NUREG-1437
Supplement 12

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

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Regarding Fort Calhoun Station, Unit 1

Final Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

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Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
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Abstract

The U.S. Nuclear Regulatory Commission (NRC) considered the environmental impacts of renewing nuclear-power-plant operating licenses (OLs) for a 20-year period in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, and codified the results in 10 CFR Part 51. The GEIS (and its Addendum 1) identifies 92 environmental issues and reaches generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. Additional plant-specific review is required for the remaining 23 issues. These plant-specific reviews are to be included in a supplement to the GEIS.

This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted to the NRC by the Omaha Public Power District (OPPD) to renew the OL for Fort Calhoun Station, Unit 1 for an additional 20 years under 10 CFR Part 54. This SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither the OPPD nor the staff has identified information that is both new and significant for any of these issues that apply to Fort Calhoun Station, Unit 1. In addition, the staff determined that information provided during the scoping process did not call into question the conclusions in the GEIS. Therefore, the staff concludes that the impacts of renewing the Fort Calhoun Station, Unit 1 OL will not be greater than the impacts identified for these issues in the GEIS. For each of these issues, the GEIS conclusion is that the impact is of SMALL[(a)] significance (except for collective offsite radiological impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned a single significance level).

Regarding the remaining 23 issues, those that apply to Fort Calhoun Station, Unit 1 are addressed in this SEIS. For each applicable issue, the staff concludes that the significance of the potential environmental impacts of renewal of the OL is SMALL. The staff also concludes that additional mitigation measures are not likely to be sufficiently beneficial as to be warranted. The staff determined that information provided during the scoping process did not identify any new issue that has a significant environmental impact.

(a) Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

Abstract

The NRC staff's recommendation is that the Commission determine that the adverse environmental impacts of license renewal for Fort Calhoun Station, Unit 1 are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by the OPPD; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of the public comments.

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Executive Summary

By letter dated January 9, 2002, the Omaha Public Power District (OPPD) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license (OL) for Fort Calhoun Station, Unit 1 for an additional 20-year period. This application was subsequently revised by the OPPD by letter dated January 18, 2002. If the OL is renewed, State regulatory agencies and the OPPD will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OL is renewed, the schedule is to issue the renewed license by November 2003. The renewed license would supercede the current license. The renewed license would expire on August 9, 2033, which is 20 years after the original license expiration date. If the OL is not renewed, then the plant must be shut down at or before the expiration date of the current OL, which is August 9, 2013.

Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321) directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51, Subpart A. In 10 CFR 51.20(b)(2), the Commission requires the preparation of an EIS or a supplement to an EIS for the renewal of a reactor OL; 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2.[(a)]

Upon acceptance of the OPPD application, the NRC began the environmental-review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping. The staff visited Fort Calhoun Station in June 2002 and held public scoping meetings on June 18, 2002, in Omaha, Nebraska. In preparing this supplemental environmental impact statement (SEIS) for Fort Calhoun Station, Unit 1, the staff reviewed the OPPD Environmental Report (ER) and compared it to the GEIS; consulted with other agencies; conducted an independent review of the issues following the guidance set forth in the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal,* NUREG-1555, Supplement 1; and considered the public comments received during the scoping process. The public comments received during the scoping process that were considered to be within the scope of the environmental review are provided in Appendix A, Part I, of this SEIS.

On January 14, 2003, the Notice of Availability of the draft SEIS and notice of public meetings to discuss the draft SEIS was published in the Federal Register (68FR1873). A 75-day

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

comment period began on that date, during which members of the public could comment on the preliminary results of the staff's review. The staff held two public meetings in Omaha, Nebraska, on February 26, 2003, to describe the preliminary results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on the draft SEIS. All of the comments received on the draft SEIS were considered in developing the final SEIS and are presented in Appendix A, Part II.

This SEIS includes the NRC staff's analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures for reducing or avoiding adverse effects. It also includes the staff's recommendation regarding the proposed action.

The Commission has adopted the following statement of purpose and need for license renewal from the GEIS:

> 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) decisionmakers.

The goal of the staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

> ... whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OL.

NRC regulations [10 CFR 51.95(c)(2)] contain the following statement regarding the content of SEISs prepared at the license renewal stage:

> The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed

> action and the alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) ["Temporary storage of spent fuel after cessation of reactor operation–generic determination of no significant environmental impact"] and in accordance with § 51.23(b).

The GEIS contains the results of a systematic evaluation of the consequences of renewing an OL and operating a nuclear power plant for an additional 20 years. It evaluates 92 environmental issues using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines. The following definitions of the three significance levels are set forth in a footnote to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
>
> LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS led to the following conclusions:

(1) 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.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the staff relied on conclusions as amplified by supporting information in the GEIS for issues designated as Category 1 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized. Environmental justice was not evaluated on a generic basis and must be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

This SEIS documents the staff's evaluation of all 92 environmental issues considered in the GEIS. The staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the OL for Fort Calhoun Station, Unit 1) and alternative methods of power generation. Based on projections made by the U.S. Department of Energy's Energy Information Administration, natural-gas- and coal-fired generation appear to be the most likely power-generation alternatives if the power from Unit 1 is replaced. These alternatives are evaluated assuming that the replacement power-generation plant is located at either the Fort Calhoun Station site, the OPPD's existing Nebraska City site for coal-fired generation, or the OPPD's existing Cass County site for natural-gas-fired generation.

The OPPD and the staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither the OPPD nor the staff has identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither the scoping process nor the staff has identified any new issue applicable to Fort Calhoun Station, Unit 1 that has a significant environmental impact. These determinations included consideration of public comments. Therefore, the staff relies upon the conclusions of the GEIS for all of the Category 1 issues that are applicable to Fort Calhoun Station, Unit 1.

The OPPD's license renewal application presents an analysis of the Category 2 issues that are applicable to Fort Calhoun Station, Unit 1 plus environmental justice. The staff has reviewed the OPPD analysis for each issue and has conducted an independent review of each issue plus the chronic effects of electromagnetic fields. Five Category 2 issues are not applicable, because they are related to plant design features or site characteristics not found at Fort Calhoun Station. Four Category 2 issues are not discussed in this SEIS, because they are specifically related to refurbishment. The OPPD has stated that its evaluation of structures and components, as required by 10 CFR 54.21, did not identify any major plant refurbishment activities or modifications as necessary to support the continued operation of Fort Calhoun Station, Unit 1 for the license renewal period.

Twelve Category 2 issues related to operational impacts and postulated accidents during the renewal term, as well as environmental justice and chronic effects of electromagnetic fields, are discussed in detail in this SEIS. Five of the Category 2 issues and environmental justice apply

to both refurbishment and to operation during the renewal term and are only discussed in this SEIS in relation to operation during the renewal term. For all 12 Category 2 issues and environmental justice, the staff concludes that the potential environmental effects are of SMALL significance in the context of the standards set forth in the GEIS. In addition, the staff determined that the appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for Fort Calhoun Station, Unit 1 and the plant improvements already made, the staff concludes that, with the exception of the seven candidate SAMAs identified for implementation, none of the remaining candidate SAMAs are cost-beneficial.

Mitigation measures were considered for each Category 2 issue. Current measures to mitigate the environmental impacts of plant operation were found to be adequate, and no additional mitigation measures were deemed sufficiently beneficial to be warranted.

If the Fort Calhoun Station, Unit 1 OL is not renewed and the unit ceases operation on or before the expiration of the current OL, then the adverse impacts of likely alternatives will not be smaller than those associated with continued operation of Fort Calhoun Station, Unit 1. The impacts may, in fact, be greater in some areas.

The recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for Fort Calhoun Station, Unit 1 are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the ER submitted by the OPPD; (3) consultation with other Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of the public comments.

Abbreviations/Acronyms

°	degree
μ	micro
μCi	microcurie(s)
μCi/mL	microcurie(s) per milliliter
μGy	microgray(s)
μm	micrometer(s)
μSv	microsievert(s)
A/C	air conditioner
ac	acre(s) or alternating current
ACC	averted cleanup and decontamination cost
ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Act of 1954
AEC	U.S. Atomic Energy Commission
AOC	averted offsite property damage costs
AOE	averted occupational exposure
AOSC	averted onsite costs
APE	averted public exposure
AQCR	air quality control region
ATWS	anticipated transient without scram
Bq	becquerel(s)
Bq/mL	becquerel(s) per milliliter
Btu	British thermal unit(s)
Btu/ft^3	British thermal unit(s) per cubic foot
Btu/kWh	British thermal unit(s) per kilowatt hour
C	Celsius
CAA	Clean Air Act
CARP	chemical and radiation protection
CDF	core damage frequency
CE	Combustion Engineering
CEOG	Combustion Engineering Owners Group
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Ci	curie(s)
cm	centimeter(s)
cm/s	centimeter(s) per second
COE	cost of enhancement

CSU	Colorado State University
CWA	Clean Water Act
CWCP	current water control plan
DBA	design-basis accident
dc	direct current
DOE	U.S. Department of Energy
DPR	demonstration project reactor
DSM	demand-side management
ECCS	emergency core cooling system
EDG	emergency diesel generator
EIA	Energy Information Administration (of DOE)
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
F	Fahrenheit
FES	final environmental statement
FIVE	fire-induced vulnerability evaluation
FPS	fire-protection system
FR	*Federal Register*
ft	foot (feet)
ft/s	foot (feet) per second
ft^3	cubic foot (feet)
ft^3/s	cubic foot (feet) per second
ft^3/yr	cubic foot (feet) per year
F–V	Fussel–Veseley
FWS	U.S. Fish and Wildlife Service
gal	gallon(s)
gal/s	gallon(s) per second
GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437
gpd	gallon(s) per day
gpm	gallon(s) per minute
Gy	gray(s)

ha	hectare(s)
HEPA	high-efficiency particulate air (filter)
HIC	high-integrity container
HLW	high-level waste
hr	hour(s)
HRA	human reliability analysis
Hz	Hertz
IDNR	Iowa Department of Natural Resources
in.	inch(es)
IPE	individual plant examination
IPEEE	individual plant examination of external events
ISLOCA	interfacing systems loss-of-coolant accident
J	joule(s)
km	kilometer(s)
kV	kilovolt(s)
kW	kilowatt(s)
kWh	kilowatt hour(s)
kWh/m^2	kilowatt hour(s) per square meter
L	liter(s)
L/d	liter(s) per day
L/min	liter(s) per minute
L/s	liter(s) per second
lb	pound(s)
lb/MWh	pound(s) per megawatt hour
LOCA	loss-of-coolant accident
LOCCW	loss-of-component cooling water
LOOP	loss of offsite power
LOS	level of service
m	meter(s)
m/s	meter(s) per second
m^3	cubic meter(s)
m^3/d	cubic meter(s) per day
m^3/s	cubic meter(s) per second
m^3/yr	cubic meter(s) per year
mA	milliampere(s)
MAB	maximum attainable benefit

MACCS2	MELCOR Accident Consequence Code System 2
MBq	megabecquerel(s)
MBq/L	megabecquerel(s) per liter
mGy	milligray(s)
mi	mile(s)
mL	milliliter(s)
mm	millimeter(s)
mph	mile(s) per hour
mrad	millirad(s)
mrem	millirem(s)
mrem/yr	millirem(s) per year
MSA	Metropolitan Statistical Area
mSv	millisievert(s)
mSv/yr	millisievert(s) per year
MT	metric ton(s) (or tonne[s])
MTHM	metric ton(s) (or tonne[s]) of heavy metal
MT/yr	metric ton(s) (or tonne[s]) per year
MTU	metric ton(s) (or tonne[s])-uranium
MW	megawatt(s)
MWd/MTU	megawatt-day(s) per metric ton (or tonne) of uranium
MW(e)	megawatt(s) electric
MWh	megawatt hour(s)
MW(t)	megawatt(s) thermal
NA	not applicable
NAC	Nebraska Administrative Code
NDEC	Nebraska Department of Environmental Control
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NEPA	National Environmental Policy Act of 1969
NESC	National Electric Safety Code
ng	nanogram(s)
ng/J	nanogram(s) per joule
NGPC	Nebraska Game and Parks Commission
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NO_x	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NPPD	Nebraska Public Power District
NRC	U.S. Nuclear Regulatory Commission
NSHS	Nebraska State Historical Society

ODCM	*Offsite Dose Calculation Manual*
OL	operating license
OPPD	Omaha Public Power District
PBq	petabecquerel(s)
pCi	picocurie(s)
pCi/L	picocurie(s) per liter
PDS	plant damage state
PM_{10}	particulate matter, 10 micrometers or less in diameter
PORV	power-operated relief valve
PRA	probabilistic risk assessment
psig	pounds per square inch above atmospheric pressure
PWR	pressurized-water reactor
RAI	request for additional information
RAS	recirculation actuation signal
RAW	risk achievement worth
RCP	reactor coolant pump
RCS	reactor coolant system
rem	special unit of dose equivalent, equal to 0.01 sievert
REMP	radiological environmental monitoring program
RIMS	Regional Input-Output Modeling System
rkm	river kilometer
rmi	river mile
RPC	replacement-power cost
RRW	risk-reduction worth
RWPB	radioactive-waste-processing building
s	second(s)
SAMA	severe accident mitigation alternative
SAR	safety analysis report
SBO	station blackout
SEIS	supplemental environmental impact statement
SER	safety evaluation report
SG	steam generator
SGTR	steam-generator tube rupture
SHPO	State Historic Preservation Office
SIRWT	safety injection refueling water storage tank
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
Sv	sievert(s), special unit of dose equivalent

TBq	terabecquerel(s)
TLD	thermoluminescent dosimeter
UFSAR	updated final safety analysis report
U.S.	United States
USACE	U.S. Army Corps of Engineers
USBC	U.S. Bureau of the Census
USC	United States Code
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
V	volt(s)
yr	year(s)

1.0 Introduction

Under the Nuclear Regulatory Commission's (NRC's) environmental-protection regulations in Title 10 of the Code of Federal Regulations (CFR) Part 51, which implement the National Environmental Policy Act of 1969 (NEPA), renewal of a nuclear power plant operating license (OL) requires the preparation of an environmental impact statement (EIS). In preparing the EIS, the NRC staff is required first to issue the statement in draft form for public comment and then issue a final statement after considering public comments on the draft. To support the preparation of the EIS, the staff has prepared a *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)] The GEIS is intended to (1) provide an understanding of the types and severity of environmental impacts that may occur as a result of license renewal of nuclear power plants under 10 CFR Part 54, (2) identify and assess the impacts that are expected to be generic to license renewal, and (3) support 10 CFR Part 51 to define the number and scope of issues that need to be addressed by the applicants in plant-by-plant renewal proceedings. The GEIS guides the preparation of complete plant-specific information in support of the OL renewal process.

The Omaha Public Power District (OPPD) operates the Fort Calhoun Station, Unit 1 in Nebraska under OL DPR-40, which was issued by the NRC. This OL will expire in August 2013. On January 9, 2002, the OPPD submitted an application to the NRC to renew the Fort Calhoun Station, Unit 1 OL for an additional 20 years under 10 CFR Part 54. On January 18, 2002, the OPPD submitted a revised application that corrected minor administrative errors in Appendix E of the application. The OPPD is a *licensee* for the purposes of its current OL and an *applicant* for the renewal of the OL. Pursuant to 10 CFR 54.23 and 51.53(c), the OPPD submitted an Environmental Report (ER; OPPD 2002) as Appendix E to the OL renewal application in which the OPPD analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects.

This report is the plant-specific supplement to the GEIS (the supplemental EIS [SEIS]) for the OPPD license renewal application. This SEIS is a supplement to the GEIS because it relies, in part, on the findings of the GEIS. The staff will also prepare a separate safety evaluation report in accordance with 10 CFR Part 54.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

1.1 Report Contents

The following sections of this introduction (1) describe the background for the preparation of this SEIS, including the development of the GEIS and the process used by the staff to assess the environmental impacts associated with license renewal; (2) describe the proposed Federal action to renew the Fort Calhoun Station, Unit 1 OL; (3) discuss the purpose and need for the proposed action; and (4) present the status of the OPPD's compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies that are responsible for environmental protection.

The ensuing chapters of this SEIS closely parallel the contents and organization of the GEIS. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 and 4, respectively, discuss the potential environmental impacts of plant refurbishment and plant operation during the renewal term. Chapter 5 contains an evaluation of potential environmental impacts of plant accidents and includes a consideration of severe accident mitigation alternatives. Chapter 6 discusses the uranium fuel cycle and solid-waste management. Chapter 7 discusses decommissioning, and Chapter 8 discusses alternatives to license renewal. Finally, Chapter 9 summarizes the findings of the preceding chapters and draws conclusions about the adverse impacts that cannot be avoided (the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and the irreversible or irretrievable commitment of resources). The final chapter also presents the staff's recommendation with respect to the proposed license renewal action.

Additional information is included in appendices. Appendix A contains public comments received on the environmental review for license renewal and staff responses. Appendices B through F, respectively, list the following:

- the contributors to the supplement
- the chronology of the NRC staff's environmental review correspondence related to this SEIS
- the organizations contacted during the development of this SEIS
- the OPPD's compliance status
- GEIS environmental issues that are not applicable to Fort Calhoun Station, Unit 1.

1.2 Background

Use of the GEIS, which examines the possible environmental impacts that could occur as a result of renewing individual nuclear-power-plant OLs under 10 CFR Part 54, and the established license renewal evaluation process supports the thorough evaluation of the impacts of the renewal of OLs.

1.2.1 Generic Environmental Impact Statement

The NRC initiated a generic assessment of the environmental impacts associated with the license renewal term to improve the efficiency of the license renewal process by documenting the assessment results and codifying the results in the Commission's regulations. This assessment is provided in the GEIS, which serves as the principal reference for all nuclear power plant license renewal EISs.

The GEIS documents the results of the systematic approach that was taken to evaluate the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. For each potential environmental issue, the GEIS (1) describes the activity that affects the environment, (2) identifies the population or resource that is affected, (3) assesses the nature and magnitude of the impact on the affected population or resource, (4) characterizes the significance of the effect for both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants, and (6) considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants.

The NRC's standard of significance was established using the Council on Environmental Quality (CEQ) terminology for "significantly" (40 CFR 1508.27, which requires consideration of both "context" and "intensity"). Using the CEQ terminology, the NRC established three significance levels—SMALL, MODERATE, or LARGE. The definitions of the three significance levels are set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, 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.

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

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

The GEIS assigns a significance level to each environmental issue, assuming that ongoing mitigation measures would continue.

The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, **Category 1** issues are those that meet all of the following criteria:

(1) 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.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) 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 not be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this SEIS unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1, and therefore, additional plant-specific review for these issues is required.

In the GEIS, the staff assessed 92 environmental issues and determined that 69 qualified as Category 1 issues, 21 qualified as Category 2 issues, and 2 issues were not categorized. The latter 2 issues, environmental justice and chronic effects of electromagnetic fields, are to be addressed in a plant-specific analysis. Of the 92 issues, 11 are related only to refurbishment, 6 are related only to decommissioning, 67 apply only to operation during the renewal term, and 8 apply to both refurbishment and operation during the renewal term. A summary of the findings for all 92 issues in the GEIS is codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

1.2.2 License Renewal Evaluation Process

An applicant seeking to renew its OL is required to submit an ER as part of its application. The license renewal evaluation process involves a careful review of the applicant's ER and assurance that all new and potentially significant information not already addressed in or

available during the GEIS evaluation is identified, reviewed, and assessed to verify the environmental impacts of the proposed license renewal.

In accordance with 10 CFR 51.53(c)(2) and (3), the ER submitted by the applicant must

- provide an analysis of the Category 2 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B in accordance with 10 CFR 51.53(c)(3)(ii)

- discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action.

In accordance with 10 CFR 51.53(c)(2), the ER does not need to

- consider the economic benefits and costs of the proposed action and alternatives to the proposed action except insofar as such benefits and costs are either (1) essential for making a determination regarding the inclusion of an alternative in the range of alternatives considered or (2) relevant to mitigation

- consider the need for power and other issues not related to the environmental effects of the proposed action and the alternatives

- discuss any aspect of the storage of spent fuel within the scope of the generic determination in 10 CFR 51.23(a) in accordance with 10 CFR 51.23(b)

- contain an analysis of any Category 1 issue unless there is significant new information on a specific issue—this is pursuant to 10 CFR 51.23(c)(3)(iii) and (iv).

New and significant information is (1) information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or (2) information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

In preparing to submit its application to renew the Fort Calhoun Station, Unit 1 OL, the OPPD developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for Fort Calhoun Station, Unit 1 would be properly reviewed before submitting the ER and to ensure that such new and potentially significant information related to the renewal of the license for Unit 1 would be identified, reviewed, and assessed during the period of the NRC review. The OPPD reviewed the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to Fort Calhoun Station,

Unit 1. This review was performed by personnel from the OPPD and its support organization who were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

The NRC staff also has a process for identifying new and significant information. That process is described in detail in *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*, NUREG-1555, Supplement 1 (NRC 2000). The search for new information includes (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies; and (5) review of the technical literature. New information discovered by the staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of the issue that are not affected by the new information.

Chapters 3 through 7 discuss the environmental issues considered in the GEIS that are applicable to Fort Calhoun Station, Unit 1. At the beginning of the discussion of each set of issues, there is a table that identifies the issues to be addressed and lists the sections in the GEIS where the issue is discussed. Category 1 and Category 2 issues are listed in separate tables. For Category 1 issues for which there is no new and significant information, the table is followed by a set of short paragraphs that state the GEIS conclusion codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, followed by the staff's analysis and conclusion. For Category 2 issues, in addition to the list of GEIS sections where the issue is discussed, the tables list the subparagraph of 10 CFR 51.53(c)(3)(ii) that describes the analysis required and the SEIS sections where the analysis is presented. The SEIS sections that discuss the Category 2 issues are presented immediately following the table.

The NRC prepares an independent analysis of the environmental impacts of license renewal and compares these impacts with the environmental impacts of alternatives. The OPPD license renewal application was reviewed by the staff for completeness and acceptability for docketing, and a notice was published in the *Federal Register* (FR; 67 FR 6551 [NRC 2002d]). This FR notice, which also outlined the opportunity for a hearing, was amended on April 22, 2002, to correct an error in the title and date (67 FR 19599 [NRC 2002c]). The staff published a notice of intent to prepare an EIS and conduct scoping (67 FR 31847 [NRC 2002a]) on May 10, 2002. Two public scoping meetings were held on June 18, 2002, in Omaha, Nebraska. Comments received during the scoping period were summarized in the *Fort Calhoun Station License Renewal Environmental Scoping Report* (NRC 2002b) dated November 22, 2002. Comments that are applicable to this environmental review are presented in Part I of Appendix A.

The staff followed the review guidance contained in the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal,* NUREG-1555, Supplement 1 (NRC 2000). The staff and its contractors visited Fort Calhoun Station on June 18, 19, and 20, 2002, to gather information and to become familiar with the site and its environs. The staff also reviewed the comments received during scoping and consulted with Federal, State, regional, and local agencies. A list of the organizations consulted is provided in Appendix D. Other documents related to Fort Calhoun Station, Unit 1 were reviewed and are referenced in this report.

On January 14, 2003, the Notice of Availability of the draft SEIS and notice of public meetings to discuss the draft SEIS was published in the Federal Register (68FR1873 [NRC 2003]). A 75-day comment period began on that date, during which members of the public could comment on the preliminary results of the staff's review. The staff held two public meetings in Omaha, Nebraska, on February 26, 2003, to describe the preliminary results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on the draft SEIS. All of the comments on the draft SEIS received during the comment period were considered in developing the final SEIS and are presented along with responses in Appendix A, Part II.

This SEIS presents the staff's analysis that considers and weighs the environmental effects of the proposed renewal of the OL for Fort Calhoun Station, Unit 1, the environmental impacts of alternatives to license renewal, and the mitigation measures available for avoiding adverse environmental effects. Chapter 9, "Summary and Conclusions," provides the NRC staff's recommendation to the Commission on whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the OL for Fort Calhoun Station, Unit 1. The Fort Calhoun Station site is located in Washington County, Nebraska, on the southwestern bank of the Missouri River, approximately 31 km (19 mi) north-northwest of downtown Omaha, Nebraska.

The current OL for Unit 1 expires on August 9, 2013. By letter dated January 9, 2002 (Gates 2002a), as amended by letter dated January 18, 2002 (Gates 2002b), the OPPD submitted an application to the NRC to renew the OL for an additional 20 years of operation, until August 9, 2033. If the OL is renewed, the schedule is to issue the renewed license in November 2003. The renewed license would supersede the current license. If the OL is not renewed, then the plant must be shut down at or before the expiration date of the current OL, which is August 9, 2013.

Fort Calhoun Station, Unit 1 is a pressurized-water-reactor plant designed by Combustion Engineering, with a net generating capability of 476 megawatts electric (MW[e]). Plant cooling is provided by a once-through heat dissipation system that dissipates heat to the environment. Fort Calhoun Station, Unit 1 produces electricity to supply the needs of approximately 320,000 households in the OPPD's service territory.

1.4 The Purpose and Need for the Proposed Action

Although a licensee must have a renewed license to operate a reactor beyond the term of the existing OL, the possession of that license is just one of a number of conditions that must be met for the licensee to continue plant operation during the term of the renewed license. Once an OL is renewed, State regulatory agencies and the owners of the plant will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners.

Thus, for license renewal reviews, the NRC has adopted the following definition of purpose and need (GEIS Section 1.3):

> 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) decisionmakers.

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954 or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and power plant licensees as to whether a particular nuclear power plant should continue to operate. From the perspective of the licensee and the State regulatory authority, the purpose of renewing an OL is to maintain the availability of the nuclear plant to meet system energy requirements beyond the current term of the plant's license.

1.5 Compliance and Consultations

The OPPD is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, the OPPD provided a list of the authorizations from Federal, State, and local authorities for current operations, as well as environmental approvals and consultations associated with the Fort Calhoun Station, Unit 1 OL renewal. The list of authorizations and consultations provided by the OPPD is included in

Appendix E. The staff reviewed the list and consulted with the appropriate Federal, State, and local agencies to identify any compliance or permit issues or significant environmental issues of concern to the reviewing agencies. No agency, with the exception of the U.S. Fish and Wildlife Service (FWS), identified any issues.

The staff consulted with FWS in accordance with Section 7 of the Endangered Species Act (ESA). Although the staff has come to the conclusion that the proposed renewal of the Fort Calhoun Station, Unit 1, operating license is not likely to adversely affect any threatened or endangered species, the FWS has been unable to concur with the staff's determination. As a result, pursuant to 50 CFR § 402.14(a), the staff plans to pursue formal consultation with FWS. Since the current operating license (the impacts of which were analyzed in *Final Environmental Statement Related to the Operation of Fort Calhoun Station Unit 1* [AEC 1972]) does not expire until August 2013, the staff has determined that the proposed action causes no irreversible or irretrievable commitment of resources not previously considered, and that proceeding with the proposal does not foreclose the formulation or implementation of any reasonable and prudent alternatives. Therefore, pursuant to 50 CFR § 402.09, the staff has concluded that the proposed action may proceed.

The OPPD's ER states that the OPPD is in compliance with applicable environmental standards and requirements for Fort Calhoun Station, Unit 1. The staff has not identified any environmental issues that are both new and significant.

1.6 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act*, Part 1508, "Terminology and Index."

Atomic Energy Act of 1954 (AEA). 42 USC 2011, et seq.

Gates, W. G. 2002a. Letter from W. G. Gates, Vice-President, the Omaha Public Power District, to the U.S. Nuclear Regulatory Commission. Subject: "Fort Calhoun Station Unit 1 Application for Renewed Operating License." January 9, 2002.

Gates, W. G. 2002b. Letter from W. G. Gates, Vice-President, the Omaha Public Power District, to the U.S. Nuclear Regulatory Commission. Subject: "Fort Calhoun Station Unit 1 Revised Application for Renewed Operating License." January 18, 2002.

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

Omaha Public Power District (OPPD). 2002. *Applicant's Environmental Report – Operating License Renewal Stage Fort Calhoun Station Unit 1*. Omaha, Nebraska.

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

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*. NUREG-1555, Supplement 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002a. "Omaha Public Power District, Fort Calhoun Station Unit 1; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register*, Vol. 67, No. 91, pp. 31847–31848. May 10, 2002.

U.S. Nuclear Regulatory Commission (NRC). 2002b. *Issuance of Environmental Scoping Summary Report Associated with the Staff's Review of the Application for Renewal of the Operating License for Fort Calhoun Station Unit 1*. November 22, 2002.

U.S. Nuclear Regulatory Commission (NRC). 2002c. "Omaha Public Power District (OPPD), Fort Calhoun Station Unit 1; Notice of Acceptance for Docketing of the Application and Notice of Opportunity for a Hearing Regarding Renewal of License No. DPR-40 for an Additional Twenty-Year Period: Correction." *Federal Register*, Vol. 67, No. 77, pp. 19599–19600. April 22, 2002.

U.S. Nuclear Regulatory Commission (NRC). 2002d. "Omaha Public Power District (OPPD) Fort Calhoun Station Unit 1 Notice of Receipt of Application for Renewal of Facility Operating License No. DPR-40 for an Additional 20-Year Period." *Federal Register*, Vol. 67, No. 29, p. 6551. February 12, 2002.

U.S. Nuclear Regulatory Commission (NRC). 2003. "Omaha Public Power District, Fort Calhoun Station, Unit 1; Notice of Availability of the Draft Supplement 12 to the Generic Environmental Impact Statement and Public Meeting for the License Renewal of Fort Calhoun Station, Unit 1." *Federal Register*, Vol. 68, No. 91, pp. 1873–1874. January 14, 2003.

2.0 Description of the Nuclear Power Plant and Site and Plant Interaction with the Environment

The Omaha Public Power District's (OPPD's) Fort Calhoun Station, Unit 1 is a single-unit nuclear power plant located on the southwestern bank of the Missouri River, approximately 31 km (19 mi) north of downtown Omaha, Nebraska. Unit 1 is an operating pressurized-water nuclear reactor and the subject of this action. In addition to the nuclear unit, the site features include the power-generation and ancillary facilities, a switchyard and maintenance area, the administration building and training building, a firing range (for security staff), a meteorological tower, a closed water-treatment sludge landfill, and sanitary-waste lagoons. The plant and its environment are described in Section 2.1, and the plant's interaction with the environment is presented in Section 2.2.

2.1 Plant and Site Description and Proposed Plant Operation During the Renewal Term

Fort Calhoun Station is located in Washington County, Nebraska, and consists of 267 ha (660 ac) of land. Approximately 55 ha (135 ac) of this land is occupied by plant facilities or maintained as part of the plant operations. Figures 2-1 and 2-2 show the site location and features within 80 km (50 mi) and 10 km (6 mi), respectively. The site region encompasses portions of eastern Nebraska and western Iowa and is characterized by a maximum relief of approximately 91 m (300 ft) (OPPD 2002a).

The region surrounding Fort Calhoun Station was identified in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999)[(a)] as having a low population density. Fort Calhoun Station employs a workforce of about 632 permanent employees and about 140 contractor employees. The OPPD refuels Fort Calhoun Station, Unit 1 at 18-month intervals. During refueling outages, site employment increases by as many as 600 workers for temporary duty (typically, 30 to 40 days). The nearest municipalities are Blair, Nebraska, approximately 10 km (6 mi) to the northwest, and Fort Calhoun, Nebraska, approximately 8 km (5 mi) south of Fort Calhoun Station.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

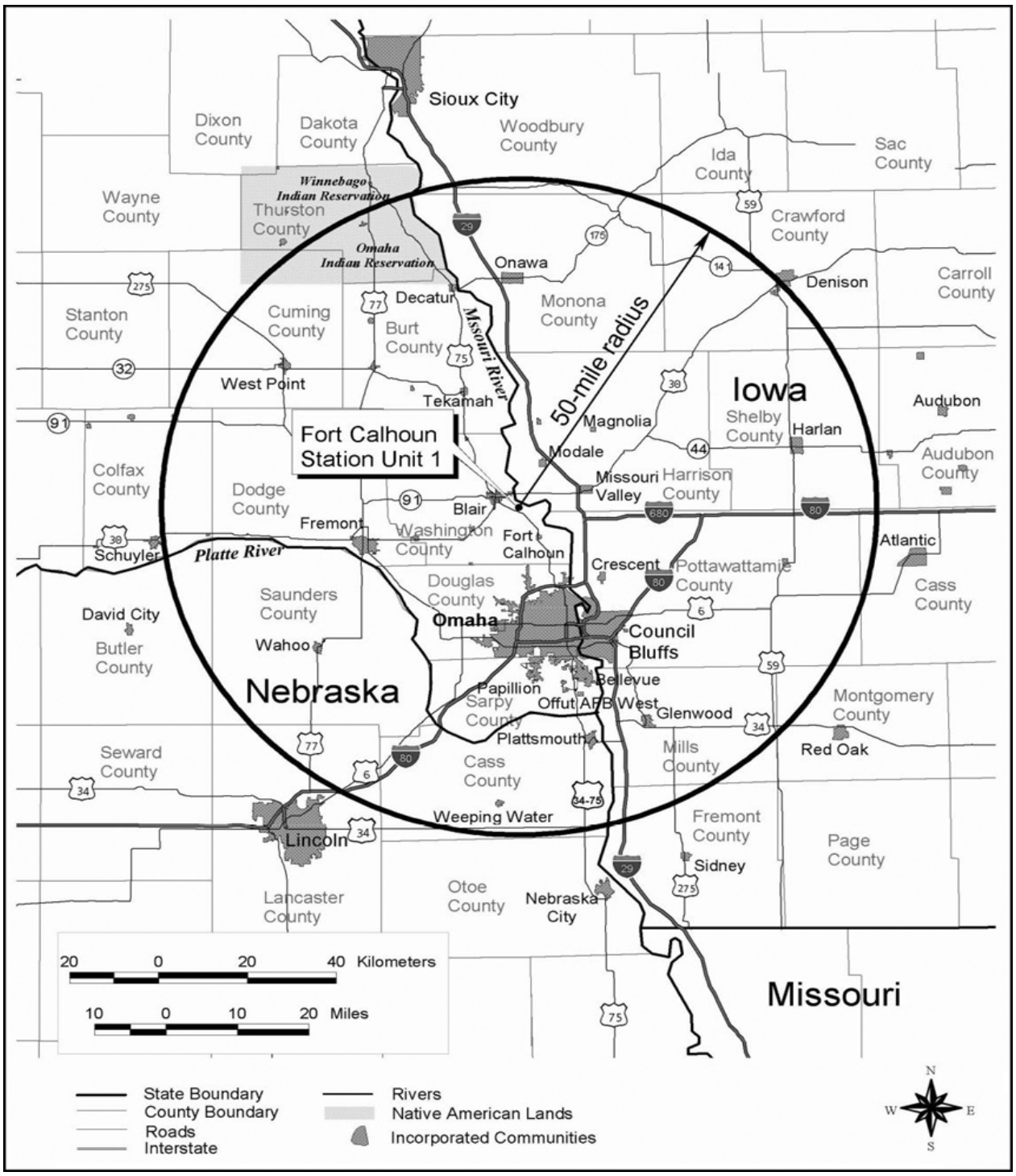


Figure 2-1. Location of Fort Calhoun Station, 80-km (50-mi) Region

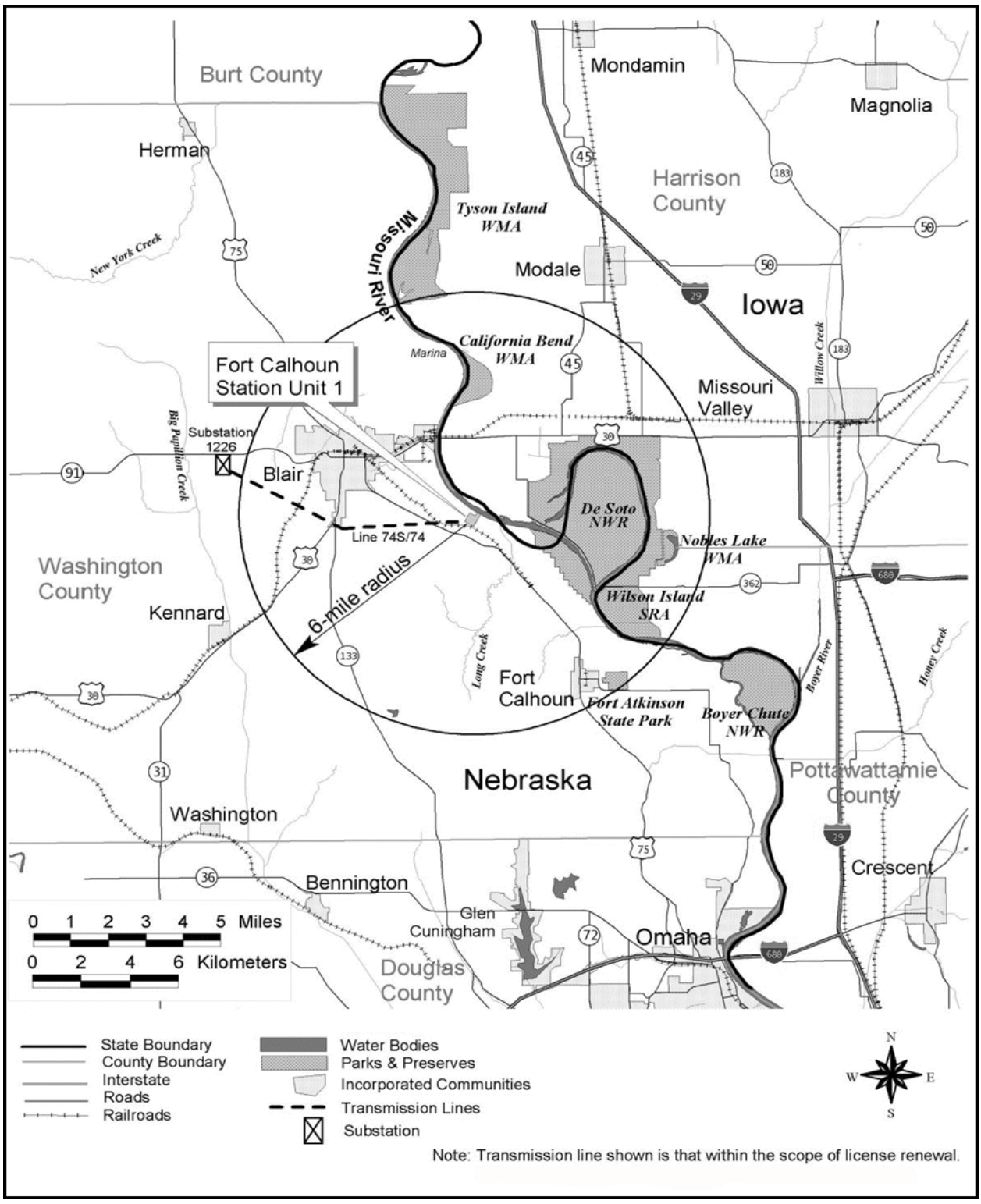


Figure 2-2. Location of Fort Calhoun Station, 10-km (6-mi) Region

2.1.1 External Appearance and Setting

Located in the dissected till plains of the central lowlands physiographic province, the Fort Calhoun Station region is characterized by a maximum relief of approximately 91 m (300 ft). Fort Calhoun Station, Unit 1 and its supporting structures can be seen from the immediate surrounding area and by recreational users on the Missouri River. Approximately 85 percent of the site is on relatively level ground on the river bottomlands (OPPD 2002a).

The main channel of the Missouri River, its associated flat bottomlands and bluffs, and the dissected loess-covered till plains of western Iowa and drift hills of Nebraska are defining natural features in the region. The Missouri River is highly modified and controlled for most of its length as a result of numerous U.S. Army Corps of Engineers (USACE) actions. The reach of the river on which Fort Calhoun Station is located has been modified by a system of dikes and revetments designed to provide a continuous navigation channel without the use of locks and dams.

2.1.2 Reactor Systems

The Fort Calhoun Station, Unit 1 nuclear-steam-supply system consists of a pressurized-water reactor and its associated coolant system designed by Combustion Engineering. The steam and power conversion system, including its turbine generator, is designed to permit the generation of a net electrical output of approximately 476 megawatts (MW[e]). See Figure 2-3 for the layout of Fort Calhoun Station. The reactor was initially licensed to operate at a maximum power level of 1420 megawatts thermal (MW[t]). However, on the basis of additional safety and environmental evaluations, the NRC issued a license amendment on August 15, 1980, to allow operation at the system's full-rate power level of 1500 MW(t). The NRC authorized Fort Calhoun Station, Unit 1 to operate at full power with the issuance of Operating License DPR-40, which was effective August 9, 1973 (OPPD 2002a).

The reactor's primary containment building is constructed of steel-reinforced concrete and houses the reactor, steam generators, reactor coolant pumps, other nuclear-steam-supply system components, and equipment for refueling and other operations. The containment building provides a highly reliable, essentially leak-tight barrier against the escape of radioactive material. The containment system is designed to withstand an internal pressure of 60 pounds per square inch above atmospheric pressure (psig). Together with its engineered safety features, the containment system is designed to provide adequate radiation protection for both normal operation and postulated design-basis accidents, such as earthquakes, tornadoes, or loss of coolant. The Fort Calhoun Station reactor is licensed for uranium dioxide fuel that has a maximum enrichment of 5.0 percent by weight uranium-235. Maximum fuel enrichment through Fuel Cycle 20, which began in April 2001, is 4.66 percent by weight uranium-235.

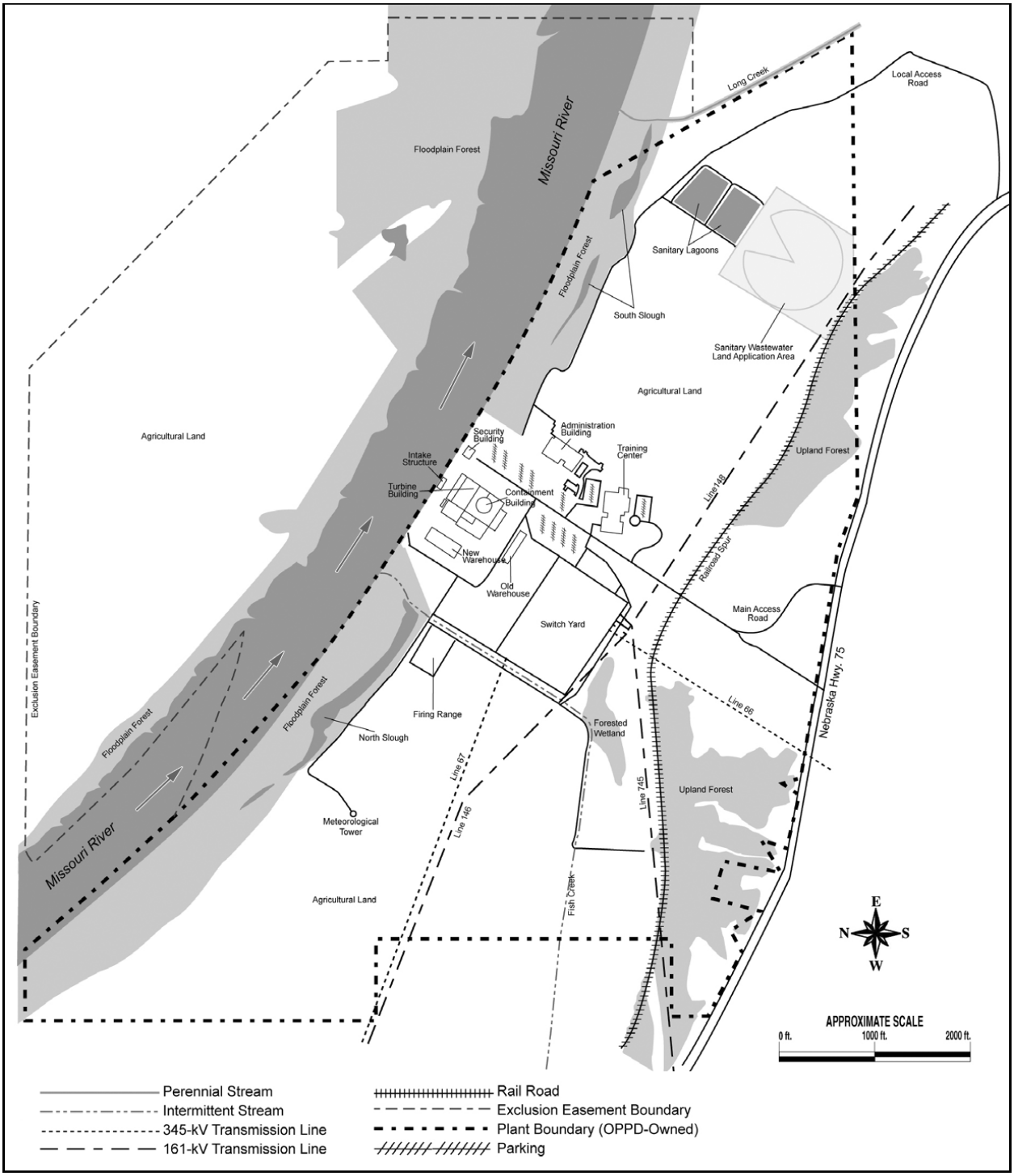


Figure 2-3. Fort Calhoun Station Layout

The approximate maximum fuel burn-up is less than 53,000 megawatt-days per metric ton uranium (MWd/MTU) (OPPD 2002a).

2.1.3 Cooling- and Auxiliary-Water Systems

During its operations, Fort Calhoun Station obtains water from (1) a once-through, noncontact cooling system that uses water from the Missouri River and (2) potable water supplies from the City of Blair Municipal Water System. In addition, a small quantity (less than 6.3 L/s [100 gpm]) of groundwater from two onsite wells is used at the plant. The groundwater is used predominantly to (1) adjust water levels and (2) flush the sanitary-waste lagoons and the center-pivot irrigation system, which is used to land-apply treated effluent from the lagoons. Details of the once-through cooling system and groundwater withdrawals are discussed in the following sections.

2.1.3.1 Cooling-Water System

The once-through, noncontact cooling system (water is self-contained, and cooling water does not come into contact with the reactor core) at Fort Calhoun Station consists of an intake structure that collects cooling water from the water source (the Missouri River). The cooling water is used to remove heat from internal (contained) coolants and is then released directly back into the water source. Thermal-plume studies were initiated in the early days of the plant's operation and have recently been repeated at Fort Calhoun Station (OPPD 1976, EPA 2003). These studies examined the impact of discharging the heated water back into the water source and identified a thermal gradient that moves parallel to the shoreline of the Missouri River. This thermal gradient does not significantly impact gross ambient temperatures in the river. The maximum change in the temperature of the receiving water is regulated by the State of Nebraska under the Clean Water Act using National Pollution Discharge Elimination System (NPDES) permits.

At Fort Calhoun Station, the intake structure is a reinforced-concrete building that extends approximately 24 m (80 ft) along the bank of the Missouri River at river mile (rmi) 645.85. Most of the water withdrawn at the structure is used in the circulating-water system, which employs three pumps operating at 7571 L/s (2000 gal/s). The water in the circulating-water system removes heat from the main (turbine) condensers and other turbine plant-heat exchangers, which are used to cool turbine bearings, lubricating oil, and related equipment (OPPD 2002a).

Water is also withdrawn from the intake structure by the raw-water system, which provides once-through cooling water to component cooling-water-heat exchangers. This cooling water removes heat from various auxiliary systems, the spent fuel pool, ventilation equipment, pump

components, and other equipment. The raw-water system consists of four pumps; each pump has an operating capacity of 336 L/s (89 gal/s). During normal plant operations, only one pump operates, but two pumps may operate in the summer when ambient river temperatures are higher.

Water enters the intake structure through six separate inlet bays. Vertical trash screens or racks (steel bars placed approximately 8 cm [3 in.] apart) are placed on each inlet to prevent large debris from entering the system. Debris that accumulates on the trash racks is removed periodically by isolating the outer portion of the inlet bay and using the surface sluice system to backwash the racks. Approximately 3 m (9.8 ft) beyond the gates are traveling screens with a 1-cm (3/8-in.) mesh to prevent small debris from entering the system. Any debris that is washed from the traveling screens is then directed to a screen wash trough that discharges back to the river at the downstream end of the intake structure.

Water passing through the intake screens enters three pump cells with two inlet bays per cell. The pumps for both the circulating-water system and the raw-water system take suction from this area of the intake structure. The circulating-water-system pumps, transfer water from the pump cells to the intake tunnel and through the main condensers and turbine plant-heat exchangers. Side streams from the intake tunnel provide water for backwashing the trash racks and traveling screens and for operating the surface sluice system.

Under extreme low-flow conditions, the average velocity of intake water flowing through the sluice gate openings in the curtain walls is approximately 0.85 m/s (2.8 ft/s). The estimated average approach velocities to the traveling screens are 0.2 and 0.3 m/s (0.7 and 1.1 ft/s) at river surface elevations of 302 and 300 m (992 and 983 ft), respectively. These two river surfaces correspond to normal- and low-flow conditions in this reach of the Missouri River.

Once cooling water from the Missouri River passes through the main condensers and heat exchangers, the water is discharged from a below-grade, reinforced-concrete discharge tunnel that measures 10 by 4 m (33 by 14 ft). This tunnel is approximately 12 m (40 ft) downstream of the intake structure. The floor of the discharge structure protrudes an additional 8 m (25 ft) downstream to protect against riverbed scouring.

2.1.3.2 Auxiliary-Water Systems

Fort Calhoun Station uses groundwater (less than 6.3 L/s [100 gpm]) pumped from two onsite wells to provide makeup and flushing water for various components of the sewage-treatment system. These components include flushing the center-pivot irrigation systems for land-application of sewered waste water and maintaining adequate water levels in the two sanitary-

waste lagoons. Groundwater pumping for these purposes occurs on an irregular schedule that is relatively infrequent.

2.1.4 Radioactive-Waste Management Systems and Effluent-Control Systems

The OPPD uses liquid, gaseous, and solid radioactive-waste management systems to collect and process the liquid, gaseous, and solid wastes that are by-products of the operation of Fort Calhoun Station, Unit 1. These systems process radioactive liquid, gaseous, and solid effluents to maintain releases to the environment within regulatory limits. The Fort Calhoun Station, Unit 1 waste-disposal system meets the design objectives of 10 CFR Part 50, Appendix I ("Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as Is Reasonably Achievable' for Radiological Material in Light-Water-Cooled Nuclear Power Reactor Effluents") and controls the processing, disposal, and release of radioactive liquid, gaseous, and solid wastes.

Radioactive material in the reactor coolant is the source of 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. These fission products are contained in the sealed fuel rods, but small quantities escape from the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system is also responsible for coolant contamination.

Nonfuel solid wastes result from treating and separating radionuclides from gases and liquids, and from removing contaminated material from various reactor areas. Solid wastes also consist of reactor components, equipment, and tools removed from service, as well as contaminated protective clothing, paper, rags, and other trash generated from plant-design modifications and operations and routine maintenance activities. Solid wastes are shipped to a waste processor for volume reduction before disposal at a licensed burial site. Spent resins and filters are stored or packaged for shipment to a licensed offsite processing or disposal facility (OPPD 2001b).

Fuel rods that have exhausted a certain percentage of their fuel and that have been removed from the reactor core for disposal are called spent fuel. Fort Calhoun Station, Unit 1 currently operates on an 18-month refueling cycle. Spent fuel is stored onsite in the spent fuel pool in the auxiliary building adjacent to the containment building. Spent fuel has been stored at Fort Calhoun Station since 1973.

The *Offsite Dose Calculation Manual* (ODCM) describes the methods used for calculating radioactivity concentrations in the environment and the estimated potential offsite doses associated with liquid and gaseous effluents from Fort Calhoun Station, Unit 1 (OPPD 1999).

The ODCM also specifies controls for release of liquid and gaseous effluents to ensure compliance with the following:

- The concentration of radioactive liquid effluents released from the site to the unrestricted area will not exceed 10 times the concentration specified in 10 CFR Part 20, Appendix B, Table 2, Column 2 for radionuclides other than noble gases. For dissolved or entrained noble gases, the concentration shall not exceed 7.4 Bq/mL (2×10^{-4} μCi/mL).

- The dose or dose commitment to a member of the public from any radioactive materials in liquid effluents released to unrestricted areas shall be limited to the design objectives of 10 CFR Part 50, Appendix I: (1) less than or equal to 0.015 mSv (1.5 mrem) to the total body and less than or equal to 0.05 mSv (5 mrem) to any organ during any calendar quarter and (2) less than or equal to 0.03 mSv (3 mrem) to the total body and less than or equal to 0.1 mSv (10 mrem) to any organ during any calendar year.

- The air dose to areas at and beyond the site boundary due to noble gases in gaseous effluents shall be limited to the design objectives of 10 CFR Part 50, Appendix I, of less than or equal to 0.1 mGy (10 mrad) for gamma radiation and less than or equal to 0.2 mGy (20 mrad) for beta radiation during any calendar year.

- The dose to any individual or dose commitment to any organ of an individual in unrestricted areas due to the release of iodine-131, tritium, and radioactive materials in particulate form with half-lives greater than eight days (excluding noble gases) in airborne effluents shall not exceed 0.075 mSv (7.5 mrem) in any calendar quarter and 0.15 mSv (15 mrem) from all exposure pathways during any calendar year.

- The dose to any individual member of the public from the uranium fuel cycle (including Fort Calhoun Station nuclear facility operations) will not exceed the maximum limits of 40 CFR Part 190 (less than 0.25 mSv [25 mrem]) and 10 CFR Part 20 (5 mSv [500 mrem] in a year and 0.02 mSv [2 mrem] in any hour).

2.1.4.1 Liquid-Waste Processing Systems and Effluent Controls

Potentially radioactive liquid wastes originating from the reactor coolant liquids, auxiliary-systems process wastes, and hotel wastes (laundry and shower drains) are collected in waste-drain tanks located in the containment building and the auxiliary building. (OPPD 1999). In the radioactive waste processing building, liquid wastes can then be processed through a charcoal filter and a demineralizer system, which remove most radioactive materials and dissolved solids. Hotel wastes can also be processed through the filters and demineralizer if necessary. The processed liquid waste is collected in one of two liquid-waste monitoring tanks and is

sampled before being released to the overboard header. The overboard header is the only path through which liquid radioactive waste from the plant can be released to the environment. Releases from the overboard header enter the condenser-circulating-water-discharge tunnel downstream of the warm-water recirculation return. The overboard header is equipped with a radiation monitor that will interrupt the flow if the waste activity reaches a predetermined set point (OPPD 2001b).

Potentially radioactive liquid wastes can also be generated from steam-generator blowdown. The steam generators are located in the containment building. Blowdown wastes from the steam generators are discharged directly to the raw water system and then to the circulating-water-discharge tunnel. There are two radiation monitors that control liquid effluent releases from the steam-generator blowdown. If a high alarm set point is reached on either monitor, the blowdown isolation valves are automatically closed.

The ODCM prescribes the alarm/trip set points for the liquid-effluent radiation monitors. There are three liquid-effluent radiation monitors for the two potentially radioactive liquid-waste discharge pathways at Fort Calhoun Station. The alarm/trip set point for each liquid-effluent monitor is based on the radioactivity measurements in a batch of liquid to be released or in the continuous liquid discharge (OPPD 1999).

During 2001, there was a total volume of 1.66×10^8 L (4.39×10^7 gal) of liquid waste released prior to dilution (OPPD 2002c). In this liquid waste, there was a total fission and activation product activity of 0.02 TBq (0.56 Ci) and a total tritium activity of 6.43 TBq (175 Ci). These volumes and activities are typical of past years. The actual liquid waste generated is reported in the *Annual Radioactive Effluent Release Report for the Fort Calhoun Station Unit 1* (OPPD 2002c). See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual as a result of these releases.

The OPPD does not anticipate any increase in liquid-waste releases during the renewal period.

2.1.4.2 Gaseous-Waste Processing Systems and Effluent Controls

There are three air effluent-discharge pathways at Fort Calhoun Station, Unit 1: the condenser off-gas, the laboratory (CARP facility) and RWPB exhaust stack, and the auxiliary building exhaust stack (OPPD 1999). Condenser off-gases originate from operations in the turbine building. Chemistry laboratories and various waste operations vent through the laboratory and the RWPB. The auxiliary building exhaust stack receives discharges from the waste-gas decay tanks, containment purge, containment-vent systems, and the auxiliary building ventilation system.

Radioactive waste gases are normally present in trace amounts in reactor coolant liquids. These gases are collected, compressed, stored, analyzed, and monitored in the airborne radioactive-waste disposal system. Waste gases are collected in a vent header. Two waste-gas compressors take suction from the vent header, compress the gas, and then deliver it to one of the four gas-decay tanks. Waste gases collected in the waste-gas-decay tanks include hydrogen, nitrogen, particulates, and fission product gases (i.e., xenon and krypton) (OPPD 2001b). The contents of a filled decay tank are analyzed to determine whether a batch of waste gas must be retained to permit radioactive decay or whether it is suitable for controlled release to the atmosphere. Prior to release, waste gases are passed through high-efficiency particulate air (HEPA) filters and charcoal absorbers so that particulates and iodines in the waste gases are removed before the waste gases enter the auxiliary building ventilation stack. Once these gases are released to the ventilation stack, the gases are mixed with dilution air and can be combined with gases from other pathways. A radiation recorder-controller monitors the auxiliary building ventilation-system exhaust for gaseous activity and automatically closes a control valve in the gas discharge header upon detecting a high-activity reading.

There may be small amounts of radioactive gases in the work spaces in the containment, auxiliary, CARP, and radioactive-waste-processing buildings. However, the concentrations are too dilute and the volumes of carrier gases are too large to permit collection. The amounts of radioactivity released in low-concentration waste gas are known, measured, and recorded.

Radioactive gaseous wastes from Fort Calhoun Station, Unit 1 are released through three monitored release points. These release points are continuously monitored for noble gases, and radioiodines and particulate activity, as appropriate (OPPD 1999). Two radiation-monitoring systems provide noble-gas monitoring and iodine-and-particulate sampling for the auxiliary building exhaust stack. The laboratory and the RWPB has one monitoring system for noble gases, particulates, and iodine. The condenser off-gas has one monitor for noble-gas activity only. These release points are continuously monitored, and the ODCM prescribes alarm/trip set points for these monitors. The auxiliary building and condenser off-gas monitoring systems provide alarms and automatic closure of the release path when radiation levels exceed a preset level, thereby terminating discharge (OPPD 1999). The laboratory and the RWPB monitoring systems provide alarms only.

During 2001, there was a total fission and activation-gas activity of 122 TBq (3330 Ci), a total iodine activity of 2.46×10^{-4} TBq (6.71×10^{-3} Ci), a total particulate activity of 9.63×10^{-8} TBq (2.63×10^{-6} Ci), and a total tritium activity of 0.05 TBq (1.45 Ci) released from Fort Calhoun Station (OPPD 2002c). These releases are typical of past years. The actual gaseous waste generated is reported in the *Annual Radiological Effluent Release Report for Fort Calhoun*

Station Unit 1 (OPPD 2002c). See Section 2.2.7 of this SEIS for a discussion of the theoretical doses to the maximally exposed individual as a result of these releases. The OPPD does not anticipate any increase in gaseous releases during the renewal period.

2.1.4.3 Solid-Waste Processing

Solid wastes from Fort Calhoun Station consist of spent process resins, used waste and process filters, dewatered ion-exchange and filtration media, and miscellaneous materials from station and radioactive-waste facility operation and maintenance (OPPD 2001b). Spent resin from the filtration/ion-exchange system is sluiced to a high-integrity container (HIC) that is stored and eventually shipped for disposal. Used filters are placed in a shielded container, stored in the cask decontamination area, and eventually shipped offsite. Miscellaneous solid wastes, such as equipment parts, laboratory glassware, clothing, tools, and rags, are stored prior to offsite shipment (OPPD 2001b). The solid-waste system is normally operated on a batch basis. The RWPB is sized to accumulate a number of containers (e.g., liners, drums, HICs) to permit the scheduling of offsite shipments (OPPD 2001b).

Solid wastes from Fort Calhoun Station are either shipped directly to an offsite, licensed disposal facility (e.g., spent resins) or consigned to a licensed processing facility for volume-reduction and decontamination activities (e.g., compactible trash). Any material that remains after volume reduction is transported by the processing facility to a final disposal facility, depending on the activity limits.

Disposal and transportation of solid wastes are performed in accordance with the applicable requirements of 10 CFR Parts 61 and 71, respectively. There are no releases to the environment from radioactive solid wastes generated at Fort Calhoun Station.

In 2001, Fort Calhoun Station made 1 shipment of Type A solid wastes (e.g., spent resins or filter sludges) and 34 shipments of Type B solid wastes (e.g., dry compressible, contaminated equipment, etc.) with a total volume of 21.8 m^3 (771 ft^3) and a total activity of 26.7 TBq (729 Ci) (OPPD 2002c). These shipments are representative of the shipments made in the past several years and are not expected to change appreciably during the license renewal period.

2.1.5 Nonradioactive-Waste Systems

The principal nonradioactive wastes from Fort Calhoun Station consist of chemical (hazardous and nonhazardous) wastes, lubrication-oil wastes, and sanitary wastes. Fort Calhoun Station operates its own sanitary-waste lagoons to collect and treat sanitary wastes generated at the plant. The lagoons are located southeast of the main plant complex. Treated waste water from the lagoons is land-applied onsite using a center-pivot irrigation system. Effluent discharges of

treated waste water, irrigation water from the center-pivot system, and overflow from the sanitary-waste lagoons are permitted by NPDES Permit NE0000418 issued by the Nebraska Department of Environmental Quality (NDEQ) for Fort Calhoun Station.

The sanitary-waste lagoons are lined with an impermeable 60-mm polyethylene geomembrane. The lining impedes the leaching of waste water in the lagoons into groundwater. Solid wastes from the sanitary-waste lagoons do not need to be removed regularly; however, if disposal becomes necessary, provisions for disposing solid wastes from the lagoons have been provided by the NDEQ in the NPDES Permit NE0000418.

The small quantities of chemical wastes that are produced at Fort Calhoun Station are disposed of properly according to State and Federal regulations. Other nonradioactive wastes are either recycled or disposed of under contract with waste-management companies. For example, spent batteries and fluorescent light bulbs are recycled, and lubrication oils used in the plant are taken to other OPPD facilities to be burned in fossil-fuel power plants.

A small landfill exists onsite just west of the sanitary-waste lagoons. This closed landfill (no longer in use) contains only materials from previous water-purification activities occurring at Fort Calhoun Station. When the water-purification facility was shut down, the material from two evaporation ponds was buried in the landfill. Groundwater-monitoring wells have been placed on each side of the landfill (four wells total) to monitor any leaching of the landfill into the groundwater. Data from the groundwater wells provides no evidence that groundwater chemistry has been influenced by the materials in the landfill (Hutchens 2001).

2.1.6 Plant Operation and Maintenance

Routine maintenance performed on plant systems and components is necessary for safe and reliable operation of a nuclear power plant. Maintenance activities conducted at Fort Calhoun Station, Unit 1 include inspection, testing, and surveillance to maintain the current licensing basis of the plant and to ensure compliance with environmental and safety requirements. Certain activities can be performed while the reactor is operating. Others require that the plant be shut down. Long-term outages are scheduled for refueling and for certain types of repairs or maintenance, such as replacement of a major component. The OPPD refuels Fort Calhoun Station, Unit 1 at 18-month intervals. During refueling outages, site employment increases by as many as 600 workers for temporary duty (typically, 30 to 40 days). The OPPD provided an appendix (Appendix A) in the *Updated Safety Analysis Report* (OPPD 2001b) regarding the aging management review to manage the effects of aging on systems, structures, and components in accordance with 10 CFR Part 54. The Fort Calhoun Station, Unit 1 license renewal application describes the programs and activities that will manage the effects of aging during the license renewal period. The OPPD expects to conduct the activities related to the

management of aging effects during plant operation or normal refueling and other outages, but the OPPD does not plan any outages specifically for the purpose of refurbishment. The OPPD has no plans to significantly add additional full-time staff (non-outage workers) at the plant during the period of the renewed licenses.

2.1.7 Power Transmission System

The transmission corridor of concern for license renewal is the corridor that was constructed between the plant switchyard and its connection to the existing transmission system. Thus, the only transmission line subject to review under this application for license renewal is Line 74S/74, which was originally constructed in connection with Fort Calhoun Station, Unit 1. According to the OPPD Environmental Report (ER; OPPD 2002a), three transmission lines were installed and connected to the Fort Calhoun Station, Unit 1 switchyard, which was designated by the OPPD as Substation 3451/1251 as a direct result of the construction, startup, and operation of Fort Calhoun Station, Unit 1. These transmission lines were evaluated by the U.S. Atomic Energy Commission (AEC) in its permit review for continued construction and operation of the plant (AEC 1972).

The first line is approximately 0.4 km (0.25 mi) of single-circuit 161-kV line from the Fort Calhoun Station Substation to the Fort Calhoun Station plant; the second line is approximately 0.8 km (0.5 mi) of 345-kV line from the Fort Calhoun Station generator/main transformer to the Fort Calhoun Station Substation. These transmission lines, which were installed for plant startup use and have not been modified since the initial plant construction, lie entirely on developed portions of Fort Calhoun Station. The third line is approximately 11 km (7 mi) of 161-kV line from the Fort Calhoun Station Substation westward to Substation 1226, approximately 5 km (3 mi) west of Blair, Nebraska (Line 74S, a 0.8-km-long [0.5-mi-long] single-circuit line on a 15-m-wide [50-ft-wide] right-of-way, connects to Line 74, a 10-km-long [6.5-mi-long] double-circuit line on a 30-m-wide (100-ft-wide) right-of-way to Substation 1226). This line was originally constructed in 1969 and provided a connection to the transmission grid once the plant became operational. The line was entirely reconstructed in February 1999 to single steel poles and to the 1997 National Electrical Safety Code (NESC) requirements that were in effect at the time. Leaving the Fort Calhoun Station Substation and leading west, this 161-kV line (Line 74S/74) traverses (for approximately 1.6 km [1 mi]) disturbed shrub lands and woodlands, primarily on the hilly upland terrain of the Missouri River bluffs in the vicinity of U.S. Highway 75. For the remaining 10 km (6 mi) or so to the Blair Substation, this line is routed across agricultural cropland. The line crosses several small intermittent streams, but no other surface waters or wetlands were encountered on the right-of-way when it was rebuilt in 1999. Land use adjacent to the right-of-way has undergone little change since initial construction; however, some additional development has occurred along U.S. Highway 30 near the line crossing, and new rural residential development has occurred along the north side of line for approximately 1.2 km (0.75 mi) in the bluff area just west of U.S. Highway 75 (OPPD 2002a).

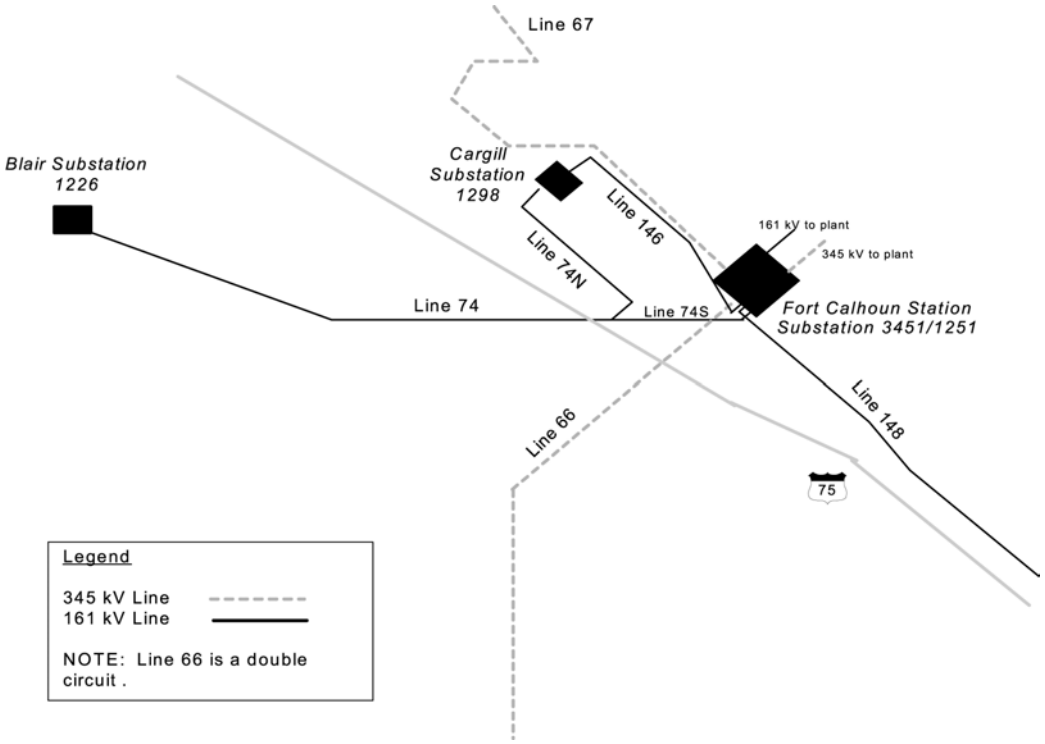
The transmission line originally constructed in connection with Fort Calhoun Station, Unit 1 (Line 74S/74) covers approximately 33 ha (82 ac) over a total corridor length of approximately 11 km (7 mi; Figure 2-4 and Table 2-1). The OPPD makes annual flight inspections of its transmission line right-of-way to ensure nonencroachment by vegetation. Vegetation control within the transmission line right-of-way is performed every three years to ensure the continued reliability of the lines. Vegetation control includes removing or trimming woody vegetation to ensure adequate line clearance and to allow vehicular access along the right-of-way. Large woody vegetation that can interfere with conductors is mechanically trimmed or removed, and stumps are treated with approved herbicides. Small woody vegetation is manually removed or controlled by basally applying approved herbicides. Low-growing woody vegetation, including sumac, chokecherry, and wild plum, that is important wildlife food is only trimmed or removed if needed for vehicular access. The OPPD does not mow vegetation or use broadcast herbicides. The OPPD also does not use herbicides in or near wetlands or stream crossings. All herbicide applicators must be certified in accordance with Nebraska Pesticide Regulations in the Nebraska Administrative Code, Title 25, Chapter 2 (OPPD 2002a).

Table 2-1. Fort Calhoun Station Transmission-Line Corridor

Substation	Number of Lines	kV	Approximate Distance		Right-of-Way Width		Right-of-Way Area	
			km	(mi)	m	(ft)	ha	(ac)
Fort Calhoun Station	1	161	10	(6.5)	30.5	(100)	32	79
Substation 3451/1251			1	(0.5)	15.2	(50)	1	3
Total	1	161	11	7			33	82

Source: OPPD 2002a

Figure 2-4. Fort Calhoun Station, Unit 1 Transmission Lines



2.2 Plant Interaction with the Environment

Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near Fort Calhoun Station as background information. They also provide detailed descriptions where needed to support the analysis of potential environmental impacts of refurbishment and operation during the renewal term, as discussed in Chapters 3 and 4. Section 2.2.9 describes the historic and archaeological resources in the area, and Section 2.2.10 describes possible impacts on other Federal project activities.

2.2.1 Land Use

Fort Calhoun Station is located in Washington County, Nebraska, on the southwestern bank of the Missouri River, approximately 31 km (19 mi) north-northwest of downtown Omaha, Nebraska; 16 km (10 mi) north of the Omaha metropolitan area; 10 km (6 mi) southeast of Blair, Nebraska; and 8 km (5 mi) north of Fort Calhoun, Nebraska. Blair is the county seat of Washington County.

Fort Calhoun Station consists of 267 ha (660 ac) of land. Approximately 55 ha (135 ac) of the site is occupied by plant facilities or is maintained as part of the plant operations, including the power-generation and ancillary facilities, switchyard, maintenance area, administration building, training building, firing range (for security staff), meteorological tower, closed water-treatment sludge landfill, parking areas, roadways, and sanitary-waste lagoons and associated areas used to land-apply treated effluent from the lagoons. All industrial facilities associated with the site are located in Washington County, Nebraska. Of the remaining land, approximately 140 ha (345 ac) is cropland, which is leased by the OPPD to local farmers, and the remaining land (approximately 73 ha [180 ac]) contains natural vegetation, drainage courses, and a railroad spur on a right-of-way easement to the Union Pacific Railroad. The OPPD also holds perpetual easements on an additional 244 ha (604 ac), which consists of cropland and natural vegetation. Most of this additional land is located across the Missouri River in Harrison County, Iowa (OPPD 2002a).

Fort Calhoun Station is not in an incorporated area of Washington County. There are no land-use or zoning restrictions applicable to land within unincorporated portions of Washington County.

2.2.2 Water Use

The maximum water withdrawal from the Missouri River into the intakes of the once-through cooling system during normal operation is approximately 23 m^3/s (827 ft^3/s). At the average lowest-flow conditions in the Missouri River from 1967 to 2000 (occurring in January), this would

amount to approximately 4 percent of the river flow. In the average highest-flow period (occurring in June), this intake volume accounts for 2 percent of the Missouri River flow. Aside from minor losses to evaporation, the entire volume of water that is withdrawn from the Missouri River at the intake structure is subsequently returned to the river at a small distance downstream. In addition, the once-through cooling water system at Fort Calhoun Station does not have cooling towers, so any water losses through evaporation are minimal.

Fort Calhoun Station uses approximately 38 million L (10 million gal) per month of filtered, chlorinated water from the City of Blair Municipal Water System for potable water, service water, and other uses. The principal uses of this water include the following:

- Potable water and water for the fire-protection system in the administration building and training center.

- Feed water to the vendor-owned reverse-osmosis unit in the old warehouse building. This system replaced the plant's original deionized-water system and supplies demineralized water for various plant uses, including makeup water to the reactor's primary and secondary water systems, spent fuel pool, stator cooling-water system, and auxiliary boiler. Brine generated from reverse osmosis is pumped to the circulating-water-system discharge tunnel and is discharged in accordance with the NPDES permit.

- Makeup water to the plant's potable-water-storage tank in the auxiliary building. Water from this tank supplies potable water to buildings in the protected area and the old warehouse building and provides a backup source of seal water to the circulating-water and raw-water systems.

- Supply to the service water system, which provides seal water to the circulating-water, raw-water, and screen-wash pumps in the intake structure; water for the vacuum-priming pumps in the turbine building; and water for pressurizing the fire main header via the fire-protection jockey pump.

2.2.3 Water Quality

In a noncontact cooling system such as the one in place at Fort Calhoun Station, the cooling water is self-contained and does not come into direct contact with the reactor core. In addition, this type of cooling system does not discharge water that has been in contact with contaminants. Therefore, potential sources of pollution from a noncontact cooling system include high-temperature water discharges; heavy metal leaching from condenser piping; and biocides, which are added to cooling water to control the buildup of microbial biomass. At Fort Calhoun Station, the use of biocide has been unnecessary so far. In addition, the general potential for heavy metal leaching from condenser piping has been examined in the GEIS and

has been deemed to be a small Category 1 impact. Therefore, the applicable issue to Fort Calhoun Station is the change in temperature of the receiving waters that is caused by discharges from the once-through cooling system.

Additional water-quality issues may arise from the discharge of cooling water. The energy from the discharges can potentially mobilize sediments that can then negatively impact water quality. In addition, because the water source of Fort Calhoun Station is the highly managed Missouri River, additional issues related to channel dredging and bank stability are potential sources of sediment resuspension and are discussed in Chapter 4.

The cooling-water circulation system is operated in compliance with provisions of NPDES Permit NE0000418 for Fort Calhoun Station. The permit currently limits discharge temperatures to 43.3 °C (110 °F) and allows a conditional discharge temperature of 44.4 °C (112 °F) under the terms of a Consent Order that was entered into by the OPPD and the NDEQ (OPPD 2002a). The terms of the Consent Order allow for continued full-power operation of Fort Calhoun Station during the unusually high ambient river temperatures that have been experienced in the Missouri River in recent years. The NPDES permit also limits the use and discharge of chlorine for biofouling control in the once-through cooling-water systems. However, as mentioned previously, the relatively high background suspended-sediment levels in the river water have been effective in preventing biofouling, and, to date, no biocide applications have been necessary. The OPPD may require chlorination or other methods of control in the future if biofouling organisms, such as zebra mussels, become established in the Missouri River at Fort Calhoun Station and interfere with plant operations.

The temperature of the cooling water flowing through the main condensers is increased by approximately 13 °C (23 °F) at the current, authorized maximum power level of 1500 MW(t). Therefore, at the maximum water withdrawal and temperature changes discussed in Section 2.2.2 of this supplemental environmental impact statement (SEIS) and at discharge temperatures below the permitted 44.4 °C (112 °F) (NPDES Permit NE0000418), the maximum change in the temperature of the Missouri River receiving waters would be on average approximately 0.5 °C (0.9 °F) in a turbulent mixing system. During the winter, the total change in temperature may be greater as the upstream discharge of cooling water is performed to prevent icing of the intake structure. Under normal winter operating conditions, the total change in temperature may be as high as 18 °C (32 °F) between the intake and discharge of the cooling waters.

There are 10 discharges and monitoring points of compliance permitted by the NDEQ under NPDES Permit NE0000418 for Fort Calhoun Station. These include cooling-water intake and outfall (effluent point), low-volume waste from the water-treatment plant, effluent from the screen-backwash and surface-spray system, the upstream warm-water recirculation system for deicing, the condensation tank, the sanitary-waste lagoons, lagoon discharges, discharges from

the land-application system, and storm-water runoff discharges. Specific monitoring and reporting requirements are listed in the NPDES permit for Fort Calhoun Station and are regulated by the NDEQ.

The impacts of sediment scouring at cooling-system discharge structures have been examined in the GEIS and have been determined to be of small to moderate impact. The reach of the Missouri River in the vicinity of Fort Calhoun Station is regularly dredged by the USACE as required to maintain the depth needed for navigating large ships. The OPPD occasionally obtains permission from the USACE to dredge sand and other accumulated riverbed materials from the front of the intake structure. This was last performed in approximately 1990. As a result, the small amount of disturbed material that is taken from the front of the Fort Calhoun Station intake structure is considered to have a negligible impact on water quality.

2.2.4 Air Quality

Fort Calhoun Station, which has a continental climate, is located midway between the humid eastern and dry western climatic zones. The weather at any time may be typical of either of these zones, or it may represent a combination of the zones. Rapid changes in the weather are common, especially during the winter. Climatological records for Omaha (North), Nebraska, which is about 18 km (11 mi) south-southeast, are generally representative of Fort Calhoun Station. These records indicate that the normal daily maximum temperatures for Omaha range from about –1 °C (30 °F) in January to a high of about 31 °C (87 °F) in July. Normal minimum temperatures range from about –12 °C (11 °F) in January to about 19 °C (66 °F) in July.

The average precipitation is about 74 cm (29 in.) per year. Of this total, about 60 cm (24 in.) falls in evening showers or thundershowers during the growing season (March through September). Although thunderstorms have occurred in all months in the area, almost 90 percent of the thunderstorms occur from April through September, with thunderstorms on an average of more than 8 days per month in June, July, and August (OPPD 2002a). Based on statistics for the 30 years from 1954 through 1983 (Ramsdell and Andrews 1986), the probability of a tornado striking the site is expected to be about 9×10^{-4} per year.

Wind-energy potential is generally rated on a scale of 1 through 7. Areas suitable for wind-turbine applications have a rating of 3 or higher. The wind-energy potential in the immediate vicinity of Fort Calhoun Station, which has a rating of 2, may not be suitable for wind-energy applications. However, the annual average wind-energy resource in most of Nebraska and Iowa is rated 3 (Elliott et al. 1986) and is generally suitable for generating electricity.

Fort Calhoun Station is located within the Nebraska Intrastate Air Quality Control Region (AQCR). In addition, portions of the Metropolitan Omaha–Council Bluffs Interstate AQCR, the Metropolitan Sioux City Interstate AQCR, the Lincoln–Beatrice–Fairbury Intrastate AQCR, and

the Southwest Iowa Intrastate AQCR are found within 80 km (50 mi) of Fort Calhoun Station. The air quality in these regions is designated as better than national standards, in attainment, or unclassified for all criteria pollutants in 40 CFR 81.316 and 40 CFR 81.328. There are no mandatory Class I Federal areas in which visibility is an important value designated in 40 CFR Part 81 within 160 km (100 mi) of Fort Calhoun Station.

Diesel generators, boilers, and other activities and facilities associated with Fort Calhoun Station emit various pollutants. Emissions from these sources are lower than emission thresholds in Nebraska and Federal air-quality regulations. Therefore, Fort Calhoun Station is not required to have any air-quality permits.

2.2.5 Aquatic Resources

The aquatic resources in the vicinity of Fort Calhoun Station are associated with the Missouri River. The species composition of the fish community in this reach of the river has changed significantly (due to channelization) from the 1973 to 1977 fish studies associated with the initial licensing of Fort Calhoun Station and its operations.

Fort Calhoun Station is located on the Missouri River approximately at river kilometer (rkm) 1040 (rmi 646). The river at the site is approximately 182 m (600 ft) wide and 4.5m (15 ft) deep. A continuous rock revetment protects the cutting bank for several kilometers (miles) upstream of the plant and approximately 1.6 km (1 mi) downstream. Filling dikes are spaced along the inside of the river bend opposite the plant, providing the only shallow riverine habitat at the site. Habitat is limited for many species due to the channelization of this river reach. As noted by the NRC, slack-water areas behind wing dams, filling dams, and sloughs and stable structures, such as dikes and revetments, probably constitute the majority of suitable habitat for aquatic biota in the site vicinity (NRC 1978).

Average Missouri River flow rates taken at the gaging station in Omaha, Nebraska, for the period between 1967 and 2000 provide an approximation of river-flow conditions at Fort Calhoun Station. River flows for the month of August were used to calculate the maximum percentage of water intake of Fort Calhoun Station, Unit 1 during a period when spawning and larvae migration is most likely (i.e., summer). August has the lowest average river flows of the summer months and provides a conservative estimate. The lowest average river flows during the year occur in January; therefore, the percentage of water intake calculated for this month represents the maximum Fort Calhoun Station, Unit 1 intake that potentially may occur.

The monthly average river flow rate in August is 1209 m^3/s (42,679 ft^3/s) with a minimum flow rate of 861 m^3/s (30,409 ft^3/s). The maximum water intake by Fort Calhoun Station, Unit 1 during normal plant operations is 23 m^3/s (827 ft^3/s) and occurs during the summer due to higher river temperatures. This maximum water intake represents approximately 2 percent of

the monthly average and 2.8 percent of the minimum river flow in August. During January, the month with the lowest average river flows annually, the monthly average river flow rate is 594 m^3/s (20,982 ft^3/s) with a minimum river flow rate of 313 m^3/s (11,060 ft^3/s). The normal water intake for Fort Calhoun Station, Unit 1 represents approximately 3.9 percent of the average and 7 percent of the minimum monthly river flow during this winter month (OPPD 2002a).

The lower reaches of Long Creek downstream from U.S. Highway 75 and the North and South Sloughs, which are hydraulically connected to the Missouri River, provide slack-water areas on and adjacent to the site during high-water periods. These areas offer some spawning, nursery, and resting habitat for fish from the Missouri River. Fish Creek, a small tributary that outfalls into the Missouri River on the Fort Calhoun Station site, provides little available aquatic habitat due to channelization, small size, and intermittent flow. Portions of the North and South Sloughs support wetland vegetation (OPPD 2002a).

Fish monitoring in the Missouri River, which was conducted in the 1970s by the OPPD and others as part of a comprehensive examination of the effects of power plants (including Fort Calhoun Station), showed that the primary recruitment sources of larval fish to the channelized Missouri River are Lewis and Clark Lake; the unchannelized Missouri River from Yankton, South Dakota, to Sioux City, Iowa; and tributaries. Freshwater drum (*Aplodinotus grunniens*), catostomids, cyprinids, and carp (*Cyprinus carpio*) dominated (greater than 94 percent) the larval drift. Other taxa collected and considered common were the gizzard shad (*Dorosoma cepedianum*), goldeye (*Hiodon alsoides*), and *Stizostedion* sp. (sauger and walleye) (Hergenrader et al. 1982). Field studies conducted at Fort Calhoun Station and the Cooper Nuclear Station indicate that the seasonal highest abundance of fish larvae in the Missouri River occurs from May to July.

Larvae from 13 species were collected from the Missouri River at Fort Calhoun Station. Of the collected larvae, 69 percent were freshwater drum and river carpsucker (*Carpiodes carpio*) (NRC 1978, Section 2.7.2.7). Results of studies reported by the OPPD in connection with the proposed Fort Calhoun Station Unit 2 in the mid-1970s indicated the presence of 64 species of fish in the Missouri River and tributaries near Fort Calhoun Station (NRC 1978, Section 2.7.2.6). Of these species, 23 (36 percent) were selected as important because of their commercial or recreational value; dominance in the ecosystem; or status determination as a rare, endangered, or otherwise threatened species. As the NRC summarized in the *Unit 2 Final Environmental Statement*, common carp, freshwater drum, gizzard shad, and river carpsucker were consistently the most abundant species collected (NRC 1978, Section 2.7.2.6). Hesse et al. (1982) reported the collection of 57 species of fish from the Missouri River (Sioux City, Iowa, to Rulo, Nebraska), of which 17.8 percent were game species, 33.9 percent were nongame species, and 48.3 percent were forage species. The 10 most abundant species collected near Fort Calhoun Station by electroshocking and seining were the gizzard shad, goldeye, carp,

western silvery minnow (*Hybognathus argyritis*), silver chub (*Macrhybopsis storeriana*), emerald shiner (*Notropis atherinoides*), river shiner (*N. blennius*), red shiner (*Cyprinella lutrensis*), river carpsucker, and freshwater drum (Hesse et al. 1982).

Independent of the above studies, an Environmental Assessment issued in 2001 by the U.S. Fish and Wildlife Service (FWS) for the DeSoto National Wildlife Refuge, which is immediately downriver from Fort Calhoun Station, reports that 54 species may be found in the DeSoto Bend reach of the Missouri River based on 30 years of survey data obtained from the Nebraska Game and Parks Commission (FWS 2001a). All but five of the species reported by the FWS were also collected during the monitoring studies of the 1970s discussed above (NRC 1978). The five species not collected as part of Fort Calhoun Station studies were either introduced, difficult to sample for, or unsuited to riverine habitats available in the site vicinity.

Notable recent investigations of lower Missouri River fish populations include those Hesse reported in 1993 and 1994 (Hesse 1993; Hesse and Mestl 1993; Hesse 1994a; Hesse 1994b; Hesse 1994c; Hesse 1994d). The investigators assessed the status of 13 selected fish species in the entire Missouri River reach bordering Nebraska, including the paddlefish (*Polydon spathula*), burbot (*Lota lota*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), blue catfish (*I. furcatus*), sicklefin chub (*M. meeki*), sturgeon chub (*M. gelida*), silver chub (*M. storeriana*), speckled chub (*M. aestivalis*), flathead chub (*Platygobio gracilis*), plains minnow (*H. placitus*), western silvery minnow, and sauger (*Stizostedion canadense*). Twenty-two years of sampling data in the Missouri River (1971 to 1992) were evaluated and presented for the selected species. The focus of the research centered on data regarding the absolute and relative abundance and commercial and recreational harvest.

In the 1993 to 1994 studies, Hesse reports that the decline in the abundance of five of the species investigated—the channel catfish, flathead catfish, blue catfish, sauger, and paddlefish—was evident in historical commercial-harvest records, creel surveys, and fishery survey data collected from 1971 to 1992. Commercial and recreational harvest of these five species was one of the factors cited in the studies as responsible for the observed decline in their populations. However, the studies also characterized all of these fish species as being adapted for survival in large unaltered rivers, and the predominant factor for their decline was identified as the loss of suitable habitat, primarily due to channelization and impoundment of the river with the consequent loss of seasonal flood pulses, altered temperature regimes, and loss of nutrient loadings from bordering floodplains.

The remaining eight species investigated by Hesse (the burbot, sicklefin chub, sturgeon chub, silver chub, speckled chub, flathead chub, plains minnow, and western silvery minnow) also exhibited declines in abundance upon examination of the 22 years of Missouri River fishery survey data (Hesse 1993; Hesse 1994c). Only the burbot was subject to a minor recreational fishery and was generally considered an incidental catch to the targeted fish species. All of

these species are representative and indigenous to large unchannelized rivers. Again, the decline in abundance, as found in the fishery surveys, was attributed to the loss of habitat resulting from channelization, impoundment of the river, loss of seasonal flood pulses, altered temperature regimes due to impoundment, and loss of nutrient loading from the floodplains.

The commercial harvest of channel catfish, flathead catfish, and blue catfish from the Missouri River was banned in 1992 due to the overharvest of recruitment-size individuals. However, the commercial harvest of the common carp and buffalo fish (*Ictiobus* spp.) from the Missouri River still continues, with the State of Nebraska issuing 80 to 90 Missouri River Commercial Seining Vendor Permits annually for nonbanned species (OPPD 2002a). In 2001, 96 of these permits were issued.[(a)] The recreational harvest of the three species of catfish from the Missouri River also continues to represent a valuable resource to the State of Nebraska.

Aquatic species that have been listed; that have been proposed for listing; or that are candidates for listing by the FWS, the State of Iowa, or the State of Nebraska and that have the potential to occur in the vicinity of Fort Calhoun Station are presented in Table 2-2.

Table 2-2. Federally Listed and Nebraska and Iowa State-Listed Aquatic Species Potentially Occurring in Washington, Douglas, Harrison, and Pottawattamie Counties

Scientific Name	Common Name	Federal Status	Nebraska Status	Iowa Status
Scaphirhynchus albus	pallid sturgeon	E	E	E
Acipenser fulvescens	lake sturgeon	—	T	E
Macrhybopsis gelida	sturgeon chub	—	T	—
Lota lota	burbot	—	—	T
Ichthyomyzon castaneus	chestnut lamprey	—	—	T
Etheostoma spectabile	orangethroat darter	—	—	T

E = Endangered; T = Threatened; — = Not listed or protected (or does not occur in the state)

Source: Brandrup (2002); Godberson (2002)

There are six listed fish species that could occur in the vicinity of Fort Calhoun Station. Of these species, the pallid sturgeon (endangered) is Federally listed and is protected under the Endangered Species Act (ESA). No designated critical habitat exists for any of the listed species on or in the vicinity of Fort Calhoun Station. No aquatic species in the area is proposed for listing or is a candidate for listing.

(a) Personal communication with Nebraska Game and Parks Commission, November 22, 2002.

Of all of the designated endangered or threatened species currently listed for Nebraska and Iowa (NGPC 2000; IDNR 2001b), only six fish species are considered to be representative of species indigenous to the Missouri River. However, because of channelization and main-stem dam construction, their habitat requirements have not been adequately met in the middle Missouri River. The NGPC specifically cites alterations to the natural hydrography, channelization, and flow depletions as reasons for the decline of all three of these species (OPPD 2002a). The FWS has issued a Biological Opinion that includes recommendations for changing the flow regime in the Missouri River (FWS 2000). These FWS recommendations are included as options by the USACE (2001) in its *Missouri River Master Water Control Manual Review and Update Revised Draft Environmental Impact Statement*. If implemented, these recommendations may improve the status of these species in the river. The six representative species are discussed in more detail as follows:

The pallid sturgeon was originally listed as endangered throughout its entire range by the FWS in 1990 due to a rapidly declining population (55 FR 36641 [FWS 1990]). The species continues to decline and is nearly extirpated from large segments of its former range and is only occasionally observed (FWS 2000). The pallid sturgeon's historic range encompassed 5633 rkm (3500 rmi) and was comprised of the Yellowstone, Missouri, middle and lower Mississippi Rivers, and the lower reaches of their major tributaries (i.e., the Platte and Kansas Rivers) (55 FR 36641 [FWS 1990]; FWS 2000). It is one of the largest fish species in the Missouri River, and grows to a length of over 1.8 m (6 ft), attains a weight of 45 kg (100 lbs), and has a lifespan of 60 years (55 FR 36641 [FWS 1990]; FWS 2000). This slow-growing and late-maturing species has a flattened shovel-shaped snout, bony plates, and a long reptile-like tail (FWS 2002).

This fish is often found near confluences, islands, and at the downstream end of sandbars (Harms 2001). It is believed that this fish spends some time in the Missouri River and returns to the Platte River annually to spawn or possibly overwinter. Approximately 511 pallid sturgeons were stocked in the Platte River in 1997 and 1998. The Platte River joins the Missouri River approximately 81 rkm (50 rmi) downstream of Fort Calhoun Station.

Human activities have modified or eliminated most of the habitat and ecosystem conditions in the Missouri River to which the pallid sturgeon is adapted. The Missouri River underwent extensive modification resulting in 36 percent of its habitat inundated with reservoirs, 40 percent channelized, and 24 percent altered due to dam operations (FWS 2000). The FCS site is located within a reach of the Missouri River that has been channelized, with a relatively uniform width and swift current. This channel degradation results in a reduction of sediment and organic matter, flow modifications, and channel narrowing. These conditions result in unfavorable habitat for the pallid sturgeon. With the current overall water management regime of the Missouri River (i.e., without increased flows and with warmer water temperatures,

between June and July), it is believed that the cues for spawning are no longer present (FWS 2000).

Like the pallid sturgeon, the lake sturgeon was once common in the Missouri River. The lake sturgeon is now rare in Nebraska (threatened) and Iowa (endangered), but it is common in parts of its historic range. The lake sturgeon is not Federally listed. It is believed that the lake sturgeon occupies habitats similar to those of the pallid sturgeon but spends a greater portion of its time in the Missouri River than in the Platte River (OPPD 2002a). Similar to the pallid sturgeon, the paucity of suitable habitats in the vicinity of Fort Calhoun Station makes occurrence of the lake sturgeon in the Missouri River at Fort Calhoun Station unlikely. Neither the pallid sturgeon nor the lake sturgeon was collected during monitoring studies conducted at Fort Calhoun Station in the 1970s (Hesse et al. 1982).

The sturgeon chub is associated with fast-flowing water and a gravel riverbed but has been collected in side chutes and backwaters, which are thought to provide spawning habitat (OPPD 2002a). In the 1970s, Hesse et al. (1982) collected 1 sturgeon chub out of 90,379 fish sampled from the Missouri River in Nebraska during monitoring studies, which included the vicinity of Fort Calhoun Station. However, the sturgeon chub was collected in the vicinity of Cooper Nuclear Station, approximately 183 rkm (114 rmi) downstream from Fort Calhoun Station. The sturgeon chub was a recent candidate for Federal listing but was not approved by the FWS because it was found to be common in 50 percent of its historical home range (66 FR 19910 [FWS 2001b]). However, the sturgeon chub remains listed as endangered by the State of Nebraska.

Three additional species are State-listed as threatened in Iowa[(a)(b)] and may possibly occur in the reach of the Missouri River that runs past Fort Calhoun Station and through DeSoto National Wildlife Refuge (FWS 2001a). The refuge straddles the Missouri River and is located downstream but near Fort Calhoun Station (i.e., within a 10-km [6-mi] radius). These State-listed threatened species include the burbot, chestnut lamprey, and the orangethroat darter.

After the Gavins Point Dam was closed in the late 1950s, burbot density quickly decreased downstream in the Nebraska portion of the Missouri River, and by 1961 the burbot was no longer routinely caught in this river reach. In 1993, Hesse considered the burbot's presence to be very rare in this portion of the Missouri River and recommended that the burbot be listed as endangered in Nebraska (Hesse 1993). The burbot was already State-listed as threatened in Iowa at that time. The burbot is a northern fish; its range is primarily restricted to the Missouri

(a) Personal communication with K. Dohrmann, State of Iowa, Department of Natural Resources, Conservation and Recreation Division, November 22, 2002.
(b) Personal communication with J. Godberson, Nebraska Game and Parks Commission, Nebraska Natural Heritage Program, November 22, 2002.

River and the lower ends of larger tributaries (e.g., the burbot has been reported in the Platte River). Nebraska is located on the southern edge of the burbot's range. The Burbot requires habitat with underwater structure (e.g., large rocks, snags, aquatic vegetation, erosional banks) that can be used as cover during daylight. For the burbot, foraging occurs at night, with larvae subsisting on amphipods and adults on fish, crawfish, and crustaceans (Hesse 1993).

Although a sedentary species, the burbot may have lengthy upstream migrations during breeding periods. The burbot tends to prefer turbid and glacial rivers. Burbot spawning occurs during winter, in water that is 1 m (3.3 ft) or less deep and over gravel or compacted sand. Weed beds with gravel bottoms and in swift current provide young burbot habitat (Hesse 1993).

The burbot is likely to occur in the Missouri River (OPPD 2002a; FWS 2001a). Sport fishermen harvested six burbots (1 percent by composition) downstream of Omaha, Nebraska, in 1972 (Hesse 1993). Hesse et al. (1982) reported collecting 18 burbots out of 90,379 adult fish collected from the Missouri River (1971 through 1977) in Nebraska, with 8 of these collected near Fort Calhoun Station (the other 10 were collected near Cooper Nuclear Station). In 1977, a single larval burbot was taken at Fort Calhoun Station (Hesse 1982). Based on 30 years of survey data from the NGPC, there have been no records of the burbot's occurrence in the DeSoto Bend reach of the Missouri River (FWS 2001a).

The chestnut lamprey is also a State-listed threatened species in Iowa[(a)] and may possibly occur in the Missouri River in the vicinity of Fort Calhoun Station (FWS 2001a). The chestnut lamprey spawns in small streams during the spring, and the larvae require several years to reach the adult stage. At that time, the fish returns to larger streams and remains there until spring spawning the following year. This parasitic fish is usually found attached to a host fish, subsisting on the host blood. Adults reach a length of 20–33 cm (8–13 in.) (IDNR 2002a).

The chestnut lamprey occurs largely in the Mississippi River, yet it is rarely found. The Upper Mississippi River Conservation Committee has reported occurrences of the chestnut lamprey in the Mississippi River throughout Iowa but not in any other Iowa location (IDNR 2002a). The FWS (2001a) states that the chestnut lamprey may possibly occur in the reach of the Missouri River that runs past Fort Calhoun Station and through DeSoto National Wildlife Refuge. However, 30 years of survey data from the NGPC have not provided any reports of the chestnut lamprey in the DeSoto Bend reach of the Missouri River (FWS 2001a).

The orangethroat darter is State-listed as threatened in Iowa.[(a)] The distribution of the orangethroat darter is extremely limited in Iowa (IDNR 2002b). The orangethroat darter is generally found in small, clear, spring-fed streams with sand, gravel, or rock substrates.

(a) Personal communication with K. Dohrmann, State of Iowa, Department of Natural Resources, Conservation and Recreation Division, November 22, 2002.

However, it is sometimes tolerant of warmer, more turbid environments. Spawning occurs in the spring and summer (CSU 2002; ILDNR 2002). Larvae reach the adult stage in two to three years (ILDNR 2002). Adults reach a maximum length of 6.5 cm (2.5 in.) (CSU 2002). The orangethroat darter feeds on chironomids, tiny crustaceans, and small insect larvae (IDNR 2002b). Based on 30 years of survey data from the NGPC, this species has not been found in the DeSoto Bend reach of the Missouri River (FWS 2001a).

Although not occurring in the vicinity of Fort Calhoun Station, an additional 14 species of fish are listed as either threatened or endangered at the State level in either Nebraska or Iowa (NGPC 2000; IDNR 2001b). The distribution of 7 of these 14 State-listed species (American brook lamprey, black redhorse, weed shiner, freckled madtom, bluntnose darter, least darter, and western sand darter) is limited to the Mississippi River drainage or the lower Missouri River within the Missouri state boundary (Lee et al. 1980). Therefore, these species are not considered to have a reasonable likelihood of occurring within the vicinity of Fort Calhoun Station. The remaining State-listed species (grass pickerel, Topeka shiner, pugnose shiner, blacknose shiner, northern redbelly dace, finescale dace, and the pearl dace) would not be expected in the main-stem Missouri River or lower portions of tributary streams on the basis of their habitat requirements. These species are restricted to small- to medium-sized streams that are characterized as being clear and silt-free with no turbidity, conditions that are more common in the headwater reaches of tributaries than in the middle Missouri River (Pflieger 1975). Therefore, these species are not considered to have a reasonable likelihood of occurring within the vicinity of Fort Calhoun Station. None of these 14 species are included in the NGPC list of species collected near Fort Calhoun Station in the DeSoto Bend reach of the Missouri River, based on 30 years of survey data (FWS 2001a).

No mussels or other aquatic organisms that have threatened or endangered status are expected to occur in the vicinity of Fort Calhoun Station. No mussels are listed as endangered or threatened by the State of Nebraska (OPPD 2002a). The State of Iowa lists 14 species of mussels as being either threatened or endangered, one of which (the Higgin's eye pearly mussel) is also considered to be endangered at the Federal level. However, the Higgin's eye pearly mussel's habitat is the Mississippi River and some of its larger northern tributaries, in gravel or sand (Cummings and Mayer 1992). The State of Iowa could not confirm that any of the listed identified mussels inhabit portions of Iowa in the vicinity of Fort Calhoun Station or have ever been collected from the Missouri River (IDNR 2001a). However, the habitat in the area of Fort Calhoun Station on the outside (cutting) bank of the river is not conducive to colonization by mussels because of the channelization, swift current, high turbidity, and unstable substrates.

2.2.6 Terrestrial Resources

Most (75 percent) of the 267-ha (660-ac) Fort Calhoun Station consists of agricultural land, station facilities, and other developed land (OPPD 2002a). The developed areas are mostly paved or graveled areas and are devoid of natural vegetation. The agricultural land is devoted primarily to corn and soybean production. Much of the remaining developed area is planted in nonnative grasses that are periodically cut for hay. The remaining 25 percent of Fort Calhoun Station supports mostly natural vegetation, including upland forest on slopes in the southern part of the site and floodplain forest and wetlands on the Missouri River floodplain associated with onsite streams and sloughs. The upland forest is dominated by cottonwood, black locust, red mulberry, Siberian elm, and hackberry; poison ivy and stinging nettle are abundant in the understory. Narrow bands of floodplain forest border the bank of the Missouri River, the North and South Sloughs, and Long Creek. The floodplain forest is dominated by green ash, cottonwood, box elder, silver maple, and hackberry; understory species include false indigo, rough dogwood, giant ragweed, goldenrod, and milkweed. Wetland communities (less than 5 percent of Fort Calhoun Station) are associated with the North and South Sloughs, Fish Creek, and Long Creek. Wetland plants on Fort Calhoun Station include narrow-leaved cattail, reed canary grass, sedges, rushes, spikerush, milkweed, rough dogwood, and black willow.

Transmission lines used by Fort Calhoun Station primarily cross agricultural land or are within the U.S. Highway 75 right-of-way. Line 74S/74, which is of particular concern to this SEIS, crosses agricultural land for approximately 10 km (6 mi). The remainder of this line occupies a 15- to 30-m (50- to 100-ft) right-of-way through disturbed old-field and upland forest on the Missouri River bluffs.

Terrestrial species that have been listed, that have been proposed for listing, or that are candidates for listing by the FWS or the States of Iowa or Nebraska and that have the potential to occur in the vicinity of Fort Calhoun Station and Line 74S/74 are presented in Table 2-3.

The bald eagle was originally listed as endangered by the FWS in 1978, but population increases prompted downlisting to threatened status in 1995, and the species is currently proposed for delisting (64 FR 36453 [FWS 1999]). The bald eagle is a common visitor to DeSoto National Wildlife Refuge, which is approximately 3 km (2 mi) to the east of Fort Calhoun Station, in the spring and fall but has never successfully nested there (FWS 2001b). Bald eagles nest along the Missouri River. There is some potential for the occurrence of nests along the river in Washington County, but no bald eagle nests exist on Fort Calhoun Station, and no nests are known to occur in the vicinity (OPPD 2002a). Bald eagles were observed in the vicinity of Fort Calhoun Station during field surveys conducted in 1975 (OPPD 2002a), and migrants or winter visitors are occasionally observed on and near Fort Calhoun Station. Occurrence of this species along Line 74S/74 is unlikely because the line crosses mostly agricultural land and is near U.S. Highway 75 and residential development.

Table 2-3. Terrestrial Species Listed as Endangered or Threatened or Candidates for Listing by the FWS or the States of Iowa and Nebraska That Occur or Potentially Occur Within Washington County, Nebraska, and Harrison County, Iowa

Scientific Name	Common Name	Federal Status	Nebraska Status	Iowa Status
Mammals				
Perognathus flavescens	plains pocket mouse	—	—	E
Synaptomys cooperi	southern bog lemming	—	—	T
Birds				
Haliaeetus leucocephalus	bald eagle	T	T	E
Sterna antillarum	least tern	E	E	E
Charadrius melodus	piping plover	T	T	E
Circus cyaneus	northern harrier	—	—	E
Buteo lineatus	red-shouldered hawk	—	—	E
Asio otus	long-eared owl	—	—	T
Asio flammeus	short-eared owl	—	—	T
Ammodramus henslowii	Henslow's sparrow	—	—	T
Reptiles				
Sistrurus catenatus	massasauga	—	T	—
Plants				
Cypripedium candidum	small white lady's-slipper	—	T	—
Panax quinquifolium	American ginseng	—	T	—
Plantanthera praeclara	western prairie fringed orchid	T	T	T
Penstemon gracilis	slender penstemon	—	—	T
Sphaeralcea coccinea	red-globe mallow	—	—	T

T = Threatened; E = Endangered; — = Not listed or protected (or does not occur in the state)

Source: Brandrup (2002); State of Iowa (2002); Godberson (2002); OPPD (2002a)

Least terns and piping plovers nest on riverine sandbars within the central United States, including those present along the Missouri River. The loss of sandbar nesting habitat due to river channelization and changes in flow from the construction and operation of main-stem dams have resulted in population declines for both the least tern and the piping plover along the

Missouri River (FWS 2001a). Both species once nested in the nearby DeSoto National Wildlife Refuge, but no nests have been observed since the 1970s (FWS 2001a). Least terns are occasionally observed at the refuge, but the last piping plover observation was made there in 1977. The lack of exposed sandbars in the vicinity of Fort Calhoun Station reduces the likelihood of occurrence of either species, and neither species was observed on or near the site during field surveys in 1975 (OPPD 2002a). The recent FWS Biological Opinion on operations of the Missouri River reservoir and navigation system calls for increasing spring flow and lowering summer flow to improve nesting and foraging habitat for these species (FWS 2000).

The western prairie fringed orchid (Federally listed as threatened) is found most often on unplowed, calcareous prairies and sedge meadows (FWS 1996). It potentially occurs in Washington County based on historic observations, but no populations are known to occur in the county (FWS 1996), and the potential for occurrence on or near Fort Calhoun Station or along Line 74S/74 is low given the lack of prairie habitat in these areas.

Two mammal species listed only by the State of Iowa could occur on or in the vicinity of Fort Calhoun Station: the plains pocket mouse (endangered) and the southern bog lemming (threatened). The plains pocket mouse prefers habitats with sparse vegetation and sandy soil; the southern bog lemming prefers bogs and wet meadows with abundant vegetation. Neither species has been documented on Fort Calhoun Station.

Five bird species that are listed only by the State of Iowa could occur in the vicinity of Fort Calhoun Station based on their potential occurrence at DeSoto National Wildlife Refuge (Table 2-3; FWS 2001a). These species include the red-shouldered hawk (endangered), the northern harrier (endangered), the long-eared owl (threatened), the short-eared owl (endangered), and Henslow's sparrow (threatened). Fort Calhoun Station is outside the normal range of the red-shouldered hawk, and the hawk's occurrence in the area is considered accidental. The northern harrier inhabits grassland and wetlands during the spring, summer, and fall and is considered uncommon in the area; the northern harrier was observed on Fort Calhoun Station during surveys in 1975 (OPPD 2002a). The long-eared owl is rare in the vicinity of Fort Calhoun Station where it occupies woodlands in the winter. The short-eared owl also is considered rare in the area where it inhabits open grassland and wetlands in the winter. The Henslow's sparrow occupies grassland and wetlands and has been observed only rarely in the area in the fall. Of these species, the most likely to occur on Fort Calhoun Station is the northern harrier.

The historic range of the massasauga (listed by the State of Nebraska as threatened) included eastern Nebraska and Washington County, but there are no recent records within 80 km (50 mi) of Fort Calhoun Station. In the last 20 years, extant populations of the massasauga have been documented only in Colfax and Pawnee counties (Godberson 2002). This small rattlesnake prefers wet prairie habitat.

Four plant species are listed by either the State of Nebraska or the State of Iowa, but not by the Federal government. These include small white lady's-slipper (Nebraska-listed as threatened; occurs in wet meadows), American ginseng (Nebraska-listed as threatened; occurs in high-quality upland forest), slender penstemon (Iowa-listed as threatened; occurs in dry prairies), and red-globe mallow (Iowa-listed as threatened; occurs in dry prairies). None of these species are known to occur on Fort Calhoun Station.

2.2.7 Radiological Impacts

The OPPD conducts an annual radiological environmental monitoring program (REMP) around Fort Calhoun Station. This program was initiated prior to plant operation in 1973 (OPPD 2002b). The primary function of the REMP is to ensure the overall safety of the general public by monitoring plant liquid and gaseous discharges to the environment. The accumulated data is used to assess the overall impact of plant operation on the environment and to determine whether adjustments to plant operations or the REMP are needed.

Program objectives are accomplished by monitoring the potential radiation-exposure pathways to the public, including adsorption, inhalation, ingestion, and direct exposure. Both grab samples and composite samples are collected and analyzed to represent these exposure pathways, including air, water, milk, vegetation, fish, sediment, and food crops. Direct exposure is monitored by using thermoluminescent dosimeters (TLDs) that are installed in the field at several locations, including air-monitoring stations. Samples are collected at both control (background) and indicator locations, which are selected based on radiological, meteorological, and geographical factors that are obtained from the *Annual Radiological Effluent Release Report* (OPPD 2002c) and the Environmental Land Use Survey (OPPD 2001a). Most monitoring is conducted within a 8-km-radius (5-mi-radius) circle centered on Fort Calhoun Station, Unit 1. However, some samples, typically control samples, are collected outside the 8-km (5-mi) radius.

Radiological releases are summarized in two annual reports: the *Fort Calhoun Station Radiological Environmental Operating Report* (OPPD 2002b) and the *Annual Radiological Effluent Release Report* (OPPD 2002c). The limits for all radiological releases are specified in the Fort Calhoun Station ODCM, and these limits are designed to meet Federal standards and requirements (OPPD 1999).

A review of the historical data on releases and the resultant dose calculations revealed that the doses to maximally exposed individuals in the vicinity of Fort Calhoun Station were a small fraction of the design objectives of 10 CFR Part 50, Appendix I, and the limits specified in the U.S. Environmental Protection Agency's environmental radiation standards in 40 CFR Part 190, as required by 10 CFR 20.1301(d). On April 4, 2003, OPPD informed the NRC that they had corrected the data submitted in the 2001 annual report (OPPD 2003). The corrected data is

used below. The corrected data change was minor and did not change any staff conclusions. For 2001 the dose estimates were calculated based on the corrected actual liquid and gaseous effluent-release data (OPPD 2003). Calculations were performed using the plant effluent-release data, onsite meteorological data, and appropriate pathways identified in the ODCM as corrected by OPPD letter dated April 4, 2003. A breakdown of the maximum dose to an individual located at the Fort Calhoun Station boundary from liquid and gaseous effluents released during 2001 is summarized as follows:

- The total body dose from liquid effluents at the site discharge was 4.41×10^{-3} mSv (4.41×10^{-1} mrem), which is about 14.7 percent of the 0.03-mSv (3-mrem) dose limit. The critical organ dose due to the liquid effluents at the site discharge was 5.94×10^{-3} mSv (5.94×10^{-1} mrem). This dose was about 5.94 percent of the respective 0.10-mSv (10-mrem) dose limit (OPPD 2002c).

- The air dose due to noble gases in gaseous effluents was 3.24×10^{-3} mSv (3.24×10^{-1} mrad) gamma (3.24 percent of the 0.10-mGy [10-mrad] gamma dose limit) and 1.19×10^{-2} mGy (1.19 mrad) beta (5.95 percent of the 0.20-mGy [20-mrad] beta dose limit) (OPPD 2002c, OPPD 2003).

- The critical organ dose from gaseous effluents due to iodine-131, tritium, and particulates with half-lives greater than eight days was 4.83×10^{-2} mSv (4.83 mrem), which is 32.2 percent of the 0.15-mSv (15-mrem) dose limit (OPPD 2002c, OPPD 2003).

The applicant does not anticipate any significant changes to the radioactive effluent releases or exposures from Fort Calhoun Station operations during the renewal period, and, therefore, the impacts to the environment are not expected to change.

2.2.8 Socioeconomic Factors

The staff reviewed the applicant's ER (OPPD 2002a) and information obtained from several county, city, and economic-development staff during a site visit to Washington, Douglas, and Sarpy counties from June 17 to June 20, 2002. The following information describes the economy, population, and communities near Fort Calhoun Station.

2.2.8.1 Housing

Approximately 772 employees work at Fort Calhoun Station, Unit 1 (about 140 contract employees and approximately 632 permanent employees). Approximately 23 percent of these employees live in Washington County; 56 percent live in Douglas County; 7 percent live in Sarpy County, and the rest live in other locations (see Table 2-4). Given the predominance of OPPD employees living in Washington, Douglas, and Sarpy counties and the absence of the likelihood of significant socioeconomic effects in other locations, the focus of the analyses undertaken in this SEIS is on these three counties.

Table 2-4. Fort Calhoun Station, Unit 1—Employee Residence Information by County

County	Number of Personnel	Percent of Total Personnel
Washington	177	23
Douglas	432	56
Sarpy	54	7
Other	109	14
Total Plant Personnel	772	100

Source: OPPD 2002a

The OPPD refuels Fort Calhoun Station, Unit 1 on an 18-month cycle. During these refueling outages, site employment increases by as many as 600 temporary workers for 30 to 40 days. Most of these temporary workers are assumed to be located in the same geographic areas as the permanent OPPD staff.

Table 2-5 provides the number of housing units and housing unit vacancies for Washington, Douglas, and Sarpy counties for 1990 and 2000, the latest years for which information is available. Washington, Douglas, and Sarpy counties have developed comprehensive growth-management plans that characterize current conditions and set standards, regulations, and goals for land development in order to manage future growth.

Table 2-5. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990[a]	2000[b]	Approximate Percentage Change 1990 to 2000
WASHINGTON COUNTY			
Housing Units	6378	7408	16
Occupied Units	6017	6940	15
Vacant Units	361	468	30
DOUGLAS COUNTY			
Housing Units	172335	192672	12
Occupied Units	161113	182194	13
Vacant Units	11222	10478	–7
SARPY COUNTY			
Housing Units	35994	44981	25
Occupied Units	33960	43426	28
Vacant Units	2034	1555	–24

(a) Source: ESRI 1990
(b) Source: USBC 2000

2.2.8.2 Public Services

- **Water Supply**

This discussion of public water systems focuses on Washington, Douglas, and Sarpy counties because approximately 86 percent of Fort Calhoun Station employees reside in these counties. Local municipalities and private water companies provide public potable-water service to residents who do not have individual onsite wells. These providers are subject to regulation under the Federal Safe Drinking Water Act, as implemented by the Nebraska Department of Health.

According to Nebraska Department of Natural Resources estimates for 1995, approximately 42 percent of Washington County residents use onsite wells to obtain potable water, while only 13 percent and 21 percent of residents use onsite wells in Douglas and Sarpy counties, respectively. Additionally, water use for irrigation is substantially greater in Washington County than in Douglas and Sarpy counties. The total domestic water use in 1995, from both public water-supply systems and private

groundwater wells, equaled an estimated 252.2 million L/d (66.63 million gpd) in the combined-county region of Washington, Douglas, and Sarpy counties (OPPD 2002a).

The lack of a public water-supply system in unincorporated portions of Washington County has hindered development in the county. The largest public water supplier in Washington County is the City of Blair's Department of Utilities. The City of Blair Municipal Water Plant services approximately 8500 residents in Blair and its surrounding areas in Washington County. In addition, the city serves industrial customers, such as Fort Calhoun Station and the neighboring Cargill agricultural-product plant. Fort Calhoun Station acquires potable water through the City of Blair's Department of Utilities. Current plant usage averages 3.8 million L (10 million gal) per month (an average of approximately 1.2 million L/d [321,000 gpd]) for Fort Calhoun Station with no restrictions on supply (OPPD 2002a). The water-treatment plant expanded its capacity from 30 million L/d (8 million gpd) to 53 million L/d (14 million gpd) in August 2001.[(a)] Source water is obtained from the Missouri River. The plant is operating near capacity, as the actual daily demand averages 28 million L/d (7.5 million gpd) with a peak demand of approximately 30 million L/d (8 million gpd) (OPPD 2002a).

The Omaha Metropolitan Utilities District (the District) serves more than 170,000 customers in Douglas and Sarpy counties, including Omaha, Bellevue, Offutt Air Force Base, Elkhorn, Waterloo, LaVista, and Carter Lake. The District also supplies water to the Papio–Missouri River Natural Resources District, which provides potable-water supplies to the township of Fort Calhoun. The District operates two water plants with a combined average daily demand of approximately 360 million L/d (95 million gpd) of water. The combined permitted capacity of the two plants is 887 million L/d (234 million gpd). Source water for the plants is obtained from the Missouri and Platte Rivers, as well as several groundwater peaking wells. The District estimates that peak demand could approach or reach the permitted capacity levels in the summer. In 1998, the Nebraska Department of Water Resources approved the first two in a series of permits to begin construction of a third water-treatment plant that will use groundwater wells for source water. This third water-treatment plant is projected to increase the permitted capacity of the water system to 379 million L/d (100 million gpd), thereby meeting the water demands of the service area until at least 2030 (OPPD 2002a).

The City of Papillion Public Works Department is the other primary public potable-water-service provider in Sarpy County. The Department serves approximately 17,000 customers in Papillion and its surrounding areas in Sarpy County. The water-treatment plant has a

(a) Personal communication with A. Schomaker, Director of Public Works, City of Blair, November 13, 2002.

permitted capacity of 45 million L/d (12 million gpd). The actual daily demand averages 21 million L/d (5.5 million gpd) during the winter and 28 million L/d (7.5 million gpd) during the summer, with a peak demand of approximately 34 million L/d (9 million gpd) (OPPD 2002a).

- **Education**

In 2000, there was a total enrollment of 100,246 students attending mainstream public schools in Washington, Douglas, and Sarpy counties. Although the region's 16 school districts do not keep track of Fort Calhoun Station, Unit 1 employee children, Table 2-6 shows the total enrollment for those school districts that likely serve most of these children.

Table 2-6. School District Enrollment in Counties with Significant Numbers of Fort Calhoun Station Employees

County	Enrollment
Washington	3397
Douglas	77448
Sarpy	19401
Total	100246

Source: National Center for Educational Statistics 2001

- **Transportation**

Washington County is served by U.S. Highway 75, which runs north-south towards Omaha and is also the largest-capacity highway in the immediate vicinity of Fort Calhoun Station. Highway 30 (U.S. 30) is the major east-west highway that traverses across the middle of the county to Iowa. It is located within 16 km (10 mi) of Fort Calhoun Station.

Road access to Fort Calhoun Station is via U.S. Highway 75, a two-lane highway running north-south near the Nebraska–Iowa state boundary. In the vicinity of the site, from Blair to Fort Calhoun, the Nebraska Department of Roads estimates that U.S. Highway 75 carries a level-of-service designation of "B," based on 1998 data (OPPD 2002a). In 2000, the estimated traffic volume passing Fort Calhoun Station was 7400 per day (MAPA 2000). The only other access to Fort Calhoun Station is via the Missouri River or by railway.

Employees commuting to and from work use U.S. Highway 75. Local residents and OPPD employees agree that the area is extremely rural and that there are no traffic-related issues.

2.2.8.3 Offsite Land Use

The area within 10 km (6 mi) of Fort Calhoun Station includes part of Washington County in Nebraska and sections of Harrison and Pottawattamie counties in Iowa, with the channelized Missouri River defining the boundary between Nebraska and Iowa in this area. However, this section will focus on the Nebraska counties of Washington, Douglas, and Sarpy because approximately 86 percent of the permanent Fort Calhoun Station workforce live in these communities. Blair, which has a population of 7512 (USBC 2000), is the nearest municipality and is located northwest of Fort Calhoun Station. Fort Calhoun, which has a population of 856 (USBC 2000), is located south of Fort Calhoun Station. No major metropolitan areas occur within 10 km (6 mi) of Fort Calhoun Station. However, one urban area, the Omaha Metropolitan Statistical Area (MSA), which has a population of 100,000 or more, is approximately 16 km (10 mi) south-southeast of Fort Calhoun Station (OPPD 2002a).

Washington, Douglas, and Sarpy counties have developed comprehensive growth-management plans that characterize current conditions and set standards, regulations, and goals for land development in order to manage future growth. Planning agencies in these counties encourage growth in existing urban areas and limit business activities in agricultural areas to those supporting agricultural production. Zoning regulations restrict growth in areas susceptible to flooding. Each county planning agency supports the goal of protecting environmentally sensitive lands, natural resources, rural and agricultural land uses, historic and archaeological resources, and habitats for threatened and endangered species. There are currently no growth-control measures in place to restrict development (OPPD 2002a).

Residential and commercial land uses are predominant in the eastern and central portions of both Douglas and Sarpy counties. Development is strong along the Missouri River and has largely spread out from Omaha. By comparison, land uses in the western portions of both counties are largely rural and agricultural. Washington County is more rural in character, with a larger emphasis on agricultural and open land uses. More than 59 percent of Washington County's population live in rural areas, while only 4 percent of Douglas County's population and 14 percent of Sarpy County's population live in rural areas. Commercial and urban development in Washington County centers on the City of Blair and smaller municipalities where public services are available (OPPD 2002a).

Washington County has a total land area of 101,008 ha (249,600 ac); of this area, 88,691 ha (219,165 ac), or 88 percent, is used for agriculture and open land. Sarpy County covers approximately 62,418 ha (154,240 ac). Like Washington County, the predominant land use in Sarpy County is agricultural; approximately 41,148 ha (101,682 acres), or 66 percent of the land, is used for agriculture (USDA 1997b). Douglas County has a total land area of 87,727 ha (211,840 ac); agriculture uses only occupy 53 percent, or 45,634 ha (112,765 ac), of the land in Douglas County (USDA 1997b).

Industrial development is limited in the site vicinity. The Cargill facility is located on property adjacent to Fort Calhoun Station to the northeast, and several small industrial facilities are located near the Blair Industrial Park between the Cargill facility and the City of Blair (OPPD 2002a).

The area of the Missouri River bottomlands within 10 km (6 mi) of Fort Calhoun Station consists primarily of sparsely populated agricultural cropland and public lands dedicated to wildlife management, recreation, and historical preservation. Notable among these public lands in Nebraska are the DeSoto and Boyer Chute National Wildlife Refuges and the Fort Atkinson State Park. In Iowa, notable public lands include the Wilson Island State Recreation Area and Nobles Lake Wildlife Management Area southward from the site and the California Bend and Tyson Island Wildlife Management Areas northward from the site. One commercial marina operates on the Missouri River approximately 8 rkm (5 rmi) upstream from Fort Calhoun Station (OPPD 2002a).

2.2.8.4 Visual Aesthetics and Noise

Fort Calhoun Station, Unit 1 and its supporting structures can be seen from the immediate surrounding area, from U.S. Highway 75, and by recreational users on the Missouri River; however, only the steam plume is visible from the Cargill facility, which is located on adjacent property to the northeast. The most visible features of Fort Calhoun Station are the meteorological tower, Auxiliary buildings, the containment structure, and the transmission lines connecting to the Fort Calhoun Station Substation. Approximately 85 percent of the site is on relatively level ground on the river bottomlands, with the southern portion of the site rising sharply by approximately 18 m (60 ft) to U.S. Highway 75. Fort Calhoun Station is also completely visible from the Missouri River and U.S. Highway 75 at night because both the Fort Calhoun Station, Unit 1 emission stacks and the meteorological tower have outside lighting. Noise from Fort Calhoun Station is usually not noticeable by recreational users of the Missouri River and facilities upstream of Fort Calhoun Station.

2.2.8.5 Demography

Population was estimated from Fort Calhoun Station out to a distance of 80 km (50 mi). The OPPD used 1990 U.S. Bureau of the Census (USBC) tract data and 2000 USBC Census data for other areas of its ER because 2000 Census tract data was not available at the time the OPPD completed the ER. NRC guidance calls for the use of the most recent USBC decennial census data, which in the case of Fort Calhoun Station, was the 1990 Census at the time of publication of the ER (OPPD 2002a). Updated information was presented after the ER was completed (USBC 1991 and 2001). The Census Bureau provides updated annual projections, in addition to decennial data, for selected portions of its demographic information. Section 2.11 (Minority and Low-Income Populations) of the ER used 1990 minority and low-income

population demographic information because updated projections were not available by census tract. The OPPD also chose to use 1990 data in discussing total population so that the data sets would be consistent throughout the Fort Calhoun Station ER. The NRC staff used 2000 Census data in this section and in discussing minority populations.

As derived from USBC 2000 information, at least 339,911 people live within 32 km (20 mi) of Fort Calhoun Station (Geolytics Software 2000). Applying the GEIS sparseness measures, Fort Calhoun Station has a population density of 104 persons/km^2 (270 persons/mi^2) within 32 km (20 mi) and falls into the least sparse category, Category 4 (having greater than or equal to 46 persons/km^2 [120 persons/mi^2] within 32 km [20 mi]). As estimated from USBC 2000 information, at least 852,717 people live within 80 km (50 mi) of Fort Calhoun Station (Geolytics Software 2000). This equates to a population density of 42 persons/km^2 (109 persons/mi^2) within 80 km (50 mi). Applying the GEIS sparseness and proximity matrix, Fort Calhoun Station ranks as sparseness Category 4 and proximity Category 3, resulting in the conclusion that Fort Calhoun Station is located in a high-population area. All or parts of 22 counties are located within 80 km (50 mi) of Fort Calhoun Station (see Figure 2-1). Of these 22 counties, 12 are in Nebraska, and 10 are in Iowa.

The Omaha MSA is the largest metropolitan area within 80 km (50 mi) of Fort Calhoun Station. Approximately 86 percent of Fort Calhoun Station employees live in Washington, Douglas, and Sarpy counties. The remaining 14 percent are distributed across 19 counties.

The populations of Washington, Douglas, and Sarpy counties are growing at faster rates than those of the State of Nebraska as a whole. Between 1990 and 2000, Nebraska's population increased by 8.4 percent, while the population in Washington, Douglas, and Sarpy counties increased by 13.1, 11.3, and 19.5 percent, respectively. Projections for the period from 2000 through 2030 show increases of 29, 20, and 55 in Washington, Douglas, and Sarpy counties, respectively.

The largest town near Fort Calhoun Station is Omaha, which is 24 km (15 mi) away in Douglas County. Between 1990 and 2000, Douglas County experienced a population growth from 416,444 (in 1990) to 463,585 (in 2000), an 11.3 percent increase over the decade (USBC 2000). The greatest relative population growth within the 80-km (50-mi) radius around Fort Calhoun Station between 1990 and 2000 occurred in Washington County (13.1 percent).

Table 2-7 shows estimated populations and annual growth rates for the three counties with the greatest potential to be affected by license renewal activities.

Table 2-7. Regional Demographies

	Estimated Populations and Average Annual Growth Rates in Washington, Douglas, and Sarpy Counties from 1980 to 2030					
	Washington County		Douglas County		Sarpy County	
Year	Population	Percent	Population	Percent	Population	Percent
1980	15508	1.6	397038	0.2	86015	3.5
1990	16607	0.7	416444	0.5	102583	1.9
2000	18780	1.3	463585	1.1	122595	2
2010	20829	1.1	482765	0.4	145494	1.9
2020	22653	0.9	513449	0.6	171386	1.5
2030	24239	0.7	554525	0.8	190239	1.1

Source: OPPD 2002a

- **Resident Population Within 80 km (50 mi)**

  Table 2-8 presents the population distribution within 80 km (50 mi) of Fort Calhoun Station for the year 2000.

  Table 2-8. Population Distribution in 2000 Within 80 km (50 mi) of Fort Calhoun Station

0 to 16 km (0 to 10 mi)	16 to 32 km (10 to 20 mi)	32 to 48 km (20 to 30 mi)	48 to 64 km (30 to 40 mi)	64 to 80 km (40 to 50 mi)	Total
17672	322239	392219	73120	47467	852717

Source: Geolytics Software 2000

The population centers within the 16-km (10-mi) area are the towns of Fort Calhoun and Blair. The populations of these settlements in 2000 were respectively, 856 and 7512 (USBC 2000). Most of the new residential development within the 16-km (10-mi) radius has been in Blair.

The county planning departments for Washington, Douglas, and Sarpy counties project low to medium population growth for the area (0.4 to 1.9 percent for the next decade). There are several residential developments that have recently been completed in the vicinity of Blair.

- **Transient Population**

  The transient population in the vicinity of Fort Calhoun Station can be identified as daily or seasonal. Daily transients are associated with places where a large number of people gather regularly, such as local businesses, industrial facilities, and schools. Seasonal transients result from part-time residents who may reside in the Omaha metropolitan area to pursue recreational activities there throughout the year. The major seasonal population associated within 16 km (10 mi) of Fort Calhoun Station for recreational activities includes the DeSoto National Wildlife Refuge, Fort Atkinson State Park, and Boyer Chute National Wildlife Refuge. Their combined average annual visitors is approximately 405,000 people per year (OPPD 2002a). The largest employer within 16 km (10 mi) of Fort Calhoun Station is Cargill, Incorporated, with approximately 1000 employees.[(a)]

- **Agricultural Labor**

  There are over 32,376 ha (80,000 ac) of farmland in Washington County.[(b)] The main agricultural crops grown within the 80-km (50-mi) radius of Fort Calhoun Station are corn and soybeans. Almost all of the laborers on farms in the area are believed to be residents in the area.

  Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These employees may or may not have a permanent place of residence. Migrant labor is not used in this part of the country. Little to no migrant workers are employed within a 80-km (50-mi) radius of Fort Calhoun Station, Unit 1.[(b)]

2.2.8.6 Economy

The Omaha MSA has experienced steady growth in recent years. The employed workforce in Omaha increased 25.7 percent between 1990 and 1999, which compares favorably to the national growth rate of 17.6 percent (OPPD 2002a). Services is the largest employment sector, accounting for 33.1 percent of total employment in the Omaha MSA. Trade accounts for approximately 24.1 percent of total employment, while the government and manufacturing sectors account for approximately 12.1 percent and 9.5 percent, respectively (OPPD 2002a).

In 2000, the Omaha MSA had an estimated labor force of 400,049 and an unemployment rate of 2.5 percent. For the past decade, unemployment rates in the region have been much lower than the national average and have been comparable to the Nebraska average. The median

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(a) Personal communication with R. Storm, City Administrator, City of Blair, June 18, 2002.
(b) Personal communication with J. Peterson, University of Nebraska, Cooperative Extension Office, June 18, 2002.

household in Omaha in 2000 had an estimated effective buying income of $46,575. In comparison, the estimated effective buying income of the median household in the nation was $37,233 (OPPD 2002a).

U.S. Interstates 80 and 29, as well as 12 other U.S. and State highways, intersect in the Omaha MSA. This extensive highway network gives the region access to east-west and north-south corridors. The region's transportation network also includes rail and trucking terminals, the Eppley airfield and four other local airports, and two barge lines that are capable of transporting large volumes of commodities on the Missouri River (OPPD 2002a).

Agriculture contributes significantly to the regional economy, particularly in more rural Washington County. Principal crops in the region include corn, soybeans, and hay (OPPD 2002a). According to the U.S. Department of Agriculture's 1997 Census of Agriculture, receipts from all agricultural products contributed $92.5 million to Washington County's economy (USDA 1997a). Livestock sales alone accounted for 51 percent of the market value of agricultural-product sales. By comparison, agricultural sales contributed only $44.1 million and $57.2 million to the economies in Douglas and Sarpy counties, respectively (OPPD 2002a).

The Nebraska State Constitution Article VIII, Section 11, (1958) stipulates:

> Every corporation and political subdivision organized primarily to provide electricity shall annually make the same payments in lieu of taxes as it made in 1957, which payments shall be allocated in the same proportion to the same public bodies or their successors as they were in 1957. The legislature may require each such public corporation to pay to the treasurer of any county in which may be located any incorporated city or village, within the limits of which such public corporation sells electricity at retail, a sum of five percent of the annual gross revenue (OPPD 2002a).

The OPPD is a publicly owned electric utility with a total generation capability as of July 31, 2001, of 2,203,000 kW from its five power stations. The OPPD leases an additional 6600 MW from the Tecumseh Municipal Utility (OPPD 2002a). As a political subdivision responsible for the production and distribution of electricity within its 13-county service area, the OPPD is exempt from paying State-occupational, personal-property, and real-estate taxes. Instead, the OPPD makes six payments in lieu of taxes each year to the municipalities and 12 Nebraska counties (Burt, Cass, Colfax, Dodge, Douglas, Johnson, Nemaha, Otoe, Richardson, Sarpy, Saunders, and Washington) in which the OPPD sold power in 1957. In addition, each county receives 5 percent of the total gross revenues the OPPD receives from electricity sales from within the county, minus the amount already paid to the incorporated area of the county.

Payments are made to the counties and municipalities within the service area irrespective of whether the power is purchased from another generator or produced at OPPD power plants. The counties and municipalities then distribute the money to the appropriate cities, school districts, and agencies.

From 1996 to 2000, approximately 80 percent of the OPPD's total annual in lieu payments have been paid to Douglas County, the largest consumer of OPPD electricity. In 2000, the OPPD's in lieu payments totaled $17.6 million, $15.0 million of which was paid to Douglas County and its constituent municipalities. In comparison, the OPPD made in lieu payments totaling approximately $1.79 million and $330,000 to the county governments and constituent municipalities in Sarpy and Washington counties, respectively (see Table 2-9).

Table 2-9. Fort Calhoun Station, Unit 1 Contributions to County Operating Budgets

Year	Washington County In Lieu Revenues	Douglas County In Lieu Revenues	Sarpy County In Lieu Revenues
2000	$330,000	$15,000,000	$1,790,000

Source: OPPD 2002a

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at Fort Calhoun Station and in the surrounding area.

2.2.9.1 Cultural Background

The area around Fort Calhoun Station is rich in prehistoric and historic Native American and historic Euro-American resources. This is due, in large part, because of the plant's location adjacent to the Missouri River, a focal point of human occupation and travel throughout prehistoric and historic times.

- **Prehistoric Period**

  Archaeologists commonly divide the Great Plains into several cultural subareas, based primarily on a particular set of ecological conditions that is somewhat reflected in the cultural systems that occupied those areas over time. Fort Calhoun Station is located in the "Central Plains" subarea, which includes all of eastern Nebraska and adjoining parts of South Dakota, Iowa, Missouri, and Kansas (Wood 1998). The prehistoric Native American occupation of the region that includes Fort Calhoun Station has four general periods: the Paleo-Indian period (about 10,000 B.C. to 7000 B.C.), the Archaic period (about 7000 B.C.

to A.D. 1), the Plains Woodland period (about A.D. 1 to A.D. 1100), and the Plains Village (about A.D. 1100 to A.D. 1700). Toward the end of the Plains Village period, about A.D. 1700, a transitional episode known as the Protohistoric period began in which initial contacts with Europeans and cultural changes associated with subsequent White exploration and settlement of the region took place.

The prehistoric periods were marked by an initial reliance on big-game hunting subsistence, followed by an increased use of smaller game animals and plant foods in the Archaic era. Major environmental changes late in the Archaic period led to an increasingly more sedentary lifestyle in the Plains Woodland period that followed. Late in the Plains Woodland era, more sedentary villages and an increasing reliance on cultivated crops became the norm. The subsequent Plains Village period was characterized by substantial earth-covered lodges in semipermanent villages in the river valleys, with subsistence based on agriculture, hunting and gathering, and intergroup trade. In the Central Plains, Plains Village groups focused their activities along the Missouri River and the lower reaches of its immediate tributaries.

- **Historic Period Native American**

At the time of European contact and subsequent intrusion into the area surrounding Fort Calhoun Station, the lands on the west side of the Missouri River (in what would become the state of Nebraska) were occupied principally by the Omaha Indian Nation (Fletcher and La Flesche 1911; O'Shea and Ludwickson 1992; Smith 1974), although nearby to the west were the Pawnee (Hyde 1951) and immediately to the east, south, and north were other Siouan-speaking tribes such as the Ponca (Howard 1965), Otoe and Missouria (Chapman 1965), Ioway (Blaine 1979), Sac & Fox (Hagan 1958), and Kansa (Unrau 1971). In 1854, the Omaha Tribe ceded the land on which Fort Calhoun Station is located to the United States, and the tribe was settled on a reservation about 80 km (50 mi) northwest of Fort Calhoun Station. Another tribe, the Winnebago, was relocated from Wisconsin to the Omaha Reservation in the 1860s to 1870s and eventually was granted a separate reservation immediately north of the Omaha (Radin 1923; Jones and Smith 1974). Legal work by the U.S. Indian Claims Commission to judicially establish the lands of original tribal occupancy found that all of northeastern Nebraska south to the Platte River was occupied by the Omaha, with adjacent tribes being the Otoe and Missouria south of the Platte River, the Pawnee to the west and southwest, and the Ponca to the northwest (U.S. Indian Claims Commission 1979). To the east, lands immediately on the other side of the Missouri River in present-day Iowa were found to have been occupied by several tribes, including the Otoe and Missouria, Ioway, Omaha, and Sac & Fox.

- **Historic Period Euro-American**

  The historic period in the area where Fort Calhoun Station is located was particularly eventful, especially with regard to activities associated with the early exploration and settlement of the western United States. Most notable was the Corps of Discovery expedition of 1804 to 1806, which was led by Captains Meriwether Lewis and William Clark. In the vicinity of the project area, Lewis and Clark held a council on August 3, 1804, with six leaders of the Otoe and Missouria at a bluff on the west side of the Missouri River near the present-day town of Fort Calhoun, about 8 km (5 mi) southeast of the plant. Leaving this locale, the party traveled upriver on August 3, camping for the night within what is today the DeSoto National Wildlife Refuge. The following day, the Lewis-and-Clark party continued upriver past the location of the current Fort Calhoun Station, although the channel of the river was not then in the same position as its current location.

  In 1819, Fort Atkinson was established on the same bluff where Lewis and Clark met in council with the American Indian leaders as one of the line of forts established to guard the western frontier and to protect U.S. fur trade from English competition (Ney 1978). The fort was abandoned in 1827, and only archaeological remains survive (Carlson 1979). Today, the fort exists in reconstructed form as the Fort Atkinson State Historic Park.

  The next significant historical event to occur in the vicinity of the nuclear plant was the establishment in 1847 of the “Summer Quarters” or “Brigham Young’s Farm” by Mormon settlers at a locale about 3 km (1.75 mi) southeast of the present plant site. This farming venture was begun in an area that had been formerly cultivated by personnel from the earlier Fort Atkinson. The farm was intended to provide food and grain for any Mormon immigrants who might be stalled in the “Winter Quarters” (in the northern part of Omaha) while traveling west. Because of hardships (troubles with the both Omaha and Otoe Indians and an epidemic that killed 18 people in the camp), the Mormons abandoned the farm on April 26, 1848.

  White settlement of the area occurred rapidly following a treaty with the Omaha Tribe in 1854 that ceded lands to the United States (Bell 1985; Washington County Historical Association 1980). Washington County was established the same year and was reorganized the following year. Adjacent to the site of the current Fort Calhoun Station, the town of DeSoto was laid out in the fall of 1854 and was incorporated in March 1855. Located on the then-channel of the Missouri River, DeSoto quickly became one of the primary population centers of the area and was designated as the county seat between 1858 and 1866. Prosperity in DeSoto ended, however, in the late 1860s, mainly because of the construction of an east-west rail line that crossed the Missouri River about 6.5 km (4 mi) north of DeSoto and the associated founding of the town of Blair.

Throughout the last half of the 1800s, use of the Missouri River as a thoroughfare for commerce and passenger transport was common. As discussed in the next section, one result of these activities was the loss of many steamships and other watercraft to accidents along the river channel. The most notable of these wrecks is the steamship *Bertrand* (Petsche 1974), which is located in the FWS DeSoto National Wildlife Refuge, about 4 km (2.5 mi) east of Fort Calhoun Station.

2.2.9.2 Historic and Archaeological Resources at Fort Calhoun Station

To assess both known and potential cultural resource sites at Fort Calhoun Station, several existing literature and database sources were consulted, along with contacts at several organizations (see Appendix D). In addition to the sources included in Appendix D, electronic database searches were conducted at the National Park Service's National Register of Historic Places Information System, the National Historic Landmarks Program, and the Historic American Buildings Survey/Historic American Engineering Record listings. Finally, a number of historical maps ranging in age from 1855 to 1948 were examined to identify cultural sites and transportation routes that may have once existed in the vicinity of Fort Calhoun Station, as well as the historical movements of the Missouri River channel.

Several previous cultural-resources investigations have been conducted near Fort Calhoun Station. When combined, these investigations provide an overview of the cultural-resources picture in the immediate vicinity of Fort Calhoun Station. The principal cultural resource in proximity to the plant is the Old DeSoto town site. Essentially abandoned since 1870, the property has been impacted by three activities: (1) the construction of the Chicago and Northwestern rail line, (2) an earlier realignment of U.S. Highway 73 (now known as U.S. Highway 75), and (3) construction of Fort Calhoun Station, Unit 1 (Carlson and Steinacher 1996, p. 5). The first two activities impacted the property by relocating transportation routes from the floodplain to closer to the base of the bluffs. The Old DeSoto town site was further impacted during the construction of Fort Calhoun Station, Unit 1 when a large amount of fill was removed from the center of the former town site. Following the removal of fill, personnel from the Nebraska State Historical Society examined locations that had already been disturbed by earth-moving activities and made a small collection of artifactual materials.

After the initial construction of Fort Calhoun Station, Unit 1, two archaeological surveys were conducted in 1975 as part of the proposal to construct Fort Calhoun Station Unit 2. These surveys included the proposed plant site (Henning 1975) and two borrow areas (Carlson and Steinacher 1996). The results of these two surveys, along with the assumption that significant impacts had already taken place at the DeSoto town site, led the 1975 investigators to conclude that the site was ineligible for listing on the National Register of Historic Places. As noted below, however, subsequent fieldwork and assessment have reversed this evaluation.

More intensive archaeological survey and excavation within the DeSoto site took place in 1976 as part of the reconstruction and upgrading of U.S. Highway 73 (now known as U.S. Highway 75) between the towns of Fort Calhoun and Blair (Steinacher 1976). Excavations within the highway right-of-way located adjacent to Fort Calhoun Station yielded important archaeological data and provided information that significant subsurface data remained at the town site. Accordingly, the former town of DeSoto was evaluated as being potentially eligible for nomination to the National Register of Historic Places in January 1989.

Apart from the town of DeSoto, a review of the National Register listings did not disclose any Register-listed or -eligible historic properties in immediate proximity to Fort Calhoun Station. Fort Atkinson, about 8 km (5 mi) southeast of the plant, is both listed on the National Register and designated as a National Historic Landmark. Seven historic buildings in the town of Blair, about 6.5 km (4 mi) north of the plant, are listed on the National Register, as is the steamship *Bertrand*.

Another officially designated historic site in the vicinity of Fort Calhoun Station is the Lewis and Clark National Historic Trail. Designated in March 1978, the trail receives oversight from the National Park Service, although there are no Park Service lands involved. Aside from the location of the 1804 council at Fort Atkinson, there are no known historic sites specifically related to this historic trail in the immediate vicinity of Fort Calhoun Station.

A review of the site files at the Nebraska State Historical Society Archaeology Division and the State Historic Preservation Office yielded a total of 22 recorded historic and archaeological sites within 8 km (5 mi) of Fort Calhoun Station on the Nebraska side of the Missouri River. These sites range from prehistoric village and burial sites, primarily located on the higher bluffs above the Missouri River floodplain, to historic properties such as farmsteads and mills in the lower area of the floodplain. Of these sites, three (including the DeSoto site and the *Bertrand*) are eligible for the National Register, and two have been evaluated as being ineligible. The remaining 17 sites have not been evaluated. On the Iowa side of the river, an archaeological survey of the DeSoto National Wildlife Refuge recorded 13 sites, all historic Euro-American (Blakeslee and King 1978).

Steamboat wrecks in the vicinity of Fort Calhoun Station, which date back to the 1860s for the most part, deserve mention because the precise location of only one (the *Bertrand*) is known. According to various sources (Chittenden 1897; McDonald 1927; Bowers, Muessig, and Soike 1990; and the Nebraska State Historical Society site files), there are at least six wrecks within 3 to 5 km (2 to 3 mi) of Fort Calhoun Station. Because of historic changes, both natural and engineered, to the channel of the Missouri River, none of these wrecks lie in the current channel; instead, all of the wrecks are buried in floodplain deposits away from the present watercourse. Four of these wrecks—the *Bertrand* (1865), the *E. O. Stanard* (1865), the *Cora* (1865), and the *Susan* (1907)—occurred along the former DeSoto Bend and are located either

within the DeSoto National Wildlife Refuge or just downriver from the refuge. The *Anderson* (date of wreck unknown) is thought to be located about 0.4 km (1 mi) west of Fort Calhoun Station, between Fish Creek and the Chicago and Northwestern rail line. The location of the *Benton* (1869) is problematic and has been thought to be in a variety of locations, ranging from 13 km (8 mi) north of DeSoto to 3 km (2 mi) south of the town. The most recent investigators believe that the remains of the *Benton* "probably lie in the immediate vicinity of the Ft. Calhoun Nuclear Power Plant" (Bowers, Muessig, and Soike 1990, p. 32).

Although prehistoric-period villages and human burials have been recorded within 3 km (2 mi) of the plant, a review of the existing literature and site files has not revealed any sites, areas, or resources in the immediate vicinity of Fort Calhoun Station that have been identified as having significant cultural values for modern American Indian tribes. To date, contacts with the Omaha Tribe by the OPPD and six tribes by NRC staff, including the Iowa Tribe of Kansas and Nebraska, the Omaha Tribe, the Ponca Tribe of Nebraska, the Sac & Fox Tribe of Missouri in Kansas and Nebraska, the Santee Sioux Tribe, and the Winnebago Tribe, have not yielded information about known or potential traditional properties or other important American Indian resources that could exist at Fort Calhoun Station. Similarly, no such issues have been raised during the public scoping period.

2.2.10 Related Federal Project Activities and Consultations

The staff reviewed the possibility that the activities of other Federal agencies might impact the renewal of the OL for Fort Calhoun Station, Unit 1. Any such activities could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency for the preparation of the SEIS.

The FWS is currently examining the impact of six alternatives for regulating flows in the Missouri River Main Stem Reservoir System, which was constructed and is operated by the USACE. Issuance of the final environmental impact statement (EIS) and the revised Master Manual is expected by the end of 2003.

The Reservoir System is operated using guidelines published in the *Missouri River Main Stem Reservoir System Master Manual* (USACE 1979). The Master Manual, which has been subject to only minor revisions—the last in 1979, prescribes implementation protocols for Reservoir System storage and release functions to accommodate the multiple purposes described below. Although hydropower and water supply provide about 70 percent of the economic benefits, the release criteria for Gavins Point Dam are currently influenced most by navigation considerations. The navigation considerations are overridden by the need to either cut back releases for downstream flood control or to evacuate flood-control storage space in the reservoirs (OPPD 2002a).

Based on prior experience and requirements that address Federal legislation, long-term adjustments have been made in Reservoir System operations. The most significant long-term adjustment in Reservoir System operations involved the modification of summertime peak-power releases from Fort Peck, Garrison, Fort Randall, and Gavins Point Dams to limit adverse impacts to two Federally protected bird species, the piping plover (*Charadrius melodus*) (designated threatened) and the least tern (*Sterna antillarum*) (designated endangered), which have historically depended on exposed sandbars in the river for nesting (FWS 2000).

The navigation industry on the lower river has not grown as expected, while the recreation industry associated with the river reaches and reservoirs in the upper basin has grown significantly. In addition, the ecological impacts of the USACE's Missouri River projects have become better known, and several affected species—most notably the least tern, the piping plover, and the pallid sturgeon (*Scaphirhynchus albus*)—have been listed as threatened or endangered under the Federal ESA. These and other changes since the Main Stem Reservoir System was first authorized have prompted the USACE to undertake a review and update of the Master Manual. The objectives of the revision are to determine what best meets the current needs of the basin and to incorporate controls to appropriately meet those needs. These activities, which began in 1989, include the development of an EIS. In a revised draft EIS, which was issued in August 2001 (USACE 2001), the FWS examines the impact of six alternatives for regulating flows in the Reservoir System. The issuance of the final EIS and the revised Master Manual is expected in 2003.

Regulation of the flow in the Missouri River Main Stem Reservoir System is a matter that affects the current operation of Fort Calhoun Station, Unit 1, and therefore, is not a consideration for the staff's review of the license renewal application for the facility. Therefore, after reviewing Federal activities in the vicinity of Fort Calhoun Station, the staff determined that there were no Federal project activities that would make it desirable for another Federal agency (NRC) to become a cooperating agency for the preparation of this SEIS.

The NRC is required under Section 102 of the National Environmental Policy Act of 1969 to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. The NRC is consulting with the FWS. Consultation correspondence is included in Appendix E.

2.3 References

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10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 61. Code of Federal Regulations, Title 10, *Energy,* Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

10 CFR Part 71. Code of Federal Regulations, Title 10, *Energy,* Part 71, "Packaging and Transportation of Radioactive Material."

40 CFR Part 81. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 81, "Designation of Areas for Air Quality Planning Purposes."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

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3.0 Environmental Impacts of Refurbishment

Environmental issues associated with refurbishment activities are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) 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.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

License renewal actions may require refurbishment activities for the extended plant life. These actions may have an impact on the environment that requires evaluation, depending on the type of action and the plant-specific design. Environmental issues associated with refurbishment that were determined to be Category 1 issues are listed in Table 3-1.

Environmental issues related to refurbishment considered in the GEIS for which these conclusions could not be reached for all plants, or for specific classes of plants, are Category 2 issues. These are listed in Table 3-2.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Refurbishment	3.5
GROUND-WATER USE AND QUALITY	
Impacts of refurbishment on ground-water use and quality	3.4.2
LAND USE	
Onsite land use	3.2
HUMAN HEALTH	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	3.7.4; 3.7.4.3; 3.7.4.4; 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Category 1 and Category 2 issues related to refurbishment that are not applicable to Fort Calhoun Station because they are related to plant design features or site characteristics not found at Fort Calhoun Station are listed in Appendix F.

The potential environmental effects of refurbishment actions would be identified, and the analysis would be summarized within this section, if such actions were planned. The Omaha Public Power District (OPPD) indicated that it has performed an assessment of structures and components pursuant to 10 CFR 54.21 to identify activities that are necessary to continue operation of Fort Calhoun Station, Unit 1 during the requested 20-year period of extended operation. During this assessment, the OPPD did not identify the need to undertake any refurbishment or replacement actions to maintain the functionality of important systems, structures, and components during the Fort Calhoun Station license renewal period (OPPD 2002). Therefore, refurbishment is not considered in this supplemental environmental impact statement.

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53 (c)(3)(ii) Subparagraph
TERRESTRIAL RESOURCES		
Refurbishment impacts	3.6	E
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)		
Threatened or endangered species	3.9	E
AIR QUALITY		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
SOCIOECONOMICS		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archaeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed[(a)]	Not addressed[(a)]

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. If a licensee plans to undertake refurbishment activities for license renewal, environmental justice must be addressed in the licensee's environmental report and the staff's environmental impact statement.

3.1 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

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4.0 Environmental Impacts of Operation

Environmental issues associated with operation of a nuclear power plant during the renewal term are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) 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.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues related to operation during the renewal term that are listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, and are applicable to Fort Calhoun Station, Unit 1. Section 4.1 addresses issues applicable to the cooling system. Section 4.2 addresses issues related to the transmission line and onsite land use. Section 4.3 addresses the radiological impacts of normal operation. Section 4.4 addresses issues related to the socioeconomic impacts of normal operation during the renewal term. Table 4-7 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and environmental justice, which was not addressed in the GEIS. Section 4.5 addresses issues related to groundwater use and quality. Section 4.6 discusses the impacts of renewal-term operations on threatened and endangered species. Section 4.7 addresses new information that was raised

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

during the scoping period. The results of the evaluation of environmental issues related to operation during the renewal term are summarized in Section 4.8. Finally, Section 4.9 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable to Fort Calhoun Station because they are related to plant design features or site characteristics not found at Fort Calhoun Station are listed in Appendix F.

4.1 Cooling System

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B that are applicable to Fort Calhoun Station cooling-system operation during the renewal term are listed in Table 4-1. The Omaha Public Power District (OPPD) stated in its Environmental Report (ER; OPPD 2002) that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station, Unit 1 operating license (OL). The staff has not identified any significant new information during its independent review of the OPPD ER (OPPD 2002), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the issues, the GEIS concluded that the impacts are SMALL, and additional plant-specific mitigation measures beyond those already in place at Fort Calhoun Station are not likely to be sufficiently beneficial to be warranted.

Table 4-1. Category 1 Issues Applicable to the Operation of the Fort Calhoun Station, Unit 1 Cooling System During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Temperature effects on sediment transport capacity	4.2.4.2.3; 4.3.2.2
Scouring caused by discharged cooling water	4.2.1.2.3
Eutrophication	4.2.1.2.3
Discharge of chlorine or other biocides	4.2.1.2.4; 4.3.2.2
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4; 4.3.2.2
Discharge of other metals in waste water	4.2.1.2.4; 4.3.2.2
Water use conflicts (plants with once-through cooling systems)	4.2.1.3; 4.3.2.1
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4; 4.3.3; 4.4.3; 4.4.2.2
Entrainment of phytoplankton and zooplankton	4.2.2.1.1; 4.3.3; 4.4.3

Table 4-1 (contd)

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
Cold shock	4.2.2.1.5; 4.3.3; 4.4.3
Thermal plume barrier to migrating fish	4.2.2.1.6; 4.4.3
Distribution of aquatic organisms	4.2.2.1.6; 4.4.3
Premature emergence of aquatic insects	4.2.2.1.7; 4.4.3
Gas supersaturation (gas bubble disease)	4.2.2.1.8; 4.4.3
Low dissolved oxygen in the discharge	4.2.2.1.9; 4.3.3; 4.4.3
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10; 4.4.3
Stimulation of nuisance organisms (e.g., shipworms)	4.2.2.1.11; 4.4.3
HUMAN HEALTH	
Microbiological organisms (occupational health)	4.3.6
Noise	4.3.7

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Altered current patterns at intake and discharge structures. Based on information in the GEIS, the Commission found that

  > Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of altered current patterns at intake and discharge structures during the renewal term beyond those discussed in the GEIS.

- Temperature effects on sediment transport capacity. Based on information in the GEIS, the Commission found that

  > These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of temperature effects on sediment transport capacity during the renewal term beyond those discussed in the GEIS.

- Scouring caused by discharged cooling water. Based on information in the GEIS, the Commission found that

  > Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of scouring caused by discharged cooling water during the renewal term beyond those discussed in the GEIS.

- Eutrophication. Based on information in the GEIS, the Commission found that

  > Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER; the staff's site visit; the scoping process; or its evaluation of other available information, including plant monitoring data and technical reports. Therefore, the staff concludes that there are no impacts of eutrophication during the renewal term beyond those discussed in the GEIS.

- Discharge of chlorine or other biocides. Based on information in the GEIS, the Commission found that

  > Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER; the staff's site visit; the scoping process; or its evaluation of other available information, including the National Pollutant Discharge Elimination System (NPDES) permit for Fort Calhoun Station, Unit 1. Therefore, the staff concludes that there are no impacts of discharge of chlorine or other biocides during the renewal term beyond those discussed in the GEIS.

- Discharge of sanitary wastes and minor chemical spills. Based on information in the GEIS, the Commission found that

  > Effects are readily controlled through NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER; the staff's site visit; the scoping process; or its evaluation of other available information, including the NPDES permit for Fort Calhoun Station, Unit 1. Therefore, the staff concludes that there are no impacts of discharges of sanitary wastes and minor chemical spills during the renewal term beyond those discussed in the GEIS.

- Discharge of other metals in waste water. Based on information in the GEIS, the Commission found that

  > These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER; the staff's site visit; the scoping process; or its evaluation of other available information, including the NPDES permit for Fort Calhoun Station, Unit 1. Therefore, the staff concludes that there are no impacts of discharges of other metals in waste water during the renewal term beyond those discussed in the GEIS.

- Water use conflicts (plants with once-through cooling systems). Based on information in the GEIS, the Commission found that

  > These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.

  The water supplied by the Missouri River for the cooling system is ample, and changes in river management in both wet and dry years are not expected to result in significant supply issues for cooling waters. The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of water-use conflicts associated with the once-through cooling system during the renewal term beyond those discussed in the GEIS.

- Accumulation of contaminants in sediments or biota. Based on information in the GEIS, the Commission found that

  > Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.

  Fort Calhoun Station monitors discharges of metals under NPDES Permit NE0000418 and has not identified concerns with metal loadings. Further, the staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of available information. Therefore, the staff concludes that there are no impacts of accumulation of contaminants in sediments or biota during the renewal term beyond those discussed in the GEIS.

- Entrainment of phytoplankton and zooplankton. Based on information in the GEIS, the Commission found that

  > Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of entrainment of phytoplankton and zooplankton during the renewal term beyond those discussed in the GEIS.

- Cold shock. Based on information in the GEIS, the Commission found that

  > Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of cold shock during the renewal term beyond those discussed in the GEIS.

- Thermal plume barrier to migrating fish. Based on information in the GEIS, the Commission found that

  > Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of thermal plume barriers to migrating fish during the renewal term beyond those discussed in the GEIS.

- Distribution of aquatic organisms. Based on information in the GEIS, the Commission found that

  > Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on the distribution of aquatic organisms during the renewal term beyond those discussed in the GEIS.

- Premature emergence of aquatic insects. Based on information in the GEIS, the Commission found that

  > Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of premature emergence of aquatic insects during the renewal term beyond those discussed in the GEIS.

- Gas supersaturation (gas bubble disease). Based on information in the GEIS, the Commission found that

  > Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of gas supersaturation during the renewal term beyond those discussed in the GEIS.

- Low dissolved oxygen in the discharge. Based on information in the GEIS, the Commission found that

  > Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of low dissolved oxygen during the renewal term beyond those discussed in the GEIS.

- Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses. Based on information in the GEIS, the Commission found that

  > These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of losses from predation, parasitism, and disease among organisms exposed to sublethal stresses during the renewal term beyond those discussed in the GEIS.

- Stimulation of nuisance organisms (e.g., shipworms). Based on information in the GEIS, the Commission found that

  > Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of stimulation of nuisance organisms during the renewal term beyond those discussed in the GEIS.

- Microbiological organisms (occupational health). Based on information in the GEIS, the Commission found that

  > Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of microbiological organisms on occupational health during the renewal term beyond those discussed in the GEIS.

- Noise. Based on information in the GEIS, the Commission found that

  > Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of noise during the renewal term beyond those discussed in the GEIS.

The Category 2 issues related to cooling system operation during the renewal term that are applicable to Fort Calhoun Station are discussed in the section that follows and are listed in Table 4-2.

Table 4-2. Category 2 Issues Applicable to the Operation of the Fort Calhoun Station, Unit 1 Cooling System During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY (FOR PLANTS WITH ONCE-THROUGH AND COOLING POND HEAT-DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	4.2.2.1.2; 4.3.3	B	4.1.1
Impingement of fish and shellfish	4.2.2.1.3; 4.3.3	B	4.1.2
Heat shock	4.2.2.1.4; 4.3.3	B	4.1.3
HUMAN HEALTH			
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	4.3.6	G	4.1.4

4.1.1 Entrainment of Fish and Shellfish in Early Life Stages

For plants with once-through cooling systems, entrainment of fish and shellfish in early life stages into cooling-water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment before license renewal. To perform this evaluation, the staff reviewed the Fort Calhoun Station ER (OPPD 2002); visited Fort Calhoun Station; and reviewed the applicant's State of Nebraska NPDES Permit NE0000418, issued on December 27, 1974, and in force until March 31, 2006.

Section 316(b) of the Clean Water Act (CWA) requires that the location, design, construction, and capacity of cooling-water-intake structures reflect the best technology available for minimizing adverse environmental impacts (33 USC 1326). Entrainment of fish and shellfish in the early life stages into the condenser cooling system is a potential adverse environmental impact that can be minimized by the best available technology. The OPPD submitted an intake-monitoring plan to the Nebraska Department of Environmental Control (NDEC), the predecessor agency to the Nebraska Department of Environmental Quality (NDEQ), on February 24, 1975. The NDEC approved the OPPD intake-monitoring plan on March 25, 1975, concluding that the plan fulfilled the requirements of the CWA Section 316(b) guidelines (Lessig 1975), and the OPPD implemented the plan through 1977. The plan continued the ongoing OPPD intake-monitoring program, which was being conducted in accordance with the Fort Calhoun Station OL. The program monitored fish impingement on Fort Calhoun Station traveling screens, fish larvae in the ambient Missouri River, and fish larvae entrained into the plant cooling-water systems. The OPPD also submitted a comprehensive CWA Section 316(b) demonstration to the NDEC in July 1, 1976, in accordance with the "Special Conditions: Environmental Studies" provision of the NPDES Permit NE0000418, issued December 27, 1974, and in force until March 31, 2006.

The report included results from the OPPD monitoring of fish larvae in 1974 and 1975, as well as an assessment of entrainment impacts. Based on the small percentage of fish larvae entrained, the fish taxa collected, and the high natural mortality of fish during early life stages, the study concluded that entrainment at Fort Calhoun Station would have minimal adverse effects on the fish populations in the stretch of the Missouri River near the Fort Calhoun Station. The NDEC reviewed and approved this report on January 19, 1977, concluding that losses due to entrainment at Fort Calhoun Station were within the acceptable range. When approving the *Fort Calhoun Station Intake-Monitoring Report*, the NDEC indicated its interest in any additional information the OPPD might develop concerning larval-fish entrainment and other topics related to assessing associated impacts. The OPPD continued to conduct fish-larvae-entrainment studies at Fort Calhoun Station through 1977 and summarized the results of the entire program, which spanned the period from 1973 to 1977, in a comprehensive report. These results were also reported in the context of a more general assessment of entrainment effects that included monitoring results for both Fort Calhoun Station and Cooper Nuclear Station.

The OPPD has neither conducted entrainment studies nor been required to carry out such activities since 1977. Subsequent NPDES permits and modifications, which constitute the Fort Calhoun Station CWA 316(b) determination, have not required any further entrainment studies. In compliance with the provisions of the CWA, Nebraska issued the current NPDES permit.

Fort Calhoun Station is sited, designed, and operated so as to minimize entrainment impacts. The maximum water intake at Fort Calhoun Station during normal plant operations is 23 m^3/s

(827 ft^3/s). Under low-river-flow conditions (January), the water intake by Fort Calhoun Station, represents approximately 3.9 percent of the average and a maximum 7 percent of the minimum river flow during this winter month (OPPD 2002). This occurs during a time when fish eggs and larvae are rare. During high-river-flow conditions when spawning is more likely to occur (summer), this maximum water intake represents approximately 2 percent of the monthly average and 2.8 percent of the minimum river flow (August) (OPPD 2002).

The staff has reviewed the available information provided by the OPPD in the OPPD ER and related to the CWA 316(b) demonstration. Based on the results of past entrainment studies and the operating history of the Fort Calhoun Station intake structure, the staff concludes that the potential impacts of entrainment of fish and shellfish in the early life stages into the cooling water intake system are SMALL. Therefore, new mitigation measures are not warranted.

4.1.2 Impingement of Fish and Shellfish

For plants with once-through cooling systems, impingement of fish and shellfish on debris screens of cooling-water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment before license renewal. To perform this evaluation, the staff reviewed the Fort Calhoun Station ER (OPPD 2002); visited Fort Calhoun Station; met with Federal and State resource agencies; and reviewed the applicant's State of Nebraska NPDES Permit NE0000418, issued on December 27, 1974, and in force until March 31, 2006.

Section 316(b) of the CWA requires that any standard established pursuant to Sections 301 or 306 of the CWA shall require that the location, design, construction, and capacity of cooling-water-intake structures reflect the best technology available for minimizing adverse environmental impacts (33 USC 1326). Impingement of fish and shellfish on the debris screens of the cooling system is a potential adverse environmental impact that can be minimized by the best available technology. The OPPD submitted an intake-monitoring plan to the NDEC, the predecessor agency to the NDEQ, on February 24, 1975. The NDEC approved the OPPD intake-monitoring plan on March 25, 1975, concluding that the plan fulfilled the requirements of the CWA Section 316(b) guidelines (Lessig 1975), and the OPPD implemented the plan through 1977. The plan continued the ongoing OPPD intake-monitoring program, which was being conducted in accordance with the Fort Calhoun Station, Unit 1 OL. The program monitored fish impingement on Fort Calhoun Station traveling screens, fish larvae in the ambient Missouri River, and fish larvae entrained into the plant cooling-water systems. The OPPD also submitted a comprehensive CWA Section 316(b) demonstration to the NDEC in July 1, 1976, in accordance with the "Special Conditions: Environmental Studies" provision of the NPDES Permit NE0000418, issued on December 27, 1974, and in force until March 31, 2006.

The report included results from the OPPD monitoring of fish impingement from May 1973 through December 1975, as well as an assessment of impingement impacts. Because impingement involved few adult fish and because most of the small fish that were impinged would have been lost as a result of natural mortality, the study concluded that the overall effect of impingement on fish populations in the vicinity of Fort Calhoun Station appeared to be minimal. The NDEC reviewed and approved this report on January 19, 1977, concluding that losses due to impingement at Fort Calhoun Station were within the acceptable range.

When approving the *Fort Calhoun Station Intake-Monitoring Report*, the NDEC indicated its interest in any additional information the OPPD might develop concerning compensatory mechanisms and fish recruitment potential in the Missouri River. The OPPD continued to monitor fish impingement at Fort Calhoun Station, as well as juvenile and adult fish at nearby sampling locations in the Missouri River, through 1977. The results of these programs, which spanned the period from 1973 to 1977, were summarized in a comprehensive report (OPPD 1978, Section IV). These results were also reported in the context of a more general assessment of power-station impacts on Missouri River fish populations that included impingement-monitoring results for both Fort Calhoun Station and Cooper Nuclear Station (Hesse 1982, Chapter 9).

The OPPD has neither conducted impingement studies nor been required to carry out such activities since 1977. Subsequent NPDES permits and modifications, which constitute the Fort Calhoun Station CWA 316(b) determination, have not required any further impingement studies. In compliance with the provisions of the CWA, Nebraska issued the current NPDES permit.

The staff has reviewed the available information. Based on the results of past impingement studies and the operating history of the Fort Calhoun Station intake structure, the staff concludes that the potential impacts of impingement of fish and shellfish on the debris screens of the cooling-water-intake system are SMALL. Therefore, new mitigation measures are not warranted.

4.1.3 Heat Shock

For plants with once-through cooling systems, the effects of heat shock are listed as a Category 2 issue and require plant-specific evaluation before license renewal. The NRC made impacts on fish and shellfish resources resulting from heat shock a Category 2 issue because of continuing concerns about thermal-discharge effects and the possible need to modify thermal discharges in the future in response to changing environmental conditions (NRC 1996). Information to be ascertained includes (1) type of cooling system (whether once-through or cooling pond) and (2) evidence of a CWA Section 316(a) variance or equivalent State

documentation. To perform this evaluation, the staff reviewed the Fort Calhoun Station ER (OPPD 2002); visited Fort Calhoun Station; and reviewed the applicant's State of Nebraska NPDES Permit NE0000418, which was issued on December 27, 1974, and is in force until March 31, 2006.

Fort Calhoun Station has a once-through heat dissipation system. The OPPD has consistently operated Fort Calhoun Station in compliance with the thermal-discharge limits established for the plant by either the NDEQ or its predecessor agency, the NDEC. No formal CWA Section 316(a) variance has been needed or sought for the facility. Thermal-discharge limits (the maximum-allowable effluent temperatures), which have been included in the plant's NPDES permit since its initial issue by NDEC on December 27, 1974 (NPDES Permit NE0000418; Drain 1975), have been established based on comprehensive studies of thermal-discharge effects to ensure continued compliance with water-quality standards and an acceptable level of impact to aquatic biota.

The OPPD conducted these studies in response to numerous stakeholder interests, including requirements of the National Environmental Policy Act of 1969 (NEPA) that were associated with the initial licensing of the plant; monitoring requirements established in the OL technical specifications; and NDEC requirements set forth in a State of Nebraska Certificate of Compliance for Fort Calhoun Station, which was issued October 13, 1972, prior to Fort Calhoun Station, Unit 1's initial operation (NDEC 1972). The Certificate of Compliance indicated that there was reasonable assurance that the operation of Fort Calhoun Station would be in compliance with applicable water-quality standards. However, the certificate also required that the OPPD undertake a study to determine the effects of the thermal discharge upon the physical, chemical, and biological aspects of the Missouri River; monitor cooling-water discharge and intake; monitor discharge temperatures; and conduct thermal-plume mapping during the operation of Fort Calhoun Station.

These thermal-effects investigations were conducted in the context of long-term, comprehensive ecological studies to better determine the effects of Fort Calhoun Station and Cooper Nuclear Station on the Missouri River and its associated biota. The Missouri River Study Group, which consisted of the OPPD; the Nebraska Public Power District (NPPD); consultants; academic institutions; and regulators, including the NDEC, performed the studies as a coordinated effort. The Fort Calhoun Station Five-Year Report (OPPD 1978) summarizes the results of these studies, which were conducted in the vicinity of Fort Calhoun Station. These studies included operational-phase monitoring from the plant's initial startup in 1973 through 1977. The Missouri River Study Group described the results of broader studies, which examined power-station effects and monitoring results for both Fort Calhoun Station and Cooper Nuclear Station, in a separate report (Hesse 1982, Chapter 3).

Fort Calhoun Station was initially authorized to operate at a maximum power level of 1420 MW(t). In addition, a maximum daily temperature limit of 40.6 °C (105 °F) was established for the Fort Calhoun Station cooling-water discharge in the initial NPDES permit on the basis of initial operational-monitoring results (NPDES Permit NE0000418; Drain 1975). On August 18, 1980, the NRC amended the Fort Calhoun Station OL to increase the maximum authorized power level to 1500 MW(t) (NRC 1980). This increase was supported by an OPPD environmental assessment report (AEC 1972) that used the results of thermal-plume modelling and monitoring studies and other relevant information presented in the Fort Calhoun Station Five-Year Report (OPPD 1978).

This OPPD environmental assessment report indicated that the thermal-plume dimensions resulting from the anticipated increase in discharge temperature of 2.7 °C (5 °F) would be bounded by projections originally reported by the U.S. Atomic Energy Commission (AEC) in the Final Environmental Statement for the plant (AEC 1972, Part V). The OPPD environmental assessment report also indicated that impacts to aquatic biota would be small. On the basis of its review, the NDEC agreed that the increase in maximum daily discharge temperature to 43.3 °C (110 °F) would not adversely affect the Missouri River and would comply with Nebraska water-quality standards (Drain 1979). On August 28, 1980, the NDEC issued a corresponding modification to the NPDES permit for the plant.

In accordance with the provisions of the NPDES permit, the NDEQ has established the maximum daily discharge limits for cooling-water discharges from the plant (outfalls 001 and 005) at 43.3 °C (110 °F).

The OPPD is seeking to permanently increase the Fort Calhoun Station NPDES daily maximum-temperature limit to 44.4 °C (112 °F) to better ensure that the plant can operate at full power under unusually high ambient river temperatures, which have been experienced in recent summers. In the interim period until the NDEQ acts on the permit-modification request, the OPPD has entered into a Consent Order with the NDEQ that allows a daily maximum-temperature limitation of 44.4 °C (112 °F). This Consent Order, which is acknowledged by the current NPDES permit, requires that the OPPD submit water-quality information that evaluates the impacts of this temperature increase, thereby enabling the NDEQ to verify that instream water-quality criteria are being met.

The OPPD is participating in a cooperative effort with the U.S. Environmental Protection Agency and the NDEQ to obtain the information required under the terms of the Consent Order. This study, which includes thermal modeling, focuses on power plants and other industries discharging to the lower Missouri River, and addresses the potential effects of historically high, ambient river temperatures. This study is assisting the OPPD and the NDEQ in assessing the implications of reduced river flows in the summer, such as those being considered by the

USACE in the context of revisions to the *Missouri River Master Water Control Manual* (USACE 1979; 2001) and the associated FWS Biological Opinion (FWS 2000). The study began in the fall of 2001 and the EPA provided the results of the study to the NRC by a letter dated April 10, 2003 (EPA 2003).

The thermal modelling studies performed by EPA, the United States Geological Survey, and the Oregon Graduate Institute, indicate that as temperatures in the Missouri River upstream of Fort Calhoun Station rise above those historically observed toward 31 °C (88 ºF), the 32 °C (90 ºF) limit of the Nebraska Surface Water Quality Standards (Title 117 Chapter 4.003.01B) at the end of the mixing zone may be exceeded (EPA 2003). The EPA model was based on the highest observed river temperatures (early August 2001), the calculated heat seasons under the 7-day, 10-year low flow conditions (7Q10), both the historical 7Q10 and a modified 7Q10 based on Missouri River Master Water Control Manual revisions alternatives GP 1521 or GP2021, and peak power generation. The EPA models showed that the Fort Calhoun Station is able to meet the current State of Nebraska Water Quality Standard for heat under all the assumptions shown above (EPA 2003). The NDEQ will make the determination to issue or deny the permit modification. The OPPD will continue to comply with the NDEQ thermal-discharge standards through the duration of the current OL and the license renewal term. Based on the recent thermal modelling studies and compliance with the NPDES permit the staff concludes the direct impacts of discharging heated water from the cooling-water-intake-system are SMALL.

On the issue of cumulative impacts on the Missouri River, the major issue related to plant operation is the thermal impact of the cooling system discharges. Fort Calhoun Station is a baseload unit, which means it generally operates at full power. In the short term an increase in power demand will not result in Fort Calhoun Station, Unit 1 increasing its power output because it is already operating at full power.

Power demands are expected to increase with population and growth of industry over the license renewal period, and this may cause the OPPD to seek an increase in the authorized power level for the Fort Calhoun Station, Unit 1. OPPD is required to request an amendment to Fort Calhoun Station, Unit 1 operating license for any increase in the plant's authorized power level. OPPD plans to submit an amendment request to the NRC for a less than 2 percent power uprate by the end of July 2003. The less than 2 percent power increase that OPPD plans to submit in July 2003, could have a minor impact on the modelling results, however, it is unlikely as the maximum discharge temperatures from the Fort Calhoun Station, Unit 1 will continue to be limited by the NPDES permit to 43.3 °C (110 °F) (Permit # NE0000418 or 44.4 °C (112 °F) with the current Consent Order, Case #2206). At this time, the NRC is unaware of any other power uprates for Fort Calhoun Station, Unit 1 beyond the planned July 2003 request. Any power uprates would require a separate review process.

In reviewing the scientific literature on thermal regimes in the Missouri River, a recent study performed by scientists from the University of Iowa was identified (Wright et al., 1999). The study utilized available temperature data and a dynamic river flow and mixing model (CHARIMA) to examine the thermal regime in the Missouri from Gavins Point Dam down to Rulo, Nebraska (near the Kansas border). There are at least five power plants along this reach which discharge into the River, two of which (Omaha Units and Council Bluffs) lie between Fort Calhoun Station, Unit 1 and the confluence of the Platte and Missouri Rivers. This investigation established that, relative to other discharges to the Missouri, the total impact of Fort Calhoun Station, Unit 1 discharge on the thermal regime of the Missouri is minor (Wright et al., 1999). This study examined a number of different scenarios beyond those that could result from proposals in the Missouri River Main Stem Reservoir System Master Manual, projecting the thermal regime 40 years into the future. The most extreme simulation assumed all the power plants on the reach were operating at maximum capacity, a summer low-flow regime, and an increase in ambient temperature due to global warming. Even under these most extreme conditions, while a cumulative warming effect was demonstrated, water temperatures did not exceed the 90 °F (32 °C) maximum limit of Title 117 of the Nebraska Surface Water Quality Standards (Title 117 Chapter 4.003.01B). Also under those extreme conditions, average river temperature for the month of August (an indicative summer month) were less than 79 °F (26 °C). It is the conclusion of NRC staff that based on these conservative analyses that the cumulative impacts of the operation of Fort Calhoun Station, Unit 1 through 2033 on the thermal regime of the Missouri River will be SMALL.

The staff has reviewed the available information and, on the basis of the conditions of the NPDES permit, the recent thermal studies, and the operating history of the Fort Calhoun Station discharge, concludes that the direct and potential cumulative impacts of discharging heated water from the cooling-water-intake system are SMALL. Therefore, new mitigation measures are not warranted.

4.1.4 Microbiological Organisms (Public Health)

For plants discharging cooling water to cooling ponds, lakes, canals, or small rivers with annual average flow rates less than 9×10^{10} m^3/yr (3.15×10^{12} ft^3/yr), the effects of microbiological organisms on human health are listed as a Category 2 issue and require plant-specific evaluation before license renewal. Because the annual average flow rate for the Missouri River in the vicinity of Fort Calhoun Station is approximately 3.4×10^{10} m^3/yr (1.2×10^{12} ft^3/yr), the effects of its discharge on microbiological organisms must be addressed.

The Category 2 designation is based on the magnitude of the potential public-health impacts associated with thermal enhancement of *Naegleria fowleri* (a pathogenic amoeba) that could not be determined generically. The NRC noted that impacts of nuclear-plant cooling towers and

thermal discharges are considered to be of small significance if they do not enhance the presence of microorganisms that are detrimental to water quality and public health (NRC 1999). The assessment criteria relate to thermal-discharge temperature, thermal characteristics, thermal conditions for the enhancement of *N. fowleri*, and impact to public health. Populations of *N. fowleri* can be enhanced in thermally altered water bodies at temperatures ranging from 35 to 41 °C (95 to 106 °F), but this organism is rarely found in water that is cooler than 35 °C (95 °F) (OPPD 2002).

The staff independently reviewed the Fort Calhoun Station ER (OPPD 2002); visited the site; and reviewed the applicant's State of Nebraska NPDES Permit NE0000418, which was issued on December 27, 1974, and is in force until March 31, 2006.

Based on Fort Calhoun Station discharge-monitoring data for the period from December 1997 to March 2001, the mean monthly average temperature of the discharge at the outfall was 24.9 °C (76.8 °F), and the maximum daily temperature was 41.7 °C (107 °F). Monthly average discharge temperatures at or above 35 °C (95 °F) occurred during this time period only in the months of July and August, with the exception of September 1998. The ambient temperatures of the Missouri River near Fort Calhoun Station vary from freezing, approximately 0 °C (32 °F), in the winter to 29 °C (85 °F) in the summer (OPPD 2002).

Thermophilic organisms occurring in the water column, if any, that might be of concern are expected to be limited to those entrained into the condenser cooling water. These organisms would be subjected to a rapid temperature rise through the condenser followed by relatively rapid cooling as the discharge plume mixes with the ambient river water. Residence time in those areas of the plume with temperatures greater than 35 °C (95 °F) would be short because of mixing in the plume and river flow.

The Missouri River in the vicinity of Fort Calhoun Station is confined to a sinuous artificial channel. Water flow is regulated to meet the needs of barge traffic, flood control, irrigation, and pollution control. Based on river traffic, currents, and shoreline characteristics, swimming in the vicinity of Fort Calhoun Station is unlikely. However, recreational use (e.g., boating, fishing) may occur, and sampling in the river by OPPD employees may be performed, thereby creating the potential for human exposure.

The OPPD has initiated contacts with the Nebraska Department of Public Health and Human Services and the Iowa Department of Public Safety regarding the Fort Calhoun Station license renewal. There has been no known impact from operation of Fort Calhoun Station on public health related to thermophilic microorganisms. Because of this, the impact of deleterious microbiological organisms during the continued operation of Fort Calhoun Station during the renewal term is low.

Based on its review of the above information, the staff concludes that the potential impacts to public health from microbiological organisms resulting from operation of the Fort Calhoun Station cooling-water discharge system to the aquatic environment on or in the vicinity of the site area are SMALL, and additional mitigation is not warranted.

4.2 Transmission Line

The corridor for the transmission line originally constructed in connection with Fort Calhoun Station (Line 74S/74) covers approximately 33 ha (82 ac) over a total corridor length of approximately 11 km (7 mi; Figure 2-5 and Table 2-1). The OPPD conducts annual flight inspections of its transmission line right-of-way to ensure nonencroachment by vegetation. Vegetation control within the transmission line right-of-way is performed every three years to ensure the continued reliability of the line. Vegetation control includes removing or trimming woody vegetation to ensure adequate line clearance and to allow vehicular access along the right-of-way. Large, woody vegetation that can interfere with conductors are mechanically trimmed or removed, and stumps are treated with approved herbicides. Small, woody vegetation is manually removed or controlled by basally applying approved herbicides. Low-growing, woody vegetation, including sumac, chokecherry, and wild plum, that is important wildlife food is only trimmed or removed if needed for vehicular access. The OPPD does not mow vegetation or use broadcast herbicides. The OPPD also does not use herbicides in or near wetlands or stream crossings. All OPPD herbicide applicators must be certified in accordance with Nebraska Pesticide Regulations in the Nebraska Administrative Code, Title 25, Chapter 2.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to the transmission line from Fort Calhoun Station, Unit 1 are listed in Table 4-3. The OPPD stated in its ER that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station OL. The staff has not identified any significant new information during its independent review of the OPPD ER (OPPD 2002), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-3. Category 1 Issues Applicable to the Transmission Line During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
TERRESTRIAL RESOURCES	
Power line right-of-way management (cutting and herbicide application)	4.5.6.1
Bird collision with power lines	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3
Floodplains and wetland on power line right of way	4.5.7
AIR QUALITY	
Air quality effects of transmission lines	4.5.2
LAND USE	
Onsite land use	4.5.3
Power line right of way	4.5.3

A brief description of the staff's review and GEIS conclusions, as codified in Table B-1 of the GEIS, for each of these issues follows:

- Power line right-of-way management (cutting and herbicide application). Based on information in the GEIS, the Commission found that

  > The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, consultation with the FWS, or its evaluation of other information. Therefore, the staff concludes that there are no impacts of power-line right-of-way management during the renewal term beyond those discussed in the GEIS.

- Bird collision with power lines. Based on information in the GEIS, the Commission found that

  > Impacts are expected to be of small significance at all sites.

  During an independent review of the OPPD ER, the staff's site visit, the scoping process, consultation with the FWS, and the staff's evaluation of other information, the staff has not identified any significant new information that indicates that Line 74S/74 has resulted in bird

mortality or represents a hazard to birds. Therefore, the staff concludes that there are no impacts of bird collisions with power lines during the renewal term beyond those discussed in the GEIS.

- Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock). Based on information in the GEIS, the Commission found that

  > No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other information. Therefore, the staff concludes that there are no impacts of electromagnetic fields on flora and fauna during the renewal term beyond those discussed in the GEIS.

- Floodplains and wetlands on power line right of way. Based on information in the GEIS, the Commission found that

  > Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, consultation with the FWS, or its evaluation of other information. Therefore, the staff concludes that there are no impacts of power-line right-of-way on floodplains and wetlands during the renewal term beyond those discussed in the GEIS.

- Air quality effects of transmission lines. Based on the information in the GEIS, the Commission found that

  > Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other information. Therefore, the staff concludes that there are no air-quality impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

- Onsite land use. Based on information in the GEIS, the Commission found that

  > Projected onsite land use changes required during the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other information. Therefore, the staff concludes that there are no onsite-land-use impacts during the renewal term beyond those discussed in the GEIS.

- Power line right of way. Based on information in the GEIS, the Commission found that

  > Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other information. Therefore, the staff concludes that there are no impacts of power-line right-of-way on land use during the renewal term beyond those discussed in the GEIS.

There is one Category 2 issue and one uncategorized issue related to the transmission line. These issues are listed in Table 4-4 and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-4. Category 2 and Uncategorized Issues Applicable to the Transmission Line During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
HUMAN HEALTH			
Electromagnetic fields, acute effects (electric shock)	4.5.4.1	H	4.2.1
Electromagnetic fields, chronic effects	4.5.4.2	NA	4.2.2

4.2.1 Electromagnetic Fields, Acute Effects (Electric Shock)

In the GEIS (NRC 1996), the staff found that without a review of the conformance of each nuclear-plant transmission line with National Electrical Safety Code (NESC) criteria (NESC 1997), it was not possible to determine the significance of the electric-shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric-

shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power-distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

The main connection of Fort Calhoun Station with the power grid is a 345-kV line that was built roughly concurrently with Fort Calhoun Station. However, as noted in the AEC's Final Environmental Statement (AEC 1972), this line was built to interconnect the Iowa Public Service Company, the NPPD, and others, and the decision to construct the line predates the decision to build Fort Calhoun Station. Consequently, this line is not within the scope of this review.

One 161-kV transmission line was constructed to connect Fort Calhoun Station to the transmission system. This transmission line runs approximately 11 km (7 mi) from the plant switchyard to Substation 1226, which is about 5 km (3 mi) west of Blair, Nebraska. The line occupies a single corridor in a 15-m-wide (50-ft-wide) right-of-way for the first 0.8 km (0.5 mi). For the remaining 10 km (6.5 mi), the line occupies a 30-m-wide (100-ft-wide) right-of-way. This line was entirely rebuilt in February 1999 to NESC code requirements (OPPD 2002).

The staff concludes that the impact of the potential for electric shock is SMALL and additional mitigation measures are not warranted because the transmission line constructed to connect Fort Calhoun Station to the grid has been reconstructed to NESC code requirements.

4.2.2 Electromagnetic Fields, Chronic Effects

In the GEIS, the chronic effects of 60-Hz electromagnetic fields from power lines were not designated as Category 1 or 2 and will not be until a scientific consensus is reached on the health implications of these fields.

The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (DOE). A recent report (NIEHS 1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF [extremely low frequency-electromagnetic field] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because

> virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the staff to change its position with respect to the chronic effects of electromagnetic fields. The staff considers the GEIS finding of "not applicable" still appropriate and will continue to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to Fort Calhoun Station, Unit 1 in regard to radiological impacts are listed in Table 4-5. The OPPD stated in its ER (OPPD 2002) that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station, Unit 1 OL. The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the staff concluded in the GEIS that the impacts are SMALL and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-5. Category 1 Issues Applicable to Radiological Impacts of Normal Operations During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
HUMAN HEALTH	
Radiation exposures to public (license renewal term)	4.6.2
Occupational radiation exposures (license renewal term)	4.6.3

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Radiation exposures to public (license renewal term). Based on information in the GEIS, the Commission found that

  > Radiation doses to the public will continue at current levels associated with normal operations.

The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of radiation exposures to the public during the renewal term beyond those discussed in the GEIS.

- Occupational radiation exposures (license renewal term). Based on information in the GEIS, the Commission found that

  > Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of occupational radiation exposures during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to radiological impacts of routine operations.

4.4 Socioeconomic Impacts of Plant Operations During the License Renewal Period

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to socioeconomic impacts during the renewal term are listed in Table 4-6. The OPPD stated in its ER (OPPD 2002) that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station, Unit 1 OL. The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the staff concluded in the GEIS that the impacts are SMALL and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-6. Category 1 Issues Applicable to Socioeconomics During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6
Public services: education (license renewal term)	4.7.3.1
Aesthetic impacts (license renewal term)	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	4.5.8

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Public services: public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found that

  > Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on public safety, social services, and tourism and recreation during the renewal term beyond those discussed in the GEIS.

- Public services: education (license renewal term). Based on information in the GEIS, the Commission found that

  > Only impacts of small significance are expected.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on education during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts (license renewal term). Based on information in the GEIS, the Commission found that

  > No significant impacts are expected during the license renewal term.

The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no aesthetic impacts during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts of transmission lines (license renewal term). Based on information in the GEIS, the Commission found that

  No significant impacts are expected during the license renewal term.

  The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no aesthetic impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

Table 4-7 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and environmental justice, which was not addressed in the GEIS.

Table 4-7. Environmental Justice and GEIS Category 2 Issues Applicable to Socioeconomics During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
SOCIOECONOMICS			
Housing impacts	4.7.1	I	4.4.1
Public services: public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public services, transportation	4.7.3.2	J	4.4.4
Historic and archaeological resources	4.7.7	K	4.4.5
Environmental justice	Not addressed[(a)]	Not addressed[(a)]	4.4.6

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in the licensee's environmental report and the staff's environmental impact statement.

4.4.1 Housing Impacts During Operations

In determining housing impacts, the applicant chose to follow Appendix C of the GEIS (NRC 1996), which presents a population characterization method that is based on two factors, "sparseness" and "proximity (GEIS Section C.1.4 [NRC 1996; 1999]). Sparseness measures population density within 32 km (20 mi) of the site, and proximity measures population density and city size within 80 km (50 mi). Each factor has categories of density and size (GEIS Table C.1), and a matrix is used to rank the population category as low, medium, or high (GEIS Figure C.1).

Using data from the U.S. Bureau of the Census (USBC) 1990 Census of Population, the OPPD estimated 329,650 persons live within 32 km (20 mi) of Fort Calhoun Station (OPPD 2002). Using this data, the OPPD calculated a population density of 101 persons/km^2 (262 persons/mi^2) within 32 km (20 mi) of Fort Calhoun Station. Thus, Fort Calhoun Station falls into Category 4 of the GEIS sparseness classification. There are an estimated 760,514 persons living within 80 km (50 mi) of Fort Calhoun Station (OPPD 2002). This equates to a population density of 60 persons/km^2 (97 persons/mi^2) within 80 km (50 mi) of Fort Calhoun Station. Because Omaha is the largest city within 80 km (50 mi) of Fort Calhoun Station and has a total population well over 100,000, Fort Calhoun Station falls into Category 3 (one or more cities with 100,000 or more persons and fewer than 119 persons/km^2 [190 persons/mi^2] within 80 km [50 mi]) of the GEIS proximity classification. According to the GEIS sparseness and proximity matrix, Fort Calhoun Station's sparseness Category 4 and proximity Category 3 indicate that Fort Calhoun Station is in a high-population area.

The proximity score also was recalculated by the NRC staff using the 2000 Census. The conservative estimate using the 2000 Census was about 852,717, or 42 persons/km^2 (109 persons/mi^2) within 80 km (50 mi) of Fort Calhoun Station, well within proximity Category 3. Applying the GEIS proximity measures (NRC 1996; 1999a), Fort Calhoun Station is classified as Category 3 (one or more cities with 100,000 or more persons and fewer than 119 persons/km^2 [190 persons/mi^2] within 80 km [50 mi]). According to the GEIS, these sparseness and proximity scores identify the nuclear unit as being located in a high-population area.

In 10 CFR Part 51, Subpart A, Appendix B, Table B-1, the NRC concluded that impacts on housing availability are expected to be of small significance at plants located in a high-population area where growth-control measures are not in effect. Fort Calhoun Station is located in a high-population area; growth-control measures are not in effect. Based on the NRC criteria, the OPPD expects housing impacts to be SMALL during continued operations (OPPD 2002).

SMALL impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing

construction or conversion is required to meet new demand (NRC 1996). The GEIS assumes that no more than a total additional staff of 60 permanent workers might be needed during the license renewal period to perform routine maintenance and other activities. Although the OPPD expects to perform these routine activities during scheduled outages, the OPPD assumed that no more than 60 total employees would be added to its permanent staff during the license renewal period (OPPD 2002). Using the Regional Input-Output Modeling System (RIMS II), the U.S. Bureau of Economic Analysis calculated a regional employment multiplier appropriate for the electric services (utilities) sector for the Omaha Metropolitan Statistical Area (MSA). The OPPD used this value (4.0387) to estimate the number of direct and indirect jobs supported by additional Fort Calhoun Station employees that might be needed during the license renewal period (OPPD 2002). After applying the multiplier, a total of 242 (60 × 4.0387) new jobs would be created in the area with a USBC year-2000 labor force of 400,049 workers. These 242 new direct and indirect jobs represent less than 1 percent of the current total employment in the Omaha MSA (OPPD 2002). In summary, the OPPD is assuming that 60 additional permanent direct workers during the license renewal period would create an additional 182 indirect jobs in the community. These 242 new jobs (60 direct and 182 indirect) could result in a population increase of 603 in the area (242 jobs multiplied by 2.49 [the average number of persons per household in the state of Nebraska] [OPPD 2002]). This increase represents approximately 0.1 percent of the USBC's estimated population in year 2000 (604,960) for the combined area of Washington, Douglas, and Sarpy counties (OPPD 2002). The demand for the existing housing units could be met with the construction of new housing or the use of existing, unoccupied housing. In 2000, Omaha MSA employment was approximately 400,049, and the population was approximately 716,998 in the year 2000 (OPPD 2002). The vacancy rate is approximately 6 percent (OPPD 2002). The 242 projected housing units needed for OPPD personnel would not create a discernible change in housing availability, change in rental rates or housing values, or spur much new construction or conversion. As a result, the OPPD concludes that the impacts would be SMALL and mitigation measures would not be necessary (OPPD 2002).

The staff reviewed the available information relative to housing impacts and the OPPD's conclusions. Based on this review, the staff concludes that the impact on housing during the license renewal period would be SMALL and further mitigation is not warranted.

4.4.2 Public Services: Public Utility Impacts During Operations

Impacts on public utility services are considered SMALL if there is little or no change in the ability of the system to respond to the level of demand, and thus, there is no need to add capital facilities. Impacts are considered MODERATE if overtaxing of service capabilities occurs during periods of peak demand. Impacts are considered LARGE if existing levels of service (e.g., water or sewer services) are substantially degraded and additional capacity is needed to

meet ongoing demands for services. The GEIS indicates that, in the absence of new and significant information to the contrary, the only impacts on public utilities that could be significant are impacts on public water supplies (NRC 1996).

Analysis of impacts on the public water-supply system considered both plant demand and plant-related population growth. Section 2.2.2 describes the Fort Calhoun Station permitted withdrawal rate and actual use of water. The OPPD plans no refurbishment at Fort Calhoun Station, so plant demand would not change beyond current demands (OPPD 2002).

The OPPD assumed an increase of 60 license renewal employees during license renewal, the generation of 242 new jobs, and a net overall-population increase of approximately 603 persons and 242 households as a result of those jobs,[(a)] all of which would create SMALL impacts. The plant-related population increase would require an additional 182 m^3/d (48,240 gpd) of potable water (OPPD 2002).[(b)] This amount represents less than 0.1 percent of the 252,386 m^3/d (66.63 million gpd) that was consumed in 1995 in the combined region of Washington, Douglas, and Sarpy counties (OPPD 2002). This amount is within the residual capacity of the existing water systems that service Washington County. The staff finds that the impact of increased water use on area water systems is SMALL and that further mitigation is not warranted.

4.4.3 Offsite Land Use During Operations

Offsite land use during the license renewal term is a Category 2 issue (10 CFR 51, Subpart A, Appendix B, Table B-1). Table B-1 of 10 CFR 51 Subpart A, Appendix B notes that "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal."

Section 4.7.4 of the GEIS defines the magnitude of land-use changes as small if very little new development and minimal changes to an area's land-use pattern result. Moderate change results if considerable new development and some changes to the land-use pattern occur. The magnitude of change is large if large-scale new development and major changes in the land-use pattern occur.

The OPPD has identified a maximum of 60 additional employees during the license renewal term plus an additional 182 indirect jobs (total 242) in the surrounding community (OPPD 2002). Section 3.7.5 of the GEIS (NRC 1996) states that if plant-related population growth is less than 5 percent of the study area's total population, offsite land-use changes would be small,

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(a) Calculated by assuming that the average number of households is 1 per new job and that there are 2.49 persons per household (OPPD 2002).

(b) Calculated by assuming that the average American uses between 50 and 80 gal of water for personal use per day; 603 people × 80 gal per person/day = 48,240 gpd (182 m^3/d).

especially if the study area has established patterns of residential and commercial development, a population density of at least 23 persons/km^2 (60 persons/mi^2), and at least one urban area with a population of 100,000 or more within 80 km (50 mi). In this case, population growth will be less than 5 percent of the area's total population; the area has established patterns of residential and commercial development, a population density of well over 23 persons/km^2 (60 persons/mi^2), and at least one urban area (Omaha MSA) with a population of 100,000 or more within 80 km (50 mi). Consequently, the staff concludes that population changes resulting from license renewal are likely to result in SMALL offsite land-use impacts.

Tax revenue can affect land use because it enables local jurisdictions to be able to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven, land-use impacts during the license renewal term should consider (1) the size of the plant's 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. If the plant's tax payments are projected to be small relative to the community's total revenue, 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. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be small. 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.

The Nebraska State Constitution Article VIII, Section 11 stipulates that every corporation and political subdivision organized primarily to provide electricity shall annually make the same payments in lieu of taxes as it made in 1957 to the same public bodies, and that additionally, each public corporation pay to the treasurer of any county, within the limits of which such public corporation sells electricity at retail, a sum of 5 percent of the annual gross revenue. Because the OPPD is a publicly owned electric utility and a political subdivision responsible for the production and distribution of electricity within a 13-county service area, the OPPD is exempt from paying State-occupational, personal-property, and real-estate taxes. Instead, the OPPD, as directed by Article VIII, makes 6 payments in lieu of taxes each year to the municipalities and 12 Nebraska counties (Burt, Cass, Colfax, Dodge, Douglas, Johnson, Nemaha, Otoe, Richardson, Sarpy, Saunders, and Washington) in which the OPPD sold power in 1957. In addition, each county receives 5 percent of the total gross revenue the OPPD receives from electricity sales from within the county, minus the amount already paid to the incorporated area of the county. From 1996 to 2000, approximately 80 percent of the OPPD's total annual payments have been paid to Douglas County, the largest consumer of OPPD electricity. In 2000, the OPPD's payments totaled $17.6 million, $15 million of which was paid to Douglas

County and its constituent municipalities. By comparison, the OPPD made payments totalling approximately $1.79 million and $330,000 to the county governments and constituent municipalities in Sarpy and Washington counties, respectively (OPPD 2002).

Based on a review of the issues related to land use and the criteria in the GEIS, the staff concludes that the net impact of plant-related population increases is likely to be SMALL. The staff also concludes that tax-related, land-use impacts are likely to be SMALL. There are several reasons for these conclusions. First, the OPPD does not intend to refurbish Fort Calhoun Station in conjunction with license renewal. Thus, there will be no increase in employment at Fort Calhoun Station as a result of refurbishment activities. Second, the OPPD has stated that the permanent workforce at Fort Calhoun Station will remain stable during the renewed-license operating period of 20 years (OPPD 2002). Last, the publicly owned OPPD will still be responsible for producing and distributing electricity (and the resulting in lieu payments) even if the license for Fort Calhoun Station is not renewed. Consequently, the staff concludes that the offsite land-use impacts are likely to be SMALL and would not require mitigation.

4.4.4 Public Services: Transportation Impacts During Operations

On October 4, 1999, 10 CFR 51.53(c)(3)(ii)(J) and 10 CFR Part 51, Subpart A, Appendix B, Table B-1 were revised to clearly state that “Public Services: Transportation Impacts During Operations” is a Category 2 issue (see NRC 1999 for more discussion of this clarification). The issue is treated as such in this SEIS.

The permanent employment associated with Fort Calhoun Station, Unit 1 is currently 772 employees (OPPD and contractors) (OPPD 2002). During periods of refuelling, which occur every 18 months and last about 30 days, approximately 600 workers are hired on a temporary basis. The “upper bound” for the potential increase in permanent staff during the license renewal term is 60 additional workers, or approximately 8 percent of the current permanent and contract workforce of 772. Access to Fort Calhoun Station is via U.S. Highway 75. The OPPD states that the highway in the vicinity of Fort Calhoun Station carries a level-of-service (LOS) designation of “B” from the City of Blair to Fort Calhoun. The NRC concluded in the GEIS that impacts to roads with LOS designations of “A” or “B” are small. Based on this information, the OPPD concluded that the impacts on transportation during the license renewal term would be SMALL and no mitigative measures would be warranted.

The staff reviewed the OPPD’s assumptions and resulting conclusions. The staff concludes that any impact of the OPPD on transportation-service degradation is likely to be SMALL and does not require further mitigation.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA), as amended through 1992, requires Federal agencies to take into account the potential effects of their undertakings on historic properties. The historic-review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, as amended through 2001. Renewal of an OL for a nuclear power plant is an undertaking that could possibly affect either known or potential historic properties that may be located at the plant. Therefore, in accordance with the provisions of NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effects. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve possible adverse effects of the undertaking. In general, lands within the boundaries of a nuclear-plant site fall into one of the following categories:

(1) Areas with No Potential for archaeological resources. These areas include lands where past disturbances related to the construction of the power station and appurtenant facilities have taken place to such an extent that once-extant cultural resources are no longer present. No further archaeological investigations would be recommended for these areas.

(2) Areas with Low Potential for archaeological resources. Lands within the plant site that fall into this category are those that are relatively undisturbed but that possess characteristics that would normally indicate a low possibility for most types of cultural resources to occur. For the most part, these lands have a degree of slope greater than 15 percent. For most of these areas, further archaeological work would not be necessary, although there could be smaller areas within the larger zone where specific ground conditions could require investigation.

(3) Areas with Moderate-to-High Potential for archaeological resources. These areas are classified as those that are relatively undisturbed by past activities and have a likelihood for prehistoric and historic archaeological sites, according to local models of prehistoric and historic land use and settlement patterning. Archaeological investigation would be recommended prior to undertaking any ground-disturbing activities in these areas.

According to the Fort Calhoun Station ER (OPPD 2002), the plant site is relatively small in terms of total acreage. The exclusion zone about 512 ha (1265 ac). Approximately 267 ha (660 ac) of the exclusion zone is on the Nebraska side of the Missouri River and consists of nearly level floodplain deposits (85 percent), with the remainder in the lower slopes of the Missouri River bluffs. The acreage lying between the existing rail spur and U.S. Highway 75

also includes upland forest vegetation. Another 245 ha (604 ac) of the exclusion zone lies east of the Missouri River in Iowa and consists of river floodplain with cropland and natural vegetation. Of the 267 ha (660 ac) at the plant site, about 55 ha (135 ac) is occupied by plant facilities or is maintained as part of plant operations. Another 140 ha (345 ac) consists of leased cropland.

Based on the impacts of past construction activities and particularly the fact that much of the plant site is situated on floodplain alluvium, which has been developed since approximately 1850, the section of the site that lies south of the current Union Pacific rail spur should be categorized as having No Potential for cultural resources, either prehistoric or historic. A possible exception to this categorization could be the hypothesized buried presence of the steamboat wreck, the *Benton*, in proximity to the current nuclear-plant site (Section 2.2.9.2).

However, the section of the plant site that lies north of the rail spur and that is bounded on the west by U.S. Highway 75 should be categorized as having Moderate-to-High Potential because it contains remnants of the former town of DeSoto, a historic property that is potentially eligible for listing on the National Register of Historic Places. As discussed in Section 2.2.9.2, archaeological investigations within the highway right-of-way revealed the existence of significant subsurface remains of elements of the former town site. The OPPD has indicated that no additional land-disturbing activities at the plant site or along the existing transmission line right-of-way are planned for the license renewal period.

Based on the presently known cultural-resources status at the Fort Calhoun Station plant and the staff's cultural-resource analysis and consultation, the staff concludes that the potential impacts on historic and archaeological resources during the license renewal period are expected to be SMALL and mitigation is not warranted.

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy in which Federal actions should not result in disproportionately high and adverse impacts on minority[(a)] or low-income populations. Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider environmental justice under NEPA. The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice (CEQ 1997). Although the Commission is not subject to the Executive Order, the Commission has voluntarily committed to undertake environmental-justice reviews. Specific guidance is provided in NRC Office of Nuclear Reactor

(a) The NRC guidance for performing environmental justice reviews defines "minority" as American Indian or Alaskan Native, Asian, Native Hawaiian or other Pacific Islander, Black races, or Hispanic ethnicity. "Other" races and multiracial individuals may be considered as separate minorities (NRC 2001).

Regulation Office Instruction LIC-203, *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues* (NRC 2001).

For the purpose of the staff's review, a minority population is defined to exist if the percentage of minorities within the census block groups[(a)] in each state within the 80 km (50 mi) potentially affected by the license renewal of Fort Calhoun Station, Unit 1 exceeds the corresponding percentage of minorities in the state of which it is a part by 20 percentage points, or if the corresponding percentage of minorities within the census block group is at least 50 percent. A low-income population is defined to exist if the percentage of low-income population within a census block group exceeds the corresponding percentage of low-income population in the state of which it is a part by 20 percentage points, or if the corresponding percentage of low-income population within a census block group is at least 50 percent. For census block groups within Washington, Douglas, and Sarpy counties, for example, the percentage of minority and low-income populations is compared to the percentage of minority and low-income populations in Nebraska. The OPPD conducted its analysis using census tracts rather than the smaller block groups.

The scope of the review as defined in NRC Guidance (NRC 2001) should include an analysis of impacts on minority and low-income populations, the location and significance of any environmental impacts during operations on populations that are particularly sensitive, and any additional information pertaining to mitigation. The descriptions to be provided by this review should state whether these impacts are likely to be disproportionately high and adverse. The review should also evaluate the significance of such impacts.

The staff examined the geographic distribution of minority populations recorded during the 2000 Census (Geolytics Software 2000) and low-income populations recorded during the 1990 Census (Geolytics Software 1990) within 80 km (50 mi) of Fort Calhoun Station, Unit 1, encompassing 12 counties in Nebraska (Burt, Butler, Cass, Colfax, Cuming, Dodge, Douglas, Lancaster, Sarpy, Saunders, Thurston, and Washington) and 6 counties in Iowa (Crawford, Harrison, Mills, Monona, Pottawattamie, and Shelby). The analysis was also supplemented by

(a) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the Census Bureau collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census data users in accordance with Census Bureau guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts (USBC 1999).

field inquiries to the planning department and social service agencies in Washington, Douglas, and Sarpy counties.[(a)]

The OPPD conducted its analysis for minority and low-income populations using the convention of including a census tract if at least 50 percent of its area lay within 80 km (50 mi) of Fort Calhoun Station, Unit 1 (OPPD 2002). Using this convention, the 80-km (50-mi) radius included 153 census tracts. The "more than 20 percentage points" criterion was used to determine whether a census tract should be counted as containing a minority or low-income population (OPPD 2002). Figures 4-1 and 4-2 show the distribution of census block groups for the minority and low-income populations, respectively (shaded areas).

Based on the "more than 20 percentage points greater" criterion, minority populations exist in three counties in Nebraska (Thurston, Colfax, and Douglas) and one county in Iowa (Crawford). Figure 4-1 shows the locations of census block groups with minority populations.

By the NRC criteria (50 percent of population, or at least 20 percentage points greater than the state), three counties in Nebraska (Thurston, Burt, and Douglas) and one county in Iowa (Pottawattamie) contain census block groups within 80 km (50 mi) of Fort Calhoun Station that contain low-income populations. Figure 4-2 shows the locations of census block groups with low-income populations.

With the locations of minority and low-income populations identified, the staff proceeded to evaluate whether any of the environmental impacts of the proposed action could affect these populations in a disproportionate manner. Based on staff guidance (NRC 2001), air, land, and water resources within about 80 km (50 mi) of Fort Calhoun Station were examined. Within that area, a few potential environmental impacts could affect human populations; all of these were considered SMALL for the general population. These include

- groundwater-use conflicts (discussed in Section 4.5)
- electric shock (discussed in Section 4.2.1)
- microbiological organisms (discussed in Section 4.1.4)
- postulated accidents (discussed in Chapter 5 of this SEIS and Chapter 5 of the GEIS)

(a) Washington, Douglas, and Sarpy counties were the focus of this inquiry because all of these counties lie within the 80-km (50-mi) radius and are nearest Fort Calhoun Station. The staff concluded that any findings of environmental-justice issues in these counties would warrant further field inquiries in more distant counties. For reasons stated later in this section, further investigation was not warranted.

The pathways through which the environmental impacts associated with the Fort Calhoun Station, Unit 1 license renewal can affect human populations are discussed in each associated section. The staff then evaluated whether minority and low-income populations could be disproportionately affected by these impacts. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately affected. In addition, the staff did not identify any location-dependent disproportionate impacts affecting these minority and low-income populations. The staff concludes that offsite impacts from Fort Calhoun Station, Unit 1 to minority and low-income populations would be SMALL and no additional mitigation actions are warranted.

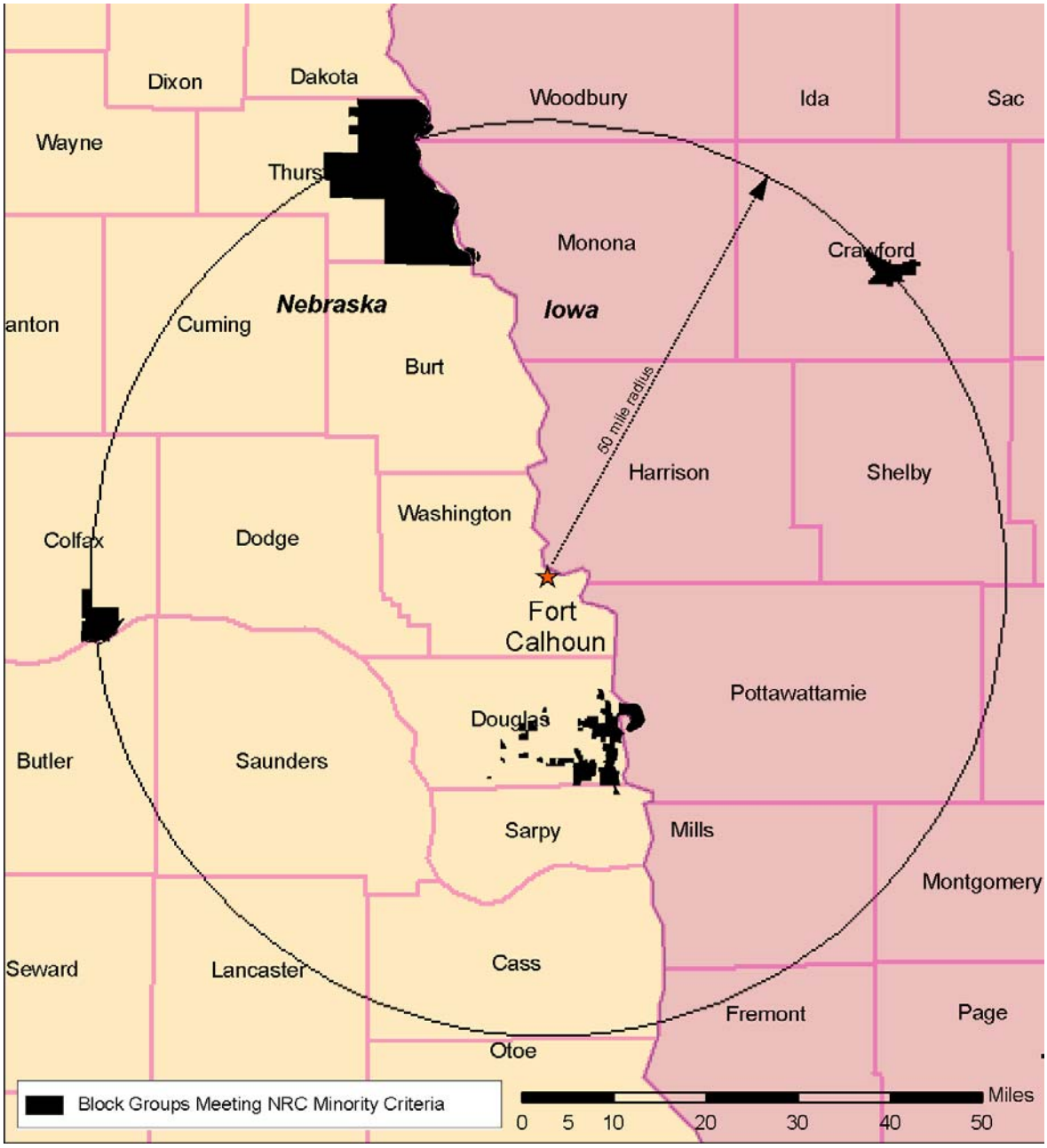

Figure 4-1. Geographic Distribution of Minority Populations (shown in shaded areas) Within 80 km (50 mi) of Fort Calhoun Station Based on 2000 Census Block Group Data

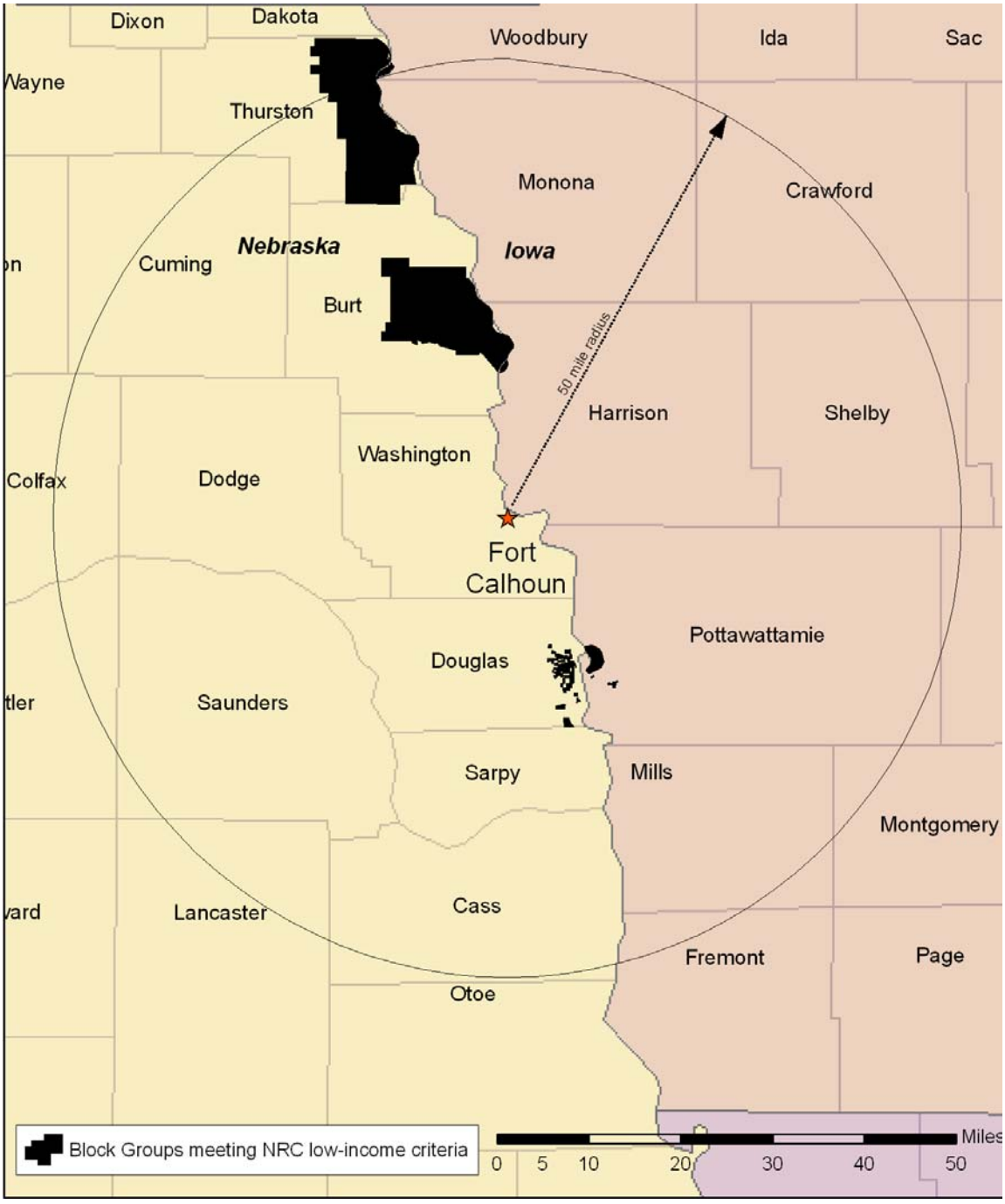

Figure 4-2. Geographic Distribution of Low-Income Populations (shown in shaded areas) Within 80 km (50 mi) of Fort Calhoun Station Based on 1990 Census Block Group Data

4.5 Groundwater Use and Quality

The Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 applicable to Fort Calhoun Station groundwater use and quality is identified in Table 4-8. The OPPD stated in its ER (OPPD 2002) that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station OL. The staff has not identified any significant new information during its independent review of the OPPD ER (OPPD 2002), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS. For this issue, the staff concluded that the impacts are SMALL and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-8. Category 1 Issue Applicable to Groundwater Use and Quality During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
GROUND-WATER USE AND QUALITY	
Ground-water use conflicts (potable and service water; plants that use <100 gpm)	4.8.1.1

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, follows:

- Ground-water use conflicts (potable and service water; plants that use <100 gpm). Based on information in the GEIS, the Commission found that

  > Plants using less than 100 gpm are not expected to cause any groundwater use conflicts.

  As discussed in Section 2.2.2, Fort Calhoun Station groundwater use is less than 0.068 m^3/s (100 gpm). The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no groundwater-use conflicts during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to groundwater use and quality that are applicable to Fort Calhoun Station.

4.6 Threatened or Endangered Species

Threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-9.

Table 4-9. Category 2 Issue Applicable to Threatened or Endangered Species During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
Threatened or endangered species	4.1	E	4.6

The presence of threatened or endangered species in the vicinity of Fort Calhoun Station is discussed in Sections 2.2.5 and 2.2.6 of this SEIS. This issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by the continued operation of the nuclear power plant during the license renewal term. The staff began consultation with the FWS regarding threatened and endangered species by requesting a list of threatened and endangered species (NRC 2002a). The staff submitted a biological assessment to the FWS on December 9, 2002, concerning threatened and endangered species that could be affected by continued operation and maintenance of Fort Calhoun Station and the associated transmission lines (NRC 2002b, Appendix E). The assessment concluded that the continued operation of Fort Calhoun Station, Unit 1 may affect, but is not likely to adversely affect, the Federally listed pallid sturgeon and bald eagle, and would have no effect on the western prairie fringed orchid, piping plover, or least tern. On January 13, 2003, FWS requested additional information on the pallid sturgeon, which the NRC provided by letter May 30, 2003 (see Appendix E). Based on all the data available, it is still the NRC's position that the license renewal and continued operation of Fort Calhoun Station, Unit 1 may affect, but is not likely to adversely affect, the pallid sturgeon and bald eagle, and would have no effect on the western prairie fringed orchid, piping plover, or least tern.

Although the staff has come to the conclusion that the proposed renewal of the Fort Calhoun operating license is not likely to adversely affect any threatened or endangered species, the Fish and Wildlife Service has been unable to concur with the staff's determination. As a result, pursuant to 50 CFR § 402.14(a), the staff plans to pursue formal consultation with FWS. Since the current operating license (the impacts of which were analyzed in *Final Environmental Statement Related to the Operation of Fort Calhoun Station Unit 1* [AEC 1972]) does not expire until August 2013, the staff has determined that the proposed action causes no irreversible or

irretrievable commitment of resources not previously considered, and that proceeding with the proposal does not foreclose the formulation or implementation of any reasonable and prudent alternatives. Therefore, pursuant to 50 CFR § 402.09, the staff has concluded that the proposed action may proceed.

4.6.1 Aquatic Species

As described in Section 2.2.5, only the pallid sturgeon (*Scaphirhynchus albus*) is Federally listed as threatened or endangered. No other aquatic organisms that have Federally threatened or endangered status are expected to occur in the vicinity of Fort Calhoun Station. This fish is often found near confluences, islands, and at the downstream end of sandbars (OPPD 2002). It is believed that this fish spends some time in the Missouri River and returns to the Platte River annually to spawn or possibly overwinter (66 FR 19910 [FWS 2001]).

The pallid sturgeon, once common in the Missouri River, is endangered throughout its historic range. The relative rarity of the pallid sturgeon in the vicinity of Fort Calhoun Station and upstream to Gavins Point Dam is indicated by historical collections. No pallid sturgeon were reported to be collected in the extensive monitoring studies conducted by OPPD and others in the Fort Calhoun Station vicinity in the 1970s (OPPD 1978, Hesse, Bliss, and Zuerlein 1982). Kallemeyn and Novotney (1977) collected 248 sturgeon as a result of extensive collections in 1976 at four stations, one station in the unchannelized reach below Fort Randall Dam river kilometer (rkm) 1416 (river mile [rmi] 880), two stations in the unchannelized reach below Gavins Point Dam rkm 1305 (rmi 811), and one station in the channelized reach below Sioux City, Iowa. Only one pallid sturgeon was found in these collections, in the reach below Fort Randall Dam. All of the remainder were shovelnose sturgeon and, of these, 227 were collected in the unchannelized reach below Gavins Point. No sturgeon were collected in the channelized reach below Sioux City. This finding is consistent with the low catches of shovelnose sturgeon in the OPPD studies for Fort Calhoun Station (OPPD 1978).

According to the FWS, habitat-restoration projects, which have occurred since the mid-1970s, have benefited fish species on the Missouri River. Approximately 511 pallid sturgeon were stocked in the Platte River in 1997 and 1998. Nevertheless, in the lower Missouri River, within which Fort Calhoun Station is situated, more recent documented occurrences of pallid sturgeon are rare. According to the Nebraska Natural Heritage Program (NGPC 2001), between Gavins Point Dam, including its tailwaters, and Nemaha County, approximately at river kilometer (Rkm) 887 (river mile [Rmi] 525), 32 occurrences of pallid sturgeon were documented from January 1980 through June 2001. Fort Calhoun Station is located at Rkm 1039 (Rmi 646). The number of pallid sturgeon occurring upstream of Fort Calhoun Station, according to this data source (NGPC 2001), is 15 out of the 32 occurrences with 17 out of the 32 occurrences downstream of Fort Calhoun Station and approximately 7 out of the 32 occurrences documented at the Plattsmouth Bend. This data source (NGPC 2001) also documents an

additional 8 pallid sturgeon near the confluence of the Platte and Missouri Rivers, but in the Platte River, during this same time period (i.e., from Rkm 0.0 to Rkm 53 [Rmi 0.0 to Rmi 33] within the Platte River). In a separate study funded by the U.S. Army Corps of Engineers (USACE) and carried out by the Nebraska Game and Parks Commission (Mestl 2003), 13 pallid sturgeon were documented in this same reach of the lower Missouri River (i.e., between Rkm 1305 and Rkm 887 [Rmi 811 and Rmi 525]) during 2001–2002. The majority of these (i.e., 10 out of the 13 pallid sturgeon) were located near the Plattsmouth Bend (approximately Rkm 954 to 956 [Rmi 593 to 594]).

The studies done by OPPD in the early 1970s documented no occurrences of the pallid sturgeon in the reach of the river near Fort Calhoun Station and the Natural Heritage Program has documented only 15 occurrences of pallid sturgeon upstream of Fort Calhoun Station to Gavins Point Dam, in the years ranging from January 1980 through June 2001 (NGPC 2001), while NGPC documented none upstream of Fort Calhoun Station in their independent study carried out in 2001 and 2002 (Mestl 2003).

The staff has concluded that continued operation of the plant under license renewal is not likely to adversely affect the pallid sturgeon, and will have no effect on other listed or proposed endangered or threatened aquatic species within the immediate vicinity of Fort Calhoun Station. Therefore, it is the staff's determination that the impact on threatened or endangered aquatic species from an additional 20 years operation of Fort Calhoun Station would be SMALL and further mitigation is not warranted.

4.6.2 Terrestrial Species

Federally listed threatened and endangered terrestrial species that have the potential to occur on or in the vicinity of Fort Calhoun Station or Line 74S/74 are described in Section 2.2.6 of this SEIS. These species include the bald eagle, least tern, piping plover, and western prairie fringed orchid.

Bald eagles occur in the vicinity of Fort Calhoun Station predominantly during spring and fall migrations and during the winter. Continued operation of Fort Calhoun Station, Unit 1 could affect bald eagles if plant operations resulted in changes to conditions in the Missouri River that affected food availability (i.e., the availability of fish or waterfowl) or if Line 74S/74 presented a hazard to the eagles.

Discharges of heated water to the Missouri River during plant operations result in warmer water in the outfall area, and during the winter, the resulting open water can attract eagles that would otherwise migrate further south. This additional open water increases food availability for bald eagles during the winter and represents a benefit to eagles.

Only one transmission line (Line 74/74S) is associated with Fort Calhoun Station and within the scope of the license renewal application review. On the basis of its design, location, and surrounding habitats, it is unlikely that the line could adversely affect the bald eagle. Line 74S/74 is an 11-km (7-mi) long 161-kV line that was completely reconstructed in 1999 to National Electrical Safety Code requirements that include configuration standards that reduce the hazard of raptor electrocution. Approximately 1.6 km (1 mi) of the line crosses old-field and woodland habitats of the Missouri River bluff; the remaining 10 km (6 mi) cross agricultural land. The Missouri River bluffs area that is traversed by the line is relatively developed and is traversed by U.S. Highway 75. The line does not cross the Missouri River or any water body that might attract eagles or serve as travel corridors for the species. In addition, because of the level of disturbance and human activities, habitats along the line are not likely to be used by bald eagles. These conditions greatly reduce or eliminate the probability that bald eagles would accidentally strike the transmission line and be killed or injured.

The NRC has assessed the impacts of transmission lines on avian populations in its GEIS on the effects of nuclear power plant license renewal (NRC 1996). In the GEIS, the NRC concluded that mortality resulting from bird collisions with transmission lines associated with license renewal and an additional 20 years of operation would be of small significance. This conclusion was based on (1) the fact that existing literature does not indicate that collision mortality is high enough to result in population-level effects and (2) the lack of known instances where nuclear power plant lines affect large numbers of individuals in local areas. There have been no reports of collisions or electrocutions of bald eagles along Line 74S/74 and no other demonstrated impact to this species during the operation of Fort Calhoun Station. Therefore, the staff has concluded that the continued operation of Fort Calhoun Station may affect, but is unlikely to adversely affect, the bald eagle.

Least terns and piping plovers use sandbar habitats along the Missouri River, but none have been observed in the Fort Calhoun Station area because of the lack of suitable habitat in this reach of the river. There have been no reports of collisions or electrocutions of piping plovers or least terns along Line 74S/74 and no other demonstrated impact to either of these species during the operation of Fort Calhoun Station. The lack of suitable prairie habitat at Fort Calhoun Station and along the corridor of Line 74S/74 makes the occurrence of the western prairie fringed orchid in the Fort Calhoun Station vicinity very unlikely. Therefore, the staff has concluded that the continued operation of Fort Calhoun Station and the continued maintenance of Line 74S/74 will have no affect on the least tern, piping plover, or western prairie fringed orchid.

The staff has concluded that the continued operation of Fort Calhoun Station may affect, but is not likely to adversely affect, the bald eagle and will have no effect on the western prairie fringed orchid, piping plover, or the least tern. Therefore, it is the staff's determination that the impact on threatened or endangered terrestrial species from an additional 20 years of operation of Fort Calhoun Station would be SMALL and further mitigation is not warranted.

4.7 Evaluation of Potential New and Significant Information on Impacts of Operations During the Renewal Term

The staff has not identified significant new information on environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 related to operation during the renewal term. The staff reviewed the discussion of environmental impacts associated with operation during the renewal term in the GEIS; reviewed the licensee's program to determine any significant new impacts; and conducted its own independent review, including public scoping meetings, to identify issues with significant new information. Processes for identifying and evaluating new information are described in Chapter 1 under License Renewal Evaluation Process.

4.8 Summary of Impacts of Operations During the Renewal Term

Neither the OPPD nor the staff is aware of information that is both new and significant related to any of the applicable Category 1 issues associated with Fort Calhoun Station operation during the renewal term. Consequently, the staff concludes that the environmental impacts associated with these issues are bounded by the impacts described in the GEIS. For each of these issues, the GEIS concluded that the impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Plant-specific environmental evaluations were conducted for 12 Category 2 issues applicable to Fort Calhoun Station operation during the renewal term and for environmental justice and chronic effects of electromagnetic fields. For all 12 issues and environmental justice, the staff concluded that the potential environmental impact of renewal-term operations of Fort Calhoun Station would be of SMALL significance in the context of the standards set forth in the GEIS and that further mitigation would not be warranted. In addition, the staff determined that a consensus has not been reached by appropriate Federal health agencies regarding chronic adverse effects from electromagnetic fields. Therefore, no evaluation of this issue is required.

4.9 References

10 CFR Part 51. Code of Federal Regulations, Title 10*, Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

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5.0 Environmental Impacts of Postulated Accidents

Environmental issues associated with postulated accidents are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) 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.

(2) Single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term.

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents (DBAs) and severe accidents, as discussed below.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and Addendum 1.

5.1.1 Design-Basis Accidents

In order to receive NRC approval to operate a nuclear power facility, an applicant must submit a safety analysis report (SAR) as part of the application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50 and 10 CFR Part 100.

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license (OL). The results of these evaluations are found in license documentation such as the staff's safety evaluation report (SER), the final environmental statement (FES), the licensee's updated final safety analysis report (UFSAR), and Section 5.1 of this supplemental environmental impact statement (SEIS). The licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the license renewal period. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable, and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, design-basis events are designated as a Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The early resolution of the DBAs make them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and,

therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This issue, applicable to Fort Calhoun Station, Unit 1, is listed in Table 5-1.

Table 5-1. Category 1 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
POSTULATED ACCIDENTS	
Design-basis accidents	5.3.2; 5.5.1

Based on information in the GEIS, the Commission found that

> The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.

The Omaha Public Power District (OPPD) stated in its Environmental Report (ER; OPPD 2002) that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station, Unit 1 OL. The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. The GEIS assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Based on information in the GEIS, the Commission found that

> 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.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to Fort Calhoun Station, Unit 1, is listed in Table 5-2.

Table 5-2. Category 2 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
POSTULATED ACCIDENTS			
Severe Accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	L	5.2

The staff has not identified any significant new information with regard to the consequences from severe accidents during its independent review of the OPPD ER (OPPD 2002), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the staff has reviewed severe accident mitigation alternatives (SAMAs) for Fort Calhoun Station, Unit 1. The results of the staff's review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives

10 CFR 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS) or related supplement or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe-accident safety performance are identified and evaluated. SAMAs have not been previously considered for Fort Calhoun Station, Unit 1; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

The OPPD submitted an assessment of SAMAs for Fort Calhoun Station, Unit 1 as part of the ER (OPPD 2002). This assessment was based on the current Fort Calhoun Station, Unit 1 probabilistic risk assessment (PRA), a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) and insights from the Fort Calhoun Station, Unit 1 individual plant examination of external events (IPEEE; Patterson 1995). In identifying and evaluating potential SAMAs, the OPPD considered several

SAMA analyses for other plants and advanced light-water reactor designs, including Watts Bar, Calvert Cliffs, Oconee, Turkey Point, and Combustion Engineering (CE) System 80+, and other documents that discuss potential plant improvements, such as NUREG-1560 (NRC 1997a) and NUREG-1462 (NRC 1994). The OPPD identified and evaluated 190 potential SAMA candidates. This list was reduced to 20 unique SAMA candidates by eliminating SAMAs that either were not applicable to Fort Calhoun Station, Unit 1, were already implemented, were similar to other SAMAs being considered, were prohibitively expensive, or provided minimal risk reduction. Further cost-benefit analysis, including sensitivity studies, showed that 7 of the 20 candidate SAMAs are potentially cost-beneficial. Although the OPPD does not consider it a regulatory commitment, the OPPD is planning to implement these seven SAMAs by the end of 2005.

Based on a review of the SAMA assessment, the NRC issued a request for additional information (RAI) to the OPPD by letter dated July 16, 2002 (Kenyon 2002a). Key questions concerned differences between the PRA used for the SAMA analysis and earlier risk assessments for Fort Calhoun Station, Unit 1, the potential impact of uncertainties and external-event initiators on the study results, the use of importance measures, and detailed information on several candidate SAMAs. The OPPD submitted additional information on September 18, 2002, in response to the RAIs (Ridenoure 2002). This supplemental information was responsive to the staff's concerns and reaffirmed that none of the SAMAs (other than the seven planned for implementation) would be cost-beneficial.

An assessment of the SAMAs for Fort Calhoun Station, Unit 1 is presented below.

5.2.2 Estimate of Risk for Fort Calhoun Station, Unit 1

The OPPD's estimates of offsite risk at Fort Calhoun Station, Unit 1 are summarized in Section 5.2.2.1 of this SEIS. The summary is followed by a review of the OPPD's risk estimates in Section 5.2.2.2 of this SEIS.

5.2.2.1 The OPPD's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the Fort Calhoun Station, Unit 1 Level 1 and 2 PRA performed by the OPPD and documented as the Fort Calhoun Station, Unit 1 PRA, Revision 3 and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The Fort Calhoun Station, Unit 1 PRA is a November 2000 update to the Fort Calhoun Station, Unit 1 individual plant examination (IPE) (for internal events) (Gates 1993) and is considered to be a living PRA in that it tracks the changes in the plant design, procedures, and operating changes as they impact the PRA. The

scope of the Fort Calhoun Station, Unit 1 PRA does not include full consideration of seismic or fire initiators. However, the dominant seismic sequences are included in the PRA.

The Fort Calhoun Station, Unit 1 IPEEE (Patterson 1995) addresses seismic, fire, tornado, external flooding, transportation, nearby facility accidents, and other external events. The contribution from seismic events was assessed using the seismic margin approach, and the fire risk was assessed using the fire-induced vulnerability evaluation (FIVE) approach. The estimated core damage frequency (CDF) in the Fort Calhoun Station, Unit 1 IPEEE was 3.13×10^{-5} per year. The OPPD notes that the results from the seismic margins approach were not part of the IPEEE CDF, but as noted above, the dominant seismic sequences were subsequently added to the PRA. About 88 percent of the IPEEE CDF is dominated by fires. However, the OPPD's position is that the FIVE methodology results in a fire-induced CDF that is much greater than the actual plant fire CDF.

Although the OPPD did not include the contribution of risk from external events within the Fort Calhoun Station, Unit 1 risk estimates (except for the dominant seismic initiators), the OPPD did account for the potential risk-reduction benefits associated with external events by applying a factor of 2 multiplier to the benefits estimates for internal events. This is discussed further in Sections 5.2.2.2 and 5.2.6.2 of this SEIS.

The total CDF for internal events (including internal flooding), as calculated in the original IPE, was 1.36×10^{-5} per year. The current baseline CDF for internal events (including internal flooding) is approximately 2.4×10^{-5} per year. The breakdown of the CDF is provided in Table 5-3. As shown in this table, loss of offsite power (LOOP), station blackout (SBO), and transients are major contributors to the CDF, accounting for 46 percent of the CDF. Loss-of-coolant accidents (LOCAs), internal flooding, and other internal-events initiators contribute to about 40 percent of the CDF. The containment bypass initiators (interfacing systems LOCA [ISLOCA] and steam-generator tube rupture [SGTR] events) contribute to about 14 percent of the CDF.

In the ER, the OPPD uses 2.48×10^{-5} per year as the baseline CDF. This includes a contribution from seismic events, which, according to the OPPD's response to an RAI, is 1.1×10^{-6} per year (Ridenoure 2002). The sum of internal and seismic yields 2.52×10^{-5} per year, a slight (<2 percent) discrepancy from the 2.48×10^{-5} per year baseline value. In response to a staff question, the OPPD stated that the difference between the two numbers was due to a combination of roundoff and truncation errors (Kenyon 2002b).

Table 5-3. Fort Calhoun Station, Unit 1 CDF for Internal Events

Initiating Event	Frequency (per year)	Percent Contribution to the CDF
Loss of offsite power (LOOP)	3.8×10^{-6}	16
Station blackout (SBO)	4.2×10^{-6}	17
Transients	3.0×10^{-6}	13
Anticipated transient without scram (ATWS)	Negligible	Negligible
Loss-of-coolant accident (LOCA)	6.3×10^{-6}	26
Interfacing systems LOCA (ISLOCA)	9.6×10^{-7}	4
Steam-generator tube rupture (SGTR)	2.3×10^{-6}	10
Internal flooding	1.3×10^{-6}	5
Others	2.3×10^{-6}	9
Total CDF (from internal events)	2.41×10^{-5}	100

The Level 2 PRA model is based on the containment event tree and source terms from the IPE (Gates 1993). A description of the plant damage states (PDSs) input to the Level 2 analysis was provided in the OPPD's response to staff RAIs (Ridenoure 2002). Of the 520 potential PDSs, 12 listed in the response have contributions greater than 1 percent of the CDF. The PDSs are propagated into release classes with corresponding source terms. A summary of the mapping of the initiating events into the release categories was also provided in the RAI responses (Ridenoure 2002). The fission-product release fractions and characteristics (source terms) for each release category are provided in Table 4.8.2.6 of the Fort Calhoun Station, Unit 1 IPE (Gates 1993).

The offsite-consequences and economic-impact analyses use the MACCS2 code, Version 1.12, to determine the offsite risk impacts on the surrounding environment and public. Inputs for this analysis include plant- and site-specific input values for core radionuclide inventory, source term and release fractions, meteorological data, projected population (within an 80-km [50-mi] radius) for the year 2030, emergency response evacuation modeling, and economic data.

The OPPD estimated the dose to the population within 80 km (50 mi) of Fort Calhoun Station to be approximately 0.1 person-Sv (10.2 person-rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-4. Releases due to containment bypass (i.e., SGTR and ISLOCAs) account for most (71 percent) of the population

dose risk at Fort Calhoun Station, Unit 1. Early and late containment failures contribute about 16 percent and 11 percent of the population dose, respectively. Events in which the containment remains intact account for the remaining 2 percent of the population dose.

Table 5-4. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose [person-rem[(a)] per year]
SGTR (Late and Early)	4.7
ISLOCAs	2.5
Early containment failure	1.6
Late containment failure	1.1
No vessel breach, no containment failure	0.2
No containment failure	<0.05
Total	10.2

[(a)]1 person-Sv = 100 person-rem

5.2.2.2 Review of the OPPD's Risk Estimates

The OPPD's estimate of offsite risk at Fort Calhoun Station, Unit 1 is based on the following major elements of the analysis:

- the Level 1 and 2 risk models that form the bases for the 1993 IPE and 1995 IPEEE submittals (Gates 1993; Patterson 1995),
- the major modifications to the IPE model that have been incorporated in the Fort Calhoun Station, Unit 1 PRA, as provided by the licensee in response to RAIs (Ridenoure 2002), and
- the MACCS2 analyses performed to translate fission-product release frequencies from the Level 2 PRA model into offsite consequence measures.

Each of these analyses was reviewed to determine the acceptability of the OPPD's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the Fort Calhoun Station, Unit 1 IPE is described in an NRC report dated December 9, 1996 (Wharton 1996b). In that review, the staff evaluated the methodology, models, data, and assumptions used to estimate the CDF and characterize containment performance and fission-product releases. The staff concluded that the OPPD's analysis met the intent of Generic Letter 88-20 (NRC 1988); that is, the IPE was of adequate quality to be

used to look for design or operational vulnerabilities. The staff's review primarily focused on the licensee's ability to examine Fort Calhoun Station, Unit 1 for severe-accident vulnerabilities and not specifically on the detailed findings or quantification estimates. Overall, the staff concluded that the Fort Calhoun Station, Unit 1 IPE was of adequate quality to be used as a tool in searching for areas with high potential for risk reduction and to assess such risk reductions, especially when the risk models are used in conjunction with insights, such as those from risk importance, sensitivity, and uncertainty analyses.

The Fort Calhoun Station, Unit 1 PRA has been updated several times since the IPE to reflect changes in data on equipment performance, plant configuration, and PRA model refinements. In response to an RAI, the OPPD provided a description of plant and PRA model changes implemented since the IPE (Ridenoure 2002). The specific changes to the plant and PRA include the following:

- adding two 161-kV lines, two 345/161-kV auto-transformers, and interconnection capabilities to improve alternating current (ac) power reliability;
- modifying the condensate-storage-tank dump valve and installing a protective trip-override switch to improve the availability of the diesel-driven auxiliary feedwater pump;
- making potable water and raw water available for makeup to the emergency feedwater storage tank and modifying the roof hatch to allow makeup following a turbine-building fire;
- reconfiguring a component cooling-water isolation valve to provide improved closure capabilities in ISLOCA-type events;
- procuring and prestaging portable pumps for feeding steam generators (SGs) in external-flooding events;
- updating initiating event frequencies based upon the CE Owners Group (CEOG) standard;
- improving the human reliability analysis (HRA) dependency analysis;
- adding common-cause basic events for emergency-core-cooling-system (ECCS) sump strainer blockage and for common-cause battery demand failure; and
- revising the model to account for possible loss of air to air-operated ECCS recirculation actuation switches and valves.

The changes from the IPE version to the current PRA appear to be reasonable and have a relatively small effect on the PRA results. A comparison of risk profiles between the IPE and

the PRA used in the SAMA analysis indicates a slight (1×10^{-5} per year) increase in the total CDF.

In an RAI, the staff questioned whether the current Fort Calhoun Station, Unit 1 PRA had been subjected to peer review (Kenyon 2002a). In response, the OPPD noted that the PRA was peer-reviewed by a team of PRA engineers from Westinghouse, four other utilities, and a PRA consultant (Ridenoure 2002). This peer review was conducted in accordance with the CEOG implementation of the nuclear-industry, peer-review process documented in NEI 00-02 (NEI 2000). The peer review resulted in a total of 89 specific peer-review comments and observations, seven of which were identified by the OPPD for expedited resolution and were included in the plant's PRA configuration-control program. In response to a further staff inquiry, the OPPD stated that two of the seven items were already resolved in the Revision 3 PRA model used in the initial SAMA evaluation. The other five items, mainly related to human-reliability dependencies and methodologies, were not specifically addressed in the PRA, but these items were qualitatively reviewed by the OPPD and were judged to have no significant impact on the SAMA analysis (Kenyon 2002b).

The IPE and updated CDF values for Fort Calhoun Station, Unit 1 are lower than most of the original IPE values estimated for other pressurized-water reactors (PWRs) with a large, dry containment. Figure 11.6 of NUREG-1560 shows that the IPE-based total internal-events CDF for CE plants ranges from 1×10^{-5} to 3×10^{-4} per year (NRC 1997a). While it is recognized that other plants have reduced the values for CDF since the IPE submittals, due to modeling and hardware changes, the CDF results for Fort Calhoun Station, Unit 1 confirm that the overall risks are lower than or comparable to other plants of similar vintage and characteristics.

The OPPD submitted an IPEEE by letter dated June 30, 1995 (Patterson 1995), in response to Supplement 4 of Generic Letter 88-20. The OPPD did not identify any fundamental weaknesses or vulnerabilities to severe-accident risk in regard to the external events related to seismic, fire, or other external events. The Fort Calhoun Station, Unit 1 high-winds and tornado analyses show that Fort Calhoun Station, Unit 1 is adequately designed or that procedures exist to cope against the effects of these natural events. Additionally, the Fort Calhoun Station, Unit 1 IPEEE demonstrated that transportation and nearby facility accidents were not considered to be significant vulnerabilities at Fort Calhoun Station, Unit 1. However, a number of areas were identified for improvement in both the seismic and fire areas. In a letter dated May 6, 1996 (Wharton 1996a), the staff concluded that the submittal met the intent of Supplement 4 to Generic Letter 88-20 and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe-accident vulnerabilities.

The ER (OPPD 2002) acknowledges that the methods used for the Fort Calhoun Station, Unit 1 IPEEE do not provide the means to determine the numerical estimates of the CDF contributions from seismic initiators (i.e., the seismic IPEEE uses a reduced-scope margins method

emphasizing plant walkdowns) and fire initiators (i.e., the fire IPEEE uses the FIVE method). The IPEEE fire CDF estimates are considered by the OPPD to be conservative and overestimate the fire risk for screening purposes (OPPD 2002). The OPPD performed several procedural and hardware modifications in the areas of seismic, external flooding, and fire. As a result, the seismic and external flooding CDF was reduced by almost 2 orders of magnitude, and the fire CDF was reduced by a factor of 3 (Patterson 1995).

Because of the small expected contribution of external events to the overall risk profile for Fort Calhoun Station, Unit 1, the risk-reduction estimates for the SAMAs were evaluated based on a consideration of the internal-events risk profile. However, in the SAMA screening process described in Section 5.3 of Appendix 5 of the ER, the OPPD screened out SAMAs from further consideration only if a SAMA's implementation cost would be greater than twice its estimated benefit (based on internal events). The staff notes that the contribution of external events to total risk would be bounded by this factor of 2 if (1) the total contribution from external events is a small fraction of the contribution from internal events and (2) there are no external-event vulnerabilities that can be eliminated or mitigated by cost-effective SAMAs. As noted above, the external-event contribution to total CDF at Fort Calhoun Station, Unit 1 is small, and the OPPD has previously made modifications specifically addressing external-event vulnerabilities. Also, the use of a factor of 2 multiplier results in a CDF that exceeds the 95th percentile CDF for internal events (see Table 5-6). Finally, as discussed in Section 5.2.6.2 of this SEIS, the OPPD assessed the impact that the use of a factor of 3 would have on the SAMA process and concluded that the results would not be altered. Based on the above considerations, the staff finds the OPPD's treatment of external events within the SAMA analysis to be acceptable.

The staff reviewed the process used by the OPPD to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (a Level 3 PRA). This included consideration of the source terms used to characterize fission-product releases for each containment-release category and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was used to estimate offsite consequences. Plant-specific input to the code includes the Fort Calhoun Station, Unit 1 reactor core radionuclide inventory (obtained from Fort Calhoun Station, Unit 1-specific ORIGEN-S computer code calculations performed as part of the OPPD alternative source-term application submittal of February 2001), emergency evacuation modeling, release category source terms from the Fort Calhoun Station, Unit 1 IPE, site-specific meteorological data, and projected population distribution within an 80-km (50-mi) radius for the year 2030. This information is provided in Section 5.2 of the ER (OPPD 2002).

The applicant used source-term release fractions for 27 different release classes defined for Fort Calhoun Station. The staff reviewed the OPPD's source-term estimates for the major release categories and found the release fractions to be consistent with those of similarly designed plants and of expected magnitudes when considering early versus late containment

failures and rupture versus leak-type failures. A sensitivity analysis was performed for a 10-percent increase in the fission-product release. The increase in fission-product release results in approximately a 6-percent increase in population dose risk. The staff concludes that the assignment of source terms is acceptable for use in the SAMA analysis.

The applicant used site-specific meteorological data (wind speed, wind direction, stability class, and precipitation) processed from hourly measurements for the 1998 calendar year as input to the MACCS2 code. As a sensitivity study, the applicant also considered the meteorological data from 1994 to 1998 to verify that the 1998 data set is representative for Fort Calhoun Station.

A detailed discussion of the methodology for estimating population is provided in Section 5.2.1.4 of the ER (OPPD 2002). Briefly summarized, 1990 census data were used to prepare population estimates for the region surrounding the plant. The 1990 population distribution by sector for the 80-km (50-mi) region was prepared using population data extracted from the STF3A files released by the U.S. Bureau of the Census in 1992 (USBC 1992). A commercially available geographic-information tool was used to estimate the population within each of 16 sectors. The total 1990 population residing in the 80-km (50-mi) radius region was estimated to be 770,000 persons.

County-level data extracted from the year 2000 census data were used to estimate the year 2000 population distribution. Changes in population between 1990 and 2000 were calculated under the assumption that an increase or decrease in the population for each census block group within a given county was the same as that of the county as a whole. The total year 2000 80-km (50-mi) radius population estimate is 853,000 persons.

County-specific population estimates were used to extrapolate the year 2000 population estimate to year 2030. County-population projections for the year 2030 were not available for the states of Iowa and Nebraska; therefore, straight-line projections to the year 2030 were made using available population projections for 2020 and 2025 (Iowa) or 2015 and 2020 (Nebraska). The county-population change factors were then applied to the respective block groups. The year 2030 80-km (50-mi) radius population total for the Fort Calhoun Station, Unit 1 region was estimated to be 1,056,000 persons. The staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA analysis.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 km (10 mi) from the plant. It was assumed that 95 percent of the population would move at an average speed of approximately 2 m/s with a 45-minute delay time. This assumption is conservative relative to the NUREG-1150 study (NRC 1990), which assumed an evacuation of 99.5 percent of the population within the emergency planning zone. In addition, a sensitivity

analysis was performed that assumed both 100-percent evacuation and no evacuation of the surrounding population. The difference between the two evacuation assumptions (zero and 100 percent) correlates to approximately a 10-percent variation in population dose. The evacuation assumptions and analysis are deemed reasonable and acceptable for the purposes of the SAMA evaluation.

The staff concludes that the methodology used by the OPPD to estimate the CDF and offsite consequences for Fort Calhoun Station, Unit 1 provides an acceptable basis from which to proceed with an assessment of risk-reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDF and offsite doses reported by the OPPD.

5.2.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by the OPPD are discussed in this section.

5.2.3.1 Process for Identifying Potential Plant Improvements

The OPPD's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of plant-specific improvements identified in the Fort Calhoun Station, Unit 1 IPE and IPEEE,
- review of SAMA analyses submitted in support of original licensing and license renewal activities for other operating nuclear power plants,
- review of other NRC and industry documentation discussing potential plant improvements (e.g., NUREG-1560 and NUREG-1462),
- a review of the top 100 cut sets and risk achievement worth (RAW) and Fussel–Vesely (F–V) importance measures from Revision 3 of the PRA, and
- insights provided by Fort Calhoun Station, Unit 1 staff.

Based on this process, an initial list of 190 candidate SAMAs was identified, as reported in Table 5.3-1 of the ER (OPPD 2002). The OPPD performed a qualitative screening of the initial list of SAMAs and screened SAMAs from further consideration using the following criteria:

- the SAMA has already been implemented at Fort Calhoun Station, Unit 1, or the plant design meets the intent of the SAMA;

- the SAMA modifies features not applicable to Fort Calhoun Station, Unit 1;
- the SAMA will involve major plant design and/or structural changes that will clearly be well in excess of the maximum attainable benefit (MAB);
- the SAMA will provide only minimal risk reduction based on a review of system risk-reduction worth (RRW) values and other plant metrics, or previous system review results; or
- the SAMA duplicates or can be consolidated with one or more other SAMA being considered.

Based on the qualitative screening, 170 SAMAs were eliminated, leaving 20 for further evaluation. Of the 170 SAMAs eliminated, 50 were eliminated because they already had been implemented at Fort Calhoun Station, Unit 1 (or the design met the intent of the SAMA), 57 were eliminated because they were not applicable to Fort Calhoun Station, Unit 1, 31 were prohibitively expensive, 24 resulted in minimal risk reduction, and 8 were duplicates or were combined with other SAMAs. The 20 remaining SAMAs are discussed in Section 5.4 of the ER (OPPD 2002) and were subjected to further evaluation and final screening.

The final screening process was conducted in two steps: (1) identifying and eliminating those SAMAs whose cost exceeded the MAB ($784,000, as discussed in Section 5.2.6.1 of this SEIS) and (2) performing a more detailed cost-benefit analysis on the remaining SAMAs and eliminating those SAMAs whose costs exceeded twice their calculated benefit. Of the 20 SAMAs surviving the initial screening, 6 were identified as cost-beneficial. Two additional SAMAs were determined to be potentially cost-beneficial based on sensitivity analyses. These SAMAs are discussed further in Section 5.2.6 of this SEIS.

5.2.3.2 Staff Evaluation

The OPPD's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. The initial list of SAMAs generally addressed the accident categories that are dominant CDF contributors or issues that tend to have a large impact on a number of accident sequences at Fort Calhoun Station, Unit 1.

The staff requested more information on how the OPPD used cut sets and importance measures to identify candidate SAMAs. A review of the importance ranking of basic events in the PRA has the potential to identify SAMAs that may not be apparent from a review of the top cut sets. In response to the RAI, the OPPD explained that the lists of components and actions with high RRW values (greater than 1.1) or F–V values (greater than 0.005) were assembled and reviewed to establish a potential means of improving the component's or action's reliability or of using alternate systems or components to meet the intent of the component. In addition,

the OPPD examined the top 100 cut sets, which account for about 64 percent of the CDF, to identify potential SAMAs (Ridenoure 2002).

The potential SAMA candidates included both hardware and procedural alternatives. The set of SAMAs considered also includes low-cost alternatives, which have the greatest potential for being cost-beneficial.

The OPPD's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. This is reasonable, since external events contribute a small amount to the total CDF and the containment response to external events was found to be similar to that from internal events in the IPE. The list of 20 candidate SAMAs generally addressed (1) the accident categories that are dominant CDF contributors or (2) issues that tend to have a large impact on a number of accident sequences at Fort Calhoun Station, Unit 1.

The staff notes that the set of SAMAs submitted is not all inclusive since additional, possibly even less expensive, design alternatives can always be postulated. However, the staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least-expensive alternatives evaluated when the subsidiary costs associated with maintenance, procedures, and training are considered.

It should be noted that the OPPD has previously implemented processes to identify and voluntarily implement cost-beneficial enhancements to further reduce risk at Fort Calhoun Station, Unit 1. This has resulted in the implementation of numerous plant enhancements, as described in Section 5.2.2.2 of this SEIS, and reduction of the risk at Fort Calhoun Station, Unit 1 from both internally and externally initiated events. The staff concludes that the OPPD used a systematic process for identifying further plant improvements for Fort Calhoun Station, Unit 1 and that the set of potential plant improvements identified by the OPPD is reasonably comprehensive and therefore acceptable. This search included using the knowledge and experience of its PRA personnel; reviewing insights from the IPE, IPEEE, and other plant-specific studies; and reviewing plant improvements in previous SAMA analyses. While the explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for external events and fires, and the absence of external-event vulnerabilities reasonably justifies examining primarily the internal-events risk results for this purpose.

5.2.4 Risk-Reduction Potential of Plant Improvements

The OPPD evaluated the risk-reduction potential of the 20 SAMA candidates surviving the initial screening. Each SAMA evaluation was performed in a bounding fashion in that the SAMA was assumed to eliminate the core damage events the SAMA is intended to address or substantially

reduce the frequency of these events. Such bounding calculations overestimate the benefit of each SAMA and are conservative.

The OPPD used two types of evaluations, model and cut set requantification, to determine the benefit of the SAMAs. Requantified PRA results were used to establish both the CDF change and its impact on the change in the fission-product classes. These results were combined with MACCS2 release class impacts to determine the change in offsite exposure risk. Some of the SAMAs were more quickly evaluated by examining the contribution of specific components or human actions to the CDF.

Table 5-5 lists the assumptions used to estimate the risk reduction for each of the 20 SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The determination of the benefits for the various SAMAs is discussed in Section 5.2.6 of this SEIS.

In response to an RAI, the OPPD considered the uncertainties associated with the calculated CDF. This matter is considered further in Section 5.2.6.2 of this SEIS.

The staff has reviewed the OPPD's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on the OPPD's risk-reduction estimates.

5.2.5 Cost Impacts of Candidate Plant Improvements

The OPPD estimated the costs of implementing the 20 SAMAs, which were not initially screened out, through the application of engineering judgment, estimates from other licensees' submittals, and site-specific cost estimates. The cost estimates conservatively did not include the cost of replacement power during extended outages that would be required to implement the modifications, nor did the estimates include contingency costs associated with unforeseen implementation obstacles. Estimates based on modifications implemented or estimated in the past were presented in terms of dollar values at the time of implementation and were not adjusted to present-day dollars. The depth of analysis performed varied depending on the magnitude of the expected benefit. For most of the SAMAs considered, the cost estimates were sufficiently greater than the benefits calculated such that no detailed evaluation was required. Detailed cost-estimating was only applied in those situations in which the benefit is significant and the application of judgement would be questioned.

Table 5-5. SAMA Cost/Benefit Screening Analysis

SAMA #	SAMA[a]	Assumptions	Percent Risk Reduction		Total Benefit (2001 dollars)	Cost (2001 dollars)
			CDF	Population Dose		
Improvements Related to the Mitigation of the Reactor Coolant Pump (RCP) Seal LOCA						
4	**Implement procedure and operator-training enhancements for support-system failure sequences, with an emphasis on anticipating problems and coping with events that could lead to loss of cooling to RCP seals.**	**All core damage events associated with loss-of-component, cooling-water (LOCCW) initiators and those associated with SBOs with induced RCP seal failures are eliminated.**	**5**	**2.4**	**$27,000**	**>$30,000**
9	Install an additional service water pump	All core damage events associated with a LOCCW are eliminated.	3	1.4	$17,000	>2 × benefit
10	Install the improved N 9000 RCP seals	Same as SAMA 4.	5	2.4	$27,000	>$2M
41	Use the fire-protection system (FPS) as a backup source for the containment spray system	All late containment failures are eliminated.	0	8.5	$23,000	>2 × benefit
Improvements in Identifying or Coping with Containment Bypass						
52	Install additional batteries to extend 125-V direct current (dc) battery life to 24 hours	All late SBOs core damage sequences are eliminated.	16	12	$111,000	$3.5M
54	Incorporate an alternate battery-charging capability by adding an independent power supply (20-kW dc source) to charge batteries	All late SBOs core damage sequences are eliminated.	16	12	$111,000	>$150,000

[a]SAMAs in bold were judged to be cost-beneficial.

Table 5-5 (contd)

SAMA #	SAMA[(a)]	Assumptions	Percent Risk Reduction		Total Benefit (2001 dollars)	Cost (2001 dollars)
			CDF	Population Dose		
56	Improve 125-V dc busload management to allow the 125-V dc batteries to last for 24 hours	All late SBOs core damage sequences are eliminated.	16	12	$111,000	>$160,000
60	Develop procedures to repair or replace failed 4-kV breakers	Basic events ECBD1A11, ECBD1A31, ECBD1A22, and ECBD1A42 were set to zero.	0	0	0	NA
88	Develop procedures and install systems such that every possible ISLOCA path would undergo scrubbing	All ISLOCA sequences are scrubbed, reducing the associated releases by a factor of 5.	0	12.8	$35,000	>2 × benefit
92	**Modify procedures to conserve or prolong the inventory in the borated-water storage tank (safety injection refueling water storage tank [SIRWT]) during SGTRs**	**Failures associated with the depletion of the SIRWT inventory during ISLOCAs and SGTRs are eliminated.**	**25**	**16.4**	**$165,000**	**<$30,000**
Fort Calhoun Station, Unit 1-Specific SAMAs						
181	**Add accumulators or implement training on SIRWT bubblers and recirculation valves**	**The air supply to the bubblers will always be available.**	**17.2**	**3.6**	**$78,000**	**<$30,000**
182	**Add capability for SG-level indication during SBO**	**All SBOs that were not predicted to have induced RCP seal failure are eliminated.**	**17.2**	**3.6**	**$76,000**	**<$30,000**

[(a)]SAMAs in bold were judged to be cost-beneficial.

Table 5-5 (contd)

SAMA #	SAMA[a]	Assumptions	Percent Risk Reduction		Total Benefit (2001 dollars)	Cost (2001 dollars)
			CDF	Population Dose		
183	**Add 480-V ac power supply to open the power-operated relief valve (PORV)**	**No credit was taken for the use of the PORV in averting core damage. For post-core damage, all SGTRs that result in direct releases to the environment are assumed to go to zero.**	**0**	**7.8**	**$32,000**	**<$25,000**
184	**Add capability to flash the field on the emergency diesel generator (EDG) to enhance SBO recovery**	**Twenty percent of the mechanical failures of the EDGs and 15 percent of the battery-related failures are recoverable.**	**27**	**5.4**	**$118,000**	**<$30,000**
185	Remove SI-2C from auto-start	The recirculation actuation signal (RAS) dependency on SI-2C is eliminated.	10	2	$44,000	>2 × benefit
186	**Add manual steam-relief capability and associated procedures**	**Twenty percent of SGTR CDF and all CDF for small LOCA sequences are eliminated.**	**3**	**12.6**	**$62,000**	**<$40,000**
187	Enhance operation of FW-54	FW-54 (diesel-driven auxiliary feedwater pump) will never fail.	3	0.5	$14,000	>2 × benefit
188	Enhance external-flooding procedures	CDF for external flooding is reduced by 50 percent.	17 percent of flooding CDF	<<1	$16,000	>2 × benefit
189	Add trisodium phosphate into the auxiliary-building sumps	ISLOCA releases from small LOCA events are reduced by a factor of 5.	0	6.4	$17,000	>2 × benefit
190	Enhance emergency operating procedures to provide guidance to operators to better avert thermally induced SGTRs	All SGTR event loss-of-isolation releases are eliminated.	0	2.4	$20,000	>$30,000

[a]SAMAs in bold were judged to be cost-beneficial.

The staff reviewed the bases for the applicant's cost estimates. For certain improvements, the staff also compared the cost estimates (presented in Table 4.16-2 of the ER [OPPD 2002]) to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. Most of the SAMAs were screened from further consideration on the basis that the expected implementation cost would be much greater than twice the estimated risk-reduction benefit. This is reasonable for the SAMAs considered, given the relatively small estimated benefit for the SAMAs (a maximum benefit of about $165,000) and the large implementation costs typically associated with major hardware changes and hardware changes that impact safety-related systems. In previous SAMA evaluations, the implementation costs for such hardware changes were generally estimated to be $1 million or more. Where specific cost estimates were provided in the ER (OPPD 2002), these were typically obtained from previous licensees' ERs or from other industry submittals, most of which have been previously reviewed by the NRC. Accordingly, the cost estimates were found to be consistent with previous estimates. The staff concludes that the cost estimates are sufficient and appropriate for use in the SAMA evaluation.

5.2.6 Cost-Benefit Comparison

The OPPD's cost-benefit analysis and the staff's review are described in the following sections.

5.2.6.1 The OPPD Evaluation

The methodology used by the OPPD was based primarily on the NRC's guidance for performing cost-benefit analysis in the *Regulatory Analysis Technical Evaluation Handbook*, NUREG/BR-0184 (NRC 1997b). The guidance involves determining the net value for each SAMA according to the following formula:

$$\text{Net Value} = (\text{APE} + \text{AOC} + \text{AOE} + \text{AOSC}) - \text{COE},$$

where

APE = present value of averted public exposure ($),

AOC = present value of averted offsite property damage costs ($),

AOE = present value of averted occupational exposure costs ($),

AOSC = present value of averted onsite costs ($), and

COE = cost of enhancement ($).

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA, and it is not considered cost-beneficial. The OPPD's derivation of each of the associated costs is summarized below.

Averted Public Exposure Costs

The averted public exposure (APE) costs were calculated using the following formula:

APE = annual reduction in public exposure (person-rem/year)
× monetary equivalent of unit dose ($2000 per person-rem)
× present-value conversion factor (10.76 based on a 20-year period with a 7-percent discount rate).

As stated in NUREG/BR-0184 (NRC 1997b), it is important to note that the monetary value of the public-health risk after discounting does not represent the expected reduction in public-health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, the OPPD calculated an APE of approximately $218,000 for the 20-year license renewal period, which assumes the elimination of all severe accidents.

Averted Offsite Property Damage Costs

The averted offsite property damage costs (AOCs) were calculated using the following formula:

AOC = annual CDF reduction
× offsite economic costs associated with a severe accident (on a per-event basis)
× present-value conversion factor.

For the purposes of initial screening, which assumes all severe accidents are eliminated, the OPPD calculated an annual offsite economic risk of $15,427 based on the Level 3 risk analysis. This results in a discounted value of approximately $166,000 for the 20-year license renewal period.

Averted Occupational Exposure Costs

The averted occupational exposure (AOE) costs were calculated using the following formula:

AOE = annual CDF reduction
× occupational exposure per core damage event
× monetary equivalent of unit dose
× present-value conversion factor.

The OPPD derived the values for AOE from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997b). Best-estimate values provided for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents are eliminated, the OPPD calculated an AOE of approximately $9000.

Averted Onsite Costs

Averted onsite costs (AOSCs) include averted cleanup and decontamination costs and averted replacement-power costs (RPCs). Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. The OPPD derived the values for the AOSCs based on information provided in Section 5.7.6 of the regulatory analysis handbook (NRC 1997b).

The OPPD divided this cost element into two parts, the onsite cleanup and decontamination cost (also commonly referred to as averted cleanup and decontamination costs [ACCs]) and the RPC.

ACCs were calculated using the following formula:

ACC = annual CDF reduction
× present value of cleanup costs per core damage event
× present-value conversion factor.

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in the regulatory analysis handbook (NRC 1997b) to be 1.5×10^9 (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension.

Long-term RPCs were calculated using the following formula:

RPC = annual CDF reduction
× present value of replacement power for a single event
× factor to account for remaining service years for which replacement power is required
× reactor power scaling factor

Fort Calhoun Station, Unit 1 has a gross electrical rating of 478 MW(e), which is much lower than the reference rating in NUREG/BR-0184 (NRC 1997b). Thus, a reactor power scaling factor (478/910) of 0.53 was applied to the corresponding formula. For the purposes of initial screening, which assumes all severe accidents are eliminated, the OPPD calculated the AOSC to be approximately $391,000.

Using the above equations, the OPPD estimated the total present dollar-value equivalent associated with completely eliminating all severe accident risk at Fort Calhoun Station, Unit 1 to be $784,000.

The OPPD's Results

If the implementation costs of a SAMA were greater than the MAB of $784,000, then the SAMA was screened from further consideration. A more refined look at the costs and benefits was performed for the remaining SAMAs. If the expected cost for those SAMAs exceeded twice the calculated benefit, the SAMA was considered not to be cost-beneficial. The cost-benefit results for the individual analysis of the 20 SAMA candidates are presented in Table 5-5. As a result, the following six SAMAs were considered to be cost-beneficial:

- SAMA 92 – Conserve/make up borated-water storage tank inventory post-accident. This SAMA candidate would modify procedures to conserve or prolong the inventory in the borated-water storage tank (SIRWT) during SGTRs.

- SAMA 181 – Add accumulators or implement training on SIRWT bubblers and recirculation valves. This SAMA candidate would involve adding the capability to prevent an early RAS following the loss of instrument air by revising procedures to support operator actions to avert and/or recover from the premature RAS.

- SAMA 182 – Add capability for SG-level indication during an SBO. This SAMA candidate would use a portable 120-V ac generator with manual clamps to provide power supply to the SG-level instrumentation.

- SAMA 183 – Add a 480-V ac power supply to open the PORV. This SAMA candidate would use a portable power source, inverter, cables, and necessary guidance for use as a backup power supply for opening the PORVs during ISLOCAs and some SGTRs.

- SAMA 184 – Add capability to flash the field on the EDG to enhance SBO recovery. This SAMA candidate is intended to increase the capability to cope with an SBO event by using a power supply to flash the field (i.e., start an EDG if one or more EDGs fail to start or if an EDG fails and restart is required after battery depletion).

- SAMA 186 – Add manual steam-relief capability and associated procedures. This SAMA candidate involves performing specific procedural and/or hardware changes to give the plant the alternate capability to increase heat removal from the reactor coolant system (RCS) and accelerate RCS cooldown. Hardware changes may include nitrogen backup to open the main steam valves.

The OPPD performed sensitivity analyses to evaluate the impact of parameter choices on the analysis results (OPPD 2002). The sensitivity analyses included the calculation of candidate SAMA benefits using a 3-percent discount rate, as recommended in NUREG/BR-0184 (NRC 1997b). As a result, two additional SAMA candidates were determined to be potentially cost-beneficial:

- SAMA 4 – Implement procedure and operator-training enhancements to anticipate problems and cope with events that lead to loss of cooling to RCP seals

- SAMA 54 – Add independent power supply to charge batteries.

As stated in the ER (OPPD 2002), the OPPD plans to implement the first seven of the SAMAs listed above. The implementation of these SAMAs reduces the benefit of the last SAMA (SAMA 54) such that it is not cost-beneficial. The OPPD expects the SAMA implementations to be completed by the end of 2005.

5.2.6.2 Staff Evaluation

The cost-benefit analysis performed by the OPPD was based primarily on NUREG/BR-0184 (NRC 1997b) and was executed appropriately. The analysis included a 3-percent discount rate sensitivity study, as recommended in the regulatory analysis handbook (NRC 1997b), which led to the reconsideration of some SAMAs.

The OPPD's assessment of SAMAs (OPPD 2002) indicated that an upper-bound CDF for fires plus internal events (including the dominant seismic contributors) could be about a factor of 3 higher than the mean value. However, in the final screening and cost-benefit analysis, the

OPPD used a factor of 2 to account for the potential contribution to risk from external events. The staff questioned whether this factor of 2 might not be sufficiently conservative if other uncertainties (in addition to contributions from external events) are considered. In response to the RAIs, the OPPD provided the uncertainty range associated with the calculated CDF (see Table 5-6 below) and also reassessed the impact on results if a multiplication factor of 3 rather than 2 were used in the final screening (Ridenoure 2002). The OPPD found that four SAMAs (SAMAs 54, 185, 187, and 190) would become cost-beneficial using a factor of 3. However, a more detailed examination by the OPPD concluded that these SAMAs either would have little to no impact on fire risk or would continue to have a negative net value after implementation of the seven SAMAs identified in Section 5.2.6.1 of this SEIS (Ridenoure 2002). Accordingly, the initial conclusions are considered justifiable.

Table 5-6. Uncertainty in the Calculated CDF for Fort Calhoun Station, Unit 1

Percentile	CDF (per year)
Mean	2.52×10^{-5}
5th	1.22×10^{-5}
50th	1.97×10^{-5}
95th	4.68×10^{-5}

The staff concludes that, except for the seven SAMAs that were determined to be cost-beneficial, the costs of the candidate SAMAs assessed would be higher than the associated benefits. This conclusion is upheld despite a number of uncertainties and nonquantifiable factors in the calculations, which are summarized as follows:

- Uncertainty in the internal-events CDF was not explicitly included in the calculations, which employed best-estimate values to determine the benefits. The 95th percent confidence level for internal-events CDF is approximately 2 times the mean CDF. The results of the cost-benefit analysis show that all of the SAMAs evaluated (except the seven SAMAs that were determined to be cost-beneficial) would cost more than twice the associated benefit. However, since the OPPD's use of a factor of 2 in the SAMA screening was intended to account for external events, consideration of internal-event uncertainties could potentially increase that factor. The OPPD addressed the implications of an overall uncertainty factor of 3 and found that although the screening made several additional SAMA candidates worthy of further scrutiny, no new SAMAs were justified. Therefore, further consideration of internal-event uncertainty is not expected to alter the conclusions of the analysis.

- External events were similarly not explicitly included in the Fort Calhoun Station, Unit 1 risk profile. However, given that external events were accounted for by using a factor-of-2 increase in the benefits and the observation that there are no particular vulnerabilities in the

external-event risk profile at Fort Calhoun Station, Unit 1, any additional benefits that might accrue due to external events would be relatively small.

- Risk-reduction and cost estimates were generally found to be conservative. As such, uncertainty in the costs of any of the contemplated SAMAs would not likely have the effect of making them cost-beneficial.

- Sensitivity calculations were performed with respect to the discount rate (as low as 3 percent) and various MACCS2 parameters, including evacuation speed, meteorological data, and fission-product release. Using the 3-percent discount rate, two additional SAMA candidates, SAMAs 4 and 54, were introduced as cost-beneficial. SAMA 4 was added to the list of SAMA improvements, while SAMA 54 was dismissed on other sound technical grounds. The results of the MACCS2 parameter sensitivity studies showed that none of the risk benefits were increased by more than about 10 percent. Since this is less than the margin between cost and benefit for the SAMAs considered, the uncertainties in these parameters would not alter the conclusions.

5.2.7 Conclusions

The OPPD compiled a list of 190 SAMA candidates using the SAMA analyses, as submitted in support of licensing activities for other nuclear power plants; NRC and industry documents discussing potential plant improvements; and the plant-specific insights from the OPPD IPE, IPEEE, and current PRA model. A qualitative screening removed SAMA candidates that (1) had already been implemented at Fort Calhoun Station, Unit 1, (2) modified features not applicable to Fort Calhoun Station, Unit 1, (3) would involve major plant design and/or structural changes that would clearly be well in excess of the MAB, (4) would provide only minimal risk reduction, or (5) duplicated other SAMAs or could be consolidated with one or more other SAMAs being considered. A total of 170 SAMA candidates was eliminated based on the above criteria, leaving 20 SAMA candidates for further evaluation.

Using guidance in NUREG/BR-0184 (NRC 1997b), the current PRA model, and a Level 3 analysis developed specifically for SAMA evaluation, an MAB of about $784,000 was calculated, representing the total present-dollar-value equivalent associated with completely eliminating severe accidents at Fort Calhoun Station, Unit 1. Of the 20 SAMAs, 14 were screened from further evaluation because the implementation costs were greater than this MAB or exceeded twice the estimated benefit for that specific SAMA. The factor of 2 was used to account for uncertainties in the analysis and the potential impact of external events on the results of the SAMA evaluations. The end result was that six SAMA candidates were determined to be cost-beneficial. Upon completion of a 3-percent discount rate sensitivity study, one additional SAMA candidate was determined to be sufficiently cost-beneficial to be added to the list. The OPPD plans to implement these seven cost-beneficial SAMAs by 2005.

However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they are not required as part of license renewal pursuant to 10 CFR Part 54.

The staff reviewed the OPPD analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs; the generally large, negative net benefits; and the inherently small baseline risks support the general conclusion that the SAMA evaluations performed by the OPPD are reasonable and sufficient for the license renewal submittal. The unavailability of an external-event PRA model precluded a quantitative evaluation of SAMAs specifically aimed at reducing the risk of external-event initiators; however, significant improvements have been realized as a result of the IPEEE process at Fort Calhoun Station, Unit 1 that would minimize the likelihood of identifying cost-beneficial enhancements in this area.

Based on its review of the OPPD SAMA analyses, the staff concurs that, with the exception of the seven candidate SAMAs identified for implementation, none of the remaining candidate SAMAs are cost-beneficial. This is based on a conservative treatment of costs and benefits. This conclusion is consistent with the low residual level of risk indicated in the Fort Calhoun Station, Unit 1 PRA and the fact that Fort Calhoun Station, Unit 1 has already implemented plant improvements identified from the IPE and IPEEE process to reduce plant risk.

5.3 References

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5.0 Environmental Impacts of Postulated Accidents

Environmental issues associated with postulated accidents are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) 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.

(2) Single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term.

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents (DBAs) and severe accidents, as discussed below.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and Addendum 1.

5.1.1 Design-Basis Accidents

In order to receive NRC approval to operate a nuclear power facility, an applicant must submit a safety analysis report (SAR) as part of the application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50 and 10 CFR Part 100.

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license (OL). The results of these evaluations are found in license documentation such as the staff's safety evaluation report (SER), the final environmental statement (FES), the licensee's updated final safety analysis report (UFSAR), and Section 5.1 of this supplemental environmental impact statement (SEIS). The licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the license renewal period. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable, and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, design-basis events are designated as a Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The early resolution of the DBAs make them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and,

therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This issue, applicable to Fort Calhoun Station, Unit 1, is listed in Table 5-1.

Table 5-1. Category 1 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
POSTULATED ACCIDENTS	
Design-basis accidents	5.3.2; 5.5.1

Based on information in the GEIS, the Commission found that

> The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.

The Omaha Public Power District (OPPD) stated in its Environmental Report (ER; OPPD 2002) that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station, Unit 1 OL. The staff has not identified any significant new information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. The GEIS assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Based on information in the GEIS, the Commission found that

> 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.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to Fort Calhoun Station, Unit 1, is listed in Table 5-2.

Table 5-2. Category 2 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
POSTULATED ACCIDENTS			
Severe Accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	L	5.2

The staff has not identified any significant new information with regard to the consequences from severe accidents during its independent review of the OPPD ER (OPPD 2002), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the staff has reviewed severe accident mitigation alternatives (SAMAs) for Fort Calhoun Station, Unit 1. The results of the staff's review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives

10 CFR 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS) or related supplement or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe-accident safety performance are identified and evaluated. SAMAs have not been previously considered for Fort Calhoun Station, Unit 1; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

The OPPD submitted an assessment of SAMAs for Fort Calhoun Station, Unit 1 as part of the ER (OPPD 2002). This assessment was based on the current Fort Calhoun Station, Unit 1 probabilistic risk assessment (PRA), a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) and insights from the Fort Calhoun Station, Unit 1 individual plant examination of external events (IPEEE; Patterson 1995). In identifying and evaluating potential SAMAs, the OPPD considered several

SAMA analyses for other plants and advanced light-water reactor designs, including Watts Bar, Calvert Cliffs, Oconee, Turkey Point, and Combustion Engineering (CE) System 80+, and other documents that discuss potential plant improvements, such as NUREG-1560 (NRC 1997a) and NUREG-1462 (NRC 1994). The OPPD identified and evaluated 190 potential SAMA candidates. This list was reduced to 20 unique SAMA candidates by eliminating SAMAs that either were not applicable to Fort Calhoun Station, Unit 1, were already implemented, were similar to other SAMAs being considered, were prohibitively expensive, or provided minimal risk reduction. Further cost-benefit analysis, including sensitivity studies, showed that 7 of the 20 candidate SAMAs are potentially cost-beneficial. Although the OPPD does not consider it a regulatory commitment, the OPPD is planning to implement these seven SAMAs by the end of 2005.

Based on a review of the SAMA assessment, the NRC issued a request for additional information (RAI) to the OPPD by letter dated July 16, 2002 (Kenyon 2002a). Key questions concerned differences between the PRA used for the SAMA analysis and earlier risk assessments for Fort Calhoun Station, Unit 1, the potential impact of uncertainties and external-event initiators on the study results, the use of importance measures, and detailed information on several candidate SAMAs. The OPPD submitted additional information on September 18, 2002, in response to the RAIs (Ridenoure 2002). This supplemental information was responsive to the staff's concerns and reaffirmed that none of the SAMAs (other than the seven planned for implementation) would be cost-beneficial.

An assessment of the SAMAs for Fort Calhoun Station, Unit 1 is presented below.

5.2.2 Estimate of Risk for Fort Calhoun Station, Unit 1

The OPPD's estimates of offsite risk at Fort Calhoun Station, Unit 1 are summarized in Section 5.2.2.1 of this SEIS. The summary is followed by a review of the OPPD's risk estimates in Section 5.2.2.2 of this SEIS.

5.2.2.1 The OPPD's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the Fort Calhoun Station, Unit 1 Level 1 and 2 PRA performed by the OPPD and documented as the Fort Calhoun Station, Unit 1 PRA, Revision 3 and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The Fort Calhoun Station, Unit 1 PRA is a November 2000 update to the Fort Calhoun Station, Unit 1 individual plant examination (IPE) (for internal events) (Gates 1993) and is considered to be a living PRA in that it tracks the changes in the plant design, procedures, and operating changes as they impact the PRA. The

scope of the Fort Calhoun Station, Unit 1 PRA does not include full consideration of seismic or fire initiators. However, the dominant seismic sequences are included in the PRA.

The Fort Calhoun Station, Unit 1 IPEEE (Patterson 1995) addresses seismic, fire, tornado, external flooding, transportation, nearby facility accidents, and other external events. The contribution from seismic events was assessed using the seismic margin approach, and the fire risk was assessed using the fire-induced vulnerability evaluation (FIVE) approach. The estimated core damage frequency (CDF) in the Fort Calhoun Station, Unit 1 IPEEE was 3.13×10^{-5} per year. The OPPD notes that the results from the seismic margins approach were not part of the IPEEE CDF, but as noted above, the dominant seismic sequences were subsequently added to the PRA. About 88 percent of the IPEEE CDF is dominated by fires. However, the OPPD's position is that the FIVE methodology results in a fire-induced CDF that is much greater than the actual plant fire CDF.

Although the OPPD did not include the contribution of risk from external events within the Fort Calhoun Station, Unit 1 risk estimates (except for the dominant seismic initiators), the OPPD did account for the potential risk-reduction benefits associated with external events by applying a factor of 2 multiplier to the benefits estimates for internal events. This is discussed further in Sections 5.2.2.2 and 5.2.6.2 of this SEIS.

The total CDF for internal events (including internal flooding), as calculated in the original IPE, was 1.36×10^{-5} per year. The current baseline CDF for internal events (including internal flooding) is approximately 2.4×10^{-5} per year. The breakdown of the CDF is provided in Table 5-3. As shown in this table, loss of offsite power (LOOP), station blackout (SBO), and transients are major contributors to the CDF, accounting for 46 percent of the CDF. Loss-of-coolant accidents (LOCAs), internal flooding, and other internal-events initiators contribute to about 40 percent of the CDF. The containment bypass initiators (interfacing systems LOCA [ISLOCA] and steam-generator tube rupture [SGTR] events) contribute to about 14 percent of the CDF.

In the ER, the OPPD uses 2.48×10^{-5} per year as the baseline CDF. This includes a contribution from seismic events, which, according to the OPPD's response to an RAI, is 1.1×10^{-6} per year (Ridenoure 2002). The sum of internal and seismic yields 2.52×10^{-5} per year, a slight (<2 percent) discrepancy from the 2.48×10^{-5} per year baseline value. In response to a staff question, the OPPD stated that the difference between the two numbers was due to a combination of roundoff and truncation errors (Kenyon 2002b).

Table 5-3. Fort Calhoun Station, Unit 1 CDF for Internal Events

Initiating Event	Frequency (per year)	Percent Contribution to the CDF
Loss of offsite power (LOOP)	3.8×10^{-6}	16
Station blackout (SBO)	4.2×10^{-6}	17
Transients	3.0×10^{-6}	13
Anticipated transient without scram (ATWS)	Negligible	Negligible
Loss-of-coolant accident (LOCA)	6.3×10^{-6}	26
Interfacing systems LOCA (ISLOCA)	9.6×10^{-7}	4
Steam-generator tube rupture (SGTR)	2.3×10^{-6}	10
Internal flooding	1.3×10^{-6}	5
Others	2.3×10^{-6}	9
Total CDF (from internal events)	2.41×10^{-5}	100

The Level 2 PRA model is based on the containment event tree and source terms from the IPE (Gates 1993). A description of the plant damage states (PDSs) input to the Level 2 analysis was provided in the OPPD's response to staff RAIs (Ridenoure 2002). Of the 520 potential PDSs, 12 listed in the response have contributions greater than 1 percent of the CDF. The PDSs are propagated into release classes with corresponding source terms. A summary of the mapping of the initiating events into the release categories was also provided in the RAI responses (Ridenoure 2002). The fission-product release fractions and characteristics (source terms) for each release category are provided in Table 4.8.2.6 of the Fort Calhoun Station, Unit 1 IPE (Gates 1993).

The offsite-consequences and economic-impact analyses use the MACCS2 code, Version 1.12, to determine the offsite risk impacts on the surrounding environment and public. Inputs for this analysis include plant- and site-specific input values for core radionuclide inventory, source term and release fractions, meteorological data, projected population (within an 80-km [50-mi] radius) for the year 2030, emergency response evacuation modeling, and economic data.

The OPPD estimated the dose to the population within 80 km (50 mi) of Fort Calhoun Station to be approximately 0.1 person-Sv (10.2 person-rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-4. Releases due to containment bypass (i.e., SGTR and ISLOCAs) account for most (71 percent) of the population

dose risk at Fort Calhoun Station, Unit 1. Early and late containment failures contribute about 16 percent and 11 percent of the population dose, respectively. Events in which the containment remains intact account for the remaining 2 percent of the population dose.

Table 5-4. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose [person-rem[(a)] per year]
SGTR (Late and Early)	4.7
ISLOCAs	2.5
Early containment failure	1.6
Late containment failure	1.1
No vessel breach, no containment failure	0.2
No containment failure	<0.05
Total	10.2

[(a)]1 person-Sv = 100 person-rem

5.2.2.2 Review of the OPPD's Risk Estimates

The OPPD's estimate of offsite risk at Fort Calhoun Station, Unit 1 is based on the following major elements of the analysis:

- the Level 1 and 2 risk models that form the bases for the 1993 IPE and 1995 IPEEE submittals (Gates 1993; Patterson 1995),
- the major modifications to the IPE model that have been incorporated in the Fort Calhoun Station, Unit 1 PRA, as provided by the licensee in response to RAIs (Ridenoure 2002), and
- the MACCS2 analyses performed to translate fission-product release frequencies from the Level 2 PRA model into offsite consequence measures.

Each of these analyses was reviewed to determine the acceptability of the OPPD's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the Fort Calhoun Station, Unit 1 IPE is described in an NRC report dated December 9, 1996 (Wharton 1996b). In that review, the staff evaluated the methodology, models, data, and assumptions used to estimate the CDF and characterize containment performance and fission-product releases. The staff concluded that the OPPD's analysis met the intent of Generic Letter 88-20 (NRC 1988); that is, the IPE was of adequate quality to be

used to look for design or operational vulnerabilities. The staff's review primarily focused on the licensee's ability to examine Fort Calhoun Station, Unit 1 for severe-accident vulnerabilities and not specifically on the detailed findings or quantification estimates. Overall, the staff concluded that the Fort Calhoun Station, Unit 1 IPE was of adequate quality to be used as a tool in searching for areas with high potential for risk reduction and to assess such risk reductions, especially when the risk models are used in conjunction with insights, such as those from risk importance, sensitivity, and uncertainty analyses.

The Fort Calhoun Station, Unit 1 PRA has been updated several times since the IPE to reflect changes in data on equipment performance, plant configuration, and PRA model refinements. In response to an RAI, the OPPD provided a description of plant and PRA model changes implemented since the IPE (Ridenoure 2002). The specific changes to the plant and PRA include the following:

- adding two 161-kV lines, two 345/161-kV auto-transformers, and interconnection capabilities to improve alternating current (ac) power reliability;
- modifying the condensate-storage-tank dump valve and installing a protective trip-override switch to improve the availability of the diesel-driven auxiliary feedwater pump;
- making potable water and raw water available for makeup to the emergency feedwater storage tank and modifying the roof hatch to allow makeup following a turbine-building fire;
- reconfiguring a component cooling-water isolation valve to provide improved closure capabilities in ISLOCA-type events;
- procuring and prestaging portable pumps for feeding steam generators (SGs) in external-flooding events;
- updating initiating event frequencies based upon the CE Owners Group (CEOG) standard;
- improving the human reliability analysis (HRA) dependency analysis;
- adding common-cause basic events for emergency-core-cooling-system (ECCS) sump strainer blockage and for common-cause battery demand failure; and
- revising the model to account for possible loss of air to air-operated ECCS recirculation actuation switches and valves.

The changes from the IPE version to the current PRA appear to be reasonable and have a relatively small effect on the PRA results. A comparison of risk profiles between the IPE and

the PRA used in the SAMA analysis indicates a slight (1×10^{-5} per year) increase in the total CDF.

In an RAI, the staff questioned whether the current Fort Calhoun Station, Unit 1 PRA had been subjected to peer review (Kenyon 2002a). In response, the OPPD noted that the PRA was peer-reviewed by a team of PRA engineers from Westinghouse, four other utilities, and a PRA consultant (Ridenoure 2002). This peer review was conducted in accordance with the CEOG implementation of the nuclear-industry, peer-review process documented in NEI 00-02 (NEI 2000). The peer review resulted in a total of 89 specific peer-review comments and observations, seven of which were identified by the OPPD for expedited resolution and were included in the plant's PRA configuration-control program. In response to a further staff inquiry, the OPPD stated that two of the seven items were already resolved in the Revision 3 PRA model used in the initial SAMA evaluation. The other five items, mainly related to human-reliability dependencies and methodologies, were not specifically addressed in the PRA, but these items were qualitatively reviewed by the OPPD and were judged to have no significant impact on the SAMA analysis (Kenyon 2002b).

The IPE and updated CDF values for Fort Calhoun Station, Unit 1 are lower than most of the original IPE values estimated for other pressurized-water reactors (PWRs) with a large, dry containment. Figure 11.6 of NUREG-1560 shows that the IPE-based total internal-events CDF for CE plants ranges from 1×10^{-5} to 3×10^{-4} per year (NRC 1997a). While it is recognized that other plants have reduced the values for CDF since the IPE submittals, due to modeling and hardware changes, the CDF results for Fort Calhoun Station, Unit 1 confirm that the overall risks are lower than or comparable to other plants of similar vintage and characteristics.

The OPPD submitted an IPEEE by letter dated June 30, 1995 (Patterson 1995), in response to Supplement 4 of Generic Letter 88-20. The OPPD did not identify any fundamental weaknesses or vulnerabilities to severe-accident risk in regard to the external events related to seismic, fire, or other external events. The Fort Calhoun Station, Unit 1 high-winds and tornado analyses show that Fort Calhoun Station, Unit 1 is adequately designed or that procedures exist to cope against the effects of these natural events. Additionally, the Fort Calhoun Station, Unit 1 IPEEE demonstrated that transportation and nearby facility accidents were not considered to be significant vulnerabilities at Fort Calhoun Station, Unit 1. However, a number of areas were identified for improvement in both the seismic and fire areas. In a letter dated May 6, 1996 (Wharton 1996a), the staff concluded that the submittal met the intent of Supplement 4 to Generic Letter 88-20 and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe-accident vulnerabilities.

The ER (OPPD 2002) acknowledges that the methods used for the Fort Calhoun Station, Unit 1 IPEEE do not provide the means to determine the numerical estimates of the CDF contributions from seismic initiators (i.e., the seismic IPEEE uses a reduced-scope margins method

emphasizing plant walkdowns) and fire initiators (i.e., the fire IPEEE uses the FIVE method). The IPEEE fire CDF estimates are considered by the OPPD to be conservative and overestimate the fire risk for screening purposes (OPPD 2002). The OPPD performed several procedural and hardware modifications in the areas of seismic, external flooding, and fire. As a result, the seismic and external flooding CDF was reduced by almost 2 orders of magnitude, and the fire CDF was reduced by a factor of 3 (Patterson 1995).

Because of the small expected contribution of external events to the overall risk profile for Fort Calhoun Station, Unit 1, the risk-reduction estimates for the SAMAs were evaluated based on a consideration of the internal-events risk profile. However, in the SAMA screening process described in Section 5.3 of Appendix 5 of the ER, the OPPD screened out SAMAs from further consideration only if a SAMA's implementation cost would be greater than twice its estimated benefit (based on internal events). The staff notes that the contribution of external events to total risk would be bounded by this factor of 2 if (1) the total contribution from external events is a small fraction of the contribution from internal events and (2) there are no external-event vulnerabilities that can be eliminated or mitigated by cost-effective SAMAs. As noted above, the external-event contribution to total CDF at Fort Calhoun Station, Unit 1 is small, and the OPPD has previously made modifications specifically addressing external-event vulnerabilities. Also, the use of a factor of 2 multiplier results in a CDF that exceeds the 95th percentile CDF for internal events (see Table 5-6). Finally, as discussed in Section 5.2.6.2 of this SEIS, the OPPD assessed the impact that the use of a factor of 3 would have on the SAMA process and concluded that the results would not be altered. Based on the above considerations, the staff finds the OPPD's treatment of external events within the SAMA analysis to be acceptable.

The staff reviewed the process used by the OPPD to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (a Level 3 PRA). This included consideration of the source terms used to characterize fission-product releases for each containment-release category and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was used to estimate offsite consequences. Plant-specific input to the code includes the Fort Calhoun Station, Unit 1 reactor core radionuclide inventory (obtained from Fort Calhoun Station, Unit 1-specific ORIGEN-S computer code calculations performed as part of the OPPD alternative source-term application submittal of February 2001), emergency evacuation modeling, release category source terms from the Fort Calhoun Station, Unit 1 IPE, site-specific meteorological data, and projected population distribution within an 80-km (50-mi) radius for the year 2030. This information is provided in Section 5.2 of the ER (OPPD 2002).

The applicant used source-term release fractions for 27 different release classes defined for Fort Calhoun Station. The staff reviewed the OPPD's source-term estimates for the major release categories and found the release fractions to be consistent with those of similarly designed plants and of expected magnitudes when considering early versus late containment

failures and rupture versus leak-type failures. A sensitivity analysis was performed for a 10-percent increase in the fission-product release. The increase in fission-product release results in approximately a 6-percent increase in population dose risk. The staff concludes that the assignment of source terms is acceptable for use in the SAMA analysis.

The applicant used site-specific meteorological data (wind speed, wind direction, stability class, and precipitation) processed from hourly measurements for the 1998 calendar year as input to the MACCS2 code. As a sensitivity study, the applicant also considered the meteorological data from 1994 to 1998 to verify that the 1998 data set is representative for Fort Calhoun Station.

A detailed discussion of the methodology for estimating population is provided in Section 5.2.1.4 of the ER (OPPD 2002). Briefly summarized, 1990 census data were used to prepare population estimates for the region surrounding the plant. The 1990 population distribution by sector for the 80-km (50-mi) region was prepared using population data extracted from the STF3A files released by the U.S. Bureau of the Census in 1992 (USBC 1992). A commercially available geographic-information tool was used to estimate the population within each of 16 sectors. The total 1990 population residing in the 80-km (50-mi) radius region was estimated to be 770,000 persons.

County-level data extracted from the year 2000 census data were used to estimate the year 2000 population distribution. Changes in population between 1990 and 2000 were calculated under the assumption that an increase or decrease in the population for each census block group within a given county was the same as that of the county as a whole. The total year 2000 80-km (50-mi) radius population estimate is 853,000 persons.

County-specific population estimates were used to extrapolate the year 2000 population estimate to year 2030. County-population projections for the year 2030 were not available for the states of Iowa and Nebraska; therefore, straight-line projections to the year 2030 were made using available population projections for 2020 and 2025 (Iowa) or 2015 and 2020 (Nebraska). The county-population change factors were then applied to the respective block groups. The year 2030 80-km (50-mi) radius population total for the Fort Calhoun Station, Unit 1 region was estimated to be 1,056,000 persons. The staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA analysis.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 km (10 mi) from the plant. It was assumed that 95 percent of the population would move at an average speed of approximately 2 m/s with a 45-minute delay time. This assumption is conservative relative to the NUREG-1150 study (NRC 1990), which assumed an evacuation of 99.5 percent of the population within the emergency planning zone. In addition, a sensitivity

analysis was performed that assumed both 100-percent evacuation and no evacuation of the surrounding population. The difference between the two evacuation assumptions (zero and 100 percent) correlates to approximately a 10-percent variation in population dose. The evacuation assumptions and analysis are deemed reasonable and acceptable for the purposes of the SAMA evaluation.

The staff concludes that the methodology used by the OPPD to estimate the CDF and offsite consequences for Fort Calhoun Station, Unit 1 provides an acceptable basis from which to proceed with an assessment of risk-reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDF and offsite doses reported by the OPPD.

5.2.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by the OPPD are discussed in this section.

5.2.3.1 Process for Identifying Potential Plant Improvements

The OPPD's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of plant-specific improvements identified in the Fort Calhoun Station, Unit 1 IPE and IPEEE,
- review of SAMA analyses submitted in support of original licensing and license renewal activities for other operating nuclear power plants,
- review of other NRC and industry documentation discussing potential plant improvements (e.g., NUREG-1560 and NUREG-1462),
- a review of the top 100 cut sets and risk achievement worth (RAW) and Fussel–Vesely (F–V) importance measures from Revision 3 of the PRA, and
- insights provided by Fort Calhoun Station, Unit 1 staff.

Based on this process, an initial list of 190 candidate SAMAs was identified, as reported in Table 5.3-1 of the ER (OPPD 2002). The OPPD performed a qualitative screening of the initial list of SAMAs and screened SAMAs from further consideration using the following criteria:

- the SAMA has already been implemented at Fort Calhoun Station, Unit 1, or the plant design meets the intent of the SAMA;

- the SAMA modifies features not applicable to Fort Calhoun Station, Unit 1;
- the SAMA will involve major plant design and/or structural changes that will clearly be well in excess of the maximum attainable benefit (MAB);
- the SAMA will provide only minimal risk reduction based on a review of system risk-reduction worth (RRW) values and other plant metrics, or previous system review results; or
- the SAMA duplicates or can be consolidated with one or more other SAMA being considered.

Based on the qualitative screening, 170 SAMAs were eliminated, leaving 20 for further evaluation. Of the 170 SAMAs eliminated, 50 were eliminated because they already had been implemented at Fort Calhoun Station, Unit 1 (or the design met the intent of the SAMA), 57 were eliminated because they were not applicable to Fort Calhoun Station, Unit 1, 31 were prohibitively expensive, 24 resulted in minimal risk reduction, and 8 were duplicates or were combined with other SAMAs. The 20 remaining SAMAs are discussed in Section 5.4 of the ER (OPPD 2002) and were subjected to further evaluation and final screening.

The final screening process was conducted in two steps: (1) identifying and eliminating those SAMAs whose cost exceeded the MAB ($784,000, as discussed in Section 5.2.6.1 of this SEIS) and (2) performing a more detailed cost-benefit analysis on the remaining SAMAs and eliminating those SAMAs whose costs exceeded twice their calculated benefit. Of the 20 SAMAs surviving the initial screening, 6 were identified as cost-beneficial. Two additional SAMAs were determined to be potentially cost-beneficial based on sensitivity analyses. These SAMAs are discussed further in Section 5.2.6 of this SEIS.

5.2.3.2 Staff Evaluation

The OPPD's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. The initial list of SAMAs generally addressed the accident categories that are dominant CDF contributors or issues that tend to have a large impact on a number of accident sequences at Fort Calhoun Station, Unit 1.

The staff requested more information on how the OPPD used cut sets and importance measures to identify candidate SAMAs. A review of the importance ranking of basic events in the PRA has the potential to identify SAMAs that may not be apparent from a review of the top cut sets. In response to the RAI, the OPPD explained that the lists of components and actions with high RRW values (greater than 1.1) or F–V values (greater than 0.005) were assembled and reviewed to establish a potential means of improving the component's or action's reliability or of using alternate systems or components to meet the intent of the component. In addition,

the OPPD examined the top 100 cut sets, which account for about 64 percent of the CDF, to identify potential SAMAs (Ridenoure 2002).

The potential SAMA candidates included both hardware and procedural alternatives. The set of SAMAs considered also includes low-cost alternatives, which have the greatest potential for being cost-beneficial.

The OPPD's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. This is reasonable, since external events contribute a small amount to the total CDF and the containment response to external events was found to be similar to that from internal events in the IPE. The list of 20 candidate SAMAs generally addressed (1) the accident categories that are dominant CDF contributors or (2) issues that tend to have a large impact on a number of accident sequences at Fort Calhoun Station, Unit 1.

The staff notes that the set of SAMAs submitted is not all inclusive since additional, possibly even less expensive, design alternatives can always be postulated. However, the staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least-expensive alternatives evaluated when the subsidiary costs associated with maintenance, procedures, and training are considered.

It should be noted that the OPPD has previously implemented processes to identify and voluntarily implement cost-beneficial enhancements to further reduce risk at Fort Calhoun Station, Unit 1. This has resulted in the implementation of numerous plant enhancements, as described in Section 5.2.2.2 of this SEIS, and reduction of the risk at Fort Calhoun Station, Unit 1 from both internally and externally initiated events. The staff concludes that the OPPD used a systematic process for identifying further plant improvements for Fort Calhoun Station, Unit 1 and that the set of potential plant improvements identified by the OPPD is reasonably comprehensive and therefore acceptable. This search included using the knowledge and experience of its PRA personnel; reviewing insights from the IPE, IPEEE, and other plant-specific studies; and reviewing plant improvements in previous SAMA analyses. While the explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for external events and fires, and the absence of external-event vulnerabilities reasonably justifies examining primarily the internal-events risk results for this purpose.

5.2.4 Risk-Reduction Potential of Plant Improvements

The OPPD evaluated the risk-reduction potential of the 20 SAMA candidates surviving the initial screening. Each SAMA evaluation was performed in a bounding fashion in that the SAMA was assumed to eliminate the core damage events the SAMA is intended to address or substantially

reduce the frequency of these events. Such bounding calculations overestimate the benefit of each SAMA and are conservative.

The OPPD used two types of evaluations, model and cut set requantification, to determine the benefit of the SAMAs. Requantified PRA results were used to establish both the CDF change and its impact on the change in the fission-product classes. These results were combined with MACCS2 release class impacts to determine the change in offsite exposure risk. Some of the SAMAs were more quickly evaluated by examining the contribution of specific components or human actions to the CDF.

Table 5-5 lists the assumptions used to estimate the risk reduction for each of the 20 SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The determination of the benefits for the various SAMAs is discussed in Section 5.2.6 of this SEIS.

In response to an RAI, the OPPD considered the uncertainties associated with the calculated CDF. This matter is considered further in Section 5.2.6.2 of this SEIS.

The staff has reviewed the OPPD's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on the OPPD's risk-reduction estimates.

5.2.5 Cost Impacts of Candidate Plant Improvements

The OPPD estimated the costs of implementing the 20 SAMAs, which were not initially screened out, through the application of engineering judgment, estimates from other licensees' submittals, and site-specific cost estimates. The cost estimates conservatively did not include the cost of replacement power during extended outages that would be required to implement the modifications, nor did the estimates include contingency costs associated with unforeseen implementation obstacles. Estimates based on modifications implemented or estimated in the past were presented in terms of dollar values at the time of implementation and were not adjusted to present-day dollars. The depth of analysis performed varied depending on the magnitude of the expected benefit. For most of the SAMAs considered, the cost estimates were sufficiently greater than the benefits calculated such that no detailed evaluation was required. Detailed cost-estimating was only applied in those situations in which the benefit is significant and the application of judgement would be questioned.

Table 5-5. SAMA Cost/Benefit Screening Analysis

SAMA #	SAMA[a]	Assumptions	Percent Risk Reduction		Total Benefit (2001 dollars)	Cost (2001 dollars)
			CDF	Population Dose		
Improvements Related to the Mitigation of the Reactor Coolant Pump (RCP) Seal LOCA						
4	**Implement procedure and operator-training enhancements for support-system failure sequences, with an emphasis on anticipating problems and coping with events that could lead to loss of cooling to RCP seals.**	**All core damage events associated with loss-of-component, cooling-water (LOCCW) initiators and those associated with SBOs with induced RCP seal failures are eliminated.**	**5**	**2.4**	**$27,000**	**>$30,000**
9	Install an additional service water pump	All core damage events associated with a LOCCW are eliminated.	3	1.4	$17,000	>2 × benefit
10	Install the improved N 9000 RCP seals	Same as SAMA 4.	5	2.4	$27,000	>$2M
41	Use the fire-protection system (FPS) as a backup source for the containment spray system	All late containment failures are eliminated.	0	8.5	$23,000	>2 × benefit
Improvements in Identifying or Coping with Containment Bypass						
52	Install additional batteries to extend 125-V direct current (dc) battery life to 24 hours	All late SBOs core damage sequences are eliminated.	16	12	$111,000	$3.5M
54	Incorporate an alternate battery-charging capability by adding an independent power supply (20-kW dc source) to charge batteries	All late SBOs core damage sequences are eliminated.	16	12	$111,000	>$150,000

[a]SAMAs in bold were judged to be cost-beneficial.

Table 5-5 (contd)

SAMA #	SAMA[(a)]	Assumptions	Percent Risk Reduction		Total Benefit (2001 dollars)	Cost (2001 dollars)
			CDF	Population Dose		
56	Improve 125-V dc busload management to allow the 125-V dc batteries to last for 24 hours	All late SBOs core damage sequences are eliminated.	16	12	$111,000	>$160,000
60	Develop procedures to repair or replace failed 4-kV breakers	Basic events ECBD1A11, ECBD1A31, ECBD1A22, and ECBD1A42 were set to zero.	0	0	0	NA
88	Develop procedures and install systems such that every possible ISLOCA path would undergo scrubbing	All ISLOCA sequences are scrubbed, reducing the associated releases by a factor of 5.	0	12.8	$35,000	>2 × benefit
92	**Modify procedures to conserve or prolong the inventory in the borated-water storage tank (safety injection refueling water storage tank [SIRWT]) during SGTRs**	**Failures associated with the depletion of the SIRWT inventory during ISLOCAs and SGTRs are eliminated.**	**25**	**16.4**	**$165,000**	**<$30,000**
Fort Calhoun Station, Unit 1-Specific SAMAs						
181	**Add accumulators or implement training on SIRWT bubblers and recirculation valves**	**The air supply to the bubblers will always be available.**	**17.2**	**3.6**	**$78,000**	**<$30,000**
182	**Add capability for SG-level indication during SBO**	**All SBOs that were not predicted to have induced RCP seal failure are eliminated.**	**17.2**	**3.6**	**$76,000**	**<$30,000**

[(a)]SAMAs in bold were judged to be cost-beneficial.

Table 5-5 (contd)

SAMA #	SAMA[a]	Assumptions	Percent Risk Reduction		Total Benefit (2001 dollars)	Cost (2001 dollars)
			CDF	Population Dose		
183	**Add 480-V ac power supply to open the power-operated relief valve (PORV)**	**No credit was taken for the use of the PORV in averting core damage. For post-core damage, all SGTRs that result in direct releases to the environment are assumed to go to zero.**	**0**	**7.8**	**$32,000**	**<$25,000**
184	**Add capability to flash the field on the emergency diesel generator (EDG) to enhance SBO recovery**	**Twenty percent of the mechanical failures of the EDGs and 15 percent of the battery-related failures are recoverable.**	**27**	**5.4**	**$118,000**	**<$30,000**
185	Remove SI-2C from auto-start	The recirculation actuation signal (RAS) dependency on SI-2C is eliminated.	10	2	$44,000	>2 × benefit
186	**Add manual steam-relief capability and associated procedures**	**Twenty percent of SGTR CDF and all CDF for small LOCA sequences are eliminated.**	**3**	**12.6**	**$62,000**	**<$40,000**
187	Enhance operation of FW-54	FW-54 (diesel-driven auxiliary feedwater pump) will never fail.	3	0.5	$14,000	>2 × benefit
188	Enhance external-flooding procedures	CDF for external flooding is reduced by 50 percent.	17 percent of flooding CDF	<<1	$16,000	>2 × benefit
189	Add trisodium phosphate into the auxiliary-building sumps	ISLOCA releases from small LOCA events are reduced by a factor of 5.	0	6.4	$17,000	>2 × benefit
190	Enhance emergency operating procedures to provide guidance to operators to better avert thermally induced SGTRs	All SGTR event loss-of-isolation releases are eliminated.	0	2.4	$20,000	>$30,000

[a]SAMAs in bold were judged to be cost-beneficial.

The staff reviewed the bases for the applicant's cost estimates. For certain improvements, the staff also compared the cost estimates (presented in Table 4.16-2 of the ER [OPPD 2002]) to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. Most of the SAMAs were screened from further consideration on the basis that the expected implementation cost would be much greater than twice the estimated risk-reduction benefit. This is reasonable for the SAMAs considered, given the relatively small estimated benefit for the SAMAs (a maximum benefit of about $165,000) and the large implementation costs typically associated with major hardware changes and hardware changes that impact safety-related systems. In previous SAMA evaluations, the implementation costs for such hardware changes were generally estimated to be $1 million or more. Where specific cost estimates were provided in the ER (OPPD 2002), these were typically obtained from previous licensees' ERs or from other industry submittals, most of which have been previously reviewed by the NRC. Accordingly, the cost estimates were found to be consistent with previous estimates. The staff concludes that the cost estimates are sufficient and appropriate for use in the SAMA evaluation.

5.2.6 Cost-Benefit Comparison

The OPPD's cost-benefit analysis and the staff's review are described in the following sections.

5.2.6.1 The OPPD Evaluation

The methodology used by the OPPD was based primarily on the NRC's guidance for performing cost-benefit analysis in the *Regulatory Analysis Technical Evaluation Handbook*, NUREG/BR-0184 (NRC 1997b). The guidance involves determining the net value for each SAMA according to the following formula:

$$\text{Net Value} = (\text{APE} + \text{AOC} + \text{AOE} + \text{AOSC}) - \text{COE},$$

where

APE = present value of averted public exposure ($),

AOC = present value of averted offsite property damage costs ($),

AOE = present value of averted occupational exposure costs ($),

AOSC = present value of averted onsite costs ($), and

COE = cost of enhancement ($).

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA, and it is not considered cost-beneficial. The OPPD's derivation of each of the associated costs is summarized below.

Averted Public Exposure Costs

The averted public exposure (APE) costs were calculated using the following formula:

APE = annual reduction in public exposure (person-rem/year)
× monetary equivalent of unit dose ($2000 per person-rem)
× present-value conversion factor (10.76 based on a 20-year period with a 7-percent discount rate).

As stated in NUREG/BR-0184 (NRC 1997b), it is important to note that the monetary value of the public-health risk after discounting does not represent the expected reduction in public-health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, the OPPD calculated an APE of approximately $218,000 for the 20-year license renewal period, which assumes the elimination of all severe accidents.

Averted Offsite Property Damage Costs

The averted offsite property damage costs (AOCs) were calculated using the following formula:

AOC = annual CDF reduction
× offsite economic costs associated with a severe accident (on a per-event basis)
× present-value conversion factor.

For the purposes of initial screening, which assumes all severe accidents are eliminated, the OPPD calculated an annual offsite economic risk of $15,427 based on the Level 3 risk analysis. This results in a discounted value of approximately $166,000 for the 20-year license renewal period.

Averted Occupational Exposure Costs

The averted occupational exposure (AOE) costs were calculated using the following formula:

AOE = annual CDF reduction
× occupational exposure per core damage event
× monetary equivalent of unit dose
× present-value conversion factor.

The OPPD derived the values for AOE from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997b). Best-estimate values provided for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents are eliminated, the OPPD calculated an AOE of approximately $9000.

Averted Onsite Costs

Averted onsite costs (AOSCs) include averted cleanup and decontamination costs and averted replacement-power costs (RPCs). Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. The OPPD derived the values for the AOSCs based on information provided in Section 5.7.6 of the regulatory analysis handbook (NRC 1997b).

The OPPD divided this cost element into two parts, the onsite cleanup and decontamination cost (also commonly referred to as averted cleanup and decontamination costs [ACCs]) and the RPC.

ACCs were calculated using the following formula:

ACC = annual CDF reduction
× present value of cleanup costs per core damage event
× present-value conversion factor.

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in the regulatory analysis handbook (NRC 1997b) to be 1.5×10^9 (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension.

Long-term RPCs were calculated using the following formula:

RPC = annual CDF reduction
× present value of replacement power for a single event
× factor to account for remaining service years for which replacement power is required
× reactor power scaling factor

Fort Calhoun Station, Unit 1 has a gross electrical rating of 478 MW(e), which is much lower than the reference rating in NUREG/BR-0184 (NRC 1997b). Thus, a reactor power scaling factor (478/910) of 0.53 was applied to the corresponding formula. For the purposes of initial screening, which assumes all severe accidents are eliminated, the OPPD calculated the AOSC to be approximately $391,000.

Using the above equations, the OPPD estimated the total present dollar-value equivalent associated with completely eliminating all severe accident risk at Fort Calhoun Station, Unit 1 to be $784,000.

The OPPD's Results

If the implementation costs of a SAMA were greater than the MAB of $784,000, then the SAMA was screened from further consideration. A more refined look at the costs and benefits was performed for the remaining SAMAs. If the expected cost for those SAMAs exceeded twice the calculated benefit, the SAMA was considered not to be cost-beneficial. The cost-benefit results for the individual analysis of the 20 SAMA candidates are presented in Table 5-5. As a result, the following six SAMAs were considered to be cost-beneficial:

- SAMA 92 – Conserve/make up borated-water storage tank inventory post-accident. This SAMA candidate would modify procedures to conserve or prolong the inventory in the borated-water storage tank (SIRWT) during SGTRs.

- SAMA 181 – Add accumulators or implement training on SIRWT bubblers and recirculation valves. This SAMA candidate would involve adding the capability to prevent an early RAS following the loss of instrument air by revising procedures to support operator actions to avert and/or recover from the premature RAS.

- SAMA 182 – Add capability for SG-level indication during an SBO. This SAMA candidate would use a portable 120-V ac generator with manual clamps to provide power supply to the SG-level instrumentation.

- SAMA 183 – Add a 480-V ac power supply to open the PORV. This SAMA candidate would use a portable power source, inverter, cables, and necessary guidance for use as a backup power supply for opening the PORVs during ISLOCAs and some SGTRs.

- SAMA 184 – Add capability to flash the field on the EDG to enhance SBO recovery. This SAMA candidate is intended to increase the capability to cope with an SBO event by using a power supply to flash the field (i.e., start an EDG if one or more EDGs fail to start or if an EDG fails and restart is required after battery depletion).

- SAMA 186 – Add manual steam-relief capability and associated procedures. This SAMA candidate involves performing specific procedural and/or hardware changes to give the plant the alternate capability to increase heat removal from the reactor coolant system (RCS) and accelerate RCS cooldown. Hardware changes may include nitrogen backup to open the main steam valves.

The OPPD performed sensitivity analyses to evaluate the impact of parameter choices on the analysis results (OPPD 2002). The sensitivity analyses included the calculation of candidate SAMA benefits using a 3-percent discount rate, as recommended in NUREG/BR-0184 (NRC 1997b). As a result, two additional SAMA candidates were determined to be potentially cost-beneficial:

- SAMA 4 – Implement procedure and operator-training enhancements to anticipate problems and cope with events that lead to loss of cooling to RCP seals

- SAMA 54 – Add independent power supply to charge batteries.

As stated in the ER (OPPD 2002), the OPPD plans to implement the first seven of the SAMAs listed above. The implementation of these SAMAs reduces the benefit of the last SAMA (SAMA 54) such that it is not cost-beneficial. The OPPD expects the SAMA implementations to be completed by the end of 2005.

5.2.6.2 Staff Evaluation

The cost-benefit analysis performed by the OPPD was based primarily on NUREG/BR-0184 (NRC 1997b) and was executed appropriately. The analysis included a 3-percent discount rate sensitivity study, as recommended in the regulatory analysis handbook (NRC 1997b), which led to the reconsideration of some SAMAs.

The OPPD's assessment of SAMAs (OPPD 2002) indicated that an upper-bound CDF for fires plus internal events (including the dominant seismic contributors) could be about a factor of 3 higher than the mean value. However, in the final screening and cost-benefit analysis, the

OPPD used a factor of 2 to account for the potential contribution to risk from external events. The staff questioned whether this factor of 2 might not be sufficiently conservative if other uncertainties (in addition to contributions from external events) are considered. In response to the RAIs, the OPPD provided the uncertainty range associated with the calculated CDF (see Table 5-6 below) and also reassessed the impact on results if a multiplication factor of 3 rather than 2 were used in the final screening (Ridenoure 2002). The OPPD found that four SAMAs (SAMAs 54, 185, 187, and 190) would become cost-beneficial using a factor of 3. However, a more detailed examination by the OPPD concluded that these SAMAs either would have little to no impact on fire risk or would continue to have a negative net value after implementation of the seven SAMAs identified in Section 5.2.6.1 of this SEIS (Ridenoure 2002). Accordingly, the initial conclusions are considered justifiable.

Table 5-6. Uncertainty in the Calculated CDF for Fort Calhoun Station, Unit 1

Percentile	CDF (per year)
Mean	2.52×10^{-5}
5th	1.22×10^{-5}
50th	1.97×10^{-5}
95th	4.68×10^{-5}

The staff concludes that, except for the seven SAMAs that were determined to be cost-beneficial, the costs of the candidate SAMAs assessed would be higher than the associated benefits. This conclusion is upheld despite a number of uncertainties and nonquantifiable factors in the calculations, which are summarized as follows:

- Uncertainty in the internal-events CDF was not explicitly included in the calculations, which employed best-estimate values to determine the benefits. The 95th percent confidence level for internal-events CDF is approximately 2 times the mean CDF. The results of the cost-benefit analysis show that all of the SAMAs evaluated (except the seven SAMAs that were determined to be cost-beneficial) would cost more than twice the associated benefit. However, since the OPPD's use of a factor of 2 in the SAMA screening was intended to account for external events, consideration of internal-event uncertainties could potentially increase that factor. The OPPD addressed the implications of an overall uncertainty factor of 3 and found that although the screening made several additional SAMA candidates worthy of further scrutiny, no new SAMAs were justified. Therefore, further consideration of internal-event uncertainty is not expected to alter the conclusions of the analysis.

- External events were similarly not explicitly included in the Fort Calhoun Station, Unit 1 risk profile. However, given that external events were accounted for by using a factor-of-2 increase in the benefits and the observation that there are no particular vulnerabilities in the

external-event risk profile at Fort Calhoun Station, Unit 1, any additional benefits that might accrue due to external events would be relatively small.

- Risk-reduction and cost estimates were generally found to be conservative. As such, uncertainty in the costs of any of the contemplated SAMAs would not likely have the effect of making them cost-beneficial.

- Sensitivity calculations were performed with respect to the discount rate (as low as 3 percent) and various MACCS2 parameters, including evacuation speed, meteorological data, and fission-product release. Using the 3-percent discount rate, two additional SAMA candidates, SAMAs 4 and 54, were introduced as cost-beneficial. SAMA 4 was added to the list of SAMA improvements, while SAMA 54 was dismissed on other sound technical grounds. The results of the MACCS2 parameter sensitivity studies showed that none of the risk benefits were increased by more than about 10 percent. Since this is less than the margin between cost and benefit for the SAMAs considered, the uncertainties in these parameters would not alter the conclusions.

5.2.7 Conclusions

The OPPD compiled a list of 190 SAMA candidates using the SAMA analyses, as submitted in support of licensing activities for other nuclear power plants; NRC and industry documents discussing potential plant improvements; and the plant-specific insights from the OPPD IPE, IPEEE, and current PRA model. A qualitative screening removed SAMA candidates that (1) had already been implemented at Fort Calhoun Station, Unit 1, (2) modified features not applicable to Fort Calhoun Station, Unit 1, (3) would involve major plant design and/or structural changes that would clearly be well in excess of the MAB, (4) would provide only minimal risk reduction, or (5) duplicated other SAMAs or could be consolidated with one or more other SAMAs being considered. A total of 170 SAMA candidates was eliminated based on the above criteria, leaving 20 SAMA candidates for further evaluation.

Using guidance in NUREG/BR-0184 (NRC 1997b), the current PRA model, and a Level 3 analysis developed specifically for SAMA evaluation, an MAB of about $784,000 was calculated, representing the total present-dollar-value equivalent associated with completely eliminating severe accidents at Fort Calhoun Station, Unit 1. Of the 20 SAMAs, 14 were screened from further evaluation because the implementation costs were greater than this MAB or exceeded twice the estimated benefit for that specific SAMA. The factor of 2 was used to account for uncertainties in the analysis and the potential impact of external events on the results of the SAMA evaluations. The end result was that six SAMA candidates were determined to be cost-beneficial. Upon completion of a 3-percent discount rate sensitivity study, one additional SAMA candidate was determined to be sufficiently cost-beneficial to be added to the list. The OPPD plans to implement these seven cost-beneficial SAMAs by 2005.

However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they are not required as part of license renewal pursuant to 10 CFR Part 54.

The staff reviewed the OPPD analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs; the generally large, negative net benefits; and the inherently small baseline risks support the general conclusion that the SAMA evaluations performed by the OPPD are reasonable and sufficient for the license renewal submittal. The unavailability of an external-event PRA model precluded a quantitative evaluation of SAMAs specifically aimed at reducing the risk of external-event initiators; however, significant improvements have been realized as a result of the IPEEE process at Fort Calhoun Station, Unit 1 that would minimize the likelihood of identifying cost-beneficial enhancements in this area.

Based on its review of the OPPD SAMA analyses, the staff concurs that, with the exception of the seven candidate SAMAs identified for implementation, none of the remaining candidate SAMAs are cost-beneficial. This is based on a conservative treatment of costs and benefits. This conclusion is consistent with the low residual level of risk indicated in the Fort Calhoun Station, Unit 1 PRA and the fact that Fort Calhoun Station, Unit 1 has already implemented plant improvements identified from the IPE and IPEEE process to reduce plant risk.

5.3 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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U.S. Nuclear Regulatory Commission (NRC). 1997a. *Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance*. NUREG-1560, Washington, D.C.

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6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid-Waste Management

Environmental issues associated with the uranium fuel cycle and solid-waste management are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) 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.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues that are related to the uranium fuel cycle and solid-waste management during the license renewal term and that are listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B and are applicable to Fort Calhoun Station. The generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, “Table of Uranium Fuel Cycle Environmental Data,” and in 10 CFR 51.52(c), Table S-4, “Environmental Impact of

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the “GEIS” include the GEIS and its Addendum 1.

Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor." The staff also addresses the impacts from radon-222 and technetium-99 in the GEIS.

6.1 The Uranium Fuel Cycle

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to Fort Calhoun Station from the uranium fuel cycle and solid-waste management are listed in Table 6-1.

Table 6-1. Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid-Waste Management During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and high level waste disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6; 6.6
Mixed waste storage and disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4; 6.6
On-site spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6; Addendum 1

The Omaha Public Power District (OPPD) stated in its Environmental Report (ER; OPPD 2002) that it is not aware of any new and significant information associated with the renewal of the Fort Calhoun Station operating license. The staff has not identified any significant new information during its independent review of the OPPD ER (OPPD 2002), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the impacts are SMALL except for the collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, as discussed below, and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of these issues follows:

- Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste. Based on information in the GEIS, the Commission found that

  > Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part [10 CFR 51.51(b)]. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (collective effects). Based on information in the GEIS, the Commission found that

  > The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem [148 person Sv], or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be

> mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits and even smaller fractions of natural background exposure to the same populations.
>
> Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA [National Environmental Policy Act] implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (spent fuel and high level waste). Based on information in the GEIS, the Commission found that

  > For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem [1 mSv] per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem [1 mSv] per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and

international bodies that the limits should be a fraction of the 100 millirem [1 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual dose limit is about 3×10^{-3}.

Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 [DOE 1980]. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a HLW repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM) repository.

Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for

any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and HLW disposal, this issue is considered Category 1.

Since the GEIS was originally issued in 1996, the U.S. Environmental Protection Agency (EPA) published radiation-protection standards for Yucca Mountain, Nevada, in 40 CFR Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada," on June 13, 2001 (66 FR 32132 [EPA 2001]). The Energy Policy Act of 1992 (42 USC 10101 et seq.) directs that the NRC adopt these standards into its regulations for reviewing and licensing the repository. The NRC published its regulations at 10 CFR Part 63 on November 2, 2001 (66 FR 55792 [NRC 2001]). These standards include the following: (1) 0.15-mSv/yr (15-mrem/yr) dose limit for members of the public during the storage period prior to repository closure; (2) 0.15-mSv/yr (15-mrem/yr) dose limit for the reasonably maximally exposed individual for 10,000 years following disposal; (3) 0.15-mSv/yr (15-mrem/yr) dose limit for the reasonably maximally exposed individual as a result of a human intrusion at or before 10,000 years after disposal; and (4) a groundwater-protection standard that states for 10,000 years of undisturbed performance after disposal, radioactivity in a representative volume of groundwater will not exceed (a) 0.0002 MBq/L (5 pCi/L) (radium-226 and radium-228), (b) 0.0006 Mbq/L (15 pCi/L) (gross alpha activity), and (c) 0.04 mSv/yr (4 mrem/yr) to the whole body or any organ (from combined beta- and photon-emitting radionuclides).

On February 15, 2002, subsequent to receipt of a recommendation by the Secretary Abraham, U.S. Department of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and HLW. The U.S. Congress approved this recommendation on July 9, 2002, in House Joint Resolution 87. On July 23, 2002, the President signed into law House Joint Resolution 87. This development does not represent new and significant information with respect to the offsite radiological impacts related to spent fuel and HLW disposal during the renewal term.

This change in regulatory status does not cause the staff to change its position with respect to the impact of spent fuel and HLW disposal. The staff still considers the Category 1 classification in the GEIS appropriate.

The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts related to spent fuel and HLW disposal during the renewal term beyond those discussed in the GEIS.

- Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS, the Commission found that

  > The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found that

  > The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found that

  > The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and

> the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of mixed-waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- On-site spent fuel. Based on information in the GEIS, the Commission found that

> The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

- Nonradiological waste. Based on information in the GEIS, the Commission found that

> No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.

The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

- Transportation. Based on information contained in the GEIS, the Commission found that

  > The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting HLW to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4 – Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in Sec. 51.52.

  Fort Calhoun Station meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

There are no Category 2 issues for the uranium fuel cycle and solid-waste management.

6.2 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy,* Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste."

40 CFR Part 197. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 197, "Public Health and Environmental Radiation Protection Standards for Management and Disposal for Yucca Mountain, Nevada."

Energy Policy Act of 1992. 42 USC 10101, et seq.

National Academy of Sciences (NAS). 1995. *Technical Bases for Yucca Mountain Standards*. Washington, D.C.

National Environmental Policy Act of 1969 (NEPA), as amended. 42 USC 4321, et seq.

Omaha Public Power District (OPPD). 2002. *Applicant's Environmental Report – Operating License Renewal Stage Fort Calhoun Station Unit 1*. Omaha, Nebraska.

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U.S. Environmental Protection Agency (EPA). 2001. "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada." *Federal Register*. Vol. 66, No. 114, pp. 32132–32135. June 13, 2001.

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U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001. "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada." *Federal Register*. Vol. 66, No. 213., pp. 55792–55815. November 2, 2001.

7.0 Environmental Impacts of Decommissioning

Environmental issues associated with decommissioning, which result from continued plant operation during the renewal term, are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) 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.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B that are applicable to Fort Calhoun Station, Unit 1 decommissioning following the renewal term are listed in Table 7-1. The Omaha Public Power District (OPPD) stated in its Environmental Report (ER; OPPD 2002) that it is aware of no new and significant information regarding the environmental impacts of Fort Calhoun Station, Unit 1 license renewal. The staff has not identified any significant new information during its independent review of the OPPD ER (OPPD 2002), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1

the GEIS. For all of these issues, the staff concluded in the GEIS that the impacts are SMALL and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of Fort Calhoun Station, Unit 1 Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation doses	7.3.1; 7.4
Waste management	7.3.2; 7.4
Air quality	7.3.3; 7.4
Water quality	7.3.4; 7.4
Ecological resources	7.3.5; 7.4
Socioeconomic impacts	7.3.7; 7.4

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found that

  > Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem [0.01 person-Sv] caused by buildup of long-lived radionuclides during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no radiation doses associated with decommissioning following license renewal beyond those discussed in the GEIS.

- Waste management. Based on information in the GEIS, the Commission found that

  > Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality. Based on information in the GEIS, the Commission found that

  > Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of license renewal on air quality during decommissioning beyond those discussed in the GEIS.

- Water quality. Based on information in the GEIS, the Commission found that

  > The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of the license renewal term on water quality during decommissioning beyond those discussed in the GEIS.

- Ecological resources. Based on information in the GEIS, the Commission found that

  > Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of the license renewal term on ecological resources during decommissioning beyond those discussed in the GEIS.

- Socioeconomic impacts. Based on information in the GEIS, the Commission found that

  > Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

  The staff has not identified any new and significant information during its independent review of the OPPD ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of license renewal on the socioeconomic impacts of decommissioning beyond those discussed in the GEIS.

7.1 References

10 Part CFR 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

Omaha Public Power District (OPPD). 2002. *Applicant's Environmental Report – Operating License Renewal Stage Fort Calhoun Station Unit 1*. Omaha, Nebraska.

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

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

8.0 Environmental Impacts of Alternatives to Operating-License Renewal

This chapter examines the potential environmental impacts associated with denying the renewal of the operating license (OL) (i.e., the no-action alternative), the potential environmental impacts from electricity-generating sources other than Fort Calhoun Station, Unit 1, the possibility of purchasing electric power from other sources to replace power generated by Fort Calhoun Station, Unit 1 and the associated environmental impacts, the potential environmental impacts from a combination of generating and conservation measures, and other generation alternatives that were deemed unsuitable for replacement of the power generated by Fort Calhoun Station, Unit 1. The environmental impacts are evaluated using the U.S. Nuclear Regulatory Commission's (NRC's) three-level standard of significance—SMALL, MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines and set forth in a footnote to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

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

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

The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999),[(a)] with the additional impact category of environmental justice.

8.1 No-Action Alternative

The NRC's regulations implementing the National Environmental Policy Act (NEPA) specify that the no-action alternative be discussed in an NRC environmental impact statement (EIS) (10 CFR Part 51, Subpart A, Appendix A(4)). For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the Fort Calhoun Station, Unit 1 OL, and the Omaha Public Power District (OPPD) would then decommission Fort Calhoun Station,

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Unit 1 when plant operations cease. Replacement of Fort Calhoun Station, Unit 1 electricity-generating capacity would be met by (1) demand-side management (DSM) and energy conservation, (2) power purchased from other electricity providers, (3) generating alternatives other than Fort Calhoun Station, Unit 1, or (4) some combination of these options. The OPPD will be required to comply with NRC decommissioning requirements whether or not the OL is renewed. If the Fort Calhoun Station, Unit 1 OL is renewed, decommissioning activities may be postponed for up to an additional 20 years. If the OL is not renewed, the OPPD would conduct decommissioning activities according to the requirements in 10 CFR 50.82.

The environmental impacts associated with decommissioning under both license renewal and the no-action alternative would be bounded by the discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this supplemental environmental impact statement (SEIS), and the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, *Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors,* NUREG-0586, dated November 2002. The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those occurring after 40 years of operation.

The environmental impacts for the socioeconomic, historic-and-archaeological-resources, and environmental-justice impact categories are summarized in Table 8-1 and are discussed in the following paragraphs.

Table 8-1. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Socioeconomic	SMALL TO MODERATE	SMALL, if growth projections for the Omaha Metropolitan Statistical Area materialize. MODERATE, if not offset by normal growth. In lieu tax payments would continue.
Historic and Archaeological Resources	SMALL	Disturbance of the Fort Calhoun site due to decommissioning will likely be confined to the site operational area and impacts on cultural, historic, and archaeological resources would not be considered detectable or destabilizing. Significant ground disturbance outside the site operational area would require consultation with the State Historic Preservation Office (SHPO).
Environmental Justice	SMALL	Very few minority/low-income persons live in the immediate vicinity of Fort Calhoun Station. Economic offset due to the general size and availability of other employment opportunities in the region.

- Socioeconomic. When Fort Calhoun Station, Unit 1 ceases operation, there will be a decrease in employment associated with the closure. These impacts would be most concentrated in Washington County, with smaller impacts in Douglas and Sarpy counties and much smaller impacts in other counties. Most secondary employment impacts and impacts on population would also be concentrated in Washington, Douglas, and Sarpy counties. Approximately 86 percent of the employees who work at Fort Calhoun Station, Unit 1 live in Washington, Douglas, or Sarpy counties, and the remainder live in other locations (OPPD 2002). The extent of impacts on the Omaha Metropolitan Statistical Area (MSA) will depend to some degree on the extent to which economic and population growth projected for the Omaha MSA materializes (Bureau of Business Research 1999).

  The OPPD is considered a political subdivision responsible for the production and distribution of electricity within its 13-county service area (OPPD 2002). The OPPD is exempt from paying State-occupational, personal-property, and real-estate taxes. Instead, the OPPD makes six payments in lieu of taxes each year to the municipalities and 12 Nebraska counties in which the OPPD sold power in 1957. In addition, each county receives 5 percent of the total gross revenues the OPPD receives from electricity sales within the county, irrespective of whether the power is purchased from another generator or produced at OPPD power plants. The counties and municipalities then distribute the money to the appropriate cities, school districts, and agencies. Closure of Fort Calhoun Station, Unit 1 will not have an impact on these payments.

  Most of the revenue losses that would result from the closure of Fort Calhoun Station, Unit 1 would occur as a result of the loss of the plant payroll. The no-action alternative may result in the loss of plant payrolls 20 years earlier than if the OL were renewed.

  There would be some adverse impacts on local housing values; the local economy in Omaha MSA; and employment in Washington, Douglas, and Sarpy counties if Fort Calhoun Station, Unit 1 were to cease operations. Other employers may be able to absorb the OPPD staff, but it is unlikely that these employers will be able to pay the same average salary.

  OPPD employees working at Fort Calhoun Station, Unit 1 currently contribute time and money toward community involvement, including schools, churches, charities, and other civic activities. It is likely that with a reduced presence in the community following permanent cessation of operations, the OPPD's community-involvement efforts in the region would be reduced.

  If normal economic growth continues in Washington, Douglas, and Sarpy counties, the socioeconomic consequences of nonrenewal of the OL could be partially or entirely offset by the new jobs created by such growth. What is not known is the types of jobs, pay scales,

and locations of the future employment increases. If some of the new jobs are skilled, higher-paying jobs, then the impacts of nonrenewal of the Fort Calhoun Station, Unit 1 OL could be significantly mitigated, and the socioeconomic consequence of closure would be SMALL. If not offset by normal growth, impacts would be MODERATE.

- Historic and Archaeological Resources. The potential for adverse impacts to archaeological and cultural resources at Fort Calhoun Station during site decommissioning will likely not be detectable or destabilizing. The staff has determined (NRC 2002) that activities that result in ground disturbances occurring during decommissioning and within the site operational area would result in a SMALL impact to historic and archaeological resources. The operational area is defined as that portion of the plant site where most or all of the site activities occur, such as reactor operations, materials and equipment storage, parking, substation operations, and facility service and maintenance. This includes all areas within the protected-area fence, the intake and discharge structures, the cooling system, and other site structures, as well as associated paved, graveled, and maintained landscaped areas.

  If ground disturbance beyond the Fort Calhoun operational area is planned for decommissioning, the impacts may or may not be detectable or destabilizing, depending on site-specific factors and the licensee's plans for decommissioning. Before the licensee conducts any decommissioning activities that might result in the disturbance of historic or archaeological resources outside the site operational area, consultation with the appropriate SHPO to evaluate potential impacts will occur. Following license termination it is expected that OPPD or the successive owners of the Fort Calhoun site will comply with the requirements of the National Historic Preservation Act of 1966 as amended (16 USC 470 et seq.) thereby minimizing the impacts to site historic and archaeological resources. Therefore, the overall impact of the no-action alternative on historic and archaeological resources is considered SMALL.

- Environmental Justice. Current operations at Fort Calhoun Station, Unit 1 have no disproportionate impacts on the minority and low-income populations of the surrounding counties, and no environmental pathways have been identified that would cause disproportionate impacts. Closure of Fort Calhoun Station, Unit 1 would result in decreased employment opportunities and possible negative and disproportionate impacts on minority and low-income populations. Because Fort Calhoun Station is located in a relatively high-population area with extensive employment opportunities, these effects are likely to be offset by projected growth in the local economy so that the impacts of closure on minority and low-income populations would be mitigated, regardless of whether the created jobs are low- or high-paying jobs. The environmental-justice impacts under the no-action alternative are considered SMALL.

Impacts for all other impact categories would be SMALL, as shown in Table 9-1. In some cases, impacts associated with the no-action alternative would be positive. For example, closure of Fort Calhoun Station would eliminate any impingement and entrainment of fish and shellfish and would also eliminate any negative impacts resulting from thermal discharges.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with alternative sources of electric power to replace the power generated by Fort Calhoun Station, Unit 1, assuming that the OL for Unit 1 is not renewed. The order of presentation of alternative energy sources in Section 8.2 does not imply which alternative would be most likely to occur or to have the least environmental impacts. The following generation alternatives are considered in detail:

- coal-fired generation at Fort Calhoun Station and at an alternate site (Section 8.2.1)
- natural-gas-fired generation at Fort Calhoun Station and at an alternate site (Section 8.2.2)
- nuclear generation at Fort Calhoun Station and at an alternate site (Section 8.2.3)

The alternative of purchasing power from other sources to replace power generated at Fort Calhoun Station, Unit 1 is discussed in Section 8.2.4. Other power-generation alternatives and conservation alternatives considered by the staff and found not to be reasonable replacements for Fort Calhoun Station, Unit 1 are discussed in Section 8.2.5. Section 8.2.6 discusses the environmental impacts of a combination of generation and conservation alternatives.

Coal- and natural-gas-fired generation at greenfield sites are not considered, as the applicant has identified existing sites for coal-fired (Nebraska City site) and natural-gas-fired (Cass County site) generation. Development of generation capacity at the greenfield sites would have greater impacts than developing these existing sites. Therefore, the staff did not discuss the environmental impacts at greenfield sites for coal or natural gas alternatives. However, for nuclear generation, the alternative was a greenfield site.

Each year, the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an Annual Energy Outlook. The *Annual Energy Outlook 2002 with Projections to 2020* was issued in December 2001 (DOE/EIA 2001a). In this report, the EIA projects that combined-cycle[(a)] or combustion-turbine technology fueled by natural gas is likely

(a) 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 boiler to make steam to generate additional electricity.

to account for approximately 88 percent of new electricity-generating capacity through the year 2020 (DOE/EIA 2001a). Both technologies are designed primarily to supply peak and intermediate capacity, but combined-cycle technology can also be used to meet base-load[(a)] requirements. Coal-fired plants are projected by the EIA to account for approximately 9 percent of new capacity during this period. Coal-fired plants are generally used to meet base-load requirements. Renewable energy sources, primarily wind, geothermal, and municipal solid-waste units, are projected by the EIA to account for the remaining 3 percent of capacity additions. The EIA's projections are based on the assumption that providers of new generating capacity will seek to minimize cost while meeting applicable environmental requirements. Combined-cycle plants are projected by the EIA to have the lowest generation cost in 2005 and 2020, followed by coal-fired plants and then wind generation (DOE/EIA 2001a).

The EIA projects that oil-fired plants will account for very little new generation capacity in the United States through the year 2020 because of higher fuel costs and lower efficiencies (DOE/EIA 2001a). However, oil as a backup fuel to natural-gas-fired generation (combined cycle) is considered.

The EIA also projects that new nuclear power plants will not account for any new generation capacity in the United States through the year 2020 because natural-gas- and coal-fired plants are projected to be more economical (DOE/EIA 2001a). However, there has been an increased interest in constructing new nuclear power facilities, as evidenced by the recent certification of three standard nuclear power plant designs and the recent activities involving the review of other plant designs and potential sites. Therefore, despite the EIA projection, a new nuclear plant alternative for replacing power generated by the OPPD is considered in this SEIS.

8.2.1 Coal-Fired Generation

The coal-fired alternative is analyzed for Fort Calhoun Station and an alternate site in Nebraska City, Nebraska. The Nebraska City site consists of 642 ha (1587 ac) on river bottomlands bordering the Missouri River in rural Otoe County, Nebraska, approximately 8 km (5 mi) southeast of Nebraska City, Nebraska. The western boundary of the site borders a dedicated rail line. A major 345-kV transmission north-south intertie and a 161-kV transmission line connect through the Nebraska City substation. The OPPD estimates that approximately 121 km (75 mi) of new transmission line may be required.

(a) A base-load plant normally operates to supply all or part of the minimum continuous load of a system and consequently produces electricity at an essentially constant rate. Nuclear power plants are commonly used for base-load generation; that is, these units generally run near full load.

Although the NRC pointed out that siting a new coal-fired plant where an existing nuclear plant is located would reduce many construction impacts (NRC 1996), the OPPD has already licensed and built a coal plant at its Nebraska City location. The site was originally planned as a multiunit coal site.

The staff assumes construction of one standard 500-MW(e) unit[a] as a potential replacement for Fort Calhoun Station, Unit 1, which is consistent with the OPPD's ER (OPPD 2002). Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.1 are from the OPPD ER (OPPD 2002). The staff reviewed this information and compared it to environmental-impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the coal-fired alternative for 40 years is considered (as a reasonable projection of the operating life of a coal-fired plant).

The coal-fired plant would consume approximately 1,900,000 MT (2,061,000 tons) per year of pulverized subbituminous coal with an ash content of approximately 6 percent (OPPD 2002). The OPPD assumes a heat rate[b] of 10,000 Btu/kWh and a capacity factor[c] of 0.8 in its ER (OPPD 2002). After combustion, approximately 66,600 MT (74,000 tons) would be collected and disposed of at the plant site; the remaining ash would be recycled. In addition, approximately 32,500 MT (36,000 tons) of scrubber sludge would be disposed of at the plant site.

For purposes of this SEIS, the staff assumed a coal-fired plant could use either a closed-cycle or a once-through cooling system, which are discussed in the following sections.

8.2.1.1 Once-Through Cooling System

The overall impacts of the coal-fired generating system using a once-through cooling system are discussed in this section and are summarized in Table 8-2.

(a) The coal-fired units would have a rating of 500 gross MW and 475 net MW. The difference between "gross" and "net" is the electricity consumed onsite.
(b) Heat rate is a measure of generating station thermal efficiency. It is generally expressed in British thermal units (Btu) per net kilowatt-hour (kWh). It is computed by dividing the total Btu content of fuel burned for electricity generation by the resulting net kWh generation.
(c) The capacity factor is the ratio of electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.

Table 8-2. Summary of Environmental Impacts of Coal-Fired Generation at Fort Calhoun Station and an alternate site (the Nebraska City Site) Using Once-Through Cooling

	Fort Calhoun Station		Nebraska City Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to LARGE	Use of 127 ha (313 ac) for power block, reconfiguration of land, and waste disposal. Additional impact if the land cannot accommodate an ash-scrubber sludge landfill.	SMALL to MODERATE	Use of 46 ha (114 ac) additional land at existing site for plant infrastructure and waste disposal. Use of 370 ha (910 ac) for offsite transmission lines. Additional land impacts for coal and limestone mining.
Ecology	SMALL	Uses undeveloped but low-quality habitats at Fort Calhoun Station. Additional 127 ha (313 ac) needed for new facilities.	SMALL to MODERATE	Uses undeveloped but low-quality habitats at current Nebraska City site. Uses 370 ha (910 ac) for offsite transmission lines. Terrestrial impacts may be SMALL to MODERATE, depending on the location of the new transmission lines.
		Uses a once-through cooling system already in place. Based on past studies, the aquatic impacts of this system are considered SMALL.		Uses a once-through cooling system. Similar impacts as Fort Calhoun Station. Impacts considered SMALL.
Water Use and Quality (Surface Water)	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Increased water withdrawal could lead to possible water-use conflicts. Thermal load would be higher than with closed-cycle cooling.
Water Use and Quality (Groundwater)	SMALL to MODERATE	Waste disposal (e.g., sewage treatment lagoons) could potentially leach to groundwater.	SMALL to MODERATE	Waste disposal (e.g., sewage treatment lagoons) could potentially leach to groundwater.

Table 8-2 (contd)

Impact Category	Fort Calhoun Station		Nebraska City Site	
	Impact	**Comments**	**Impact**	**Comments**
Air Quality	MODERATE	Sulfur oxides • 1100 MT/yr (1200 tons/yr) Nitrogen oxides • 390 MT/yr (430 tons/yr) Particulates • 56 MT/yr (62 tons/yr) Carbon monoxide • 470 MT/yr (520 tons/yr) Small amounts of mercury and other hazardous air pollutants, as well as naturally occurring radioactive materials (mainly uranium and thorium).	MODERATE	Same impacts as at Fort Calhoun Station.
Waste	MODERATE	Coal combustion generates waste in the form of ash, and the equipment for controlling air pollution generates additional ash and scrubber sludge.	MODERATE	Same impacts as at Fort Calhoun Station.
Human Health	SMALL	Impacts are uncertain but are considered SMALL in the absence of more quantitative data.	SMALL	Same impacts as at Fort Calhoun Station.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 1200 additional workers during the peak of the 5-year construction period at the alternate site. The Fort Calhoun Station workforce would drop to 0 after decommissioning. Impacts during operation would be SMALL to MODERATE. Employee local tax and wage contributions would decrease because of the smaller workforce, which would decrease from 772 operating staff to 250.	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 1200 additional workers during the peak of the 5-year construction period at the alternate site. The Fort Calhoun Station workforce would drop to 0 after decommissioning. Impacts during operation would be SMALL to MODERATE. Employee local tax and wage contributions would increase because of the larger workforce, which would increase by 15 operating staff.

Table 8-2 (contd)

Impact Category	Fort Calhoun Station		Nebraska City Site	
	Impact	**Comments**	**Impact**	**Comments**
	SMALL to MODERATE	Transportation impacts during operation would be SMALL. Transportation impacts associated with construction workers could be SMALL to MODERATE.	SMALL to MODERATE	Transportation impacts during operation would be SMALL. Transportation impacts associated with construction workers could be SMALL to MODERATE.
	MODERATE to LARGE	For rail transportation of coal and lime/limestone, the impact is considered MODERATE to LARGE.	SMALL to MODERATE	For rail transportation of coal and lime/limestone, the impact is considered SMALL to MODERATE due to an existing coal plant at the site.
Aesthetics	SMALL to MODERATE	Development would consume large areas that are currently used for agriculture. Infrastructure would be clearly visible, but the aesthetic impacts would be similar to the current Fort Calhoun Station, Unit 1.	SMALL	Impact would be SMALL due to existing land use in the region.
Historic and Archaeological Resources	SMALL	Some construction would affect previously disturbed or lightly disturbed parts of Fort Calhoun Station; cultural-resources studies would likely be needed to identify, evaluate, and address the mitigation of potential impacts of new plant construction on lands at the existing site and offsite corridors, as necessary.	SMALL	Some construction would affect previously disturbed or lightly disturbed parts of the Nebraska City site; cultural-resources studies would likely be needed to identify, evaluate, and address the mitigation of potential impacts of new plant construction on lands at the existing site and offsite corridors, as necessary.

Table 8-2 (contd)

Impact Category	Fort Calhoun Station		Nebraska City Site	
	Impact	Comments	Impact	Comments
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of about 522 operating jobs at Fort Calhoun Station could slightly reduce employment prospects for minority and low-income populations in Washington, Douglas, and Sarpy counties and could be offset by projected economic growth and the ability of affected workers to commute to other jobs.	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of about 772 operating jobs at Fort Calhoun Station could slightly reduce employment prospects for minority and low-income populations in Washington, Douglas, and Sarpy counties and could be offset by projected economic growth and the ability of affected workers to commute to other jobs.

- **Land Use**

  The coal-fired generation alternative identified by the OPPD for analysis would be located at its existing Nebraska City site. The Nebraska City site was located and planned as a multi-unit base load generating facility, and the infrastructure for coal delivery, storage and handling, storm-water management, ash handling and disposal, plant access, and administrative support for multiple units is currently in place on 642 ha (1587 ac). The NRC estimates that developing the representative coal-fired alternative at the Nebraska City site would require approximately 10 ha (25 ac) for the power block and related support facilities. Onsite disposal of ash and flue-gas desulfurization waste would require an estimated 36 ha (90 ac) of the site, which is currently active cropland. Most of the onsite acreage that this alternative would affect is currently farmed; however, these changes would be consistent with the planned incremental development of the site. The OPPD expects that an additional 121 km (75 mi) of 345-kV transmission lines with 30-m-wide (100-ft-wide) right-of-way would result in use of 370 ha (910 ac) for offsite transmission lines. The predominant land use in the area is agriculture, which would be the most affected, but agricultural land use could continue in areas unoccupied by tower footings. Depending on the location of the transmission lines, this alternative would result in SMALL to MODERATE land-use impacts.

No offsite development (e.g., for transmission lines) would likely be needed for the development of a coal-fired plant at Fort Calhoun Station. However, the OPPD estimates that in addition to the 10 ha (25 ac) required for the power block, a minimum of 81 ha (200 ac) would be needed to reconfigure the existing rail spur and construct the necessary facility for coal, limestone, and ash storage and handling. An additional 36 ha (90 ac) is estimated to be required for waste disposal, and although potentially developable land is available at Fort Calhoun Station, additional acreage may be acquired to efficiently configure the plant. Land disturbance of currently cultivated crops or natural vegetation at Fort Calhoun Station may be necessary to recontour the site to ensure the protection of the ash-scrubber sludge landfill from flood flows. Depending on the amount of onsite land disturbance, this alternative would result in SMALL to MODERATE land-use impacts. If the land could not accommodate the ash-scrubber sludge landfill, the waste would have to be disposed of elsewhere, resulting in a possible LARGE land-use impact.

Additional land-use changes would occur offsite in an undetermined coal-mining area to supply coal for the plant. In the GEIS, the staff estimated that approximately 8900 ha (22,000 ac) would be affected for mining coal and disposing waste to support a coal plant during its operation life (NRC 1996). This offsite land use would be partially offset by eliminating the need for uranium mining to supply fuel for Fort Calhoun Station, Unit 1. In the GEIS, the staff estimated that approximately 400 ha (1000 ac) would be affected by mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant.

- **Ecology**

The development of a coal-fired plant using a once-through cooling system at the existing Nebraska City site would alter ecological resources because of the need to convert about 46 ha (114 ac) of marginal onsite terrestrial habitat to industrial use (plant, coal storage, ash and scrubber-sludge disposal). Approximately 120 km (75 mi) of new transmission line may be required. Assuming a 30-m-wide (100-ft-wide) right-of-way, the transmission line would result in disturbance to about 370 ha (910 ac) of land. The magnitude of impacts would depend on the types of habitats crossed; a routing study would be used to avoid high-value habitat. Based on current land-use patterns, the transmission line would most likely cross agricultural land.

Construction and overall operational activities of the plant may result in some disturbance to water quality and to the habitats of aquatic species (e.g., erosion of sediments and/or contaminant spills) in the local and downstream vicinity of the plant. A once-through cooling system would have similar impacts on the aquatic ecology as those noted for Fort Calhoun Station. The magnitude of impacts on the species (i.e., impingement, entrainment, and heat shock) should be SMALL given a similar operational system, permits, and

environmental context. Overall aquatic impacts may involve habitat loss and/or fragmentation; changes to aquatic species' diversity, composition, and abundance; and the mortality of juveniles and early life stages of aquatic species.

Siting a coal-fired plant at the existing Nebraska City site would have a SMALL to MODERATE ecological impact, depending on the location of the new transmission lines.

A coal-fired plant could be located at Fort Calhoun Station. Although additional transmission lines would not be required if Fort Calhoun Station were used, an estimated 127 ha (313 ac) would be needed on the site for development of a coal-fired plant including new coal and limestone delivery, storage, and handling facilities, which would not be required for a new plant at the Nebraska City site. In addition, the limited additional acreage at Fort Calhoun Station could necessitate the acquisition of land to achieve an appropriate plant configuration. Terrestrial habitat potentially affected by the construction of a coal-fired plant at Fort Calhoun Station is mostly agricultural land and areas maintained as part of current site operations, which are of marginal ecological value. Regrading the site to ensure protection from flood flows could eliminate as much as 16 ha (40 ac) of additional habitat.

Construction and operational activities for developing a coal-fired plant at Fort Calhoun Station may result in impacts to aquatic habitats and their species through the erosion of sediments and/or the introduction of other contaminants into the water. These potential impacts should be limited through the appropriate use of National Pollutant Discharge Elimination System (NPDES) permits, pollution-prevention plans, and related regulatory requirements. Also, the use of an existing intake and discharge system, to which the area aquatic communities have become acclimated, would limit operational impacts. Therefore, siting a coal-fired plant using once-through cooling at Fort Calhoun Station would have a SMALL ecological impact.

- **Water Use and Quality**

The coal-fired generation alternative at Fort Calhoun Station is assumed to use the existing once-through cooling system, which would minimize incremental surface water use and quality impacts. Surface water impacts are expected to remain SMALL; the impacts would be sufficiently minor so that they would not noticeably alter any important attribute of the resource.

The Nebraska City site is assumed to use a once-through cooling system with intake from the Missouri River. The impact on the surface water would depend on the volume of water

needed for cooling, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the Nebraska Department of Environmental Quality (NDEQ). The impacts would be SMALL to MODERATE.

No groundwater is currently used for the cooling operation at Fort Calhoun Station, Unit 1. Groundwater is occasionally used for volume adjustment in sewage treatment lagoons. The use of groundwater at the Nebraska City site is also a possibility. Increased water withdrawal could lead to possible water-use conflicts; however groundwater withdrawal would require a permit from the appropriate permitting authority. The impacts of withdrawal for the coal-fired plant on the aquifer would be dependent on aquifer recharge and other withdrawals. Minimal leaching of wastes from sewage treatment lagoons to groundwater is possible for both Fort Calhoun Station and the Nebraska City site, but the leaching would not be large enough to have a major impact on the resource. The impacts on the groundwater for both Fort Calhoun Station and the Nebraska City site would be SMALL to MODERATE.

- **Air Quality**

  The air-quality impacts of coal-fired generation vary considerably from those of nuclear generation due to emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide, hazardous air pollutants such as mercury, and naturally occurring radioactive materials.

  A new coal-fired generating plant would likely need a prevention-of-significant-deterioration permit and an operating permit under the Clean Air Act (CAA). The plant would need to comply with the new source-performance standards for such plants set forth in 40 CFR Part 60 Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42a), SO_2 (40 CFR 60.43a), and NO_x (40 CFR 60.44a).

  Fort Calhoun Station is located within the Nebraska Intrastate Air Quality Control Region (AQCR). In addition, portions of the Metropolitan Omaha–Council Bluffs Interstate AQCR, the Metropolitan Sioux City Interstate AQCR, the Lincoln–Beatrice–Fairbury Intrastate AQCR, and the Southwest Iowa Intrastate AQCR are found within 80 km (50 mi) of Fort Calhoun Station. Portions of the Nebraska Intrastate AQCR, the Metropolitan Omaha–Council Bluffs Interstate AQCR, the Southwest Iowa Intrastate AQCR, the Northern Missouri Intrastate AQCR, and the Northeast Kansas Intrastate AQCR are found within 80 km (50 mi) of the Nebraska City site. The air quality in these regions is designated in

40 CFR 81.316, 40 CFR 81.317, 40 CFR 81.326, and 40 CFR 81.328 as better than national standards, in attainment, or unclassified for all criteria pollutants.[(a)]

The U.S. Environmental Protection Agency (EPA) has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for the review of any new major stationary source in an area designated as attainment or unclassified under the CAA. Section 169A of the CAA (42 USC 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory class I Federal areas when impairment results from man-made air pollution. In addition, the EPA issued a new regional haze rule in 1999 (64 FR 35714 [EPA 1999]). The rule specifies that for each mandatory class I Federal area located within a State, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a new coal-fired power station were located close to a mandatory class I area, additional air-pollution-control requirements could be imposed. However, there are no mandatory class I Federal areas in which visibility is an important value designated in 40 CFR Part 81 within 160 km (100 mi) of either the Fort Calhoun Station or the Nebraska City site.

Impacts for particular pollutants are as follows:

Sulfur oxides. The OPPD states in its ER that an alternative coal-fired plant would use wet-scrubber technology using lime/limestone for flue-gas desulfurization (OPPD 2002). A new coal-fired power plant would be subject to the requirements in Title IV of the CAA. Title IV was enacted to reduce emissions of SO_2 and NO_x, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power-plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. The EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances, but they are required to have allowances to cover their SO_2 emissions. Owners of new units must, therefore, reduce SO_2 emissions at other power plants that they own or purchase allowances from owners of other power plants. Allowances can be banked for use in future years. Thus, a new coal-fired power plant would not add to net regional SO_2 emissions, although it might do so locally. Regardless, SO_2 emissions would be greater for the coal alternative than the OL renewal alternative.

(a) Existing criteria pollutants under the CAA are ozone, carbon monoxide, particulates, sulfur dioxide, lead, and nitrogen oxides. Emission standards for criteria pollutants are specified in 40 CFR Part 50.

The OPPD estimates that by using the best technology to minimize SO_x emissions, the total annual stack emissions would be approximately 1100 MT (1200 tons) of SO_x (OPPD 2002). In addition, the OPPD ER states that recent integrated-resource-planning studies indicate that the OPPD would be required to purchase additional SO_2 allowances or achieve SO_2 emission reductions by other means, which could include additional SO_2 emission controls beyond those mandated in the New Source Performance Standards in 40 CFR Part 60, Subpart Da.

Nitrogen oxides. Section 407 of the CAA establishes technology-based emission limitations for NO_x emissions. The market-based allowance system used for SO_2 emissions is not used for NO_x emissions. A new coal-fired power plant would be subject to the new source-performance standards for such plants at 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (63 FR 49453 [EPA 1998]), limits the discharge of any gases that contain nitrogen oxides (expressed as NO_2) in excess of 200 ng/J of gross energy output (1.6 lb/MWh), based on a 30-day rolling average.

The OPPD estimates that by using NO_x burners with overfire air and selective catalytic reduction, the total annual NO_x emissions for a new coal-fired power plant would be approximately 390 MT (430 tons) (OPPD 2002). This level of NO_x emissions would be greater than the OL renewal alternative.

Particulates. The OPPD estimates that the total annual stack emissions would include 56 MT (62 tons) of filterable total suspended particulates (particulates that range in size from less than 0.1 micrometer [μm] up to approximately 45 μm). The 56 MT (62 tons) would include 13 MT (14 tons) of particulate matter having an aerodynamic diameter less than or equal to 10 μm (PM_{10}). Fabric filters would be used for control (OPPD 2002). In addition, coal-handling equipment would introduce fugitive particulate emissions. Particulate emissions would be greater under the coal alternative than the OL renewal alternative.

During the construction of a coal-fired plant, fugitive dust would be generated. In addition, exhaust emissions would come from vehicles and motorized equipment used during the construction process.

Carbon monoxide. The OPPD estimates that the total carbon monoxide emissions would be approximately 470 MT (520 tons) per year (OPPD 2002). This level of emissions is greater than the OL renewal alternative.

Hazardous air pollutants, including mercury. In December 2000, the EPA issued a regulatory finding on the emissions of hazardous air pollutants from electric utility steam-generating units (65 FR 79825 [EPA 2000b]). The EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants. Coal-fired power plants were found by the EPA to emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (65 FR 79825 [EPA 2000b]). The EPA concluded that mercury is the hazardous air pollutant of greatest concern. The EPA found that (1) there is a link between coal consumption and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures resulting from the consumption of contaminated fish (65 FR 79825 [EPA 2000b]). Accordingly, the EPA added coal- and oil-fired electric utility steam-generating units to the list of source categories under Section 112(c) of the CAA for which emission standards for hazardous air pollutants will be issued (65 FR 79825 [EPA 2000b]).

Uranium and thorium. Coal contains uranium and thorium. Uranium concentrations are generally in the range of 1 to 10 parts per million. Thorium concentrations are generally about 2.5 times greater than uranium concentrations (Gabbard 1993). One estimate is that a typical coal-fired plant released roughly 4.7 MT (5.2 tons) of uranium and 11.6 MT (12.8 tons) of thorium in 1982 (Gabbard 1993). The population dose equivalent from the uranium and thorium releases and daughter products produced by the decay of these isotopes has been calculated to be significantly higher than that from nuclear power plants (Gabbard 1993).

Carbon dioxide. A coal-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

Summary. The GEIS analysis did not quantify emissions from coal-fired power plants, but the analysis implied that air impacts would be substantial. The GEIS also mentioned global warming from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). Adverse human-health effects such as cancer and emphysema have been associated with the products of coal combustion. The appropriate characterization of air impacts from coal-fired generation would be MODERATE. The impacts would be clearly noticeable, but they would not destabilize air quality.

- **Waste**

  In addition to construction-related debris, coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash and scrubber sludge. During the operating life of the coal-fired plant, this waste would be disposed onsite by spreading the waste across a significant land-surface area. Waste impacts to groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste-storage area were to occur. Disposal of the waste could noticeably affect land use and groundwater quality; however, with appropriate management and monitoring, the waste disposal would not destabilize any resources. The land used for a waste site could eventually be available for other uses once the waste site had been closed and revegetation had occurred.

  In May 2000, the EPA issued a "Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels" (65 FR 32214 [EPA 2000a]). The EPA concluded that some form of national regulation is warranted to address coal-combustion waste products because (1) the composition of these wastes could present danger to human health and the environment under certain conditions; (2) the EPA has identified 11 documented cases of proven damages to human health and the environment by improper management of these wastes in landfills and surface impoundments; (3) present disposal practices are such that in 1995, these wastes were being managed in 40 to 70 percent of landfills and surface impoundments without reasonable controls in place, particularly in the area of groundwater monitoring; and (4) the EPA identified gaps in the State oversight of coal-combustion wastes. Accordingly, the EPA announced its intention to issue regulations for the disposal of coal-combustion waste under Subtitle D of the Resource Conservation and Recovery Act.

  For all of the preceding reasons, the appropriate characterization of impacts from waste generated from burning coal is MODERATE; the impacts would be clearly noticeable, but they would not destabilize any important resource.

Siting the facility at a site other than Fort Calhoun Station would not alter the waste generated. Therefore, for both the Nebraska City site and the Fort Calhoun Station, Unit 1 site, the impacts would be MODERATE.

- **Human Health**

  Coal-fired power generation introduces worker risks from coal and limestone mining, worker and public risks from coal and lime/limestone transportation, worker and public risks from disposal of coal-combustion wastes, and public risks from the inhalation of stack emissions. Emission impacts can be widespread, and health risks can be difficult to quantify. The coal alternative also introduces the risk of coal-pile fires and attendant inhalation risks.

  The staff stated in the GEIS that there could be human-health impacts (cancer and emphysema) from the inhalation of toxins and particulates from coal-fired plants, but the staff did not identify the significance of these impacts (NRC 1996). In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear-power-plant operations (Gabbard 1993).

  Regulatory agencies, including the EPA and State agencies, set air-emission standards and requirements based on human-health impacts. These agencies also impose site-specific emission limits as needed to protect human health. The EPA has recently concluded that certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures from sources such as coal-fired power plants. However, in the absence of more quantitative data, human-health impacts from radiological doses and inhaling toxins and particulates generated by burning coal are characterized as SMALL for either the Fort Calhoun Station or the Nebraska City site.

- **Socioeconomics**

  Construction of the coal-fired alternative would take approximately 5 years. The staff assumed that construction would take place while Fort Calhoun Station, Unit 1 continues operation and would be completed by the time Fort Calhoun Station, Unit 1 permanently ceases operations. The workforce would be expected to vary between 450 and 1200 workers during the 5-year construction period (NRC 1996). These workers would be in addition to the approximately 772 workers employed at Fort Calhoun Station. During construction, the surrounding communities would experience demands on housing and public services that could have MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from other parts of the Omaha MSA or from other counties. After construction, the nearby communities would be impacted by the loss of the construction jobs.

If a coal-fired replacement plant were constructed at Fort Calhoun Station and if Fort Calhoun Station, Unit 1 were decommissioned, there would be a loss of approximately 522 permanent, high-paying jobs (from 772 for the nuclear unit to 250 for the coal-fired plant), with a reduction in payroll taxes and contributions to the regional economy. For these reasons, the appropriate characterization of nontransportation socioeconomic impacts for a coal-fired plant constructed at Fort Calhoun Station would be SMALL to MODERATE.

During the 5-year construction period for the replacement coal-fired units, up to 1200 construction workers would be working at the Nebraska City site in addition to the 772 workers at Fort Calhoun Station. The addition of these workers at the Nebraska City site could place increased traffic loads on U.S. Highway 75. Such impacts would be SMALL to MODERATE.

For transportation related to the commuting of plant-operating personnel, the impacts are considered SMALL. The estimated number of additional plant-operating personnel is approximately 15 for the Nebraska City site. Traffic impacts associated with plant personnel commuting to a coal-fired plant would be expected to be SMALL.

For rail transportation related to coal and lime delivery to Fort Calhoun Station, the impacts are considered MODERATE to LARGE. Approximately 166 trains per year would be needed to deliver the coal and lime for the coal-fired unit. Each train would consist of 100 railcars. The impacts at the Nebraska City site would be SMALL to MODERATE due to an existing coal plant at that site. This would be in addition to the deliveries for the existing coal plant. Barge delivery of coal and lime/limestone would likely have SMALL socioeconomic impacts.

- **Aesthetics**

Development of the coal-fired alternative plant at the Nebraska City site would involve an incremental addition to an existing similar facility that is remotely located. Noise from plant operations presents a potential annoyance to nearby residents. Based on existing land use in the region, the aesthetic impacts from the representative coal-fired alternative would be SMALL.

Locating the plant at Fort Calhoun Station would also represent development at an existing industrial site. However, the development of the plant would consume a large area of the site that is presently agricultural land, and the boiler building, stack, and coal-storage areas would be visually prominent from Highway 75 and residences along and near this highway in the site vicinity. It is expected that offsite noise from plant operations would also be apparent but not destabilizing, considering the present industrial status of the plant site and the adjacent Cargill facility. This impact would be considered SMALL to MODERATE.

- **Historic and Archaeological Resources**

  At the Nebraska City site or Fort Calhoun Station, a cultural-resources evaluation would be necessary to identify, assess, and address the mitigation of potential impacts of new plant construction on cultural resources. Such areas would include all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission line rights-of-way, rail lines, or other rights-of-way). Based on the results of these studies, historic and archaeological impacts can generally be effectively managed by adhering to existing historic-preservation laws and guidelines and, as such, are considered SMALL for the existing Nebraska City site or Fort Calhoun Station.

- **Environmental Justice**

  No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement coal-fired plant were built at the Nebraska City site or at Fort Calhoun Station. Some impacts on housing may occur during construction; loss of over 750 operating jobs at Fort Calhoun Station could slightly reduce employment prospects for minority and low-income populations in Washington, Douglas, and Sarpy counties and could be offset by projected economic growth and the ability of affected workers to commute to other jobs. Overall, impacts would be SMALL.

8.2.1.2 Closed-Cycle Cooling System

The environmental impacts of constructing a coal-fired generation system at the Nebraska City site using closed-cycle cooling with cooling towers are essentially the same as the impacts for a coal-fired plant using a once-through system. However, there are some environmental differences between closed-cycle and once-through cooling systems. Table 8-3 summarizes the incremental differences.

Table 8-3. Summary of Environmental Impacts of Coal-Fired Generation at the Nebraska City Site with a Closed-Cycle Cooling System Using Cooling Towers

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 to 12 additional ha (25 to 30 ac) required for cooling towers.
Ecology	Land disturbance associated with the construction of cooling towers and associated infrastructure would affect the additional 10 to 12 ha (25 to 30 ac) of terrestrial habitats. Possible reduction in the impacts associated with the entrainment of fish and shellfish in early life stages, the impingement of fish and shellfish, and heat shock.
Surface Water Use and Quality	Water withdrawals would be reduced; however, cooling towers associated with closed-cycle cooling could potentially increase water losses from evaporation. Thermal loading would likely be reduced; however, there would be a greater potential for water-quality impacts from the dissolved constituents.
Groundwater Use and Quality	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Aesthetics	Introduction of cooling towers and associated plume. Natural-draft towers could be up to 159 m (520 ft) high. Mechanical-draft towers could be up to 30 m (100 ft) high and would have an associated noise impact.
Historic and Archaeological Resources	Some construction would affect previously disturbed or lightly disturbed parts of the Nebraska City site; cultural-resources studies would likely be needed to identify, evaluate, and address the mitigation of potential impacts of new plant construction on lands at the existing site and offsite corridors, as necessary. The studies would likely be needed to identify, evaluate, and address the mitigation of potential impacts of new plant construction on lands on undeveloped sites and offsite corridors.
Environmental Justice	No change.

8.2.2 Natural-Gas-Fired Generation

The environmental impacts of the natural-gas-fired alternative are examined in this section for the Cass County and Fort Calhoun sites. For the Cass County site, the OPPD evaluated the site for a closed-cycle cooling system. A once-through cooling system is not considered a viable option for the Cass County site because an adequate source of water for such a system is not available. The OPPD concluded in its ER that the Cass County site would be a reasonable site for the location of a natural-gas-fired generating unit.

If a new natural-gas-fired plant were built in Cass County to replace Fort Calhoun Station, Unit 1, approximately 120 km (75 mi) of new 345-kV transmission lines between the plant and other points in the system would be required. The Cass County site is within 1.6 km (1 mi) of seven large natural-gas-supply pipelines.

The OPPD assumed that a replacement natural-gas-fired plant would use combined-cycle technology (OPPD 2002). In a 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 boiler to make steam to generate additional electricity. The following additional assumptions are made for the natural-gas-fired plant (OPPD 2002):

- one 480-MW(e) unit that consists of two 160-MW combustion turbines and a 160-MW heat-recovery boiler
- natural gas with an average heating value of 1000 Btu/ft^3 as the primary fuel
- heat rate of 7000 Btu/kWh
- capacity factor of 0.80

Unless otherwise indicated, the assumptions and numerical values used throughout this section are from the OPPD ER (OPPD 2002). The staff reviewed this information and compared it to environmental-impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the natural-gas-fired alternative for 40 years is considered (as a reasonable projection of the operating life of a natural-gas-fired plant).

8.2.2.1 Once-Through Cooling at Fort Calhoun Station and Closed-Cycle Cooling at Cass County Site

The overall impacts of the natural-gas-fired generating system are discussed in the following sections and are summarized in Table 8-4.

Table 8-4. Summary of Environmental Impacts of Natural-Gas-Fired Generation at Fort Calhoun Station Using a Once-Through Cooling System and the Cass County Site using a Closed-Cycle Cooling System

	Fort Calhoun Station		Cass County Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	10 ha (25 ac) for power block and related facilities. Additional impact of 195 ha (484 ac) for the construction of a new gas-supply pipeline.	SMALL to MODERATE	10 ha (25 ac) for additional power block and related facilities. Additional impact for construction and/or upgrade of an underground makeup-water pipeline, if required. Additional impact of 370 ha (910 ac) for new transmission-line corridor.
Ecology	SMALL to MODERATE	Uses 10 ha (25 ac) of undeveloped but low-quality habitats at Fort Calhoun Station. Impact of a new gas-supply pipeline, which would occupy 195 ha (484 ac) would depend on the chosen route.	SMALL to MODERATE	Uses 10 ha (25 ac) of undeveloped but low-quality habitats at current Cass County site for infrastructure development. New transmission line would affect 370 ha (910 ac). Impact would depend on the chosen route.
Water Use and Quality (Surface Water)	SMALL	Uses existing cooling system.	SMALL	Cooling towers could potentially increase water losses from evaporation. Thermal loading would likely be reduced; however, there would be a greater potential for water-quality impacts from the dissolved constituents.

Table 8-4 (contd)

Impact Category	Fort Calhoun Station		Cass County Site	
	Impact	Comments	Impact	Comments
Water Use and Quality (Groundwater)	SMALL	Does not use groundwater for cooling; However, minimal leaching of the wastes, such as from sewage treatment lagoons, is possible, but the leaching would not be large enough to have a major impact on the resource.	SMALL	Although groundwater could be used as makeup water in the closed-cycle cooling and surface water discharge could percolate to the water table, relatively small impacts to groundwater are anticipated.
Air Quality	MODERATE	Sulfur oxides • 7.0 MT/yr (7.7 tons/yr) Nitrogen oxides • 110 MT/yr (120 tons/yr) Carbon monoxide • 160 MT/yr (180 tons/yr) PM_{10} particulates • 21 MT/yr (23 tons/yr) Some hazardous air pollutants	MODERATE	Same emissions as at Fort Calhoun Station.
Waste	SMALL	Small amount of ash produced.	SMALL	Same waste produced as if produced at Fort Calhoun Station.
Human Health	SMALL	Impacts considered to be minor.	SMALL	Impacts considered to be minor.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 450 additional workers during the construction period. After construction, the communities would be impacted by the loss of construction jobs and the loss of over 750 jobs due to the decommissioning of Fort Calhoun Station. If projected growth for the area materializes, the impact would be SMALL. If not offset by normal growth, then the impact would be MODERATE.	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 450 additional workers during the construction period. After construction, the communities would be impacted by the loss of construction jobs and the loss of over 750 jobs due to the decommissioning of Fort Calhoun Station. If projected growth for the area materializes, the impact would be SMALL. If not offset by normal growth, then the impact would be MODERATE.
Aesthetics	SMALL to MODERATE	Stacks and infrastructure would be clearly visible.	SMALL	The aesthetic impact would be small due to existing land use in region.

Table 8-4 (contd)

Impact Category	Fort Calhoun Station		Cass County Site	
	Impact	Comments	Impact	Comments
Historic and Archaeological Resources	SMALL	Some construction would affect previously disturbed or lightly disturbed parts of Fort Calhoun Station; cultural-resources studies would likely be needed to identify, evaluate, and address the mitigation of potential impacts of new plant construction on lands at the existing site and offsite corridors, as necessary.	SMALL	Some construction would affect previously disturbed or lightly disturbed parts of the Cass County site; cultural-resources studies would likely be needed to identify, evaluate, and address the mitigation of potential impacts of new plant construction on lands at the existing site and offsite corridors, as necessary.
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole.	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole.

- **Land Use**

  For the same reasons discussed in Section 8.2.1.1, the natural-gas-fired generation alternative identified by the OPPD for analysis is a representative plant located at the OPPD's existing Cass County site. This Cass County site is a multiunit site, which is being developed for combustion-turbine peaking units; some of these units will eventually be converted to combined-cycle operation. The current site design accommodates six 160-MW combustion turbines on approximately 36 ha (90 ac) of the site's 96 ha (237 ac). The area surrounding the site is predominantly agricultural land and is sparsely populated. The OPPD estimates that the new facility would not require new gas pipelines; however, the new facility would occupy 10 ha (25 ac) of the total 36 ha (90 ac) planned for development, and approximately an additional 121 km (75 mi) of 345-kV transmission lines with 30-m-wide (100-ft-wide) rights-of-way resulting in use of 370 ha (910 ac) for offsite transmission lines. Additionally, a new pipeline, which is assumed to be 8-km (5-mi) long, may need to be constructed to provide makeup water for cooling; this pipeline would be routed along existing road and utility rights-of-way. Depending on the locations of the transmission lines and water pipeline, the impacts would be SMALL to MODERATE.

  As noted previously for the coal-fired generation alternative, a 475-MW natural-gas-fired plant could be located at Fort Calhoun Station. However, locating the plant at Fort Calhoun

Station would require installing a new gas-supply pipeline that would be approximately 64-km (40-mi) long, resulting in some impact to offsite land use. Also, the potential onsite and offsite impacts of other infrastructure (e.g., power block and support buildings) would result in new land-use impacts. Depending on the amount of land disturbance, this alternative would result in SMALL to MODERATE land-use impacts.

For all options, additional land could be required for natural-gas wells and collection stations. In the GEIS, the staff estimated that approximately 1500 ha (3600 ac) would be needed for a 1000-MW(e) plant (NRC 1996).

Proportionately less land would be needed for a natural-gas-fired plant replacing the 476-MW Fort Calhoun Station, Unit 1. These offsite land requirements would be partially offset by eliminating the need for uranium mining to supply fuel for Fort Calhoun Station, Unit 1. In the GEIS (NRC 1996), the staff estimated that approximately 400 ha (1000 ac) would be affected by mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear-powered plant. Overall, land-use impacts at both Fort Calhoun Station and the alternative Cass County site would be SMALL to MODERATE.

- **Ecology**

The development of a natural-gas-fired plant using a closed cooling system at the existing Cass County site would require developing about 10 ha (25 ac) of land that is currently used for agriculture or that already has been modified for industrial use. Approximately 120 km (75 mi) of new transmission line may be required. Assuming a 30-m-wide (100-ft-wide) right-of-way, the transmission line would result in disturbance to about 370 ha (910 ac) of land. The magnitude of impacts would depend on the types of habitats crossed; a routing study would be used to avoid high-value habitat. Based on current land-use patterns, the transmission line would most likely cross agricultural land.

Construction and overall operational activities of the plant may result in some disturbance to water quality and to the habitats of aquatic species (e.g., erosion of sediments and/or contaminant spills) in the local and downstream vicinity of the plant. The magnitude of impacts on the species (i.e., impingement, entrainment, and heat shock) would be SMALL for a closed-cycle cooling system.

Siting a natural-gas-fired plant with closed-cooling at the existing Cass County site would likely have a SMALL to MODERATE ecological impact, depending on the location of the new transmission lines.

A natural-gas-fired plant with once-through cooling could be located at Fort Calhoun Station. Developing the plant at Fort Calhoun Station would disturb about the same amount of land on Fort Calhoun Station as on the Cass County site. However, a new gas-supply line (about 65 km long [40 mi long]) to Fort Calhoun Station would be needed and would result in the disturbance of about 195 ha (484 ac). New transmission lines would not be needed if Fort Calhoun Station were used. The terrestrial habitat potentially affected by construction at Fort Calhoun Station is mostly agricultural land and areas maintained as part of current site operations, which are of marginal ecological value. Based on current land-use patterns, the new gas-supply line would most likely cross agricultural land.

Construction and operational activities for developing a natural-gas-fired plant at Fort Calhoun Station may result in impacts to aquatic habitats and their species through the erosion of sediments and/or the introduction of other contaminants into the water. The estimated cooling-water flows for a once-through cooling system is lower than the system currently used by Fort Calhoun Station. The magnitude of impacts on the species (i.e., impingement, entrainment, and heat shock) should be SMALL given a similar operational system, permits, and the lower volume of cooling water needed.

Siting a natural-gas-fired plant with once-through cooling at Fort Calhoun Station would have a SMALL to MODERATE ecological impact, depending on the location of the new gas-supply line.

- **Water Use and Quality**

Each of the natural-gas-fired units would include a heat-recovery boiler from which steam would turn an electric generator. Steam would be condensed and circulated back to the boiler for reuse. A natural-gas-fired plant sited at Fort Calhoun Station is assumed to use the existing once-through cooling system. Therefore, the impacts are considered to be SMALL at Fort Calhoun Station.

For the Cass County site, the impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the State of Nebraska. The use of groundwater for a natural-gas-fired plant is also a possibility. Any groundwater withdrawal would require a permit from the local permitting authority. The impacts on groundwater would depend on the volume and other characteristics of the source-water budget. Minimal leaching of wastes, such as from sewage treatment lagoons, to groundwater is possible for both Fort Calhoun Station, Unit 1 and the alternate site. Such impacts should be SMALL.

Water-quality impacts from sedimentation during construction were characterized in the GEIS as SMALL. The staff also noted in the GEIS that operational water-quality impacts would be similar to, or less than, those from other generating technologies. Overall, water-use and -quality impacts at an alternate site are considered SMALL.

- **Air Quality**

Natural gas is a relatively clean-burning fuel. The natural-gas-fired alternative would release similar types of emissions, but in lesser quantities, than the coal-fired alternative. A new combined-cycle, natural-gas-fired generating plant would be subject to the new source-performance standards for such units in 40 CFR Part 60, Subpart Da. Subpart Da establishes emission limits for particulates, opacity, SO_2, and NO_x. A new natural-gas-fired plant would also be subject to the visibility and NO_x emission-reduction provisions discussed in Section 8.2.1.

The OPPD projects the following emissions for the natural-gas-fired alternative (OPPD 2002):

Sulfur oxides – 7.0 MT/yr (7.7 tons/yr)
Nitrogen oxides – 110 MT/yr (120 tons/yr)
Carbon monoxide – 160 MT/yr (180 tons/yr)
PM_{10} particulates – 21 MT/yr (23 tons/yr)

A natural-gas-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

In December 2000, the EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (65 FR 79825 [EPA 2000b]). Natural-gas-fired power plants were found by the EPA to emit arsenic, formaldehyde, and nickel (65 FR 79825 [EPA 2000b]). Unlike coal- and oil-fired plants, the EPA did not determine that emissions of hazardous air pollutants from natural-gas-fired power plants should be regulated under Section 112 of the CAA.

Construction activities would result in temporary fugitive dust. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process.

The preceding emissions would likely be the same at Fort Calhoun Station or at the alternate site. Impacts from the above emissions would be clearly noticeable, but they would not be sufficient to destabilize air resources as a whole. The overall air-quality impact for a new natural-gas-fired plant sited at Fort Calhoun Station or at the alternate site is considered MODERATE.

- **Waste**

  There will be small amounts of solid-waste products (i.e., ash) from burning natural-gas fuel. In the GEIS, the staff concluded that waste generation from natural-gas-fired technology would be minimal (NRC 1996). Gas firing results in very few combustion by-products because of the clean nature of the fuel. Waste generation at an operating natural-gas-fired plant would be largely limited to typical office wastes. Waste-generation impacts would be so minor that they would not noticeably alter any important resource attribute. Construction-related debris would be generated during construction activities. Overall, the waste impacts would be SMALL for a natural-gas-fired plant sited at Fort Calhoun Station or at the alternate site.

  During the winter, a replacement base-load, natural-gas-fired plant may need to operate on fuel oil because of a lack of gas supply. Oil combustion generates waste in the form of ash, and the equipment for controlling air pollution generates additional ash and scrubber sludge. The amount of ash and sludge generated would depend on the type and quantity of fuel oil combusted. No. 2 fuel oil does not produce any appreciable ash, while the heavier No. 6 fuel oil does. Overall, the waste impacts associated with fuel-oil combustion at a combined-cycle plant are expected to be SMALL because the amount of oil combusted is expected to be relatively small. When natural gas is available, fuel oil is generally not price-competitive with natural gas.

- **Human Health**

  In the GEIS, the staff identifies cancer and emphysema as potential health risks from natural-gas-fired plants (NRC 1996). The risk may be attributable to NO_x emissions that contribute to ozone formation, which in turn contributes to health risks. NO_x emissions from the plant would be regulated by the NDEQ or a comparable agency in another state. Human-health effects are not expected to be detectable or would be sufficiently minor that they would neither destabilize nor noticeably alter any important attribute of the resource. Overall, the impacts on human health of the natural-gas-fired alternative sited at Fort Calhoun Station or at the Cass County alternate site are considered SMALL.

- **Socioeconomics**

  Construction of a natural-gas-fired plant at either Fort Calhoun Station or the Cass County site would take approximately 2 to 3 years. Peak employment would be approximately 450 workers (OPPD 2002). During construction, the communities surrounding either site would experience demands on housing and public services. These impacts would be tempered by construction workers commuting to the site from other parts of the Omaha

MSA or from other counties. After construction, the communities would be impacted by the loss of jobs resulting from both the completion of construction of the natural-gas-fired plant and the loss of over 750 jobs due to the decommissioning of Fort Calhoun Station. The 10 operating jobs, at the natural-gas-fired plant would be an insignificant replacement. In lieu tax payments would continue to be made by OPPD. However for both sites, if growth projections for the Omaha Metropolitan Statistical Area materialize, the impact would be SMALL. If not offset by normal growth, then the impact would be MODERATE.

Transportation impacts associated with construction and operating personnel commuting to either site can be classified as SMALL.

- **Aesthetics**

The potential aesthetics impacts from constructing and operating a natural-gas-fired plant include visual impairment and offsite noise. At the Cass County site, the representative gas-fired plant would be an incremental addition to an existing plant with similar characteristics that is remotely located relative to major thoroughfares and residential developments. In addition, based on existing land use in the region, the associated transmission line would be routed overland through sparsely populated areas. The aesthetic impacts would be SMALL due to existing land use in the area.

Locating the plant at Fort Calhoun Station would also represent development at an existing industrial site. In addition, the boiler building and stack, which are assumed to be approximately 76-m (250-ft) high, would be less prominent than for the coal-fired plant alternative. Potential noise impacts would also be less than for the coal-fired plant alternative, although noise and light would be detectable offsite and from Highway 75. These impacts would result in SMALL to MODERATE aesthetic impacts.

- **Historic and Archaeological Resources**

At the Cass County site or at Fort Calhoun Station, a cultural-resources evaluation would be necessary to identify, assess, and address the mitigation of potential impacts of new plant construction on cultural resources. Such areas would include all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, gas-supply pipelines, transmission line rights-of-way, or other rights-of-way). Based on the results of these studies, historic and archaeological impacts can generally be effectively managed by adhering to existing historic-preservation laws and guidelines and, as such, are considered SMALL for both the existing Cass County site or Fort Calhoun Station.

- **Environmental Justice**

  No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement natural-gas-fired plant were built at the Cass County site. Overall impacts are expected to be SMALL.

8.2.2.2 Closed-Cycle Cooling at Fort Calhoun Station

This section discusses the environmental impacts of constructing a natural-gas-fired generation system at the Fort Calhoun Station site using closed-cycle cooling with cooling towers. The impacts of this option are essentially the same as the impacts for a natural-gas-fired plant using once-through cooling. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-5 summarizes these incremental differences.

Table 8-5. Summary of Environmental Impacts of Natural-Gas-Fired Generation at the Fort Calhoun Station Site with Closed-Cycle Cooling Towers

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 to 12 additional ha (25 to 30 ac) required for cooling towers and associated infrastructure.
Ecology	Land disturbance associated with the construction of cooling towers and associated infrastructure would affect the additional 10 to 12 ha (25 to 30 ac) of terrestrial habitats. Possible reduction in impacts at Fort Calhoun Station associated with the entrainment of fish and shellfish in their early life stages, the impingement of fish and shellfish, and heat shock.
Surface Water Use and Quality	Water withdrawals would be reduced; however, cooling towers associated with closed-cycle cooling could potentially increase water losses from evaporation. Thermal loading would likely be reduced; however, there would be a greater potential for water-quality impacts from the dissolved constituents.
Groundwater Use and Quality	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.

Table 8-5 (contd)

Impact Category	Change in Impacts from Once-Through Cooling System
Socioeconomics	No change.
Aesthetics	Introduction of cooling towers and associate plumes. Natural-draft towers could measure up to 159 m (520 ft) high. Mechanical-draft towers could measure up to 30 m (100 ft) high and would have an associated noise impact.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

8.2.3 Nuclear Power Generation

Since 1997, the NRC has certified three new standard designs for nuclear power plants under 10 CFR Part 52, Subpart B. These designs are the U.S. Advanced Boiling-Water Reactor (10 CFR Part 52, Appendix A), the System 80+ Design (10 CFR Part 52, Appendix B), and the AP600 Design (10 CFR 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 the NRC, the submission of these design-certification applications indicates continuing interest in the possibility of licensing new nuclear power plants. In addition, the recent volatility of natural gas and electricity have made new nuclear-power-plant construction more attractive from a cost standpoint. Consequently, the construction of a new nuclear power plant at Fort Calhoun Station using the existing cooling system and at an alternate Nebraska/greenfield site using both closed- and open-cycle cooling are considered in this section. The staff assumed that the new nuclear plant would have a 40-year lifetime. Consideration of a new nuclear generating plant to replace Fort Calhoun Station, Unit 1 was not included in the OPPD ER because it was too expensive.

The NRC summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10 CFR 51.51. 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 Fort Calhoun Station or an alternate site. The impacts shown in Table S-3 are for a 1000-MW(e) reactor and would need to be adjusted to reflect the replacement of Fort Calhoun Station, Unit 1, which has a capacity of 475 MW(e). 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 10 CFR 51.52. The summary of the NRC's findings on NEPA issues for license renewal of nuclear power plants in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, is also relevant, although not directly applicable, for considering the environmental impacts associated with the operation of a replacement nuclear power plant. Additional

environmental-impact information for a replacement nuclear power plant using once-through cooling is presented in Section 8.2.3.1 and using closed-cycle cooling in Section 8.2.3.2.

8.2.3.1 Once-Through Cooling System

The overall impacts of the nuclear generating system are discussed in the following sections. The impacts are summarized in Table 8-6. The extent of impacts at an alternate Nebraska/greenfield site will depend on the location of the particular site selected.

Table 8-6. Summary of Environmental Impacts of New Nuclear Power Generation at Fort Calhoun Station and an Alternate Nebraska/Greenfield Site Using Once-Through Cooling

	Fort Calhoun Station		Alternate Nebraska/Greenfield Site	
Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	MODERATE	Additional 100 to 300 ha (240 to 740 ac) of new land, some of which was previously undeveloped.	LARGE	200 to 400 ha (500 to 1000 ac) plus the possible need for land for a new transmission line, resulting in an additional 260 ha (640 ac) needed.
Ecology	MODERATE	Uses undeveloped areas at Fort Calhoun Station and some additional offsite areas. Uses a once-through cooling system already in place.	MODERATE to LARGE	Impact depends on location and ecology of the site, surface-water body used for intake and discharge, and transmission line route; potential habitat loss and fragmentation; reduced productivity and biological diversity.
Water Use and Quality	SMALL	Uses existing cooling system.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface-water body.
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.	SMALL	Same impacts as at Fort Calhoun Station.

Table 8-6 (contd)

Impact Category	Fort Calhoun Station		Alternate Nebraska/Greenfield Site	
	Impact	**Comments**	**Impact**	**Comments**
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 at Fort Calhoun Station.
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 at Fort Calhoun Station.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be MODERATE. Up to 2500 workers during the peak period of the 5-year construction period. Operating workforce is assumed to be similar to Fort Calhoun Station; tax and wage impacts from employee earnings would be preserved. Impacts during operation would be SMALL.	LARGE	Construction impacts depend on location. Impacts at a rural location could be LARGE.
	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 could be SMALL to MODERATE.
Aesthetics	SMALL to MODERATE	No exhaust stacks or cooling towers would be needed. Visual impact at night could be mitigated by the reduced use of lighting and appropriate shielding. Noise impacts would be relatively small and could be mitigated.	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 rural site is selected, the impacts could be LARGE.

Table 8-6 (contd)

Impact Category	Fort Calhoun Station		Alternate Nebraska/Greenfield Site	
	Impact	**Comments**	**Impact**	**Comments**
Historic and Archaeological Resources	SMALL	A cultural-resources evaluation would be necessary to identify, assess, and address the mitigation of potential impacts of new plant construction. Historic and archaeological impacts can generally be effectively managed through adherence to existing historic-preservation laws and guidelines.	SMALL	Same impacts as at Fort Calhoun Station.
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole.	SMALL	Same as at Fort Calhoun Station.

- **Land Use**

  The existing facilities and infrastructure at Fort Calhoun Station would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that a replacement nuclear power plant would use the existing cooling system, switchyard, offices, and transmission line right-of-way. A replacement nuclear power plant at Fort Calhoun Station would require approximately an additional 100 to 300 ha (240 to 740 ac) of new land, some of which may be previously undeveloped land. It is not clear whether there is enough usable land for a replacement unit at Fort Calhoun Station. Additional land beyond the Fort Calhoun Station boundary may be needed to construct a new nuclear power plant while the existing Fort Calhoun Station, Unit 1 continues to operate.

  There would be no net change in land needed for uranium mining because land needed to supply the new nuclear plant would offset the land needed to supply uranium for fueling the existing Fort Calhoun Station, Unit 1 reactor.

  The impact of a replacement nuclear generating plant on land use at Fort Calhoun Station is best characterized as MODERATE. The impact would be greater than the OL renewal alternative.

Land-use requirements at an alternate site would be 200 to 400 ha (500 to 1000 ac) plus the possible need for land for a new transmission line. Assuming a 25-km (15-mi) transmission line, an additional 260 ha (640 ac) would be needed. In addition, it may be necessary to construct a rail spur to an alternate site to bring in equipment during construction. Siting a new nuclear plant at an alternate site would result in LARGE land-use impacts.

- **Ecology**

  Locating a replacement nuclear power plant at Fort Calhoun Station would alter ecological resources because of the need to convert additional land to industrial use. Additional offsite land would be required to meet the needs of this alternative. Some of this land, however, would have been previously disturbed by Fort Calhoun Station activities or agricultural practices. Development of this additional land is expected to result in MODERATE impacts to terrestrial ecology.

  Construction and operational activities for developing the replacement nuclear power plant may result in impacts to aquatic habitats and their species through the erosion of sediments and/or the introduction of other contaminants into the water. The magnitude of impact on the aquatic ecology would depend upon the cooling-water system operations. The impacts (i.e., impingement, entrainment, and heat shock) to aquatic species would be SMALL if operated with the same cooling system that is in place for Fort Calhoun Station and with minor water withdrawals and discharges. Impacts may increase if the once-through cooling system requires higher volumes of withdrawals and/or discharges.

  Overall, siting at Fort Calhoun Station would have a MODERATE ecological impact that would be greater than renewal of the Unit 1 OL.

  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 terrestrial and aquatic ecology. Impacts could include wildlife-habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Construction and maintenance of the transmission line would have ecological impacts. Overall, the ecological impacts at an alternate site would be MODERATE to LARGE and would depend on the ecological characteristics of the area to be developed.

- **Water Use and Quality**

  The replacement nuclear plant alternative at Fort Calhoun Station is assumed to use the existing once-through cooling system, which would minimize incremental water-use and quality impacts. Surface-water impacts are expected to remain SMALL; the impacts would

be sufficiently minor so that they would not noticeably alter any important attribute of the resource.

The staff assumed that a new nuclear power plant located at Fort Calhoun Station would obtain potable, process, and fire-protection water from the City of Blair public water system similarly to the current practice for Fort Calhoun Station (see Section 2.2.2).

Cooling towers would likely be used at alternate sites. For alternate sites, the impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the State of Nebraska. The impacts would be SMALL to MODERATE.

No groundwater is currently used for operation or cooling at Fort Calhoun Station, Unit 1. It is unlikely that groundwater would be used for an alternative nuclear power plant sited at Fort Calhoun Station. Use of groundwater for a nuclear power plant sited at an alternate site is a possibility. Any groundwater withdrawal would require a permit from the local permitting authority.

- **Air Quality**

  Construction of a new nuclear plant at Fort Calhoun Station 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 by the NDEQ or the appropriate agency in another state. Overall, emissions and associated impacts are considered SMALL.

- **Waste**

  The waste impacts associated with the operation of a nuclear power plant are set out in Table B-1 of 10 CFR 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 would be removed to an appropriate disposal site. Overall, waste impacts are considered SMALL.

  Siting the replacement nuclear power plant at a site other than Fort Calhoun Station would not alter waste generation. Therefore, the impacts would be SMALL.

- **Human Health**

Human-health impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Overall, human-health impacts are considered SMALL.

Siting the replacement nuclear power plant at a site other than Fort Calhoun Station would not alter human-health impacts. Therefore, the impacts would be SMALL.

- **Socioeconomics**

The construction period and the peak workforce associated with the construction of a new nuclear power plant are currently unquantified (NRC 1996). In the absence of quantified data, the staff assumed a construction period of 5 years and a peak workforce of 2500. The staff assumed that construction would take place while the existing nuclear unit continues operation and would be completed by the time Fort Calhoun Station, Unit 1 permanently ceases operations. During construction, the communities surrounding Fort Calhoun Station 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, although this loss could be offset by other growth currently being projected for Douglas and Sarpy counties.

The replacement nuclear unit is assumed to have an operating workforce comparable to the approximately 772 workers currently working at Fort Calhoun Station. In lieu tax payments would remain unaffected. The appropriate characterization of non-transportation socioeconomic impacts for operating replacement nuclear units constructed at Fort Calhoun Station would be SMALL to MODERATE.

During the 5-year construction period, up to 2500 construction workers would be working at Fort Calhoun Station in addition to the approximately 772 workers at Fort Calhoun Station. The addition of the construction workers could place significant traffic loads on existing highways, particularly those leading to Fort Calhoun Station. Such impacts would be MODERATE to LARGE. Transportation impacts related to the commuting of plant operating personnel would be similar to current impacts associated with operation of Fort Calhoun Station, Unit 1 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 Fort Calhoun Station would still experience the impact of Fort Calhoun Station 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 workforce (up to 2500 workers at the peak of construction) and a permanent workforce of approximately 772 workers. Alternate sites would need to be analyzed on a case-by-case basis.

Socioeconomic impacts at an alternate site could be LARGE. Transportation-related impacts associated with commuting workers at an alternate site are site-dependent, but such impacts could be MODERATE to LARGE. Transportation impacts related to the commuting of plant operating personnel would also be site-dependent, but these impacts can be characterized as SMALL.

- **Aesthetics**

  The containment buildings for a replacement nuclear power plant sited at Fort Calhoun Station and other associated buildings would be visible in daylight hours. The nuclear unit would also likely be visible at night because of outside lighting. The replacement plant would be visible from Highway 75 and from the Missouri River. However, with appropriate mitigation, the visual impact could be kept SMALL to MODERATE.

  Noise from operating a replacement nuclear power plant would potentially be audible by recreationists on the Missouri River, but this noise could have a SMALL impact.

  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 constructing a new 25-km (15-mi) transmission line to connect to other lines to enable the 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 were located in an industrial area adjacent to another power plant, 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.

- **Historic and Archaeological Resources**

  At Fort Calhoun Station or an alternate site, a cultural-resources evaluation would be necessary to identify, assess, and address the mitigation of potential impacts of new plant construction on cultural resources. Such areas would include all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission line rights-of-way, rail lines, or other rights-of-way). Based on the results of these studies, historic and archaeological impacts can generally be effectively managed by adhering to existing historic-preservation laws and guidelines and, as such, are considered SMALL for Fort Calhoun Station or an alternate site.

- **Environmental Justice**

No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement nuclear plant were built at Fort Calhoun Station or an alternate greenfield site. Overall, impacts at Fort Calhoun Station or at an alternate/greenfield site are expected to be SMALL.

8.2.3.2 Closed-Cycle Cooling System

This section discusses the environmental impacts of constructing a nuclear power plant at an alternate site using closed-cycle cooling. The impacts of this option are essentially the same as the impacts for a nuclear power plant using once-through cooling. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-7 summarizes the incremental differences.

Table 8-7. Summary of Environmental Impacts of a New Nuclear Power Plant Sited at an Alternate Site with Closed-Cycle Cooling

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 to 12 additional ha (25 to 30 ac) required for cooling towers and associated infrastructure.
Ecology	Land disturbance associated with the construction of cooling towers and associated infrastructure would affect some additional terrestrial habitats. Impacts would depend on ecology at the site. Possible reduction in impacts associated with the entrainment of fish and shellfish in their early life stages, impingement of fish and shellfish, and heat shock.
Surface Water Use and Quality	Water withdrawals would be reduced; however, cooling towers associated with closed-cycle cooling could potentially increase water losses from evaporation. Thermal loading would likely be reduced; however, there would be a greater potential for water-quality impacts from the dissolved constituents.
Groundwater Use and Quality	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.

Impact Category	Change in Impacts from Once-Through Cooling System
Aesthetics	Introduction of cooling towers and associated plumes. Natural-draft towers could be up to 159 m (520 ft). Mechanical-draft towers could be up to 30 m (100 ft) high and would have an associated noise impact.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

8.2.4 Purchased Electrical Power

If available, purchased power from other sources could potentially obviate the need to renew the Fort Calhoun Station, Unit 1 OL. It is unlikely, however, that sufficient base-load, firm power supply would be available to replace the capacity of Fort Calhoun Station, Unit 1.

The OPPD has evaluated conventional and prospective power-supply options that could be reasonably implemented before the current Fort Calhoun Station Unit, 1 OL expires in 2013.

Any discussion of the potential sources of purchased power to replace the capacity of Fort Calhoun Station, Unit 1 at a future date is conjectural. Out-of-state utilities (e.g., members of the Mid-Continent Area Power Pool) and independent power producers represent potential sources of such power. Nebraska has been a net exporter of electricity in recent years (OPPD 2002), suggesting that power also could be available from instate sources. If present conditions persist, these potential instate sources would be limited to other utilities. Nebraska is unique in that it is the only state in the country served entirely by publicly owned power entities, which include public power districts such as the OPPD, cooperatives, and municipalities. In view of the relatively low-cost power and nonprofit services from these consumer-owned systems, Nebraska's utility industry remains regulated, and the State is pursuing a "condition certain" approach to deregulation. Under this framework, Nebraska would continue to monitor industry deregulation in the nation and wholesale market prices, and would implement a public process to assess and adopt retail competition in the event that a deregulated market is determined to offer assured benefits and protections to Nebraska consumers (OPPD 2002). Non-utility generating capability in Nebraska amounted to only 16 MW in 1999, and no additions are planned through 2004 (OPPD 2002).

Any predictions regarding the technologies that would be used to generate purchased power at a future date are similarly speculative and conjectural. However, the OPPD assumes one or more of the technologies evaluated by the NRC in the GEIS would be used. The OPPD also considers the GEIS descriptions of these technologies to be appropriately representative.

It is similarly unclear at present what, if any, additional transmission infrastructure would be required in the event the OPPD purchased power to replace the capacity of Fort Calhoun Station. The transmission system in eastern Nebraska is inherently secure and stable because approximately 80 percent of the state's electrical load is there. The bulk 345-kV transmission system in this area has sufficient redundancy, and strong electrical ties exist between major load centers in eastern Nebraska (OPPD 2002). Importing power from the west would be relatively more likely to require additional transmission. Western Nebraska is characterized by low local area loads, high base-load generation, and no synchronous ties to the western interconnected system of the United States. This mismatch creates a heavy reliance on the transmission system to transport power to load centers in eastern Nebraska (OPPD 2002). In any event, importing power could result in the need for additional transmission facilities (OPPD 2002), although supply from multiple diverse sources would minimize the amount of transmission needed. The OPPD assumes for this option that 56 km (35 mi) of new 345-kV transmission line could be required on a 80-m (100-ft) right-of-way and that this line would be routed according to the results of an appropriate routing study to minimize potential environmental impacts, including land-use incompatibilities.

8.2.5 Other Alternatives

Other generation technologies considered by NRC are discussed in the following subsections.

8.2.5.1 Oil-Fired Generation

The EIA projects that oil-fired plants will account for very little of the new generation capacity in the United States through the year 2020 because of higher fuel costs and lower efficiencies (DOE/EIA 2001a). Nevertheless, an oil-fired generating alternative at Fort Calhoun Station for replacing the power generated by Fort Calhoun Station, Unit 1 is considered in this section.

The OPPD has determined that oil-fired operation is more expensive than 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. The high cost of oil has prompted a steady decline in its use for electricity generation. For these reasons, oil-fired generation is not an economically feasible alternative to the license renewal of Fort Calhoun Station, Unit 1.

Also, construction and operation of an oil-fired plant would have environmental impacts. In Section 8.3.11 of the GEIS, the staff estimated that construction of a 1000-MW(e) oil-fired plant would require about 49 ha (120 ac). Additionally, operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant.

8.2.5.2 Wind Power

Wind-energy potential is generally rated on a scale of 1 through 7; areas that have a rating of 3 or higher are suitable for wind-energy applications (Elliott et al. 1986). Although the wind-energy resource in much of Nebraska and Iowa is rated 3, the wind-energy resource in the vicinity of Fort Calhoun Station is rated 2. Wind energy is intermittent, and as a result, wind turbines operate at a 30 to 35 percent capacity factor (NWPPC 2000). The staff concludes that wind energy is not a feasible alternative to energy generated by Fort Calhoun Station, Unit 1 because of the intermittency of wind energy and the limited wind-energy resource in the vicinity of Fort Calhoun Station.

8.2.5.3 Solar Power

Solar technologies use the sun's energy and light to provide heat and cooling, light, hot water, and electricity for homes, businesses, and industry. Solar-power technologies, both photovoltaic and thermal, cannot currently compete with conventional fossil-fueled technologies in grid-connected applications due to higher capital costs per kW of capacity. The average capacity factor of photovoltaic cells is about 25 percent (NRC 1996), and the capacity factor for solar thermal systems is about 25 to 40 percent (NRC 1996). Energy-storage requirements limit the use of solar-energy systems as base-load electricity supply.

In the GEIS, the staff noted that by its nature, solar power is intermittent. Therefore, solar power by itself is not suitable for base-load capacity and is not a feasible alternative to the license renewal of Fort Calhoun Station, Unit 1. Solar power, in conjunction with energy-storage mechanisms, might serve as a means of providing base-load power. However, current energy-storage technologies are too expensive to permit solar power to serve as a large base-load generator. Even without storage capacity, solar-power technologies (photovoltaic and thermal) cannot currently compete with conventional fossil-fueled technologies in grid-connected applications, due to high costs per kW of capacity (NRC 1996).

There are substantial impacts to natural resources (wildlife-habitat, land-use, and aesthetic impacts) from the construction of solar-generating facilities. As stated in the GEIS, land requirements are high—14,000 ha (35,000 ac) per 1000 MW(e) for photovoltaic and approximately 5700 ha (14,000 ac) per 1000 MW(e) for solar thermal systems (NRC 1996). Since Fort Calhoun Station, Unit 1 generates 475-MW(e) the land impacts would be approximately half the value estimated for a 1000 MW(e) replacement facility. Neither type of solar electric system would fit at Fort Calhoun Station, and both would have large environmental impacts at a greenfield site.

Fort Calhoun Station receives approximately 4.07 to 4.24 kWh of solar radiation per m^2 per day (OPPD 2002), compared to 6 to 8 kWh/m^2 per day in areas of the West, such as California, which are the most promising for solar technologies (NRC 1996). Because of the area's low rate of solar radiation and high technology costs, solar power is not deemed a feasible base-load alternative to the license renewal of Fort Calhoun Station, Unit 1.

Some solar power may substitute for electric power in rooftop and building applications. Implementation of non-rooftop solar generation on a scale large enough to replace Fort Calhoun Station, Unit 1 would likely result in LARGE environmental impacts.

8.2.5.4 Hydropower

Nebraska has an estimated 167 MW of hydroelectric generating capacity (OPPD 2002). As stated in Section 8.3.4 of the GEIS, hydropower's percentage of the country's generating capacity 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 alteration of natural river courses.

The staff estimated in the GEIS that land requirements for hydroelectric power are approximately 400,000 ha (1 million ac or about 1600 mi^2) per 1000 MW(e). Based on this estimate, replacing the generating capacity of Fort Calhoun Station, Unit 1 would require flooding approximately 202,300 ha (500,000 ac) or more to generate 500 MW. Due to the relatively low amount of undeveloped hydropower resource in Nebraska and the large land-use and related environmental and ecological-resource impacts associated with siting hydroelectric facilities large enough to replace Fort Calhoun Station, Unit 1, the staff concludes that local hydropower is not a feasible alternative to Fort Calhoun Station, Unit 1 OL renewal. Any attempts to site hydroelectric facilities large enough to replace Fort Calhoun Station, Unit 1 would result in LARGE environmental impacts.

8.2.5.5 Geothermal Energy

Geothermal energy has an average capacity factor of 90 percent and can be used for base-load power where available. However, geothermal technology is not widely used as base-load generation due to the limited geographical availability of the resource and the immature status of the technology (NRC 1996). As illustrated by Figure 8.4 in the GEIS, geothermal plants are most likely to be sited in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent. There is no feasible central location for geothermal capacity to serve as an alternative to Fort Calhoun Station, Unit 1. The staff concludes that geothermal energy is not a feasible alternative to renewing the Fort Calhoun Station, Unit 1 OL.

8.2.5.6 Wood Waste

A wood-burning facility can provide base-load power and can operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency (NRC 1996). The fuels required are variable and site-specific. A significant barrier to the use of wood waste to generate electricity is the high delivered-fuel cost and high construction cost per MW of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in the GEIS suggest that the overall level of construction impact per MW of installed capacity should be approximately the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996). Like coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

Due to uncertainties associated with obtaining sufficient wood and wood waste to fuel a base-load generating facility, the ecological impacts of large-scale timber cutting (e.g., soil erosion and loss of wildlife habitat), and high inefficiency, the staff has determined that wood waste is not a feasible alternative to renewing the Fort Calhoun Station, Unit 1 OL.

8.2.5.7 Municipal Solid Waste

Municipal waste combustors incinerate the waste and use the resultant heat to generate steam, hot water, or electricity. The combustion process can reduce the volume of waste by up to 90 percent and the weight of the waste by up to 75 percent (EPA 2001). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (DOE/EIA 2001b). Mass-burning technologies are most commonly used in the United States. This group of technologies process raw municipal solid waste “as is,” with little or no sizing, shredding, or separation before combustion. Because of the need for specialized waste-separation and handling equipment for municipal solid waste, the initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at wood-waste facilities (NRC 1996).

Growth in the municipal waste-combustion industry slowed dramatically during the 1990s after rapid growth during the 1980s. The slower growth was due to three primary factors: (1) the Tax Reform Act of 1986, which made capital-intensive projects such as municipal waste-combustion facilities more expensive relative to less capital-intensive, waste-disposal alternatives such as landfills; (2) the 1994 Supreme Court decision *C & A Carbone, Inc. v. Town of Clarkstown*), which struck down local flow-control ordinances that required waste to be delivered to specific municipal waste-combustion facilities rather than landfills that may have had lower fees; and (3) increasingly stringent environmental regulations that increased the capital cost necessary to construct and maintain municipal waste-combustion facilities (DOE/EIA 2001b).

Municipal solid-waste combustors generate an ash residue that is buried in landfills. The ash residue is composed of bottom ash and fly ash. Bottom ash refers to the portion of unburned waste that falls to the bottom of the grate or furnace. Fly ash represents the small particles that rise from the furnace during the combustion process. Fly ash is generally removed from flue-gases using fabric filters and/or scrubbers (DOE/EIA 2001b).

Currently, there are approximately 102 waste-to-energy plants operating in the United States. These plants generate approximately 2800 MW(e), or an average of approximately 28 MW(e) per plant (Integrated Waste Services Association 2001), much smaller than the amount needed to replace the 450-MW(e) base-load capacity of Fort Calhoun Station, Unit 1. Therefore, the staff concludes that municipal solid waste would not be a feasible alternative to renewing the Fort Calhoun Station, Unit 1 OL, particularly at the scale required.

The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at wood-waste facilities. This is due to the need for specialized waste-separation and handling equipment for municipal solid waste (NRC 1996). Furthermore, estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant should be approximately the same as that for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal). Some of these impacts would be MODERATE, but they would still be LARGER than the environmental effects of renewing the Fort Calhoun Station, Unit 1 OL. Therefore, municipal solid waste would not be a feasible alternative to the renewal of the Fort Calhoun Station, Unit 1 OL, particularly at the scale required.

8.2.5.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid-waste fuels, there are several other concepts for fueling electric generators, including burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). In the GEIS, the staff points out that none of these technologies have progressed to the point of being competitive on a large scale or of being reliable enough to replace a base-load plant such as Fort Calhoun Station, Unit 1 (NRC 1996). Further, estimates in the GEIS suggest that the overall level of construction impact from a crop-fired plant should be approximately the same as that for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air). In addition, these systems have large impacts on land use, due to the acreage needed to grow the energy crops. For these reasons, such fuels do not offer a feasible alternative to renewing the Fort Calhoun Station, Unit 1 OL.

8.2.5.9 Fuel Cells

Fuel cells work without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air over a cathode and separating the two by an electrolyte. The only by-products are heat, water, and carbon dioxide. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Phosphoric-acid fuel cells are the most mature fuel-cell technology, but they are only in the initial stages of commercialization. Phosphoric-acid fuel cells are generally considered first-generation technology. These are commercially available today at a cost of approximately $4500 per kW of installed capacity (DOE 2002). Higher-temperature, second-generation fuel cells achieve higher fuel-to-electricity and thermal efficiencies. The higher temperatures contribute to improved efficiencies and give the second-generation fuel cells the capability to generate steam for cogeneration and combined-cycle operations.

DOE has a performance target that by 2003, two second-generation, fuel-cell technologies using molten-carbonate and solid-oxide technology, respectively, will be commercially available in sizes of approximately 3 MW at a cost of $1000 to $1500 per kW of installed capacity (DOE 2002). For comparison, the installed capacity cost for a natural-gas-fired combined-cycle plant is on the order of $500 to $600 per kW (NWPPC 2000). As market acceptance and manufacturing capacity increase, natural-gas-fueled, fuel-cell plants in the 50- to 100-MW range are projected to become available (DOE 2002). At the present time, however, fuel cells are not economically or technologically competitive with other alternatives for base-load electricity generation. Fuels cells are, consequently, not a feasible alternative to renewing the Fort Calhoun Station, Unit 1 OL.

8.2.5.10 Delayed Retirement

The OPPD has no current plans to retire any existing generating units. The OPPD expects all of its existing non-nuclear base-load units to remain in service until at least 2020 (OPPD 2002). For this reason, delayed retirement of other OPPD generating units would not be a feasible alternative to renewing the Fort Calhoun Station, Unit 1 OL.

8.2.5.11 Utility-Sponsored Conservation

As part of its integrated resource planning process, the OPPD annually reviews DSM measures that could be taken to influence customer use of OPPD-supplied electricity, which in turn would reduce overall demand and make more efficient use of the existing generating capacity. To the extent that these measures reduce system demand, they can offset or delay the need for new generation capability, and the NRC thus considered them to be an alternative to license renewal in the GEIS. The OPPD has implemented the following DSM programs and has included associated changes in net demand into its projected base-load forecast (OPPD 2002):

- **Residential Energy Conservation Program**

  The OPPD's residential energy conservation program is designed to conserve energy and save money throughout the year by providing energy-credit refunds and/or special rates to customers who install high-efficiency heat pumps or high-efficiency electric heating and cooling systems.

- **Curtailable Rates**

  The OPPD offers five rate schedules wherein it can conditionally discontinue or reduce service to customers during periods of high demand, thus reducing system peak loads.

- **Load Curtailment/Standby Generation Agreements**

  The OPPD has agreements with several customers to use their own onsite generation sources to reduce or eliminate load at the OPPD's request, which acts to reduce OPPD system peak loads.

- **Commercial Heating, Ventilation, and Air Conditioning**

  The OPPD offers rebates to commercial and industrial customers who install a water-source or air-source heat pump. Additional incentives are offered with the installation of an electric boiler as a backup heat source. This measure results in off-peak (winter) load building and reduction in peak (summer) demand.

The OPPD has screened additional DSM programs and is currently considering implementing the following measures. Upon full implementation, these programs would have the following program impacts and potential system-demand reductions (OPPD 2002):

Proposed Program	Program Impact	Target Demand Reduction (MW)
Air Conditioner (A/C) Cycling	Peak Clipping	100.0
A/C Setback Thermostat	Peak Clipping/Conservation	39.5
A/C Tune-Up/Cleaning	Peak Clipping/Conservation	15.8
Commercial Efficient Lights	Conservation	4.9
Total		160.2

Source: OPPD 2002

The OPPD has achieved and continues to pursue substantial load reductions through the use of DSM efforts. However, as noted above, currently implemented measures are already credited into the OPPD's load forecast and are not available to offset generating capability attributable to Fort Calhoun Station, Unit 1. While the OPPD intends to achieve additional demand reductions of approximately 160 MW in the next few years, the OPPD considers these potential reductions to be a contingency to its overall resource plans. In any event, the potential reductions would be insufficient to replace the capacity of Fort Calhoun Station, Unit 1. On the basis of its annual screening of potentially viable DSM measures, the OPPD is unaware of additional viable opportunities. Based on these considerations, the staff does not consider DSM measures to be a feasible alternative to renewing the Fort Calhoun Station, Unit 1 OL.

8.2.6 Combination of Alternatives

Even though individual alternatives to Fort Calhoun Station, Unit 1 might not be sufficient on their own to replace the capacity of Fort Calhoun Station, Unit 1 due to the small size of the resource or the lack of cost-effective opportunities, it is conceivable that a combination of alternatives might be cost-effective.

As discussed in Section 8.2, Fort Calhoun Station, Unit 1 has a combined net summer rating of 470 MW(e). For the coal- and natural-gas-fired alternatives, the OPPD ER assumes one standard 475-MW(e) unit as a potential replacement for Unit 1. It may be possible to replace the natural-gas alternative with a 320-MW unit combined with the DSM potential of 160 MW. This would likely lead to a higher unit gas-generation cost over a larger plant due to economies of scale.

Table 8-8 contains a summary of the environmental impacts if one assumed a combination of alternatives consisting of 320 MW(e) of combined-cycle, natural-gas-fired generation using closed-cycle cooling and 160 MW(e) gained from additional DSM measures. The impacts are based on the natural-gas-fired-generation impact assumptions discussed in Section 8.2.2, adjusted for the reduced generating capacity. While the DSM measures would have few environmental impacts, operation of the new natural-gas-fired plant would result in increased emissions and environmental impacts. The environmental impacts associated with power purchased from other generators would still occur but would be located elsewhere within the region or nation, as discussed in Section 8.2.4. The impacts of purchased power are not shown in Table 8-8. The staff concludes that it is very unlikely that the environmental impacts of any reasonable combination of generating and conservation options could be reduced to the level of impacts associated with renewing the Fort Calhoun Station, Unit 1 OL.

Table 8-8. Summary of Environmental Impacts of 320 MW(e) of Natural-Gas-Fired Generation and 160 MW(e) from DSM Measures

Impact Category	Fort Calhoun Station		Cass County Site	
	Impact	Comments	Impact	Comments
Land Use	SMALL to MODERATE	10 ha (25 ac) for power block and related facilities. Additional impact of 195 ha (484 ac) for the construction of a new gas-supply pipeline.	SMALL to MODERATE	10 ha (25 ac) for additional power block and related facilities. Additional impact for construction and/or upgrade of an underground makeup-water pipeline, if required. Additional impact of 370 ha (910 ac) for new transmission-line corridor.
Ecology	SMALL to MODERATE	Uses undeveloped but low-quality habitats at Fort Calhoun Station. The impact of a new gas-supply pipeline would depend on the chosen route.	MODERATE to LARGE	Uses undeveloped but low-quality habitats at current Cass County site for infrastructure development. Impacts of new cooling pond would depend on the ecology of the chosen area.
Water Use and Quality (Surface Water)	SMALL	Uses existing cooling system.	SMALL to MODERATE	Impact depends on the volume of water withdrawal and discharge and the characteristics of the surface-water body.
Water Use and Quality (Groundwater)	SMALL	Minimal leaching of wastes produced is possible, but the leaching would not be large enough to have a major impact on the resource.	SMALL	Minimal leaching of wastes produced is possible, but the leaching would not be large enough to have a major impact on the resource.
Air Quality	MODERATE	Sulfur oxides • 4.7 MT/yr (5.1 tons/yr) Nitrogen oxides • 72 MT/yr (79 tons/yr) Carbon monoxide • 110 MT/yr (120 tons/yr) PM_{10} particulates • 14 MT/yr (15 tons/yr) Some hazardous air pollutants	MODERATE	Same as at Fort Calhoun Station.
Waste	SMALL	Small amount of ash produced.	SMALL	Same as at Fort Calhoun Station.
Human Health	SMALL	Impacts considered to be SMALL.	SMALL	Same as at Fort Calhoun Station.

Impact Category	Fort Calhoun Station		Cass County Site	
	Impact	Comments	Impact	Comments
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 450 additional workers during the peak of the 2- to 3-year construction period, followed by a reduction from the current Fort Calhoun Station workforce. The tax and wage impacts from employee earnings would be reduced proportionally to the number of workers. In lieu payments would be unchanged. Impacts during operation would be SMALL.	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 450 additional workers during the peak of the 2- to 3-year construction period. The payroll tax and wage impacts would be reduced proportionally to the number of workers, which could be potentially offset by projected economic growth. Cass County would add an additional 10 jobs. Impacts during operation would be SMALL.
Aesthetics	SMALL to MODERATE	Development would consume large areas that are currently used for agriculture. Stacks and infrastructure would be clearly visible, but the aesthetic impact would be similar to the current Fort Calhoun Station, Unit 1.	SMALL	The aesthetic impact would be SMALL due to existing land use in the region.
Historic and Archaeological Resources	SMALL	Any potential impacts can likely be effectively managed.	SMALL	Any potential impacts can likely be effectively managed.
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; the loss of 772 operating jobs at Fort Calhoun Station could reduce employment prospects for minority and low-income populations. Impacts could be offset by projected economic growth and the ability of affected workers to commute to other jobs.	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Ten additional jobs would have little impact on minority and low-income communities.

8.3 Summary of Alternatives Considered

The environmental impacts of the proposed action, renewal of the Fort Calhoun Station, Unit 1 OL, are SMALL for all impact categories (except collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, for which a single significance level was not assigned). The alternative actions, i.e., the no-action alternative (discussed in Section 8.1), new generation alternatives (from coal, natural gas, and nuclear discussed in Sections 8.2.1 through 8.2.3, respectively), purchased electrical power (discussed in Section 8.2.4), alternative technologies (discussed in Section 8.2.5), and the combination of alternatives (discussed in Section 8.2.6) were considered.

The no-action alternative would require replacing electricity-generating capacity by (1) DSM and energy conservation, (2) power purchased from other electricity providers, (3) generating alternatives other than Fort Calhoun Station, Unit 1, or (4) some combination of these options and would result in decommissioning Fort Calhoun Station, Unit 1. For each of the new generation alternatives (coal, natural gas, and nuclear), the environmental impacts would not be less than the impacts of license renewal. For example, the land-disturbance impacts resulting from the construction of any new facility would be greater than the impacts of continued operation of Fort Calhoun Station, Unit 1. The impacts of purchased electrical power would still occur, but they would occur elsewhere. Alternative technologies are not considered feasible at this time, and it is very unlikely that the environmental impacts of any reasonable combination of generation and conservation options could be reduced to the level of impacts associated with renewing the Fort Calhoun Station, Unit 1 OL.

The staff concludes that the alternative actions, including the no-action alternative, may have environmental effects in at least some impact categories that reach MODERATE or LARGE significance.

8.4 References

10 CFR Part 50. Code of Federal Regulations, Title 10*, Energy,* Part 50, “Domestic Licensing of Production and Utilization Facilities.”

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Functions.”

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy,* Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants.”

40 CFR Part 51. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans."

40 CFR Part 60. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 60, "Standards of Performance for New Stationary Sources."

40 CFR Part 81. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 81, "Designation of Areas for Air Quality Planning Purposes."

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U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*. "Section 6.3 – Transportation, Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

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9.0 Summary and Conclusions

By letter dated January 9, 2002, as amended by letter dated January 18, 2002, the Omaha Public Power District (OPPD) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license (OL) for Fort Calhoun Station, Unit 1 for an additional 20-year period (OPPD 2002). If the OL is renewed, State regulatory agencies and the OPPD will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OL is renewed, the schedule is to issue the renewed license by November 2003. The renewed license would supercede the current license. The renewed license would expire on August 9, 2033, which is 20 years after the original license expiration date. If the OL is not renewed, then the plant must be shut down at or before the expiration of the current OL, which expires on August 9, 2013.

Section 102 of the National Environmental Policy Act (NEPA) (42 USC 4321) directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51, which identifies licensing and regulatory actions that require an EIS. In 10 CFR 51.20(b)(2), the Commission requires the preparation of an EIS or a supplement to an EIS for the renewal of a reactor OL; 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)]

Upon acceptance of the OPPD application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping (67 FR 31847 [NRC 2002]) on May 10, 2002. The staff visited the Fort Calhoun Station site in June 2002 and held public scoping meetings on June 18, 2002, in Omaha, Nebraska. The staff reviewed the OPPD Environmental Report (ER; OPPD 2002), compared it to the GEIS, consulted with other agencies, and conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 2000). The staff also considered the public comments received during the scoping process for preparation of the draft supplemental EIS (SEIS) for Fort Calhoun Station, Unit 1. The public comments received during the scoping process that were considered to be within the scope of the environmental review are provided in Appendix A, Part I, of this SEIS.

The staff held two public meetings in Omaha, Nebraska, in February 2003 to describe the

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

preliminary results of the NRC environmental review and to answer questions to provide members of the public with information to assist them in formulating their comments. All the comments received on the draft SEIS were considered by the staff in developing this final SEIS and are presented in Appendix A, Part II.

This SEIS includes the NRC staff's analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse effects. It also includes the staff's recommendation regarding the proposed action.

The NRC has adopted the following statement of purpose and need for license renewal from the GEIS:

> 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) decisionmakers.

The goal of the staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

> ... whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OL.

NRC regulations [10 CFR 51.95(c)(2)] contain the following statement regarding the content of SEISs prepared at the license renewal stage:

> The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and the

alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b).[(a)]

The GEIS contains the results of a systematic evaluation of the consequences of renewing an OL and operating a nuclear power plant for an additional 20 years. In the GEIS, the NRC evaluated 92 environmental issues using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines. The following definitions of the three significance levels are set forth in a footnote to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

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

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

For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS shows the following:

(1) 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.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).

(3) 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 not to be sufficiently beneficial to warrant implementation.

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the staff relied on conclusions as amplified by supporting information in the GEIS for issues designated Category 1 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

(a) The title of 10 CFR 51.23 is "Temporary storage of spent fuel after cessation of reactor operations – generic determination of no significant environmental impact."

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized. Environmental justice was not evaluated on a generic basis and must also be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS or this supplement to the GEIS was prepared.

This SEIS documents the staff's evaluation of all 92 environmental issues considered in the GEIS. The staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the OL for Fort Calhoun Station, Unit 1) and alternative methods of power generation. These alternatives are evaluated assuming that the replacement power-generation plant is located at either the Fort Calhoun Station site or at the OPPD's existing Nebraska City site for coal-fired generation or the OPPD's existing Cass County site for natural-gas-fired generation.

9.1 Environmental Impacts of the Proposed Action — License Renewal

The OPPD and the NRC staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither the OPPD nor the staff has identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither the scoping process, the OPPD, nor the staff has identified any new issue applicable to Fort Calhoun Station, Unit 1 that has a significant environmental impact. Therefore, the staff relies upon the conclusions of the GEIS for all Category 1 issues that are applicable to Fort Calhoun Station, Unit 1.

The OPPD's license renewal application presents an analysis of the Category 2 issues that are applicable to Fort Calhoun Station, Unit 1 plus environmental justice. The staff has reviewed the OPPD analysis for each issue and has conducted an independent review of each issue. Five Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at Fort Calhoun Station. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. The OPPD (OPPD 2002) has indicated that its evaluation of structures and components, as required by 10 CFR 54.21, did not identify any major plant refurbishment activities or modifications as necessary to support the continued operation of Fort Calhoun Station, Unit 1 for the license renewal period. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant component replacement and, therefore, are not expected to affect the environment outside of the bounds of the plant operations evaluated in the *Final Environmental Statement Related to the Operation of Fort Calhoun Station Unit 1* (AEC 1972).

Twelve Category 2 issues related to operational impacts and postulated accidents during the renewal term, as well as environmental justice, are discussed in detail in this SEIS. Five of the Category 2 issues and environmental justice apply to both refurbishment and to operation during the renewal term and are only discussed in this SEIS in relation to operation during the renewal term. For all 12 Category 2 issues and environmental justice, the staff concludes that the potential environmental effects are of SMALL significance in the context of the standards set forth in the GEIS. In addition, the staff determined that appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for Fort Calhoun Station, Unit 1 and the plant improvements already made, the staff concludes that with the exception of the seven candidate SAMAs identified for implementation, none of the remaining candidate SAMAs are cost-beneficial.

Mitigation measures were considered for each Category 2 issue. Current measures to mitigate the environmental impacts of plant operation were found to be adequate, and no additional mitigation measures were deemed sufficiently beneficial to be warranted.

The following sections discuss unavoidable adverse impacts, irreversible or irretrievable commitments of resources, and the relationship between local short-term use of the environment and long-term productivity.

9.1.1 Unavoidable Adverse Impacts

An environmental review conducted at the license renewal stage differs from the review conducted in support of a construction permit because the plant is in existence at the license renewal stage and has operated for a number of years. As a result, adverse impacts associated with the initial construction have been avoided, have been mitigated, or have already occurred. The environmental impacts to be evaluated for license renewal are those associated with refurbishment and continued operation during the renewal term.

The adverse impacts of continued operation identified are considered to be of SMALL significance, and none warrant the implementation of additional mitigation measures. The adverse impacts of likely alternatives if Fort Calhoun Station, Unit 1 ceases operation at or before the expiration of the current OL will not be smaller than those associated with continued operation of these units, and they may be greater for some impact categories in some locations.

9.1.2 Irreversible or Irretrievable Resource Commitments

The commitment of resources related to construction and operation of Fort Calhoun Station, Unit 1 during the current license periods was made when the plant was built. The resource commitments to be considered in this SEIS are associated with the continued operation of the plant for an additional 20 years. These resources include materials and equipment required for plant maintenance and operation, the nuclear fuel used by the reactors, and ultimately, permanent offsite storage space for the spent fuel assemblies.

The most significant resource commitments related to operation during the renewal term are the fuel and the permanent storage space. The OPPD replaces approximately one-third of the fuel assemblies in Fort Calhoun Station, Unit 1 during every refueling outage, which occurs on an 18-month cycle.

The likely power-generation alternatives if Fort Calhoun Station, Unit 1 ceases operation on or before the expiration of the current OL will require a commitment of resources for constructing the replacement plants as well as for fuel to run the plants.

9.1.3 Short-Term Use Versus Long-Term Productivity

An initial balance between short-term use and long-term productivity of the environment at the Fort Calhoun Station site was set when the plant was approved and construction began. That balance is now well established. Renewing the OL for Fort Calhoun Station, Unit 1 and the continued operation of the plant will not alter the existing balance, but renewing the OL may postpone the availability of the site for other uses. Denial of the application to renew the OL will lead to the shutdown of the plant and will alter the balance in a manner that depends on subsequent uses of the site. For example, the environmental consequences of turning the Fort Calhoun Station site into a park or an industrial facility are quite different.

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives

The proposed action is renewal of the OL for Fort Calhoun Station, Unit 1. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. As noted in Chapter 3, no refurbishment and no refurbishment impacts are expected at Fort Calhoun Station, Unit 1. Chapters 4 through 7 discuss environmental issues associated with renewing the OL. Environmental issues associated with the no-action alternative and alternatives involving power generation and use reduction are discussed in Chapter 8.

The significance of the environmental impacts from the proposed action (approval of the application for renewing the OL), the no-action alternative (denial of the application),

alternatives involving nuclear or coal- or natural-gas-fired generation of power at the Fort Calhoun Station site and the OPPD's existing natural-gas- or coal-fired generation sites, and a combination of alternatives are compared in Table 9-1.

Table 9-1 shows that the significance of the environmental effects of the proposed action are SMALL for all impact categories (except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, for which a single significance level was not assigned [see Chapter 6]). The alternative actions, including the no-action alternative, may have environmental effects in at least some impact categories that reach MODERATE or LARGE significance.

Table 9-1. Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Methods of Generation

Alternative	Impact Category	Land Use	Ecology	Water Use and Quality	Air Quality	Waste
Proposed Action	License Renewal	SMALL	SMALL	SMALL	SMALL	SMALL
No-Action Alternative	Denial of Renewal	SMALL	SMALL	SMALL	SMALL	SMALL
Coal-Fired Generation	Fort Calhoun Station Site	SMALL to LARGE	SMALL	SMALL to MODERATE	MODERATE	MODERATE
	Alternate Site	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	MODERATE	MODERATE
Natural-Gas-Fired Generation	Fort Calhoun Station Site	SMALL to MODERATE	SMALL to MODERATE	SMALL	MODERATE	SMALL
	Alternate Site	SMALL to MODERATE	SMALL to MODERATE	SMALL	MODERATE	SMALL
New Nuclear Generation	Fort Calhoun Station Site	MODERATE	MODERATE	SMALL	SMALL	SMALL
	Alternate Site	LARGE	MODERATE to LARGE	SMALL to MODERATE	SMALL	SMALL
Combination of Alternatives	Fort Calhoun Station Site	SMALL to MODERATE	SMALL to MODERATE	SMALL	MODERATE	SMALL
	Alternate Site	SMALL to MODERATE	MODERATE to LARGE	SMALL to MODERATE	MODERATE	SMALL

Table 9-1 (contd)

Alternative	Impact Category	Human Health[(a)]	Socioeconomics	Aesthetics	Historic and Archaeological Resources	Environmental Justice
Proposed Action	License Renewal	SMALL	SMALL	SMALL	SMALL	SMALL
No-Action Alternative	Denial of Renewal	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL
Coal-Fired Generation	Fort Calhoun Station Site	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL	SMALL
	Alternate Site	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL
Natural Gas-Fired Generation	Fort Calhoun Station Site	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL
	Alternate Site	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL
New Nuclear Generation	Fort Calhoun Station Site	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL	SMALL
	Alternate Site	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL	SMALL
Combination of Alternatives	Fort Calhoun Station Site	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL
	Alternate Site	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL

(a) Except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, for which single significance levels were not assigned. See Chapter 6 for details.

9.3 Staff Conclusions and Recommendations

Based on (1) the analysis and findings in the GEIS (NRC 1996; 1999); (2) the ER submitted by the OPPD (OPPD 2002); (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of the public comments received, the staff recommends that the Commission determine that the adverse environmental impacts of license renewal for Fort Calhoun Station, Unit 1 are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable.

9.4 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

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

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