (in MWe) and configuration used by the electrical power industry in the application of coal-fired generation technology vary. For evaluation of the coal-fired generation alternative, Entergy utilized information from evaluations already conducted in the ANO-1 SEIS. Therefore, the coal-fired evaluation is based on information about the Delmarva Power and Light Company's Dorchester Power Plant and the South Carolina Electric and Gas Company's Cope Power Plant, with estimates adjusted appropriately to develop a representative alternative coal-fired plant [NRC 2001, Section 8.2.1].

8.1.1.1 Closed-Cycle Cooling System

The environmental impacts of building a coal-fired generation facility with a closed-cycle cooling system at an alternate site are summarized in Table 8-1.

Construction of the coal-fired plant would take approximately 5 years. The peak workforce during the construction is estimated to be 1200 to 2500 for the construction of a 1000-MWe plant. Additional water would be needed to control wet-scrubber sulfur dioxide (SO_2) emissions and for boiler makeup during operation [NRC 2001, Section 8.2.1.1].

8.1.1.1.1 Land Use

The GEIS estimates that approximately 1700 acres would be needed for a 1000-MWe coal plant, which would amount to a considerable loss of natural habitat or agricultural land for the plant site alone, excluding that required for mining and other fuel-cycle impacts.

Additional land might also be needed for transmission lines and rail lines, depending on the location of the site relative to the nearest inter-tie connection and rail spur. Depending on the transmission line routing and nearest rail line, these alternatives could result in MODERATE to LARGE land use impacts.

8.1.1.1.2 Ecology

Constructing a coal-fired plant at an alternate site would alter ecological resources because of the need to convert roughly 1700 acres of land at the site to industrial use for plant, coal storage, and ash and scrubber sludge disposal. However, some of this land might have been previously disturbed.

The coal-fired generation alternative would introduce construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts would alter the ecology. In addition, impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity.

The use of cooling makeup water from a nearby surface water body could also have adverse aquatic resource impacts. Ecological impacts associated with transporting coal and lime to the alternate would be significant. The construction and maintenance of an additional transmission line and a rail spur would have ecological impacts. Overall, the ecological impacts at an alternate site would be MODERATE to LARGE.

8.1.1.1.3 Water Use and Quality

Surface Water: Impact on surface water would depend on the volume of water needed, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to a surface body of water would be regulated by the State of Arkansas or another state. Therefore, the impacts would be SMALL to MODERATE.

Groundwater: Impacts of groundwater withdrawal would be small if only used for potable water. If groundwater is used as make-up water, then the impacts could be moderate to large. Therefore, groundwater impacts from a coal-fired plant on the aquifer would be site-specific and dependent on aquifer recharge and other withdrawals. The overall impacts would be SMALL to LARGE.

8.1.1.1.4 Air Quality

It was assumed that the coal-fired unit could be tangentially fired with dry-bottom boilers. This firing configuration was chosen because it would have moderate uncontrolled emissions of NOx compared with other configurations. The NOx emission controls would include low-NOx burners, overfire air, and post-combustion SCR. The combination of low-NOx burners and overfire air would achieve a NOx reduction of 40 to 60 percent from uncontrolled levels. The combustion controls, along with SCR, can achieve the current upper limit of NOx control (95-percent reduction). Based on an operating capacity factor of 83.9 percent, the resulting annual NOx emissions would be approximately 850 metric tons. Filters and electrostatic precipitators (99.9-percent particulate removal efficiency), a wet lime/limestone flue gas de-sulfurization system (95-percent scrubber removal efficiency), and an operating factor of 83.9 percent would result in annual emissions of 120 MT of filterable particulates, 30 MT of particulate matter having a diameter of 10 microns or less (PM10), and 1820 MT of SOx. CO emissions would be approximately 580 MT per year [NRC 2001, Section 8.2.1.1].

The air quality impacts are MODERATE for coal-fired generation. The impacts would be clearly noticeable, but would not destabilize air quality [NRC 2001, Section 8.2.1.1].

Sulfur oxides emissions: Using current SO_x emissions control technology, the total annual stack emissions would include approximately 1820 MT of SO_x, most of which would be SO_2. Additional reductions could become necessary. The acid rain provision of the Clean Air Act of 1970 (Sections 403 and 404) capped the nation's SO_2 emissions from power plants. Under the Act, affected fossil-fired steam units are allocated a number of SO_2 emission allowances. To achieve compliance, each utility must hold enough allowances to cover its SO_2 emissions annually or be subject to certain penalties. If the utility's SO_2 emissions are less than its annually allocated emission allowances, then the utility may bank the surplus allowances for

use in future years. An SO_2 allowances market has been established for the buying and selling of allowances. Entergy may have to purchase additional allowances to operate a coal-fired alternative. Because of allowances, a major new combustion facility in Arkansas would not add SO_2 impacts on a regional basis, though it might do so locally [NRC 2001, Section 8.2.1.1].

Nitrogen oxides emissions: Using current NO_x emissions control technology, the total annual stack emissions would include approximately 850 MT of NO_x. Section 407 of the Clean Air Act of 1970 establishes an annual reduction program for the NO_x emissions program. Putting additional burdens on coal use are the U.S. Environmental Protection Agency 8-hour ozone standard, the EPA standard requiring particulate matter to have a diameter less than 2.5 microns ($PM_{2.5}$), and the Regional Haze rules. In addition, modeling for visibility impacts may be required. A major new combustion facility would add to local emissions [NRC 2001, Section 8.2.1.1].

Particulate emissions: The total estimated annual stack emissions would include 120 MT of filterable particulate matter and 30 MT of PM_{10}. In addition, coal-handling equipment would introduce fugitive particulate emissions [NRC 2001, Section 8.2.1.1].

Carbon monoxide emissions: The total CO emissions are estimated to be approximately 580 MT per year [NRC 2001, Section 8.2.1.1].

Mercury: Coal-fired boilers account for nearly one-third of mercury emissions in the U.S. Technologies available to control mercury emissions have varying degrees of success. In response to growing concerns with mercury, the Clean Air Act Amendments of 1990 require the EPA to identify mercury emission sources, evaluate the contributions of power plants and municipal incinerators, identify control technologies, and evaluate toxicological effects from the consumption of mercury-contaminated fish. It is likely that these studies will lead to additional restrictions concerning mercury emissions associated with coal-fired power plants, as well as other sources of mercury emissions. Recent studies by the Maryland Power Plant Research Program have indicated that although coal-fired power plants contribute to mercury emissions, the resulting concentrations are not high enough to adversely affect humans or other organisms [NRC 2001, Section 8.2.1.1].

Summary: The GEIS analysis did not quantify coal-fired boiler emissions, but implied that air impacts would be substantial. The GEIS also mentioned global warming from unregulated carbon dioxide emissions and acid rain from SOx and NOx emissions as potential impacts. Adverse human health effects from coal combustion such as cancer and emphysema have been associated with the products of coal combustion. The appropriate characterization of air impacts from coal-fired generation is MODERATE. The impacts would be clearly noticeable, but would not destabilize air quality.

8.1.1.1.5 Waste

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash and scrubber sludge. This impact could extend well after the

operating life because revegetation management and groundwater monitoring for leachate contaminant impacts could be a permanent requirement [NRC 2001, Section 8.2.1.1].

The GEIS analysis concluded that large amounts of fly ash and scrubber sludge would be produced and would require constant management. Disposal of this waste could noticeably affect land use and groundwater quality, but with appropriate management and monitoring it would not destabilize resources. After closure of the waste site and revegetation, the land would be available for other uses, and regulatory requirements would ensure groundwater protection. For these reasons, impacts from waste generated from burning coal would be MODERATE. The impacts would be clearly noticeable, but would not destabilize important resources [NRC 2001, Section 8.2.1.1].

8.1.1.1.6 Human Health

Coal-fired power generation introduces worker risks from fuel and lime/limestone mining, and worker and public risks from fuel and lime/limestone transportation and stack-emissions inhalation. Stack-emissions impacts can be widespread and the health risks difficult to quantify. This alternative also introduces the risk of coal-pile fires and attendant inhalation risks [NRC 2001, Section 8.2.1.1].

The GEIS analysis noted that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates, but did not identify the significance of this impact. Regulatory agencies, such as the EPA, focus on air emissions and revise regulatory requirements or propose statutory changes, based on human health impacts. Such agencies also impose site-specific emission permit limits as needed to protect human health. Thus, human health impacts from inhaling toxins and particulates generated by burning coal would be SMALL [NRC 2001, Section 8.2.1.1].

8.1.1.1.7 Socioeconomics

Construction of the coal-fired alternative would take approximately 5 years. The peak workforce is estimated to range from 1200 to 2500 additional workers during the 5-year construction period, based on estimates given in the GEIS.

Communities around the new site would have to absorb the impacts of a large, temporary work force (up to 2500 workers at the peak of construction) and a permanent work force of approximately 200 workers. In the GEIS, the staff stated that socioeconomic impacts at a rural site would be larger than at an urban site, because more of the peak construction work force would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis. Therefore, socioeconomic impacts at an isolated rural site could be LARGE.

Transportation related impacts associated with commuting construction workers at an alternate site would be site dependent, but could be MODERATE to LARGE.

Transportation impacts related to commuting of plant operating personnel would also be site dependent, but can be characterized as SMALL to MODERATE.

At most alternate sites, coal and lime would be delivered by rail, although barge delivery is feasible for a location on navigable waters. Transportation impacts would depend upon the site location. Socioeconomic impacts associated with rail transportation would be MODERATE to LARGE. Barge delivery of coal and lime/limestone would have SMALL socioeconomic impacts.

8.1.1.1.8 Aesthetics

Alternative site locations could reduce the aesthetic impact of coal-fired generation if siting were in an area that was already industrialized. In such a case, however, the introduction of tall stacks and cooling towers would probably still have a MODERATE incremental impact. Locating at other, largely undeveloped sites could show a LARGE impact.

8.1.1.1.9 Historic and Archaeological Resources

Before construction at an alternate site, studies would be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would be needed for areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other rights-of-way). Historic and archeological resource impacts can generally be effectively managed and as such are considered SMALL.

Table 8-1
Summary of Environmental Impacts from Coal-Fired Generation
Closed-Cycle Cooling

	Alternative Greenfield Site	
Impact Category	**Impact**	**Comments**
Land Use	MODERATE to LARGE	Approximately 500 acres to 2000 acres, including transmission lines and rail line for coal delivery.
Ecology	MODERATE to LARGE	Impact will depend on ecology of site.
Water Use and Quality:		
Surface Water	SMALL to MODERATE	Impact will depend on volume and other characteristics of receiving water.
Groundwater	SMALL to LARGE	Impact will depend on site characteristics and availability of groundwater.

Table 8-1
(continued)

Impact Category	Alternative Greenfield Site	
	Impact	**Comments**
Air Quality	MODERATE	SOx – 1820 MT*/yr – allowances required NOx – 850 MT/yr – allowances required Particulate – 120 MT/yr (filterable) – 30 MT/yr (unfilterable) Carbon monoxide – 580 MT/yr Trace amounts of mercury, arsenic, chromium, beryllium and selenium
Waste	MODERATE	Total waste volume would be estimated around 800,000 MT/yr of ash and scrubber sludge.
Human Health	SMALL	Impacts considered minor.
Socioeconomics	SMALL to LARGE	Communities would have to absorb impacts of a large, temporary workforce (up to 2500 workers at the peak of construction) and a permanent work force of approximately 200 workers. Impacts at a rural site would be larger. Transportation-related impacts associated with commuting construction workers would be site dependent.
Aesthetics	MODERATE to LARGE	Could reduce aesthetic impact if siting is in an industrial area; Impact would be large if siting is largely in an undeveloped area.
Historic and Archaeological Resources	SMALL	Would necessitate cultural resource studies.

8.1.2 Gas-Fired Generation

It was assumed that a replacement natural-gas-fired plant would use combined cycle technology. In the combined cycle unit, hot combustion gases in a combustion turbine rotate the turbine to generate electricity. Waste combustion heat from the combustion turbine is routed through a heat-recovery steam generator to generate additional electricity. The size, type, and configuration of gas-fired generation units and plants currently operational in the U.S. vary and include simple-cycle combustion and combined-cycle units that range in size from 25 MWe to 600 MWe. As with coal-fired technology, multiple units may be configured and combined at one location to produce the desired amount of megawatts, and construction can be phased to meet electrical power needs [NRC 2001, Section 8.2.2].

8.1.2.1 Closed-Cycle Cooling System

Providing 1000 MWe of replacement power with a combined cycle system would require 110 acres of land. Natural gas typically has an average heating value of 3.7×10^7 Joules/cubic meter (J/m^3) (1,000 British thermal unit per cubic foot [Btu/ft^3]), and it would be the primary fuel; the gas-fired alternative plant would burn approximately 1.24 J/m^3-s (100 billion ft^3/yr) [NRC 2001, Section 8.2.2.1].

As a surrogate for a similar-sized gas-fired alternative plant, Entergy utilized the Baltimore Gas and Electric's Perryman Power Plant and Polk Power Plant described in the ANO-1 SEIS. The ANO-1 SEIS assumed that each unit would be less than 100 ft high and would be designed with dry, low-NO_x combusters, water injection, and selective catalytic reduction. Each unit would exhaust through a 70 m (230 ft) stack after passing through heat-recovery steam generators. This stack height is consistent with EPA regulations (40CFR51.100), which address requirements for determining the stack height of new emission sources [NRC 2001, Section 8.2.2.1].

The 880-MWe surrogate gas-fired generation plant described in the ANO-1 SEIS was utilized to measure the impacts of replacing the 1023-MWe of ANO-2. The gas-fired generation alternative would consist of two 440 MW combined-cycle units, each consisting of two 155 MW simple-cycle combustion turbines and a 130 MW heat-recovery steam generator. Natural gas would have to be delivered via pipeline. Reliant and Ozark are the two nearest natural gas pipelines, located approximately 5 miles from the ANO-2 site. Construction cost of installing a gas line has been estimated to be an average of approximately $1 million per mile. To the degree existing rights-of-way could be used, the level of impact could be reduced [NRC 2001, Section 8.2.2.1].

Environmental impacts of conversion to the gas-fired generation option at both ANO and a "greenfield" site are summarized in Table 8-2.

8.1.2.1.1 Land Use

Gas-fired generation at the ANO site would require converting the existing industrial site to a gas plant. Almost all the converted land would be used for the power block. Additional land

would be disturbed during pipeline construction. Some additional land would also be required for backup oil storage tanks. Gas-fired generation land use impacts at the existing ANO site are SMALL to MODERATE; the impacts would noticeably alter the habitat but would not destabilize important attributes of the resource. The difficulties of operating a gas-fired plant and the remaining nuclear unit (ANO-1) at the same site are expected to be less than with a coal-fired plant because of the much smaller "footprint" of a gas-fired plant [NRC 2001, Section 8.2.2.1].

In addition to the land required for the gas-fired plant, construction at a greenfield site would impact approximately 20 to 50 acres for offices, roads, parking areas, and a switchyard. The power block would require 60 acres. Some additional land would also be required for backup oil storage. In addition, it is assumed that another 424 acres would be necessary for transmission lines (assuming the plant is sited 10 miles from the nearest inter-tie connection) although this would depend on the actual plant location. Plants of this type are usually built very close to existing natural gas pipelines. Including the land required for pipeline construction, a greenfield site would require approximately 500 acres. Depending on the transmission-line routing, the greenfield site alternative could result in SMALL to MODERATE land-use impacts [NRC 2001, Section 8.2.2.1].

The GEIS estimated that land use requirements for a 1000-MW gas-fired plant at a greenfield site would be SMALL (approximately 110 acres for the plant site), and that co-locating with a retired nuclear plant would reduce these impacts. Therefore, the impacts would be SMALL to MODERATE, depending on the length and routing of required pipelines and transmission lines [NRC 2001, Section 8.2.2.1].

8.1.2.1.2 Ecology

Siting gas-fired generation at the existing ANO site would have MODERATE ecological impacts because the facility would be constructed partly on previously disturbed areas and would disturb relatively little acreage at the site. However, significant habitat would be disturbed by approximately 5 miles of pipeline construction. Ecological impacts would be reduced by using the existing intake and discharge system. Past operational monitoring of the effects of closed-cycle cooling at ANO-2 has not shown significant negative impacts to Lake Dardanelle ecology, and this would be expected to remain unchanged [NRC 2001, Section 8.2.2.1].

The GEIS noted that land-dependent ecological impacts from construction would be SMALL unless site-specific factors indicate a particular sensitivity and that operational impact would be smaller than for other fossil fuel technologies of equal capacity. The ANO-1 SEIS identified the gas pipeline as a site-specific factor that would make the gas-fired alternative's ecological impacts larger than those of license renewal. Therefore, in this case, the appropriate characterization of gas-fired-generation ecological impacts is MODERATE [NRC 2001, Section 8.2.2.1].

Construction at a greenfield site could alter the ecology of the site and could impact threatened and endangered species. These ecological impacts could be SMALL to MODERATE [NRC 2001, Section 8.2.2.1].

8.1.2.1.3 Water Use and Quality

Surface Water: The plant would use the existing ANO-2 intake and discharge structures as part of a closed-cycle cooling system; therefore, water quality impacts would continue to be SMALL.

Water quality impacts from sedimentation during construction is another land related impact that the GEIS categorized as SMALL. The GEIS also noted that operational water quality impacts would be similar to, or less than, those from other centralized generating technologies. The NRC has concluded that water quality impacts from coal-fired generation would be SMALL, and gas-fired alternative water usage would be less than that for coal-fired generation. Surface water impacts would remain SMALL; the impacts would not be detectable or be so minor that they would not noticeably alter important attributes of the resource [NRC 2001, Section 8.2.2.1].

For alternative greenfield sites, the impact on surface water would depend on the volume and other characteristics of the receiving body of water. The impacts would be SMALL to MODERATE [NRC 2001, Section 8.2.2.1].

Groundwater: ANO-2 does not use groundwater. Therefore, groundwater impacts would be SMALL; the impacts would be so minor that they would not noticeably alter important resources.

For alternative greenfield sites, the impact to the groundwater would depend on the site characteristics, including the amount of groundwater available. The impacts would range between SMALL and LARGE [NRC 2001, Section 8.2.2.1].

8.1.2.1.4 Air Quality

Natural gas is a relatively clean-burning fuel. Because ANO-2 is not in a nonattainment area for ozone, air quality impacts of gas-fired generation would not be of concern. The GEIS noted that gas-fired air quality impacts are less than other fossil technologies because fewer pollutants are emitted, and SO_2 is not emitted. Emission levels from the gas-fired alternative would be less than emission levels from the coal-fired alternative.

However, the gas-fired alternative would contribute NO_x emissions to an area that in the future may become a nonattainment area for ozone. Because NO_x contributes to ozone formation, the reduced NO_x emissions are still of future concern, and low NO_x combusters, water injection, and SCR could be mitigation measures required by regulatory agencies [NRC 2001, Section 8.2.2.1].

For these reasons, the appropriate characterization of air impacts from a gas-fired plant would be MODERATE; the impacts, primarily NO_x, would be clearly noticeable, but would not be sufficient to destabilize air resources as a whole [NRC 2001, Section 8.2.2.1].

Siting the gas-fired plant elsewhere would not significantly change air quality impacts because the site could be in a greenfield area that is not a serious nonattainment area for ozone. In addition, the location could result in installing more or less stringent pollution control equipment

to meet the regulations. Therefore, the impacts would be MODERATE [NRC 2001, Section 8.2.2.1].

8.1.2.1.5 Waste

There are only small amounts of solid waste products (i.e., ash) from burning natural gas fuel. The GEIS concluded that waste generation from gas-fired technology would be minimal. Gas firing results in very few combustion by-products because of the clean nature of the fuel. Waste generation would be limited to typical office wastes. This impact would be SMALL; waste generation impacts would be so minor that they would not noticeably alter important resource attributes [NRC 2001, Section 8.2.2.1].

Siting the facility at an alternate greenfield site would not alter the waste generation; therefore, the impacts would continue to be SMALL [NRC 2001, Section 8.2.2.1].

8.1.2.1.6 Human Health

The GEIS analysis mentions potential gas-fired alternative health risks (cancer and emphysema). The risk may be attributable to NO_x emissions that contribute to ozone formation, which in turn contributes to health risks. As discussed in Section 8.1.1.1 for the coal-fired alternative, legislative and regulatory control of the nation's emissions and air quality are protective of human health, and the human health impacts from gas-fired generation would be SMALL; that is, human health effects would not be detectable or would be so minor that they would neither destabilize nor noticeably alter important attributes of the resource [NRC 2001, Section 8.2.2.1].

Siting of the facility at an alternate greenfield site would not alter the possible human health effects. Therefore, the impacts would be SMALL [NRC 2001, Section 8.2.2.1].

8.1.2.1.7 Socioeconomics

It is assumed that gas-fired construction would take place while ANO-2 continues operation, with completion of the replacement plant at the time that the nuclear plant would halt operations. Construction of the gas-fired alternative would take much less time than constructing other plants. During the time of construction, the surrounding communities would experience demands on housing and public services that could have MODERATE impacts. After construction, the communities would be impacted by the loss of jobs, construction workers would leave, the ANO-2 nuclear plant workforce would decline through a decommissioning period to a minimal maintenance size, and the gas-fired plant would introduce a replacement tax base of about 100 new jobs [NRC 2001, Section 8.2.2.1].

The GEIS concluded that socioeconomic impacts from constructing a gas-fired plant would not be very noticeable and that the small operational workforce would have the lowest socioeconomic impacts (local purchases and taxes) of nonrenewable technologies. Compared to the coal-fired alternative, the smaller size of the construction workforce, the shorter construction time-frame, and the smaller size of the operations workforce would reduce some of

the socioeconomic impacts. For these reasons, the socioeconomic impacts of gas-fired-generation socioeconomic impacts would be SMALL to MODERATE; that is, depending on other growth in the area, socioeconomic effects could be noticed, but they would not destabilize important attributes of the resource [NRC 2001, Section 8.2.2.1].

Construction at another site would relocate some socioeconomic impacts, but would not eliminate them. The community around the ANO site would still experience the impact of the loss of ANO-2 operational jobs and the tax base. The communities around the new site would have to absorb the impacts of a temporary workforce and a small permanent workforce. Therefore, the impacts would be MODERATE to LARGE, based on net job and tax-base losses in the ANO area. This impact is about the same in the ANO area as in the no-action alternative [NRC 2001, Section 8.2.2.1].

8.1.2.1.8 Aesthetics

The combustion turbines and heat-recovery boilers would be relatively low structures and would be screened from most offsite vantage points by intervening woodlands. The steam turbine building would be taller, approximately 100 feet in height, and, together with 230-feet exhaust stacks, would be visible offsite [NRC 2001, Section 8.2.2.1].

The GEIS analysis noted that land-related impacts, such as aesthetic impacts, would be small unless site-specific factors indicate a particular sensitivity. As in the case of the coal-fired alternative, aesthetic impacts from the gas-fired alternative would be noticeable. However, because the gas-fired structures are shorter than the coal-fired structures and more amenable to screening by vegetation, it was determined that the aesthetic resources would not be destabilized by the gas-fired alternative. For these reasons, aesthetic impacts from a gas-fired plant would be SMALL to MODERATE; the impacts would be clearly noticeable, but would not destabilize this important resource [NRC 2001, Section 8.2.2.1].

Alternative locations could reduce the aesthetic impact of gas-fired generation if siting was in an area that was already industrialized. In such a case, however, the introduction of the steam generator building, stacks, and cooling tower plumes would probably still have a SMALL to MODERATE incremental impact [NRC 2001, Section 8.2.2.1].

8.1.2.1.9 Historic and Archaeological Resources

The GEIS analysis noted, as for the coal-fired alternative, that cultural resource impacts of the gas-fired alternative would be SMALL unless important site-specific resources were affected. Gas-fired alternative construction at the ANO site would affect a smaller area within the footprint of the coal-fired alternative. As discussed in Section 8.1.1 of this ER, site knowledge minimizes the possibility of cultural resource impacts. Cultural resource impacts would be SMALL; that is, cultural resource impacts would not be detectable or would be so minor that they would neither destabilize nor noticeably alter important attributes of the resource [NRC 2001, Section 8.2.2.1].

Construction at another site could necessitate instituting cultural resource preservation measures, but impacts can generally be managed and maintained as SMALL. Cultural resource surveys would be required for the pipeline construction and other areas of ground disturbance associated with this alternative [NRC 2001, Section 8.2.2.1].

Table 8-2
Summary of Environmental Impacts from Gas-Fired Generation
Closed-Cycle Cooling

Impact Category	ANO Site		Alternative Greenfield Site	
	Impact	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	Approximately 60 acres required for power block, 150 acres disturbed for pipeline construction, additional land for backup oil storage tanks.	SMALL to MODERATE	Up to 500 acres required for site, pipelines, transmission line connection; additional land for backup oil storage tanks.
Ecology	MODERATE	Constructed on land within ANO site. Possible significant habitat loss due to pipeline construction.	SMALL to MODERATE	Impact depends on location and ecology of site; potential habitat loss and fragmentation; reduced productivity and biological diversity.
Water Use and Quality:				
- Surface Water	SMALL	Uses existing intake and discharge structures and cooling system.	SMALL to MODERATE	Impact depends on volume and characteristics of receiving water body.
- Groundwater	SMALL	ANO-2 does not use groundwater nor is expected to use groundwater during license renewal period.	SMALL to LARGE	Groundwater impacts would depend on uses and available supply.
Air Quality	MODERATE	Primarily nitrogen oxides. Impacts could be noticeable but not destabilizing.	MODERATE	Same impacts as ANO site.

Table 8-2
(continued)

Impact Category	ANO Site		Alternative Greenfield Site	
	Impact	Comments	Impact	Comments
Waste	SMALL	Small amount of ash produced.	SMALL	Same impacts as ANO site.
Human Health	SMALL	Impacts considered minor.	SMALL	Same impacts as ANO site.
Socioeconomics	SMALL to MODERATE	500 to 750 additional workers during 3-year construction period, followed by reduction from current ANO workforce.	MODERATE to LARGE	Construction impacts would be relocated. Community near ANO would still experience workforce reduction.
Aesthetics	SMALL to MODERATE	Visual impact of stacks and equipment would be noticeable, but not as significant as coal option.	SMALL to MODERATE	Alternate location could reduce aesthetic impact if siting is in an industrial area.
Historic and Archaeological Resources	SMALL	Only previously disturbed and adjacent areas would be affected.	SMALL	Alternate location would necessitate cultural resource studies.

8.1.3 Nuclear Power Generation

Since 1997, the NRC has certified three new standard designs for nuclear power plants under 10CFR Part 52, Subpart B. These designs are the U.S. Advanced Boiling Water Reactor (10CFR Part 52, Appendix A), the System 80+ Design (10CFR Part 52, Appendix B), and the AP600 Design (10CFR Part 52, Appendix C). All of these plants are light-water reactors. Although no applications for a construction permit or a combined license based on these certified designs have been submitted to NRC, the submission of the design certification applications indicates continuing interest in the possibility of licensing new nuclear power plants. In addition, recent volatility of natural gas and electricity has made new nuclear power plant construction more attractive from a cost standpoint. Consequently, construction of a new nuclear power plant at the ANO site using the existing intake and discharge structures and at an alternate site using closed-cycle cooling is considered in this section. It was assumed that the new nuclear plant would have a 40-year lifetime [NRC 2003, Section 8.2.3].

The NRC summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10CFR51.51. The impacts shown in Table S-3 are representative of the impacts that would be associated with a replacement nuclear power plant built to one of the certified designs, sited at ANO or an alternate site. The impacts shown in Table S-3 are for a 1000-MWe reactor. The environmental impacts associated with transporting fuel and waste to and from a light-water cooled nuclear power reactor are summarized in Table S-4 of 10CFR51.52. The summary of NRC's findings on NEPA issues for license renewal of nuclear power plants in Table B-1 of 10CFR Part 51 Subpart A, Appendix B, is also relevant, although not directly applicable, for consideration of environmental impacts associated with the operation of a replacement nuclear power plant [NRC 2003, Section 8.2.3].

8.1.3.1 Closed-Cycle Cooling System

The environmental impacts of constructing a nuclear power plant at ANO and an alternate site using closed-cycle cooling are summarized in Table 8-3.

8.1.3.1.1 Land Use

The existing facilities and infrastructure at the ANO site would be used to the extent practical, limiting the amount of new construction. Specifically, the replacement nuclear power plant would use the existing cooling tower system, switchyard, offices, and transmission line right-of-way. Land use could require disturbance of previously undeveloped land. There would be no net change in land needed for uranium mining because land needed to supply the new nuclear plant would offset land needed to supply uranium for fueling the existing ANO-2 reactor. The impact of a replacement nuclear generating plant on land use at the existing ANO site is best characterized as MODERATE. The impact would be greater than the operating license renewal alternative [NRC 2003, Section 8.2.3.1].

Land use requirements at an alternate site would require land for the nuclear power plant plus the possible need for land for a new transmission line. In addition, it may be necessary to construct a rail spur to an alternate site to bring in equipment during construction. Depending on transmission line routing, siting a new nuclear plant at an alternate site would result in MODERATE to LARGE land use impacts, and probably would be LARGE for a greenfield site [NRC 2003, Section 8.2.3.1].

8.1.3.1.2 Ecology

Locating a replacement nuclear power plant at the ANO site would alter ecological resources because of the need to convert additional land to industrial use. Some of this land, however, would have been previously disturbed.

Siting at ANO would have a MODERATE ecological impact that would be greater than renewal of the ANO-2 operating license.

At an alternate site, there would be construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts would alter the

ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling water from a nearby surface water body could have adverse aquatic resource impacts. Construction and maintenance of the transmission line would have ecological impacts. Overall, the ecological impacts at an alternate site would be MODERATE to LARGE [NRC 2003, Section 8.2.3.1].

8.1.3.1.3 Water Use and Quality

Surface Water: A replacement nuclear power plant located at the ANO site is assumed to use the existing closed-cycle cooling system. It would obtain potable water from the Russellville City Water System in a manner similar to the current practice for ANO. Thus, the environmental impacts would be similar to the existing ANO site. Surface-water impacts are expected to remain SMALL; the impacts would be sufficiently minor that they would not noticeably alter important attributes of the resource.

For a replacement reactor located at an alternate site, new intake structures would need to be constructed to provide water needs for the facility. Impacts would depend on the volume of water withdrawn for makeup, relative to the amount available from the intake source and the characteristics of the surface water. Plant discharges would be regulated by the State of Arkansas or other state jurisdiction. Some erosion and sedimentation may occur during construction. The impacts would be SMALL to MODERATE.

Groundwater: No groundwater is currently used for operation of ANO-1 or ANO-2. It is unlikely that groundwater would be used for an alternative nuclear power plant sited at ANO, so the impacts would be SMALL. A nuclear power plant sited at an alternate site may use groundwater. The impacts of such a withdrawal rate on an aquifer would be site specific and dependent on aquifer recharge and other withdrawal rates from the aquifer. Therefore, the overall impacts would be SMALL to LARGE.

8.1.3.1.4 Air Quality

Construction of a new nuclear plant at the ANO site or an alternate site would result in fugitive emissions during the construction process. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process. An operating nuclear plant would have minor air emissions associated with diesel generators. These emissions would be regulated. Emissions for a plant sited in Arkansas would be regulated by the ADEQ. Overall, emissions and associated impacts are considered SMALL [NRC 2003, Section 8.2.3.1].

8.1.3.1.5 Waste

The waste impacts associated with operation of a nuclear power plant are listed in Table B-1 of 10CFR Part 51 Subpart A, Appendix B. In addition to the impacts shown in Table B-1, construction-related debris would be generated during construction activities and removed to an appropriate disposal site. Overall, waste impacts are considered SMALL [NRC 2003, Section 8.2.3.1].

Siting the replacement nuclear power plant at a site other than ANO would not alter waste generation. Therefore, the impacts would be SMALL.

8.1.3.1.6 Human Health

Human health impacts for an operating nuclear power plant are identified in 10CFR Part 51 Subpart A, Appendix B, Table B-1. Overall, human health impacts are considered SMALL [NRC 2003, Section 8.2.3.1].

Siting the replacement nuclear power plant at a site other than ANO would not alter human health impacts. Therefore, the impacts would be SMALL.

8.1.3.1.7 Socioeconomics

It was assumed that the construction period would be 5 years and the peak work force would be 2500. It was also assumed that construction would take place while the existing nuclear unit continues operation and would be completed by the time ANO-2 permanently ceases operation. During construction, the communities surrounding the ANO site would experience demands on housing and public services that could have SMALL to MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from other counties. After construction, the communities would be impacted by the loss of the construction jobs [NRC 2003, Section 8.2.3.1].

The replacement nuclear unit is assumed to have an operating work force comparable to the approximately 629 workers currently at ANO-2. The replacement nuclear unit would provide a new tax base to offset the loss of tax base associated with decommissioning of ANO-2. The appropriate characterization of non-transportation socioeconomic impacts for operating replacement nuclear units constructed at the ANO site is SMALL to MODERATE.

During the 5-year construction period, up to 2500 construction workers would be working at the ANO site in addition to the approximately 1258 workers at ANO-1 and ANO-2. The addition of the construction workers could place significant traffic loads on existing highways, particularly those leading to the ANO site. Such impacts could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would be similar to current impacts associated with operation of ANO-2 and are considered SMALL.

Construction of a replacement nuclear power plant at an alternate site would relocate some socioeconomic impacts, but would not eliminate them. The communities around the ANO site would still experience the impact of ANO-2 operational job loss (although potentially tempered by projected economic growth), and the communities around the new site would have to absorb the impacts of a large, temporary work force (up to 2500 workers at the peak of construction) and a permanent work force of approximately 629 workers. In the GEIS, the NRC noted that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction work force would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis. Socioeconomic impacts at rural sites could be LARGE [NRC 2003, Section 8.2.3.1].

Transportation-related impacts associated with commuting workers at an alternate site are site dependent, but could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site dependent, but can be characterized as SMALL [NRC 2003, Section 8.2.3.1].

8.1.3.1.8 Aesthetics

The containment buildings for a replacement nuclear power plant sited at ANO and other associated buildings would be visible off-site in daylight hours. The nuclear unit would also be visible at night because of outside lighting. Visual impacts could be mitigated by landscaping and selecting a color for buildings that is consistent with the environment. Visual impact at night could be mitigated by reduced use of lighting and appropriate use of shielding. No exhaust stacks would be needed. No cooling towers would be needed, assuming use of the existing closed-cycle cooling system [NRC 2003, Section 8.2.3.1].

A replacement nuclear plant sited at ANO would be visible from Lake Dardanelle. However, with appropriate mitigation, the visual impact can be kept SMALL to MODERATE.

Noise from operation of a replacement nuclear power plant could potentially be audible near the site. Mitigation measures, such as reduced or no use of outside loudspeakers can be employed to reduce noise level and keep the impact SMALL [NRC 2003, Section 8.2.3.1].

At an alternate site, depending on placement, there would be an aesthetic impact from the buildings. There would also be a significant aesthetic impact associated with construction of a new transmission line to connect to other lines to enable delivery of electricity. Noise and light from the plant would be detectable offsite. The impact of noise and light would be mitigated if the plant is located in an industrial area adjacent to other power plants, in which case the impact could be SMALL. The impact could be MODERATE if a transmission line needs to be built to the alternate site. The impact could be LARGE if a greenfield site is selected [NRC 2003, Section 8.2.3.1].

8.1.3.1.9 Historic and Archeological Resources

At the ANO site, a cultural resources inventory would be needed for onsite property that has not been previously developed. Other lands acquired to support the plant would also need an inventory of field cultural resources, identification and recording of existing historic and archeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at the ANO site or another site, studies would be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would be needed for areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other rights-of-way). Historic and archeological resource impacts can generally be effectively managed and as such are considered SMALL.

Table 8-3
Summary of Environmental Impacts from Nuclear Power Generation
Closed-Cycle Cooling

Impact Category	ANO Site		Alternative Greenfield Site	
	Impact	**Comments**	**Impact**	**Comments**
Land Use	MODERATE	Requires 500 to 1000 acres for the plant and 1000 acres for uranium mining.	MODERATE to LARGE	Same as ANO site, plus land for transmission line
Ecology	MODERATE	Potential disturbance of undeveloped areas at current ANO site.	MODERATE to LARGE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and transmission line routes; potential habitat loss and fragmentation; reduced productivity and biological diversity.
Water Use and Quality:				
- Surface Water	SMALL	Uses existing intake and discharge structures and cooling system.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body. .
- Groundwater	SMALL	ANO-2 does not use groundwater nor is expected to use groundwater during license renewal period.	SMALL to LARGE	Groundwater impacts would depend on uses and available supply.

Table 8-3 (continued)

Impact Category	ANO Site		Alternative Greenfield Site	
	Impact	Comments	Impact	Comments
Air Quality	SMALL	Fugitive emissions and emissions from vehicles and equipment during construction. Small amount of emissions from diesel generators and possibly other sources during operation. Emissions are similar as current releases at ANO site.	SMALL	Same impacts as ANO site.
Waste	SMALL	Waste impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Appendix B, Table B-1. Debris would be generated and removed during construction.	SMALL	Same impacts as ANO site.
Human Health	SMALL	Human health impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Appendix B, Table B-1.	SMALL	Same impacts as ANO site.

Table 8-3 (continued)

Impact Category	ANO Site		Alternative Greenfield Site	
	Impact	Comments	Impact	Comments
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 2500 workers during peak period of the 5-year construction period. Operating work force assumed to be similar to ANO-2; tax base preserved. Impacts during operation would be SMALL.	MODERATE to LARGE	Construction impacts depend on location. Impacts at a rural location could be LARGE. Pope County would experience loss of tax base and employment with MODERATE impacts.
	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Transportation impacts of commuting workers during operations would be SMALL.	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Transportation impacts of commuting workers during operations would be SMALL.
Aesthetics	SMALL to MODERATE	Introduction of cooling towers and associated plume. Natural draft towers could be up to 520 feet. Mechanical draft towers could be up to 100 feet high and also have an associated noise impact.	SMALL to LARGE	Impacts would depend on the characteristics of the alternate site. Impacts would be SMALL if the plant is located adjacent to an industrial area. New transmission lines would add to the impacts and could be MODERATE. If a greenfield site is selected, the impacts could be LARGE.
Historic and Archaeological Resources	SMALL	Potential impacts can be effectively managed.	SMALL	Potential impacts can be effectively managed.

8.1.4 Imported Electrical Power

"Imported power" is power purchased and transmitted from electric generation plants that the applicant does not own and that are located elsewhere within the region, nation, or Canada. Entergy purchases substantial amounts of capacity on the wholesale market. The majority of the power is purchased on the wholesale market from the Tennessee Valley Authority. For the purposes of this analysis, it is assumed that replacement power would come from the TVA. As approximately 45 percent of electricity from the TVA is generated using fossil fuels, air emissions would be greater from purchased power than from generation by ANO-2. Other large generators in the region would have as high, if not higher, emissions rates, since energy production in the region is generally from older coal-fired plants that have the highest emission per kilowatt-hour of all generation sources [NRC 2001, Section 8.2.3].

In theory, imported power is a feasible alternative to ANO-2 license renewal. There is no assurance, however, that sufficient capacity or energy would be available in the 2018 through 2038 time-frame to replace the 1023 MWe net base-load generation. More importantly, regardless of the technology used to generate imported power, the generating technology would be one of those described in this ER and in the GEIS (probably coal, natural gas, nuclear, or hydro-electric). The GEIS, Chapter 8, description of the environmental impacts of other technologies is representative of the imported electrical power alternative to ANO-2 license renewal [NRC 2001, Section 8.2.3].

8.2 <u>Alternatives Not Within the Range of Reasonable Alternatives</u>

Other commonly known generation technologies considered are listed in the following paragraphs. However, these sources have been eliminated as reasonable alternatives to the proposed action because the generation of 1023 net MWe of electricity as a base-load supply using these technologies is not technologically feasible.

8.2.1 Wind

The average annual capacity factor for this technology was estimated at 21 percent in 1995 and is projected to be 29 percent in 2010. This low-capacity factor results from the high degree of intermittence of wind energy in many locations. Current energy storage technologies are too expensive to permit wind power plants to serve as large base-load plants. Wind-energy has a large land requirement, approximately 150,000 acres of land to generate 1000 MWe of electricity. This eliminates the possibility of co-locating a wind-energy facility with a retired nuclear power plant. A greenfield siting plan would be required. This would have a LARGE impact upon much of the natural environment in the affected areas [NRC 2001, Section 8.2.4.1].

8.2.2 Solar

The average capacity factor for this technology is estimated to be between 25 and 40 percent annually. This technology has high capital costs and lacks base-load capability unless combined with natural gas backup. It requires very large energy-storage capabilities. Based

upon solar energy resources, the most promising region of the country for this technology is the West. Land use requirements again are high: 14,000 acres for 1000 MWe, which would result in LARGE environmental impacts to the affected area [NRC 2001, Section 8.2.4.2].

8.2.3 Hydropower

Hydroelectric power has an average annual capacity factor of 46 percent. Section 8.3.4 of the GEIS, indicates that the percentage of the U.S. electrical generation consisting of hydroelectricity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern over flooding, destruction of natural habitat, and destruction of natural river courses. Section 8.3.4 of the GEIS, estimates land use of 1-million acres per 1000 MWe for hydroelectric power, resulting in a LARGE environmental impact. Due to the lack of locations for siting a hydroelectric facility large enough to replace ANO-2, local hydropower is not a feasible alternative to ANO-2 license renewal [NRC 2001, Section 8.2.4.3].

8.2.4 Geothermal

Geothermal has an average capacity factor of 90 percent and can be used for base-load power where available. However, as illustrated by Figure 8.4 in the GEIS, geothermal plants might be located in the western continental U.S., Alaska, and Hawaii where geothermal reservoirs are prevalent. This technology is not widely used as base-load generation due to the limited geographic availability of the resource and the immature status of the technology. This technology is not applicable to the region where the replacement of 1023 MWe is needed. There is no feasible location for geothermal generation within the Entergy service area [NRC 2001, Section 8.2.4.4].

8.2.5 Wood Energy

A wood-burning facility can provide base-load power and operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency. The cost of the fuel required for this type of facility is highly variable and very site-specific. The rough cost for construction of this type of facility in the ANO-2 area, where the replacement of 1023 MWe is needed, is approximately $800 per kilowatt. Among the factors influencing costs are the environmental considerations and restrictions that are influenced by public perceptions, easy access to fuel sources, and environmental factors. In addition, the technology is expensive and inefficient. Therefore, economics alone eliminate biomass technology as a reasonable alternative [NRC 2001, Section 8.2.4.5].

8.2.6 Municipal Solid Waste

The initial capital costs for this technology are much greater than the comparable steam-turbine technology found at wood-waste facilities. This is due to the need for specialized municipal solid waste-handling and waste-separation equipment and stricter environmental emissions controls. The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than by energy considerations. High costs prevent this

technology from being economically competitive. Thus, municipal solid waste generation is not a reasonable alternative [NRC 2001, Section 8.2.4.6].

8.2.7 Other Biomass-Derived Fuels

In addition to wood and municipal solid waste fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive for automotive fuel), and gasifying energy crops (including wood waste). The GEIS points out that none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a base-load plant such as ANO-2. For these reasons, such fuels do not offer a feasible alternative to ANO-2 license renewal. In addition, these systems have LARGE impacts on land use [NRC 2001, Section 8.2.4.7].

8.2.8 Oil

Oil is not considered a stand-alone fuel because it is not cost-competitive when natural gas is available. The cost of an oil-fired operation is about eight times as expensive as a nuclear or coal-fired operation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive than coal-fired generation. For these reasons, oil-fired generation is not a feasible alternative to ANO-2 license renewal, nor is it likely to be included in a mix with other resources except as a back-up fuel [NRC 2001, Section 8.2.4.8].

8.2.9 Fuel Cells

Phosphoric acid fuel cells are the most mature fuel-cell technology, but they are only in the initial stages of commercialization. Two-hundred turnkey plants have been installed in the U.S., Europe, and Japan. Recent estimates suggest that a company would have to produce 100 MWe of fuel-cell stacks annually to achieve a price of $1000 to $1500 per kilowatt. However, the current production capacity of all fuel-cell manufacturers only totals about 60 MW per year. The use of fuel cells for base-load capacity requires very large energy-storage devices that are not feasible for storage of sufficient electricity to meet the base-load generating requirements. This is a very expensive source of generation, which prevents it from being competitive. This technology also has a high land use impact, which, like wind technology, results in a LARGE impact to the natural environment. It is estimated that 35,000 acres of land would be required to generate 1000 MWe of electricity. Therefore, fuel cells are not considered a feasible alternative to license renewal [NRC 2001, Section 8.2.4.10].

8.2.10 Delayed Retirement

The delayed retirement of fossil generation sources could not be used to replace the generation capacity of 1023 net MWe of ANO-2, because the sources facing retirement in the Entergy system are used for peaking and intermediate generation. Additionally, there is no guarantee that these fossil units could economically operate for an additional 20 years after the current decision dates. Entergy does not have plans to retire any of its base-load fossil plants. Therefore, delayed retirement of base-load fossil generation could not be used as an alternative

to license renewal unless such retiring base-load capacity could be found in a neighboring utility system. (The impact would then be that of imported power.) For these reasons, the delayed retirement of non-nuclear generating units is not considered a reasonable alternative to license renewal for ANO-2 [NRC 2001, Section 8.2.4.11].

8.2.11 Utility-Sponsored Conservation

The concept of conservation as a resource does not meet the primary NRC criterion "that a reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable". It is neither single, nor discrete, nor is it a source of generation [NRC 2001, Section 8.2.4.12].

The output of ANO-2, however, could be displaced by reducing energy use through a substantial amount of energy conservation. Entergy currently is reducing emissions and increasing efficiency at its plants in order to decrease greenhouse gas emissions as part of the Federal government's Climate Challenge for utilities. The carbon dioxide emissions reduction in 1998 totaled approximately 5.3 million tons, corresponding to a reduction in fossil generation of approximately 7 million MWh, using the average emissions rate for Entergy's fossil plants. This reduction, however, and future reductions of CO_2 emissions, are already accounted for in Entergy's generation needs [NRC 2001, Section 8.2.4.12].

From a review of the conservation plans at other companies, it is assumed that it would potentially be possible to displace approximately 5 percent of the generation from ANO-2 from a targeted program. The environmental impacts of an energy conservation program would be SMALL, but the potential to displace the entire generation at ANO-2 solely with conservation is not realistic [NRC 2001, Section 8.2.4.12].

8.2.12 Combination of Alternatives

NRC indicated in the GEIS that, while many methods are available for generating electricity and a huge number of combinations or mixes can be assimilated to meet system needs, such expansive consideration would be too unwieldy given the purposes of the alternatives analysis. Therefore, NRC determined that a reasonable set of alternatives should be limited to analysis of single discrete electrical generation sources and only those electric generation technologies that are technically reasonable and commercially viable [NRC 1996, Section 8.1]. Consistent with the NRC determination, Entergy has not evaluated mixes of generating sources.

8.3 Proposed Action vs. No-Action

The proposed action is the renewal of the operating license Arkansas Nuclear One – Unit 2. The specific review of the twelve environmental impacts, required by 10CFR51.53(c)(3)(ii), concluded that there would be no adverse impact to the environment from the continued operation of ANO-2 through the period of extended operation.

The no-action alternative to the proposed action is the decision not to pursue renewal of the operating license for ANO-2. The environmental impacts of the no-action alternative would be the impacts associated with the construction and operation of the type of replacement power utilized. In effect, the net environmental impacts would be transferred from the continued operation of ANO-2 to the environmental impacts associated with the construction and operation of a new generating facility. This new generating facility would almost certainly be constructed at a greenfield location due to the air impacts associated with constructing one of the viable technologies on the ANO site. Therefore, the no-action alternative would have no net environmental benefits.

The environmental impacts associated with the proposed action (the continued operation of ANO-2) were compared to the environmental impacts from the no-action alternative (the construction and operation of other reasonable sources of electric generation). Entergy believes this comparison shows that the continued operation of ANO-2 would produce fewer significant environmental impacts than the no-action alternative. There are significant differences in the impacts to air quality and land use between the proposed action and the reasonable alternative generation sources.

In addition, there would be adverse socioeconomic impacts (including local unemployment, loss of local property tax revenue, and higher energy costs) to the area around ANO from the decision not to pursue license renewal.

The *Joint DOE-Electric Power Research Institute Strategic Research and Development Plan to Optimize US Nuclear Power Plants* stated "… nuclear energy was one of the prominent energy technologies that could contribute to alleviate global climate change and also help in other energy challenges including reducing dependence on imported oil, diversifying the US domestic electricity supply system, expanding US exports of energy technologies, and reducing air and water pollution." The Department of Energy agreed with this perspective and stated "…it is important to maintain the operation of the current fleet of nuclear power plants throughout their safe and economic lifetimes" [DOE-EPRI 1998]. The renewal of the ANO-2 operating license is consistent with these goals.

8.4 Summary

The proposed action is the renewal of the ANO-2 operating license. The proposed action would provide the continued availability of approximately 1023 megawatts of base-load power generation through 2038.

The environmental impacts of the continued operation of ANO-2, providing approximately 1023 megawatts of base-load power generation through 2038, are superior to impacts associated with the best case among reasonable alternatives. The continued operation of ANO-2 would create significantly less environmental impact than the construction and operation of new base-load generation capacity.

Finally, the continued operation of ANO-2 will have a significant positive economic impact on the communities surrounding the station.

8.5 References

DOE-EPRI (Department of Energy–Electric Power Research Institute). 1998. "*Joint DOE-EPRI Strategic Research and Development Plan to Optimize U. S. Nuclear Power Plants*", Volume 1, March 20, 1998.

NRC (U.S. Nuclear Regulatory Commission). 1996. NUREG-1437, Generic Environmental Statement for License Renewal of Nuclear Power Plants, Final Report, May 1996.

NRC (U.S. Nuclear Regulatory Commission). 2001. Generic Environmental Impact Statement for License Renewal of Nuclear Plants" Arkansas Nuclear One, Unit 1, NUREG-1437, Supplement 3. Office of Nuclear Reactor Regulation, Washington, D.C., April 2001.

NRC (U.S. Nuclear Regulatory Commission). 2003. Generic Environmental Impact Statement for License Renewal of Nuclear Plants" Peach Bottom Atomic Power Station, Units 2 and 3. NUREG-1437, Supplement 10. Office of Nuclear Reactor Regulation, Washington, D.C., January 2003.

9.0 STATUS OF COMPLIANCE

9.1 Requirement [10CFR51.45(d)]

"The environmental report shall list all Federal permits, licenses, approvals and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The environmental report shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection."

9.2 Environmental Permits

Table 9-1 provides a list of the environmental permits held by ANO and the compliance status of these permits. These permits will be in place as appropriate throughout the period of extended operation given their respective renewal schedules. Other than routine renewals required at frequencies specified by the permits in Table 9-1, no state, federal, or local environmental permits have been identified as being required for re-issuance to support the extension of the ANO-2 operating license.

Since ANO is not located in a municipality, no zoning or land use restrictions apply.

9.3 Environmental Permits - Discussion of Compliance

Station personnel are primarily responsible for monitoring and ensuring that ANO complies with its environmental permits and applicable regulations. Sampling results are submitted to the appropriate agency. ANO has an excellent record of compliance with its environmental permits, including monitoring, reporting and operating within specified limits.

ANO has three ponds (lagoons) for treating domestic sewage wastewater and one emergency cooling pond for auxiliary cooling located on-site. These ponds are regulated under NPDES Permit AR0001392.

Entergy Operations has measures in place to ensure those environmentally sensitive areas of species of concern are adequately protected during site operations and project planning. These measures include an environmental evaluation checklist and also established controls and methods for evaluating potential environmental affects from plant operations and project planning. Therefore, planned projects or changes in plant operations would be required to undergo an environmental evaluation prior to implementation, with appropriate permits obtained or modified as necessary.

Maintenance activities along transmission line rights-of-way are controlled through contracts established between Entergy and the contractor. The contract outlines contractors' responsibilities regarding obtaining appropriate federal, state or local permits, including abiding with applicable environmental laws. The vegetation management method used along the

Entergy transmission line rights-of-way is mechanical clearing only. No herbicide application is utilized along this corridor. Semiannually, an aerial survey of the transmission corridor is performed to identify issues that would cause potential operational problems (i.e., erosion, vegetation control, equipment maintenance).

9.4 Agency Consultations

Although not required of an applicant by federal law or NRC regulation, Entergy has chosen to invite comment from the following federal and state agencies regarding potential effects that ANO-2 license renewal might have on threatened and endangered species and archaeological and historical sites:

Agency	Authority	Requirement	Activity Covered
U. S. Fish and Wildlife Service	Endangered Species Act Section 7	Consultation	Requires Federal agency issuing a license to consult with USFWS.
Arkansas Game and Fish Commission	Endangered Species Act Section 7	Consultation	Requires Federal agency issuing a license to consult with USFWS.
Arkansas State Historic Preservation Office	National Historic Preservation Act Section 106	Consultation	Requires Federal agency issuing a license to consider cultural impacts and consult with SHPO.
Arkansas Natural Heritage Commission	National Historic Preservation Act Section 106	Consultation	Requires Federal agency issuing a license to consider cultural impacts and consult with SHPO.

9.5 Other Permits and Licenses

Storage of spent fuel in an Independent Spent Storage Installation is conducted at ANO under a general permit issued in accordance with 10CFR72.210. Because a general permit has been issued by the NRC in accordance with 10CFR72.210, a plant specific license for the ISFSI is not required at ANO.

10CFR72.214 provides a list of approved spent fuel storage casks. ANO utilizes the VSC-24 Dry Storage Cask licensed by the NRC in Certificate of Compliance number 1007 and the HI-STORM 100 Dry Storage Cask licensed by the NRC in Certificate of Compliance number 1014. The VSC-24 Certificate of Compliance was issued on May 7, 1993 and expires May 7, 2013. The HI-STORM 100 Certificate of Compliance was issued on June 1, 2000 and expires June 1, 2020 (see 10CFR72.214).

Table 9-1
ANO Environmental Permits and Compliance Status

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
ADEQ	Clean Air Act Section 112	Air Permit	0090-AR-3	Issued October 11, 2002 No Expiration	Operation of air emission sources (diesel generators and boilers).
ADEQ	Federal Water Pollution Control Act Section 402	NPDES Permit	ARD0001392	Issued January 1, 2003 Expires December 31, 2007	Plant wastewater discharges to Lake Dardanelle.
ADEQ	Resource Conservation and Recovery Act – Subtitle C	Hazardous Waste Generator	ARD0006327 52	Not Applicable	Hazardous waste generation
ASWCC	Not Applicable	Water Use Registration	4124	Not Applicable	Divert water from Lake Dardanelle for plant use.
ADEQ	RCRA – Subtitle I	Petroleum storage tank registration	58000008 58000009	Issued July 31, 2003 Expires July 31, 2004	Underground diesel fuel storage.
CILRWC	Export Authorization Letter	Export Permit	None	Issued July 2, 2002 Expires June 30, 2004	Shipment of radioactive waste outside the regional compact.
CoE	Federal Water Pollution Control Act Section 404	Dredging Permit	00241-5	Issued March 27, 1997 No Expiration	Dredging of intake canal as needed.

Table 9-1 (continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
CoE	Title 10 USC Section 2668	Dardanelle Water Use Agreement	DACW03-71-0002	Issued November 3, 1972 No Expiration	Evaporative water loss from Lake Dardanelle.
DOT	49 CFR 107, Subpart G	Registration	053002 034 034K	Issued May 9, 2003 Expires June 30, 2004	Radioactive and hazardous materials shipments.
NRC	Atomic Energy Act, 10 CFR Part 50	License to operate	DPR-51	Issued May 21, 1974 Expires May 20, 2034	Operation of ANO-1.
NRC	Atomic Energy Act, 10 CFR Part 50	License to operate	NPF-6	Issued July 17, 1978 Expires July 17, 2018	Operation of ANO-2.
SCDHEC	South Carolina Radioactive Waste Transportation and Disposal Act (S.C. Code of Laws 13-7-110 et seq.)	Radioactive Waste Transport Permit	0047-03-03-X	Issued December 31, 2002 Expires December 31, 2003	Transportation of radioactive waste to disposal facility in South Carolina
TDEC	TCA 68-202-206	Radioactive Waste License for Delivery	T-AR001-L03	Issued January 2, 2002 Expires December 31, 2003	Shipment of radioactive waste to disposal/processing facility in Tennessee.
UDEQ	Land Disposal for Utah R313-26	Radioactive Waste Transport Permit	0209001642	Issued 10/10/02 Expires 10/10/03	Shipment of low-level radioactive waste to Envirocare in Clive, Utah.

ADEQ – Arkansas Department of Environmental Quality

ASWCC – Arkansas Soil and Water Conservation Commission

CILRWC - Central Interstate Low-Level Radioactive Waste Commission

CoE – U. S. Army Corps of Engineers

DOT – U. S. Department of Transportation

NRC – U. S. Nuclear Regulatory Commission

UDEQ - Utah Department of Environmental Quality (Division of Radiation Control)

SCDHEC - South Carolina Department of Health and Environmental Control

TDEC - Tennessee Department of Environment and Conservation