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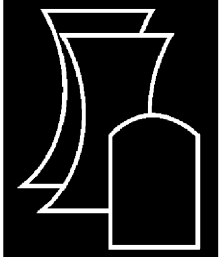
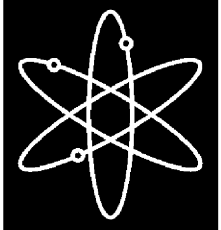
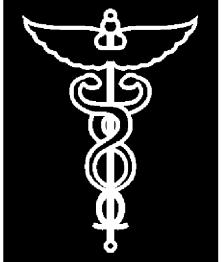
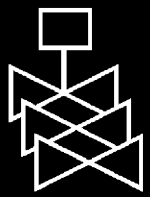
Supplement 27









Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 27

Regarding
Palisades Nuclear Plant

Final Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
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NUREG-1437
Supplement 27

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 27

Regarding Palisades Nuclear Plant

Final Report

Manuscript Completed: October 2006
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Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

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 Part 51 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 51). In the GEIS (and its Addendum 1), the NRC staff 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 Nuclear Management Company, LLC (NMC), to renew the OL for Palisades Nuclear Plant (Palisades) 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 NRC staff's recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither NMC nor the NRC staff has identified information that is both new and significant for any issue that applies to Palisades. In addition, the NRC staff determined that information provided during the scoping process did not call into question the conclusions in the GEIS. Therefore, the NRC staff concludes that the impacts of renewing the Palisades OL would not be greater than the impacts identified for these issues in the GEIS. For each of these issues, the NRC staff's conclusion in the GEIS 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 Palisades are addressed in this SEIS. For each applicable issue, the NRC staff concludes that the significance of the potential environmental impacts of renewal of the OL would be SMALL. The NRC staff determined that information provided during the public comment period did not identify any new issue with a significant environmental impact.

The NRC staff's recommendation is that the Commission determine that the adverse environmental impacts of license renewal for Palisades are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable. This

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

recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by NMC; (3) consultation with Federal, State, and local agencies; (4) the NRC staff's own independent review; and (5) the NRC staff's consideration of public comments.

Contents

Abstract iii

Executive Summary xv

Abbreviations/Acronyms xxi

1.0 Introduction 1-1

1.1 Report Contents 1-2
1.2 Background 1-3

1.2.1 Generic Environmental Impact Statement 1-3
1.2.2 License Renewal Evaluation Process 1-5

1.3 The Proposed Federal Action 1-7
1.4 The Purpose and Need for the Proposed Action 1-8
1.5 Compliance and Consultations 1-9
1.6 References 1-9

2.0 Description of Nuclear Power Plant and Site and Plant Interaction with the Environment 2-1

2.1 Plant and Site Description and Proposed Plant Operation During the Renewal Term 2-1

2.1.1 External Appearance and Setting 2-4
2.1.2 Reactor Systems 2-5
2.1.3 Cooling and Auxiliary Water Systems 2-6
2.1.4 Radioactive Waste Management Systems and Effluent Control Systems 2-9

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls 2-10
2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls . . . 2-12
2.1.4.3 Solid Waste Processing 2-13

2.1.5 Nonradioactive Waste Systems 2-14
2.1.6 Plant Operation and Maintenance 2-15
2.1.7 Power Transmission System 2-15

2.2 Plant Interaction with the Environment 2-18

2.2.1 Land Use 2-18
2.2.2 Water Use 2-19
2.2.3 Water Quality 2-21
2.2.4 Air Quality 2-24
2.2.5 Aquatic Resources 2-26
2.2.6 Terrestrial Resources 2-32
2.2.7 Radiological Impacts 2-48
2.2.8 Socioeconomic Factors 2-49

2.2.8.1 Housing 2-49
2.2.8.2 Public Services 2-51
2.2.8.3 Offsite Land Use 2-53
2.2.8.4 Visual Aesthetics and Noise 2-54
2.2.8.5 Demography 2-55
2.2.8.6 Economy 2-56

2.2.9 Historic and Archaeological Resources 2-59

2.2.9.1 Cultural Background 2-59
2.2.9.2 Historic and Archaeological Resources at the Palisades Site 2-61

2.2.10 Related Federal Project Activities and Consultations 2-62

2.3 References 2-63

3.0 Environmental Impacts of Refurbishment 3-1

3.1 References 3-4

4.0 Environmental Impacts of Operation 4-1

4.1 Cooling System 4-2
4.2 Transmission Lines 4-12

4.2.1 Electromagnetic Fields – Acute Effects 4-16
4.2.2 Electromagnetic Fields – Chronic Effects 4-17

4.3 Radiological Impacts of Normal Operations 4-18

4.4 Socioeconomic Impacts of Plant Operations During the License Renewal Period 4-19

4.4.1 Housing Impacts During Operations 4-21
4.4.2 Public Services: Public Utility Impacts During Operations 4-22
4.4.3 Offsite Land Use During Operations 4-23
4.4.4 Public Services: Transportation Impacts During Operations 4-25
4.4.5 Historic and Archaeological Resources 4-25
4.4.6 Environmental Justice 4-27

4.5 Groundwater Use and Quality 4-31
4.6 Threatened or Endangered Species 4-32

4.6.1 Aquatic Species 4-32
4.6.2 Terrestrial Species 4-33

4.7 Evaluation of New and Potentially Significant Information on Impacts of Operations During the Renewal Term 4-35
4.8 Cumulative Impacts of Operations During the Renewal Term 4-35

4.8.1 Cumulative Impacts Resulting from Operation of the Plant Cooling System 4-35
4.8.2 Cumulative Impacts Resulting from Continued Operation of the Transmission Lines 4-37
4.8.3 Cumulative Radiological Impacts 4-38
4.8.4 Cumulative Socioeconomic Impacts 4-39
4.8.5 Cumulative Impacts on Groundwater Use and Quality 4-40
4.8.6 Conclusions Regarding Cumulative Impacts 4-41

4.9 Summary of Impacts of Operations During the Renewal Term 4-42
4.10 References 4-42

5.0 Environmental Impacts of Postulated Accidents 5-1

5.1 Postulated Plant Accidents 5-1

5.1.1 Design-Basis Accidents 5-2
5.1.2 Severe Accidents 5-3

5.2 Severe Accident Mitigation Alternatives 5-4

5.2.1 Introduction 5-5
5.2.2 Estimate of Risk 5-6
5.2.3 Potential Plant Improvements 5-6
5.2.4 Evaluation of Risk Reduction and Costs of Improvements 5-8
5.2.5 Cost-Benefit Comparison 5-9
5.2.6 Conclusions 5-10

5.3 References 5-11

6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid Waste Management 6-1

6.1 The Uranium Fuel Cycle 6-2
6.2 References 6-9

7.0 Environmental Impacts of Decommissioning 7-1

7.1 Decommissioning 7-2
7.2 References 7-4

8.0 Environmental Impacts of Alternatives to License Renewal 8-1

8.1 No-Action Alternative 8-1
8.2 Alternative Energy Sources 8-6

8.2.1 Coal-Fired Generation 8-8

8.2.1.1 Closed-Cycle Cooling System 8-9
8.2.1.2 Once-Through Cooling System 8-19

8.2.2 Natural-Gas-Fired Generation 8-20

8.2.2.1 Closed-Cycle Cooling System 8-21
8.2.2.2 Once-Through Cooling System 8-31

8.2.3 Nuclear Power Generation 8-32

8.2.3.1 Closed-Cycle Cooling System 8-33
8.2.3.2 Once-Through Cooling System 8-41

8.2.4 Purchased Electrical Power 8-42

8.2.5 Other Alternatives 8-43

8.2.5.1 Oil-Fired Generation 8-43
8.2.5.2 Wind Power 8-44
8.2.5.3 Solar Power 8-45
8.2.5.4 Hydropower 8-46
8.2.5.5 Geothermal Energy 8-46
8.2.5.6 Wood Waste 8-46
8.2.5.7 Municipal Solid Waste 8-47
8.2.5.8 Other Biomass-Derived Fuels 8-48
8.2.5.9 Fuel Cells 8-48
8.2.5.10 Delayed Retirement 8-49
8.2.5.11 Utility-Sponsored Conservation 8-49

8.2.6 Combination of Alternatives 8-50

8.3 Summary of Alternatives Considered 8-54
8.4 References 8-54

9.0 Summary and Conclusions 9-1

9.1 Environmental Impacts of the Proposed Action – License Renewal 9-4

9.1.1 Unavoidable Adverse Impacts 9-5
9.1.2 Irreversible or Irretrievable Resource Commitments 9-6
9.1.3 Short-Term Use Versus Long-Term Productivity 9-6

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives 9-6
9.3 NRC Staff Conclusions and Recommendations 9-7
9.4 References 9-9

Appendix A - Comments Received on the Environmental Review A-1

Appendix B - Contributors to the Supplement B-1

Appendix C - Chronology of NRC Staff Environmental Review Correspondence Related to the Nuclear Management Company, LCC, Application for License Renewal of Palisades Nuclear Plant C-1

Contents

Appendix D - Organizations Contacted D-1

Appendix E - Nuclear Management Company, LLC's, Compliance Status and Consultation Correspondence E-1

Appendix F - GEIS Environmental Issues Not Applicable to Palisades Nuclear Plant F-1

Appendix G - NRC Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Palisades Nuclear Plant in Support of License Renewal Application G-1

Figures

2-1 Location of Palisades, 50-mi Region 2-2
2-2 Location of Palisades, 6-mi Region 2-3
2-3 Palisades Site Layout 2-7
2-4 Transmission Lines 2-16

4-1 Geographic Distribution of Minority Populations Within 50 mi of Palisades Based on Census Block Group Data 4-29
4-2 Geographic Distribution of Low-Income Populations Within 50 mi of Palisades Based on Census Block Group Data 4-30

Tables

2-1 State-Listed Aquatic Species Potentially Occurring in the Vicinity of Palisades and Associated Transmission Lines 2-33
2-2 Federally Listed and State-Listed Terrestrial Species Potentially Occurring on or in the Vicinity of Palisades and Associated Transmission Lines 2-37
| 2-3 Permanent Employee Residence Information for Palisades by County and City . 2-50
2-4 Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000 2-51
2-5 Major Public Water Supply Systems in Van Buren and Berrien Counties, 2004 2-52
2-6 Land Use in Van Buren County, 2005 2-53
2-7 Population Growth in Van Buren and Berrien Counties, 1970 to 2020 2-55
| 2-8 Major Employment Facilities Within 10 mi of Palisades 2-57
2-9 Contribution of Palisades to County Property Tax Revenues 2-58

3-1 Category 1 Issues for Refurbishment Evaluation 3-2
3-2 Category 2 Issues for Refurbishment Evaluation 3-3

4-1 Category 1 Issues Applicable to the Operation of the Palisades Cooling System During the Renewal Term 4-3
4-2 Category 1 Issues Applicable to the Palisades Transmission Lines During the Renewal Term 4-13
4-3 Category 2 and Uncategorized Issues Applicable to the Palisades Transmission Lines During the Renewal Term 4-16
4-4 Category 1 Issues Applicable to Radiological Impacts of Normal Operations During the Renewal Term 4-18
4-5 Category 1 Issues Applicable to Socioeconomics During the Renewal Term 4-19
4-6 Environmental Justice and GEIS Category 2 Issues Applicable to Socioeconomics During the Renewal Term 4-21
4-7 Category 1 Issue Applicable to Groundwater Use and Quality During the Renewal Term 4-31
4-8 Category 2 Issue Applicable to Threatened or Endangered Species During the Renewal Term 4-32

5-1 Category 1 Issue Applicable to Postulated Accidents During the Renewal Term 5-3
5-2 Category 2 Issue Applicable to Postulated Accidents During the Renewal Term 5-4
| 5-3 Palisades Core Damage Frequency for Internal Events 5-7
| 5-4 Breakdown of Population Dose by Containment Release Mode 5-7

6-1 Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste Management During the Renewal Term 6-2

7-1 Category 1 Issues Applicable to the Decommissioning of Palisades Following the Renewal Term 7-2

8-1 Summary of Environmental Impacts of the No-Action Alternative 8-3
8-2 Summary of Environmental Impacts of Coal-Fired Generation Using Closed-Cycle Cooling at an Alternate Site 8-10
8-3 Summary of Environmental Impacts of Coal-Fired Generation Using Once-Through Cooling at an Alternate Site 8-20
8-4 Summary of Environmental Impacts of Natural-Gas-Fired Generation Using Closed-Cycle Cooling at the Palisades Site and at an Alternate Site 8-22
8-5 Summary of Environmental Impacts of Natural-Gas-Fired Generation Using Once-Through Cooling at an Alternate Site 8-32
8-6 Summary of Environmental Impacts of New Nuclear Power Generation Using Closed-Cycle Cooling at the Palisades Site and at an Alternate Site 8-34
8-7 Summary of Environmental Impacts of a New Nuclear Power Plant Using Once-Through Cooling at an Alternate Site 8-42
8-8 Summary of Environmental Impacts of Combination of Alternatives at the Palisades Site and at an Alternate Site 8-51

9-1 Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Methods of Generation Using Closed-Cycle Cooling 9-8

A-1 Individuals Providing Comments During Scoping Comment Period A-3
A-2 Comments Received on the Draft SEIS A-44

E-1 Consultation Correspondence E-1
E-2 Federal, State, Local, and Regional Licenses, Permits, Consultations, and Other Approvals for the Palisades Nuclear Plant E-2

F-1 GEIS Environmental Issues Not Applicable to Palisades F-1

G-1 Palisades Core Damage Frequency for Internal Events G-3
G-2 Breakdown of Population Dose by Containment Release Mode G-4
G-3 Palisades PSA Historical Summary G-6
G-4 SAMA Cost-Benefit Screening Analysis for Palisades G-20

Executive Summary

By letter dated March 22, 2005, Nuclear Management Company, LLC (NMC), submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license (OL) for Palisades Nuclear Plant (Palisades) for an additional 20-year period. If the OL is renewed, State regulatory agencies and NMC 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 not renewed, then the plant must be shut down at or before the expiration date of the current OL, which is March 24, 2011.

The NRC has implemented Section 102 of the National Environmental Policy Act (NEPA), Title 42, Section 4321 of the *United States Code* (42 USC 4321) in Part 51 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 51). In 10 CFR 51.20(b)(2), the Commission requires preparation of an Environmental Impact Statement (EIS) or a supplement to an EIS for renewal of a reactor OL. In addition, 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 Plant*s (GEIS), NUREG-1437, Volumes 1 and 2.[(a)]

Upon acceptance of the NMC application, the NRC staff 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 NRC staff visited the Palisades site in July 2005 and held two public scoping meetings on July 28, 2005, in South Haven, Michigan. During the preparation of this Supplemental Environmental Impact Statement (SEIS) for Palisades, the NRC staff reviewed the NMC Environmental Report (ER) and compared it with the GEIS, consulted with other agencies, 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*, 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.

The draft SEIS was published in February 2006. The NRC staff held two public meetings at Lake Michigan College, South Haven, Michigan, on April 5, 2006, to describe the preliminary results of the NRC environmental review, to answer questions, and to provide members of the public with information to assist them in formulating comments on this SEIS. When the 75-day comment period ended, the NRC staff considered and dispositioned all of the comments received. These comments are addressed in Appendix A, Part II, of this SEIS.

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,

(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.

and mitigation measures for reducing or avoiding adverse effects. It also includes the NRC 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) decision makers.

The evaluation criterion for the NRC staff's environmental review, as defined in 10 CFR 51.950(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 decision makers 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 footnotes 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 reached 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 characteristics.

(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 not likely 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 NRC 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 NRC staff's consideration of all 92 environmental issues identified in the GEIS. The NRC 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 Palisades) and alternative methods of power generation. Based on projections made by the U.S. Department of Energy's Energy Information Administration, gas- and coal-fired generation appear to be the most likely power-generation alternatives if the power from the plant is replaced. These alternatives are evaluated assuming that the replacement power generation plant is located at either the Palisades site or some other unspecified alternate location.

NMC 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 NMC nor the NRC 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, the NRC staff did not identify, during the scoping process or during its review, any new issue applicable to Palisades that had a significant environmental impact. Therefore, the NRC staff relies upon the conclusions of the GEIS for all of the Category 1 issues that are applicable to Palisades.

NMC's license renewal application presents an analysis of the Category 2 issues. The NRC staff has reviewed the NMC analysis for each issue and has conducted an independent review of each issue plus environmental justice and chronic effects from electromagnetic fields. Nine Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at Palisades. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. NMC 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 Palisades for the license renewal period. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant operation and are not expected to affect the environment outside of the bounds of the plant operations evaluated in the U.S. Atomic Energy Commission's 1972 *Final Environmental Statement Related to the Operation of Palisades Nuclear Generating Plant, Consumers Power Company*.

Eight 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. Four 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 eight of the Category 2 issues and environmental justice, the NRC staff concludes that the potential environmental effects would be of SMALL significance in the context of the standards set forth in the GEIS. In addition, the

NRC 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 NRC staff concurs with NMC's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all or a subset of the identified, potentially cost-beneficial SAMA. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by NMC is warranted. However, none of the potentially cost-beneficial SAMAs directly relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of any other action undertaken by agencies or persons. For purposes of this analysis, the overall conclusion of the NRC staff is that these impacts would not result in significant cumulative impacts on potentially affected resources.

If the Palisades OL is not renewed and the plant ceases operation on or before the expiration of its current OL, then the adverse impacts of likely alternatives will not be smaller than those associated with continued operation of Palisades. 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 Palisades 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 NMC; (3) consultation with other Federal, State, and local agencies; (4) the NRC staff's own independent review; and (5) the NRC staff's consideration of public comments.

Abbreviations/Acronyms

°	degree
µCi	microcurie(s)
µg	microgram(s)
ac	acre(s)
AC	alternating current
ACC	averted cleanup and decontamination costs
ACHP	Advisory Council on Historic Preservation
ADAMS	Agencywide Documents Access and Management System
AEC	U.S. Atomic Energy Commission
AEP	American Electric Power
AFW	auxiliary feedwater
ALARA	as low as reasonably achievable
AOC	averted offsite property damage costs
AOE	averted occupational exposure
AOSC	averted onsite costs
APE	area of potential effect
APE	averted public exposure
AQCR	Air Quality Control Region
BEIR	Biological Effects of Ionizing Radiation
Btu	British thermal unit(s)
CDF	core damage frequency
CEOG	Combustion Engineering Owners Group
CEQ	Council on Environmental Quality
CET	containment event tree
CFR	Code of Federal Regulations
Ci	curie(s)
cm^3	cubic centimeter(s)
CO	carbon monoxide
COE	cost of enhancement
CWS	Circulating Water System
CZMA	Coastal Zone Management Act
DAW	dry active waste
DBA	design-basis accident
DC	direct current
DDDIP	direct drive diesel-driven injection pump
DFO	Department of Fisheries and Oceans Canada

DFS	dry fuel storage
DMR	Discharge Monitoring Report
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DSM	Demand Side Management
EDG	emergency diesel generator
EIA	Energy Information Administration
EIS	Environmental Impact Statement
ELF-EMF	extremely low frequency-electromagnetic field
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ER	Environmental Report
F	Fahrenheit
FAA	Federal Aviation Administration
FES	Final Environmental Statement
FSAR	Final Safety Analysis Report
ft	foot (feet)
ft^3	cubic foot (feet)
FWS	U.S. Fish and Wildlife Service
gal	gallon(s)
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437
GL	Generic Letter
GLSC	Great Lakes Science Center
GLSGN	Great Lakes Sea Grant Network
gpd	gallon(s) per day
gpm	gallon(s) per minute
GWd	gigawatt day(s)
HEPA	high-efficiency particulate air
HLW	high-level waste
HPI	high-pressure injection
hr	hour(s)
HPSI	high-pressure safety injection
HVAC	heating, ventilation, and air-conditioning

Hz	hertz
I-196	Interstate-196
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IDNR	Indiana Department of Natural Resources
IEEE	Institute of Electrical and Electronic Engineers
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination of External Events
ISFSI	independent spent fuel storage installation
kV	kilovolt(s)
kWe	kilowatt(s) electrical
kWh	kilowatt hour(s)
L	liter(s)
lb	pound(s)
LOCA	loss of coolant accident
LOOP	loss of offsite power
m	meter(s)
m^2	square meter(s)
mA	milliampere(s)
MAAP	Modular Accident Analysis Program
MACCS2	Melcor Accident Consequence Code System 2
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MEDC	Michigan Economic Development Corporation
MEI	maximally exposed individual
METC	Michigan Electric Transmission Company, LLC
mg	milligram(s)
MGy	milliGray(s)
mi	mile(s)
mi^2	square mile(s)
mi^3	cubic mile(s)
min	minute(s)
MMACR	modified maximum averted cost risk
MNFI	Michigan Natural Features Inventory

mph	mile(s) per hour
MRCC	Midwestern Regional Climate Center
mrem	millirem(s)
MSIV	main steam insolation valve
MSL	mean sea level
MTU	metric ton(s)-uranium
MW	megawatt(s)
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWh	megawatt hour(s)
NAS	National Academy of Sciences
NCES	National Center for Educational Statistics
NCI	National Cancer Institute
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NREL	National Renewable Energy Laboratory
NESC	National Electric Safety Code
ng/J	nanogram(s) per Joule
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NMC	Nuclear Management Company, LLC
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
OL	operating license
PCB	polychlorinated biphenyl
PCS	Primary Coolant System
PG&E	PG&E Corporation
PM_{10}	particulate matter with an aerodynamic diameter of 10 μm or less
PNL	Pacific Northwest National Laboratory
PSA	Probabilistic Safety Assessment
PSD	prevention of significant deterioration
psi	pounds per square inch
RAI	request for additional information

RCP	reactor coolant pump
REMP	radiological environmental monitoring program
ROI	region of interest
RPC	replacement power cost
RRW	risk reduction worth
s	second(s)
SAMA	severe accident mitigation alternative
SAR	Safety Analysis Report
SBO	station blackout
SCR	selective catalytic reduction
SECA	Solid State Energy Conservation Alliance
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SGTR	steam generator tube rupture
SHPO	State Historic Preservation Office(r)
SIRWT	safety injection and refueling water tank
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
spp.	species
STS	STS Consultants, Inc.
SWPPP	Storm Water Pollution Prevention Plan
SWS	Service Water System
TEDE	total effective dose equivalent
TLAA	time-limited aging analysis
TRO	total residual oxidant
TSS	total suspended solids
TWh	terawatt-hour(s)
U.S.	United States
USC	United States Code
USDA	U.S. Department of Agriculture
USI	unresolved safety issue
UWSGI	University of Wisconsin Sea Grant Institute
W	watt(s)
yd	yard(s)

1.0 Introduction

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Part 51 of Title 10 of the *Code of Federal Regulations* (10 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 NRC 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 must be addressed by the applicants in plant-by-plant renewal proceedings. Use of the GEIS guides the preparation of complete plant-specific information in support of the OL renewal process.

Nuclear Management Company, LLC (NMC), operates Palisades Nuclear Plant (Palisades) in southwestern Michigan under OL DPR-20, which was issued by the NRC. This OL will expire in March 2011. On March 22, 2005, NMC submitted an application to the NRC to renew the Palisades OL for an additional 20 years under 10 CFR Part 54. NMC 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), NMC submitted an Environmental Report (ER) (NMC 2005a) in which NMC 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 impacts.

This report is the plant-specific supplement to the GEIS (the supplemental EIS (SEIS)) for the NMC license renewal application. This SEIS is a supplement to the GEIS because it relies, in part, on the findings of the GEIS. The NRC 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 NRC staff to assess the environmental impacts associated with license renewal; (2) describe the proposed Federal action to renew the Palisades OL; (3) discuss the purpose and need for the proposed action; and (4) present the status of NMC'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 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. Chapter 9 also presents the NRC staff's recommendation with respect to the proposed license renewal action.

Additional information is included in appendixes. Appendix A contains public comments related to the environmental review for license renewal and NRC staff responses to those comments. Appendixes B through G, respectively, list the following:

- The preparers of the supplement,
- The chronology of NRC staff's environmental review correspondence related to this SEIS,
- The organizations contacted during the development of this SEIS,
- NMC's compliance status in Table E-1 (this appendix also contains copies of consultation correspondence prepared and sent during the evaluation process),
- GEIS environmental issues that are not applicable to Palisades, and
- Severe accident mitigation alternatives (SAMAs).

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 support the thorough evaluation of the impacts of 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 impact for both beneficial and adverse impacts, (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 for impacts 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, and 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 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 characteristics.

(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 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 NRC 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 two uncategorized issues are environmental justice and chronic effects of electromagnetic fields. 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.

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 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), and

- 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); and

- 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 Palisades OL, NMC developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for Palisades would be properly reviewed before

submitting the ER, and to ensure that such new and potentially significant information related to renewal of the license for Palisades would be identified, reviewed, and assessed during the period of NRC review. NMC 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 Palisades. This review was performed by personnel from NMC 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 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 Palisades. At the beginning of the discussion of each set of issues, a table identifies the issues to be addressed and lists the sections in the GEIS where the issues are 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 NRC 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 evaluation of the NMC license renewal application began with publication of a Notice of Acceptance for docketing and opportunity for a hearing in the *Federal Register* (Volume 70, page 33533 (70 FR 33533)) (NRC 2005a) on June 8, 2005. On June 27, 2005, the NRC staff published a Notice of Intent to prepare an EIS and conduct scoping (70 FR 36967) (NRC 2005b). Two public scoping meetings were held on July 28, 2005, in South Haven, Michigan. Comments received during the scoping period were summarized in the *Environmental Impact Statement Scoping Process: Summary Report – Palisades Nuclear Plant, Van Buren County, Michigan*

(NRC 2005c). Comments that are applicable to this environmental review are presented in Part I of Appendix A.

The NRC staff followed the review guidance contained in NUREG-1555, Supplement 1 (NRC 2000). The NRC staff and contractors retained to assist the NRC visited the Palisades site on July 26 and 27, 2005, to gather information and to become familiar with the site and its environs. The NRC 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 Palisades were reviewed and are referenced in this SEIS.

This SEIS presents the NRC staff's analysis that considers and weighs the environmental impacts of the proposed renewal of the OL for Palisades, the environmental impacts of alternatives to license renewal, and mitigation measures available for avoiding adverse environmental impacts. 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 decision makers would be unreasonable.

On February 23, 2006, the NRC published a Notice of Availability of the draft SEIS (71 FR 9383) (NRC 2006). A 75-day comment period began on the date of publication of the U.S. Environmental Protection Agency Notice of Filing of the draft SEIS to allow members of the public to comment on the preliminary results of the NRC staff's review. During this comment period, two public meetings, an afternoon session and an evening session, were held on April 5, 2006 at South Haven, Michigan. During these meetings, the NRC staff described the preliminary results of the NRC environmental review and answered questions related to it to provide members of the public with information to assist them in formulating their comments. The comment period for the Palisades draft SEIS ended on May 18, 2006. Comments made during the 75-day comment period, including those made at the two public meetings, are presented in Part II of Appendix A of this SEIS. The NRC's responses to those comments are also provided.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the OL for Palisades. Palisades is located in Covert Township, Van Buren County, Michigan, on the southeastern shoreline of Lake Michigan. The site is located 4.5 mi south of the South Haven city limits. Kalamazoo and Portage, Michigan, and Elkhart and South Bend, Indiana, are located inland 30 to 50 mi from Palisades. Smaller cities in the region include South Haven, Benton Harbor, and St. Joseph, Michigan. The site location is approximately 75 mi northeast of downtown Chicago, Illinois.

The plant has a single pressurized light-water reactor. Combustion Engineering, Inc., designed the Nuclear Steam Supply System, which includes the primary system (e.g., reactor vessel, steam generators, pressurizer, and pumps), reactor auxiliary system components, nuclear and certain process instrumentation, and the Reactor Protective System. Bechtel Corporation and its affiliate, Bechtel Company, designed and supplied the balance of the plant equipment, systems, and structures (NMC 2003).

The maximum authorized power level of the reactor is 2565 megawatts thermal (MW(t)) (NMC 2003). The current net summer capacity of Palisades is 786 megawatts electric (MW(e)), which is equivalent to the power needs of approximately 775,000 residences (NMC 2005a). Palisades uses a circulating water cooling system to conduct waste heat from the main condenser to two mechanical draft cooling towers where heat is removed by evaporation. The current OL for Palisades expires on March 24, 2011. By letter dated March 22, 2005, NMC submitted an application to the NRC (NMC 2005b) to renew this OL for an additional 20 years of operation (i.e., until March 24, 2031).

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) decision makers.

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 utility officials 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

NMC is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER (NMC 2005a), NMC provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with license renewal for Palisades. Authorizations and consultations relevant to the proposed OL renewal action are included in Appendix E.

The NRC staff has 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. These agencies did not identify any new and significant environmental issues. The ER (NMC 2005a) states that NMC is in compliance with applicable environmental standards and requirements for Palisades. The NRC 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, *Protection of Environment*, Part 1508, "Terminology and Index."

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

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

Nuclear Management Company, LLC (NMC). 2003. *Final Safety Analysis Report (FSAR) – Palisades Nuclear Plant*. Rev. 24, Covert, Michigan (October 2003).

Nuclear Management Company, LLC (NMC). 2005a. *Applicant's Environmental Report – Operating License Renewal Stage, Palisades Nuclear Power Plant*. Docket No. 50-255, Covert, Michigan (March 2005).

Nuclear Management Company (NMC). 2005b. *Palisades Nuclear Plant. Application for Renewed Operating License*. Covert, Michigan (March 22, 2005).

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

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

U.S. Nuclear Regulatory Commission (NRC). 2005a. "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. DPR-20 for an Additional 20-Year Period." *Federal Register*, Vol. 70, No. 109, pp. 33533–33535, Washington, D.C. (June 8, 2005).

U.S. Nuclear Regulatory Commission (NRC). 2005b. "Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register*, Vol. 70, No. 122, pp. 36967–36968, Washington, D.C. (June 27, 2005).

U.S. Nuclear Regulatory Commission (NRC). 2005c. *Environmental Impact Statement Scoping Process: Summary Report – Palisades Nuclear Plant, Van Buren County, Michigan*. Washington, D.C. (December 14, 2005).

U.S. Nuclear Regulatory Commission (NRC). 2006. "Nuclear Management Company, LLC; Palisades Nuclear Plant; Notice of Availability of the Draft Supplement 27 to the Generic Environmental Impact Statement, and Public Meeting for the License Renewal of Palisades Nuclear Plant." *Federal Register*, Vol. 71, No. 36, pp. 9383–9384, Washington, D.C. (February 23, 2006).

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

Palisades Nuclear Plant (Palisades) is owned by Consumers Energy Company (Consumers Energy), a subsidiary of CMS Energy Corporation. Nuclear Management Company, LLC (NMC), operates Palisades on behalf of Consumers Energy. With respect to the Palisades operating license (OL), Consumers Energy is the owner licensee, and NMC is the licensed operator of the facility (NMC 2005a). Palisades is located in Covert Township, Van Buren County, Michigan, on the southeastern shoreline of Lake Michigan. The plant consists of a pressurized light-water reactor that produces steam that turns turbines to generate electricity.

The Palisades facilities and infrastructure include the power block area, two independent spent fuel storage installations for dry storage, mechanical draft cooling towers, main parking lot, main access road, switchyard (Palisades Substation), and power transmission facilities and corridors, which extend eastward from the power block to the eastern site boundary at the Blue Star Memorial Highway. Other development on the site consists of waste storage and support facilities, including a radioactive waste storage building, an interim steam generator storage building for storage of old steam generators that were replaced in the early 1990s, a warehouse, an outage/training facility, and spent fuel services building. 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

Palisades is located on approximately 432 ac of land, and is bordered by Lake Michigan on the west and the Blue Star Memorial Highway and adjacent Interstate-196 (I-196) on the east in Covert Township, Van Buren County, Michigan. The nearest town is South Haven, Michigan, which is approximately 4.5 mi north of the plant, and has a population of about 5000 people. The major towns within a 50-mi radius of the plant are Kalamazoo and Portage, Michigan, and Elkhart, Mishawaka, and South Bend, Indiana. Figures 2-1 and 2-2 show the site location and features within 50 mi and 6 mi, respectively (NMC 2005a).

Based on 2000 U.S. Census Bureau data, approximately 1.3 million people live within 50 mi of the site (NMC 2005a). The population density of 293 persons/mi^2 is considered a high population area based on the criteria described in the Generic Environmental Impact Statement

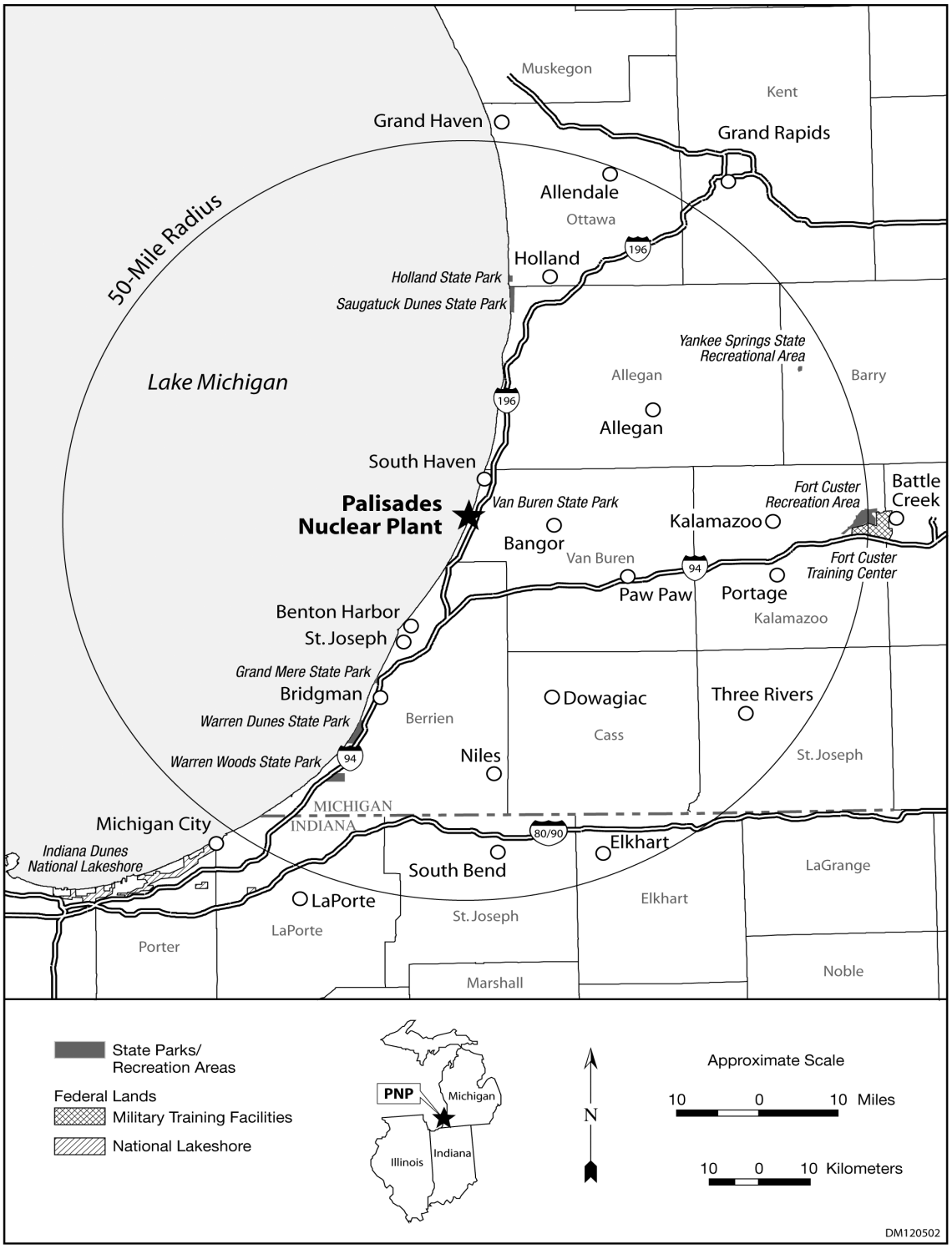

Figure 2-1. Location of Palisades, 50-mi Region

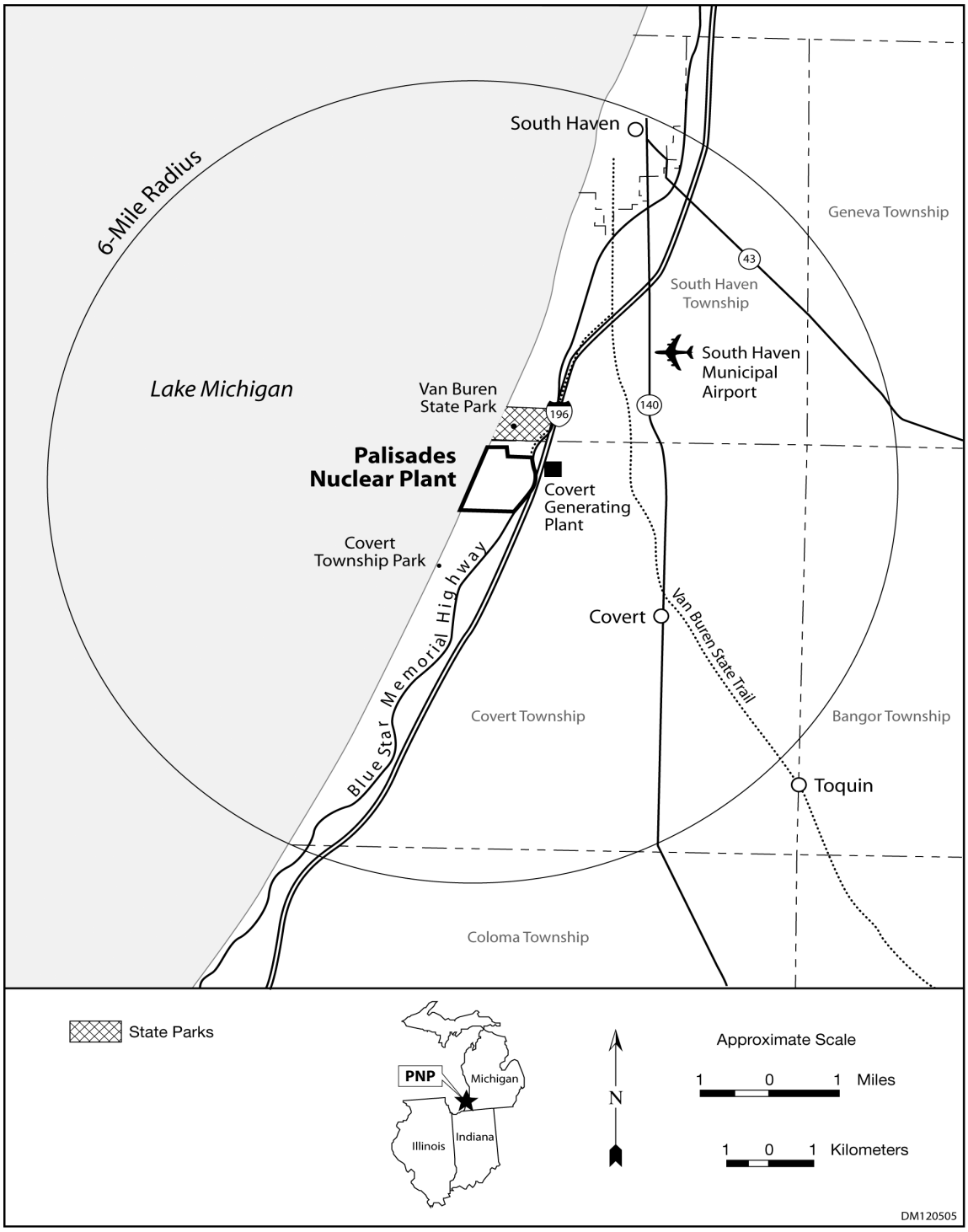

Figure 2-2. Location of Palisades, 6-mi Region

for License Renewal of Nuclear Plants (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[(a)]

NMC employs a permanent workforce of approximately 530 employees and 110 contractors. The reactor is refueled on an 18-month refueling cycle. During refueling outages, site employment increases by approximately 380 workers assigned for temporary (30 to 40 days) duty (NMC 2005a). Upon the initiation of the renewed OL, the permanent workforce is expected to increase by approximately 60 employees to perform the license renewal surveillance, online monitoring, inspections, testing, trending, and record keeping activities (NMC 2005a).

2.1.1 External Appearance and Setting

Palisades property includes approximately 1 mi of lake frontage and extends about 1 mi eastward from Lake Michigan. The local terrain consists of a gentle upward sloping beach at an elevation of about 580 ft above mean sea level (MSL) that rises sharply into sand dunes at an elevation of approximately 780 ft MSL and then drops off abruptly to about 610 ft MSL at the eastern site boundary. The area surrounding the plant property is largely rural, characterized by agriculture and heavily wooded, rugged sand dunes along the lakeshore (NMC 2005a). As indicated in Figure 2-2, there are few urban areas and little industrial development within the 6-mi radius of the plant. The only major industrial facility in the immediate vicinity of the site is the Covert Generating Station, on the east side of I-196. The Covert Generating Station, owned and operated independently of Palisades, consists of three natural-gas-fired combined-cycle electric generating units. It generates 1100 MW of electricity when all three units are operating. The electricity from the plant is connected to the grid at the Palisades Substation.

The developed area on the Palisades site, which includes power production and support facilities, roads, parking lots, and the transmission line rights-of way up to the site boundary, is approximately 80 ac. No residences exist on the site. The main access to the site is the Blue Star Memorial Highway.

Numerous public recreational areas and summer vacation properties exist within 50 mi of the Palisades site. The area is particularly popular with tourists during the summer months. There are no Federal facilities, but State-owned facilities include eight parks, two recreational areas, seven game areas, one fish and wildlife area, and seven wilderness and natural areas (NMC 2005a). There are also a large number (more than 200) of municipal and privately owned parks and recreational areas. The site is bordered by Van Buren State Park on the north and a privately owned residential and lakefront recreational community, Palisades Park and Country Club, on the south. The 400-ac Van Buren State Park has a 1-mi shoreline on Lake Michigan and contains campgrounds and picnic and beach facilities. Two of the State Parks in the region

(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.

are linear walking and riding trails. The Van Buren Trail State Park is a dirt and gravel multiuse trail between South Haven and Hartford, Michigan. The Kal-Haven Trail State Park is a 34-mi crushed limestone path between South Haven and Kalamazoo, Michigan. Both trails are located on abandoned railroad paths (NMC 2005a). Many of the State-owned and private recreational areas within 50 mi of the site offer facilities for camping, picnicking, boating, hunting, fishing, swimming, hiking, horseback riding, and winter sports (NMC 2005a).

The 432-ac Palisades site is owned by Consumers Energy. Consumers Energy has granted easements to the Michigan Electric Transmission Company, LLC (METC), which owns the transmission lines leaving the Palisades Substation on the site. The immediate plant area is fenced, with a locked gate under the control of plant personnel. Access to the site is controlled both from the land and the lake.

2.1.2 Reactor Systems

The Nuclear Steam Supply System for Palisades is a pressurized water reactor consisting of a reactor Primary Coolant System (PCS) and associated auxiliary systems (NMC 2003b). The PCS design features two closed loops in which reactor coolant is circulated, each of which includes two primary coolant pumps and a steam generator. The reactor coolant, demineralized water to which chemicals are added to control corrosion and moderate the nuclear reaction, circulates under high pressure through the reactor vessel and the tube side of the two steam generators in these closed loops. Heat from the reactor is transferred to conditioned, demineralized water in the shell side of the steam generators to produce high-pressure steam that is routed through the steam turbine, condensed back to water in the main condenser, and pumped back to the steam generators, thus comprising an isolated secondary cooling loop (i.e., the secondary system) (NMC 2003b). The steam turbine is a tandem-compound unit and is connected directly to the generator. The maximum calculated capacity of the turbine generator is 865 megawatts-electric (MW(e)) gross. Heat transfer from the main condenser is accomplished by a third cooling loop, the Circulating Water System (CWS).

The nuclear fuel is low-enriched uranium dioxide with enrichments below 5 percent by weight (NMC 2005a). The fuel is contained in long fuel rods that are assembled into fuel bundles consisting of 225 rods in 15 × 15 arrays. The collection of fuel bundles with associated instrument tubes, control rods, and structural elements make up the reactor core. The nuclear energy contained in the fuel is converted to thermal energy through fissioning of the uranium atoms in the fuel, and the thermal energy is transferred to the circulating water in the primary cooling system as described above.

The reactor, steam generators, and related systems are enclosed in a Containment Building that is designed to prevent leakage of radioactivity to the environment in the improbable event of a rupture of the reactor coolant piping. The Containment Building is a reinforced concrete

cylinder with a slab base and an arching dome. A 0.25-in. welded steel liner is attached to the inside face of the concrete shell to ensure a high degree of leak-tightness. In addition, the 3.5-ft-thick concrete walls serve as a radiation shield for both normal and accident conditions.

The Containment Building is ventilated to maintain pressure and temperatures within acceptable limits. The containment ventilation system also can purge the containment prior to entry. Exhaust from the ventilation system is monitored for radioactivity before being released to the plant vent, which is located just above the top of the containment outside wall. High-efficiency particulate air (HEPA) filters are used when needed to filter the air before releasing it.

In addition to the Containment Building, the major structures within the power block on the Palisades site include the Turbine Building, which houses the turbines, the electrical generator, condenser, feedwater heaters, and feedwater and condensate pumps; the Auxiliary Building and the attached Radioactive Waste Building, which contain the spent fuel pool, radioactive waste management equipment, heating and ventilation system components, the emergency diesel generators, switchgear, laboratories, offices, and the control room; the Condensate and Makeup Demineralizer Building, which houses the equipment and facilities used to treat the makeup water for the CWS; the Cooling Tower Pump House; and the Intake Structure, which houses the service water and fire protection pumps.

As shown in Figure 2-3, the other prominent structures outside of the power block area on the Palisades side include two independent spent fuel storage installations for dry storage, cooling towers, the Palisades Substation (the switchyard), power transmission lines extending from the Palisades Substation to the eastern site boundary, a warehouse building, a meteorological tower, and various storage areas, roads, and parking lots.

2.1.3 Cooling and Auxiliary Water Systems

Palisades relies on two sources of water: raw water from Lake Michigan and potable water from the South Haven Municipal Water Authority (Consumers Energy 2003a; NMC 2003b). The water from Lake Michigan is used primarily for waste heat removal in the plant's Service Water System (SWS) and CWS. The withdrawal rate is approximately 98,000 gpm during normal full power operation. Of this flow, evaporative loss due to evaporation from the two CWS cooling towers may range as high as 12,000 gpm during the summer, while the remaining 86,000 gpm is returned to Lake Michigan (Consumers Energy 2003a; NMC 2003b).

The water for the SWS and CWS is withdrawn from Lake Michigan via pipeline from a submerged intake crib structure located 3300 ft offshore in water about 35 ft deep (Consumers Energy and NMC 2001). The crib structure is a box measuring 57 ft wide, 57 ft long, and 13 ft high. Two-thirds of its top surface consist of steel plates, and one-third is comprised of bar

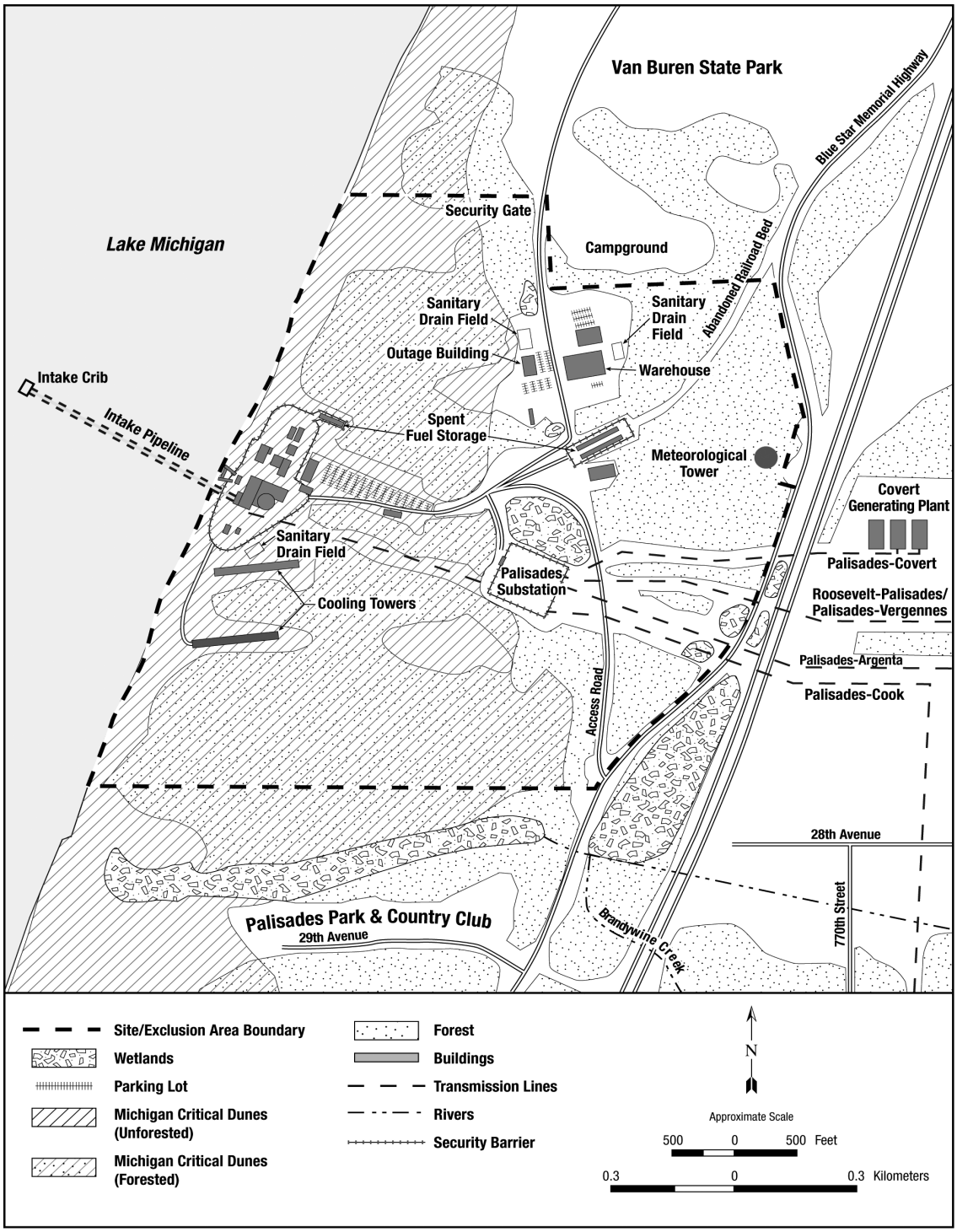

Figure 2-3. Palisades Site Layout

racks. Water enters the crib through the bar racks and on each of the crib's four sides, which are constructed of 2-in. vertical steel bars spaced at 10-in. intervals (Consumers Energy and NMC 2001).

Originally, the crib was designed for a once-through cooling-water flow rate of approximately 400,000 gpm. However, subsequent conversion to a closed-cycle cooling system reduced intake flow to approximately 98,000 gpm, resulting in low approach velocities of approximately 0.1 foot per second at the face of the structure (Consumers Energy and NMC 2001). Water flows from the intake crib through an 11-ft-diameter pipe to the onshore intake structure where it passes through trash racks constructed of steeply sloped bars to prevent entry of coarse debris. Debris accumulated on the trash racks is removed by a mechanical rake or scoop (AEC 1972). The water then flows through vertical 0.375-in. mesh traveling screens for removal of finer debris (Consumers Energy and NMC 2001). The traveling screens are cleaned by rotating and backwashing the screens as needed (in automatic or manual operation) and sluicing the debris to a collection basket (AEC 1972; Consumers Energy and NMC 2001). The accumulated debris is disposed of in accordance with the Palisades National Pollutant Discharge Elimination System (NPDES) permit (MDEQ 2004).

Three 8000-gpm service water pumps, one of which is normally on standby, are located in the onshore intake structure and provide water to the SWS (NMC 2003b). The purpose of the service water is to remove waste heat from the nuclear plant and steam plant auxiliary systems. After flowing through coolers, heat exchangers, and other plant components, this service water is discharged to the makeup basin, which is open to the suction basins for the CWS cooling-tower pumps (NMC 2003b). A small fraction of water in the SWS is used as feedwater for production of demineralized water for use in the primary and secondary cooling loops.

The CWS removes waste heat from the main condenser by recirculating water from the hot side of the condenser through the facility's two mechanical draft cooling towers (NMC 2003b). In these towers, cooling takes place through evaporation. Water circulation in this system is accomplished by two 164,000-gpm pumps located in the cooling-tower pump building. Evaporation in the cooling towers ranges from 4500 gpm in winter to 6000 gpm in summer for each of the two towers.

Evaporation and other losses (e.g., cooling-tower blowdown) from the CWS are replaced by makeup water withdrawn from the onshore intake structure by two 40,000-gpm dilution water pumps. Makeup water surplus is directed to the makeup basin where it combines with the SWS cooling water. Excess cooling water in the makeup basin flows over weirs to the mixing basin for discharge to the lake.

The cool lake water provided by the dilution water pumps increases the generation efficiency of the plant and reduces the temperature of the water discharged to the lake (NMC 2003b). Cooling water mixes with low-volume waste sources, which meet the criteria described in

Section 2.2.3, from plant operations in the mixing basin and flows through openings in the outer wall of the mixing basin to Lake Michigan via Outfall 001, which is the shoreline discharge structure (NMC 2003b). The outfall is a pile structure that widens from 37 ft at the mixing basin outlet wall to 100 ft at its terminus, 108 ft from the outlet wall (AEC 1972). The discharge (monitoring point 001A) is monitored for both radiological and nonradiological parameters in accordance with the NPDES permit (MDEQ 2004). Associated limits include a maximum allowable discharge flow of 135.2 million gpd, a daily maximum heat addition limit of 2.1×10^9 Btu/hr, and limits for release of total residual oxidants (TROs) used for biofouling control (MDEQ 2004).

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

Radioactive wastes resulting from plant operations are classified as liquid, gaseous, and solid wastes. Palisades uses liquid, gaseous, and solid radioactive waste management systems to collect and process these wastes before they are released to the environment or shipped to offsite commercial waste processing or disposal facilities. The waste disposal system meets the design objectives and release limits as set forth in Title 10 of the *Code of Federal Regulations*, Part 20 (10 CFR Part 20) and Part 50 (10 CFR Part 50), Appendix I ("Numerical Guide 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. Section 3.8.1.1 "Regulatory Requirements" of the GEIS (NRC 1996) provides a summary of the regulatory requirements and specific numerical dose limits. Unless otherwise noted, the description of the radioactive waste management systems and effluent control systems for liquid, gaseous, and solid wastes presented here (Sections 2.1.4.1, 2.1.4.2, and 2.1.4.3, respectively) is based on information provided in the *Palisades Final Safety Analysis Report* (FSAR; NMC 2003b) and as confirmed during the U.S. Nuclear Regulatory Commission (NRC) staff site visit on July 26 and July 27, 2005.

The waste disposal system collects and processes all potentially radioactive reactor plant wastes for removal from the plant site within limitations established by applicable governmental regulations. In addition, the system is capable of liquid waste segregation and reuse. All planned releases of liquid and gaseous effluents may be either batch or continuous. Before a batch may be released, the tank is sampled and the sample analyzed in the laboratory. A gas release is made only if the release can be made without exceeding Federal standards, and lack of reserve holdup capacity requires such a release. Radiation monitors are provided to maintain surveillance over the release operation, and a permanent record of activity released is provided by radiochemical analysis of known quantities of waste (NMC 2003b).

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; however, as a result of fuel

cladding failure and corrosion, 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 operations during design modification and during routine maintenance activities. The solid waste disposal system is designed to package solid wastes for removal to offsite treatment or disposal facilities. Some solid waste is temporarily stored onsite.

Fuel assemblies that have exhausted a certain percentage of their fuel and that are removed from the reactor core for disposal are called spent fuel. Palisades currently operates on an 18-month refueling cycle. Spent fuel is temporarily stored onsite in a spent fuel pool and in two dry-storage areas.

The Offsite Dose Calculation Manual (ODCM) for Palisades (NMC 2004a), which is included in the *Palisades Annual Radioactive Effluent Release and Waste Disposal Report*s (e.g., NMC 2005b), describes the methods and parameters used for calculating radioactivity concentrations in the environment and the estimated potential offsite doses associated with liquid and gaseous effluents from the plant. The ODCM also specifies controls for release of liquid and gaseous effluents from Palisades to ensure compliance with NRC regulations.

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

A small fraction of the water circulating in the primary coolant system is routinely withdrawn by the chemical and volume control system within the plant, processed, and then reinjected into the primary coolant system to control the composition and volume of the primary coolant. The processing equipment removes any radionuclides that either escape from the fuel rods or are produced in the coolant due to activation with neutrons to prevent their buildup in the primary coolant.

Any leaks from piping, valves, pump seals, and storage tanks throughout the plant are routinely collected via catch basins, building drains, or sumps. At times equipment changes, repairs, or cleanup operations also generate liquids that contain small concentrations of radioactive elements. All such liquids, including those generated by the chemical and volume control system, are handled by the Liquid Radioactive Waste System. They are collected, monitored, and processed by a combination of mechanisms, including holdup (permitting radioactive decay), filtration, demineralization, and ion-exchange treatment (removal of insoluble particulates and soluble contaminants), degassing (removal of dissolved gases), and evaporation (volume reduction). After processing, most of the liquids are recycled back into the primary coolant system or other liquid systems within the plant and reused. The wet residues or certain concentrates are solidified and sent offsite for disposal (see Section 2.1.4.3). Liquid

streams that are not needed in the plant and meet the release criteria established in 10 CFR Part 50, Appendix I, are discharged to Lake Michigan after dilution with CWS discharge. This flow is via low-velocity surface discharge at the shoreline. The releases to the lake are in batches and are strictly monitored to make sure that the release criteria are met. Any liquids that do not meet the criteria are reprocessed until they meet the criteria, or they are sent offsite for disposal after appropriate solidification and packaging.

Some of the radionuclides in the recycled primary coolant are noble gases dissolved in the water. These radionuclides are degassed during the processing of the bleed-off stream by the chemical and volume control system and sent to the gaseous radioactive waste processing system for further processing (see Section 2.1.4.2).

Prior to 1989, another source of liquid waste was the laundry facility that was used to clean contaminated clothing. Although the equipment used for laundry is still in place, the facility is no longer being used. Laundry is sent offsite to be cleaned by a contractor, and clean laundry is returned to the site.

During the 5-year period from 2000 through 2004, an average of four liquid batch releases occurred annually from Palisades. During this 5-year period, there were no unplanned or uncontrolled liquid releases to the environment. Liquid effluents were reported in the *Palisades Annual Radioactive Effluent Release and Waste Disposal Reports* for the years 2000 through 2004 (NMC 2001a, 2002, 2003a, 2004b, 2005b). Over this period, liquid effluents containing fission and activation products[(a)] and tritium were released into Lake Michigan. An annual average of 1.18×10^{-3} Ci of fission and activation products and 202 Ci of tritium were discharged with an average diluted concentration of 8.78×10^{-15} Ci/L for fission and activation products and 1.58×10^{-9} Ci/L for tritium (NMC 2001a, 2002, 2003a, 2004b, 2005b). The maximum amount released in any one year during the 5-year period was 2.12×10^{-3} Ci for fission and activation products and 342 Ci for tritium. The releases and the average diluted concentrations were well below NRC regulatory limits. In 2005 (the most recent year for which data were available), the radioactive materials released to Lake Michigan in liquid effluents were 0.01 Ci of fission and activation products and 305 Ci of tritium (NMC 2006a). Nine liquid batch releases occurred in 2005; none of them were unplanned or uncontrolled. The average diluted concentration of fission and activation products in liquid effluents released in 2005 was 7.27×10^{-14} Ci/L; the average diluted concentration of tritium was 2.13×10^{-9} Ci/L. NMC does not anticipate any significant increases in liquid waste released annually during the renewal period. See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual (MEI) as a result of these releases.

(a) The fission and activation products do not include tritium activity (which is given separately), activity of dissolved and entrained gases (which is generally below levels of detection), and gross alpha radioactivity (which is negligibly small).

Since the March 22, 2005, application for the license renewal of Palisades, NMC has modified its liquid radioactive waste processing system. The system that NMC installed in December 2005 relies on cleaning of the contaminated liquid streams through a process known as ion exchange. In this method, specially formulated resins are used to capture the contaminants from the liquid streams; streams can be recycled through the resin bed to further reduce contaminant levels if samples are above regulatory standards. Once saturated, the resins are removed from the system and are treated as solid waste. New resins are placed in the system and the cycle is repeated.

The equipment NMC has installed is commonly used in other nuclear power plants in the United States, including the Donald C. Cook Nuclear Plant in Michigan and Nine Mile Point in New York. On the basis of experience in those plants and analyses conducted by NMC staff, it is expected that the amount of radioactive material released in liquid effluent may increase slightly. However, Palisades will continue to comply with all regulatory standards and will maintain the existing ODCM release limits and set points.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

During plant operations, gaseous wastes originate from degassing reactor coolant discharged to the chemical and volume control system, displacement of cover gases as liquids accumulate in various tanks, miscellaneous equipment vents and relief valves, and sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases.

The Gaseous Radioactive Waste System in Palisades is designed to maintain gaseous effluents within limits specified in 10 CFR Part 20, 40 CFR Part 190, and to the ALARA (as low as reasonably achievable) requirement of 10 CFR Part 50, Appendix I. Section 3.8.1.1 of the GEIS (NRC 1996) provides a summary of these regulatory requirements and specific numerical dose limits. The Gaseous Radioactive Waste System is divided into two sections: (1) the gas collection header, which collects low-activity gases from liquids that have been previously degassed and/or vented in other waste handling steps, and (2) the waste gas processing system, which collects gases from potentially high-activity sources. Gases collected by the gas collection header are passed through a HEPA filter to the suction side of the main vent exhaust fans, diluted by ventilation exhaust air, and discharged through a ventilation stack to the atmosphere.

The waste gas processing system collects all potentially high-activity gaseous waste. The waste gas surge tank collects and absorbs surges from the demineralizer vents, quench tank vent, primary system drain tank vent, volume control tank vent, vacuum degassifier vent, equipment drain tank, and evaporator vents. The same tank also collects vent gas from relief valves on various waste collection tanks. The waste gas surge tank discharges to one of three compressors that compress the gas for storage and decay in one or more of six waste decay

tanks. If the activities are less than or equal to 1×10^{-5} µCi/cm^3 (xenon-133), the waste gas surge tank can be discharged through a HEPA filter directly to the ventilation stack.

Gases collected in decay tanks are held in the tanks until the radioactivity is low enough for them to be discharged to the atmosphere. Gaseous effluents entering the plant's ventilation stack are continuously monitored and flow-controlled so that the previously established limits are not exceeded. The discharge is then immediately diluted by mixing airflow from one of the two continuously operating ventilation fans that transport 75,000 ft^3/min of air up the stack. If at any time a high radiation condition is detected, the flow of radioactive gases through the stack is stopped and the control room operators are alerted of the condition.

Gaseous effluents for the years 2000 through 2004 were reported in the *Palisades Annual Radioactive Effluent Release and Waste Disposal Reports* (NMC 2001a, 2002, 2003a, 2004b, 2005b). During this 5-year period, there were no unplanned or uncontrolled gaseous releases to the environment; Palisades did, however, release measurable concentrations of fission and activation gases, radioiodine, particulate radioactivity, and tritium in gaseous effluents to the atmosphere. The average annual effluent releases over this 5-year period were 28.9 Ci of fission and activation gases, 1.93×10^{-3} Ci of iodine-131, 2.65×10^{-4} Ci of particulates, and 37.7 Ci of tritium. The maximum amount released in any one year during this 5-year period was 65 Ci for fission and activation gases, 3.49×10^{-3} Ci for iodine-131, 9.62×10^{-4} for particulates, and 99.2 Ci for tritium. In 2005 (the most recent year for which data were available), there were also no unplanned or uncontrolled gaseous releases to the environment. The radioactive materials released to the atmosphere in gaseous effluents were 43.8 Ci of fission and activation gases, 1.30×10^{-3} of iodine-131, 3.11×10^{-5} of particulates, and 108 Ci of tritium (NMC 2006a). NMC does not anticipate any significant increases in the radioactive gaseous releases during the renewal period. As discussed in Section 2.2.7, the estimated doses to the MEI as a result of these releases is a small fraction of applicable dose limits.

2.1.4.3 Solid Waste Processing

Solid wastes from Palisades include filter sludge, spent resin, radioactive tools and equipment, and miscellaneous trash from plant operations and laboratory, maintenance, and cleanup operations. The solid wastes are collected, processed, and temporarily stored onsite before being shipped offsite for disposal or further processing and disposal by an authorized third party. Radiation levels of shipped containers are maintained within the standards set forth by the NRC and the U.S. Department of Transportation (DOT) (NMC 2003b).

The Solid Radioactive Waste System consists of those systems and components that are used to process and package wet and dry solid waste so that the waste is suitable for transport and disposal. The system is not used for spent fuel storage and shipment. The spent fuel from the plant is currently stored in the spent fuel storage pool and two dry storage areas onsite.

High-activity reactor wastes other than the spent fuel are stored in the fuel storage pool to allow radioactive decay, then packaged and transferred in approved shipping containers for offsite burial. Maintenance waste, such as contaminated clothing and tools, is packed in suitable DOT-approved containers and may be stored prior to shipment. Process waste, such as filter sludges and spent resins, is collected in tanks, processed, and stored prior to shipment.

Dry active waste (DAW), generated as a result of operation and maintenance activities, is collected throughout the radiologically controlled areas of the facility. Typical DAW includes air filters, cleaning rags, protective tape, paper and plastic coverings, discarded contaminated clothing, tools, equipment parts, and solid laboratory wastes. Most DAW has relatively low radioactive content and may be handled manually. The DAW is normally stored in various work areas and then moved to the process area.

Liquid radwaste concentrates (evaporator bottoms) are volume reduced to a dry powder, mixed with a binding agent, and discharged directly into a burial container. Wet solid radioactive waste results from the processing of spent demineralizer resins (both bead and powdered) and spent filter material from the equipment drain, floor drain subsystems, and water cleanup systems. The wet waste is solidified, dried, or dewatered for acceptability for a disposal site. If storage is required for any of these types of waste, the containers of waste may be temporarily stored onsite.

Transportation and disposal of solid radioactive wastes are performed in accordance with the applicable requirements of 10 CFR Part 71 and 10 CFR Part 61, respectively. No releases to the environment occur from solid radioactive wastes generated at Palisades. During the period 2000 through 2004, Palisades made an average of 16 shipments of solid radioactive waste each year, with an average volume for spent resins, filter sludges, evaporator bottoms, contaminated equipment, and other sources of 1561 ft^3, and an average activity of 1740 Ci (NMC 2001a, 2002, 2003a, 2004b, 2005b; 2005e). The maximum volume of waste shipped offsite in any one year during this 5-year period was 2285 ft^3 in 2001. In terms of activity, the maximum amount shipped in any one year was 8554 Ci in 2000. In 2005 (the most recent year for which data were available), approximately 3630 ft^3 of solid waste containing 347 Ci of radioactivity was shipped offsite (NMC 2006a). The modification to the liquid waste processing system at Palisades completed in December 2005 (see Section 2.1.4.1) is not expected to significantly change the generation of solid waste and offsite shipments of such waste from the plant.

2.1.5 Nonradioactive Waste Systems

The principal nonradioactive effluents from Palisades consist of chemical and biocide wastes, lubrication oil waste, resin regeneration waste, Freon™ filters, and sanitary waste. Palisades stopped using chlorinated solvents and oils several years ago. The chemistry laboratory may generate small quantities of expired chemicals. Other wastes could include laboratory packs

and mercury switches. Spent batteries and discarded fluorescent lights are recycled. Sanitary waste is sent to three onsite septic tanks. The tanks are sampled twice a year and emptied quarterly. Thus far, no radioactive contamination has been detected in the tanks. Depending on the usage and the number of workers onsite during outages, they may be emptied more frequently. The sewage removed from the tanks is taken to a local sewage treatment plant and treated there, along with regular city sewage.

2.1.6 Plant Operation and Maintenance

Routine maintenance performed on plant systems and components is necessary for the safe and reliable operation of a nuclear power plant. Maintenance activities conducted at Palisades 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 the replacement of a major component. Palisades is refueled on an 18-month schedule.

As part of the License Renewal Application (Application), NMC conducted an aging management review to manage the impacts of aging on systems, structures, and components in accordance with 10 CFR Part 54. Appendix A of the Application provides the information to be submitted in a FSAR Supplement as required by 10 CFR 54.21(d) for Palisades. The Application contains the technical information required by 10 CFR Part 54. Section 4 of the Application documents the evaluations of time-limited aging analyses (TLAAs) for the period of extended operation. Appendix B of the Application provides descriptions of the programs and activities that will manage the impacts of aging for the period of extended operation. These summary descriptions of aging management program activities and TLAAs will be incorporated into the FSAR for Palisades following the issuance of the renewed OL. NMC expects to conduct the activities related to the management of aging impacts during plant operation or normal refueling and other outages, but does not plan any outages specifically for the purpose of refurbishment.

2.1.7 Power Transmission System

Transmission corridors considered in scope for license renewal are those constructed specifically to connect the facility to the transmission system (10 CFR 51.53(c)(3)(ii)(H)). The Final Environmental Statement (FES) for Palisades (AEC 1972) described two transmission lines that connected Palisades with the transmission system. Both lines were constructed in 1969 and have steel lattice support structures anchored to concrete footings (AEC 1972). The initial 0.6-mi long Palisades-Cook 345-kV transmission line (referred to as the Palisades-West Olive line in the FES (AEC 1972)) connects to the American Electric Power (AEP) system, while the 40-mi-long Palisades-Argenta 345-kV transmission line connects to the METC system and

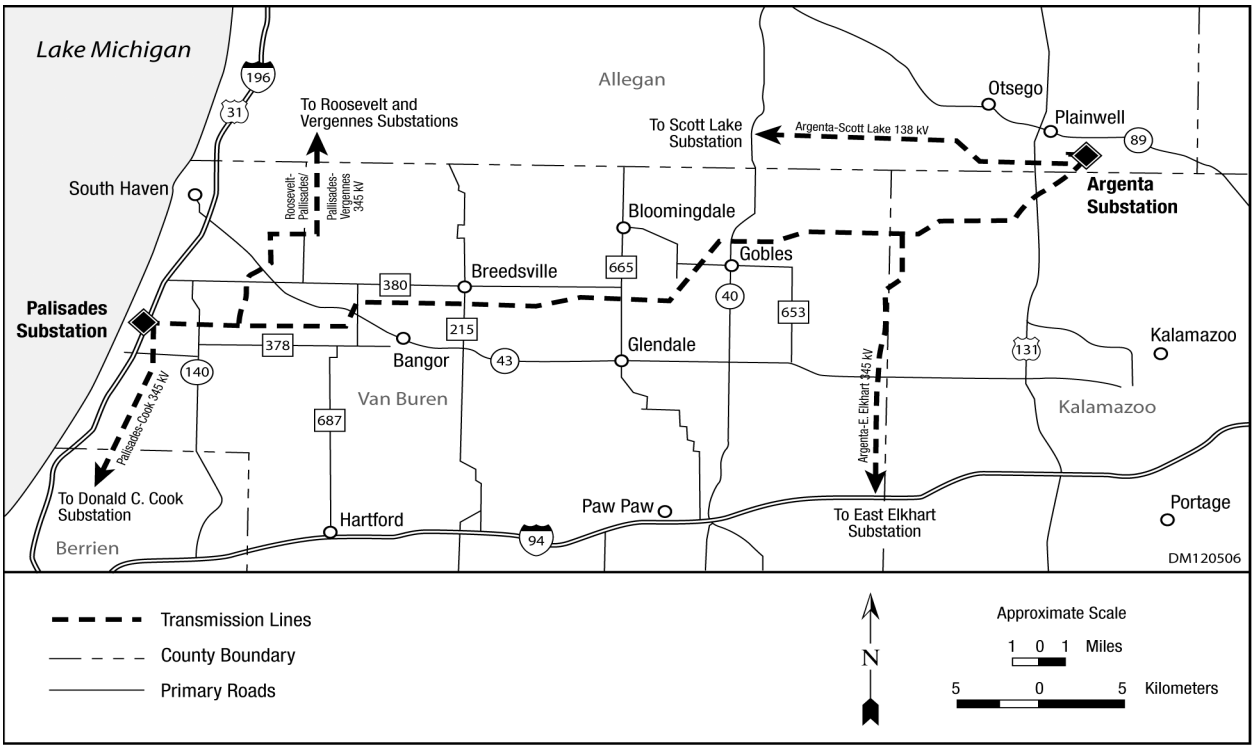

Figure 2-4. Transmission Lines

the Michigan Power Pool (NMC 2005a). The Palisades-Argenta line extends eastward to the Argenta Substation near Plainwell, north of Kalamazoo (Figure 2-4). Both transmission lines have been owned by the METC since 2002, while Consumers Energy owns the land on which the transmission lines are located (NMC 2005a).

The Palisades Substation, which operates at 345-kV, is the interconnection between Palisades and the power grid system. The applicant's ER (NMC 2005a) describes changes in the way that Palisades is connected to the transmission system that have been made since the FES was published. Currently seven 345-kV circuits on four double-circuit, steel lattice support structure transmission lines extend from the Palisades Substation (Figure 2-3): Palisades-Cook #1 and #2 (Circuits 310B and 310A); Palisades-Argenta #1 and #2 (Circuits 309A and 309B); Palisades-Vergennes and Roosevelt-Palisades (Circuits 306A and 306B); and Palisades-Covert Plant (Circuit 306J) (NMC 2005a). However, only the 0.6-mi-long Palisades-Cook line and the 40-mi-long Palisades-Argenta line are considered in scope for license renewal.

Both transmission lines associated with Palisades were constructed in accordance with the National Electrical Safety Code (NESC) (IEEE 2002) and industry guidance in effect at that time. The transmission facilities are maintained to ensure continued compliance with current standards.

The 0.6-mi-long Palisades-Cook transmission line occurs on land similar to that of the Palisades site. Its construction involved the clearing of a 150-ft-wide right-of-way totaling 10.9 ac over sand dunes (AEC 1972). The Palisades-Argenta transmission line right-of-way is 1320 ft wide for the first 4.5 mi, 350 ft wide for the next 34 mi, and 471 ft wide for the final 1.5 mi, totaling 2250 ac. This line occurs mostly on flat to gently rolling terrain crossing land used primarily for agriculture, with scattered orchards and residential and commercial properties (AEC 1972).

In general, the corridors are in remote, sparsely populated areas. Where the Palisades-Argenta line crosses agricultural lands, the land typically continues to be used for agricultural purposes. Both transmission lines cross Blue Star Memorial Highway and I-196, which occur just east of Palisades. The Palisades-Argenta line also crosses a number of other State and U.S. highways. The transmission lines are near the Van Buren State Park, and the Palisades-Argenta transmission line crosses the Kal-Haven and Van Buren State Trails (NMC 2005a). The Palisades-Argenta line crosses the Kalamazoo River and several other streams (see Section 2.2.5), while the 0.6-mi-long Palisades-Cook line does not cross any streams or rivers.

The METC recognizes that transmission line rights-of-way provide ancillary compatible uses, including agriculture, wildlife habitat, recreation, and aesthetics. The METC practices a vegetation-management program that utilizes physical, chemical, and biological treatments to promote stable, diverse, low-growing plant communities in a way that promotes wildlife habitat and/or maintains current usage of the rights-of-way and reduces environmental impacts.

Semiannual visual helicopter patrols and biennial infrared inspections of the transmission lines are conducted to check for anomalies in the conductors, insulators, and support structures, as well as for encroachments into the rights-of-way (e.g., trees, buildings, or other obstructions) (NMC 2005a). Walking inspections are also conducted about every 2 years to assess the condition of trees and other vegetation. Contractors conduct vegetation maintenance about every 4 years in accordance with METC-approved maintenance plans. Right-of-way maintenance involves both selective cutting and herbicide application. Herbicide use during right-of-way maintenance is restricted to treatment of tree species, with a basal application applied to individual stems or root crowns. Such applications are normally made at 5- to 6-year intervals (METC 2001). Only those herbicides approved by the U.S. Environmental Protection Agency (EPA) are used. They are applied by a licensed contractor in accordance with label instructions (NMC 2005a). Danger trees are generally removed whenever identified, except at critical areas where they are trimmed (METC 2001).

Border and wire zone vegetation management is employed for right-of-way maintenance. The wire zone (the area beneath the conductors) is managed to promote a mix of herbaceous plants, whereas the border area is managed to promote low-growing shrubs and other compatible vegetation. Low-growing trees and shrubs that do not interfere with the function of

the transmission lines are left undisturbed. Trees that have the potential to interfere with the transmission lines, including danger trees that are outside of the 150-ft-wide right-of-way, are removed (NMC 2005a). Special consideration is given to areas where threatened and endangered species could occur and maintenance activities are planned. Practices to mitigate adverse impacts on these species are reviewed and approved by the METC before maintenance activities are conducted (NMC 2005a).

2.2 Plant Interaction with the Environment

Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near Palisades 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 other Federal project activities that might impact license renewal.

2.2.1 Land Use

The Palisades site is located in Covert Township, Van Buren County, Michigan, on the southeastern shoreline of Lake Michigan, about 4.5 mi from South Haven, Michigan. The Palisades site is approximately 432 ac and extends approximately 1 mi inland between Lake Michigan and the Blue Star Memorial Highway and adjacent I-196. The nearest population center is the township of Covert, which is approximately 2.5 mi southeast of the Palisades site. Van Buren State Park is located immediately to the north of the Palisades site, and Van Buren Trail State Park is located northeast of the site.

The Palisades site lies on the southwest flank of the Michigan Basin within the Central Lowland physiographic province (NMC 2003b). Covert Ridge, a glacial moraine, bounds the area to the east of the site. The ridge serves as a drainage divide; the water table gradient is nearly flat with a slow westward flow toward the lake. The western part of the site is covered by large, coalescing sand dunes more than 200 ft high, while the eastern portion is characterized by scattered lower dunes with broad intervening basins, some of which contain shallow ponds. The dunes are relatively stable topographic features with occasional blowout caused by wind action. The majority of the land area is heavily wooded, with occasional wetlands.

The plant facilities are located about 2500 ft from both the northern and southern boundaries of the site. A number of buildings and other permanent structures occupy approximately 80 ac of the Palisades site. These include the power generation and administration area (20 ac), transmission corridors and switchyard (30 ac), warehouse area (7 ac), cooling towers (4 ac), and other supporting buildings and waste storage (7 ac) (DeCamp 2005).

A fence, with a locked gate under the control of plant security personnel, surrounds the protected plant area, and the site boundary is posted (NMC 2005a). As a result of events on September 11, 2001, NMC implemented actions to limit and/or monitor the entire beach area along the lakefront portion of the site. These actions include vehicle barriers and no trespassing signs at the north and south site boundaries. The U.S. Coast Guard has established a security zone extending along the lakeshore frontage of the site 1000 yds out into Lake Michigan, effectively prohibiting access without prior authorization (NMC 2005a).

In addition, Section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA) (Section 1456(c)(3)(A) of Title 16 to the *United States Code*, (16 USC 1456(c)(3)(A))) requires that applicants for Federal licenses certify that the proposed coastal zone activity is consistent with the enforceable policies of the State's coastal management program (NRC 2004). A copy of the certification is also to be provided to the State. The State is to notify the Federal agency whether the State concurs with or objects to the applicant's certification. This notification is to occur within 6 months of the State's receipt of the certification. Palisades is within Michigan's coastal zone for purposes of the Act. Following submission of the NMC certification of consistency, the Michigan Department of Environmental Quality (MDEQ) determined that renewal of the OL for Palisades would be consistent with the Michigan Coastal Management Program (NMC 2005a; Attachment D).

2.2.2 Water Use

Palisades lies on the southeastern shore of Lake Michigan, the only Great Lake that lies entirely within the boundaries of the United States. Lake Michigan is the second largest of the Great Lakes by volume at 1.3×10^{15} gal and third largest by area at 22,300 mi^2. It drains an area of 45,600 mi^2 (Fuller, Shear, and Witting 1995). Major tributaries of Lake Michigan include the Fox-Wolf, Grand, St. Joseph, Menominee, and Kalamazoo Rivers. Lake Michigan is joined to Lake Huron at the Straits of Mackinac; thus, the two basins are hydrologically connected.

The northern part of the Lake Michigan watershed is forested and sparsely populated, except for the Fox River Valley, which drains into Green Bay. The southern part of Lake Michigan is among the most urbanized areas in the Great Lakes region, containing both the Milwaukee and Chicago metropolitan areas.

Lake Michigan provides safe drinking water for 10 million people, wildlife habitat, food production and processing, active sport and sustenance fisheries, and other valuable commercial and recreational activities (EPA 2000). However, threats to the ecosystem of the lake and its basin persist.

As described in Section 2.1.3, water usage at Palisades includes Lake Michigan water by the SWS and the CWS. In addition, the facility receives municipal water from the South Haven

Municipal Water Authority. Average water use by the Palisades Domestic Water Distribution System is approximately 18,000 gpd (Consumers Energy 2003a). This system provides Palisades with water for potable, sanitary, emergency shower, eyewash station, and other uses. Average daily plant usage represents 1.1 percent of the South Haven Municipal Water Authority's average daily demand and 0.45 percent of its permitted capacity (NMC 2005a). NMC does not expect any significant change in water usage during the license renewal term. The South Haven Water Authority has an excess capacity of 0.77 million gpd.

A water intake was constructed in 2002 offshore from Van Buren State Park, approximately 1 mi north of the Palisades facility. The purpose of this intake is to provide water to the Covert Generating Station, a 1170-MW, combined-cycle, natural-gas-fired power plant that shares a transmission line with Palisades (Mulcahy 2002). The Covert plant is located about 1 mi east of Palisades (Figure 2-2). Water usage from the Covert plant has been approximately 8 million gpd (Prein & Newhof 2004). The intake is designed as infiltration beds, comprised of slotted pipe on the lake bottom, and surrounded by gravel and sand that allow infiltration while keeping lake sand out of the pipes (Prein & Newhof 2004). Each infiltration bed has a capacity of 10 million gpd (Prein & Newhof 2004), and the system may be expanded.[(a)]

From the inception of the water intake structure as a source of water for the gas plant's cooling needs, planners realized its potential as a possible future supply point for municipal water (PG&E 2001; City of South Haven 2005; Mulcahy 2002).

South Haven's water needs are anticipated to outgrow its capacity (City of South Haven 2005). South Haven's water system has been operating at 80 to 90 percent of its capacity, and additional development is anticipated, according to a water filtration plant representative.[(a)] The district engineer for the MDEQ estimates that in 3 to 5 years, a water treatment plant will be completed, relying on the intake for use in an expanded municipal water system.[(b)] The water treatment plant would be built on land provided by the Covert Generating Station (City of South Haven 2005).[(b)] As with the existing South Haven water supply system, sampling and monitoring of an additional intake and treatment plant would be regulated by the State of Michigan.

Most of the domestic water is disposed of as sanitary wastewater, which is collected by the Palisades septic system. This system collects the raw sanitary wastewater in holding tanks where solids settle out of the wastewater. Effluent from the tanks flows to three sanitary drain

(a) Personal communication from R. Packard, South Haven Michigan Water Filtration Plant, to J. Quinn, Argonne National Laboratory, Argonne, Illinois. Subject: "Municipal Water System." (September 16, 2005).

(b) Personal communication from W. Chooi, District Engineer, Michigan Department of Environmental Quality, to J. Quinn, Argonne National Laboratory, Argonne, Illinois. Subject: "Lake Michigan Water Intake at Covert." (September 16, 2005).

fields, one located between the north cooling tower and the power block, one located east of Warehouse No. 2, and one located north of the Outage Building (Figure 2-3). Wastewater is treated and disposed of by infiltration at the drain fields; solids are periodically removed from the holding tanks and disposed of at a licensed wastewater treatment facility by a commercial vendor (Consumers Energy 1998).

Palisades has three operating groundwater wells to supply water for grounds maintenance and other miscellaneous uses. Their combined pumping capacity is 24 gpm.

2.2.3 Water Quality

The water quality of Lake Michigan has been degraded by industrial, municipal, agricultural, navigational, and recreational water users for more than 150 years. Water quality is diminished near urban areas, mostly due to sewer overflows, direct storm water runoff, and industrial discharges. Sources of pollutants throughout the basin include atmospheric deposition, release from contaminated groundwater and sediments, point source discharges, and nonpoint source runoff.

The health of aquatic organisms is continually affected by the presence of toxic pollutants (e.g., mercury and polychlorinated biphenyls (PCBs)). Fish consumption advisories and beach closings adversely affect the beneficial uses of the lake. Non-native species continue to disrupt native plant and animal communities. Purple loosestrife (*Lythrum salicaria*) is still largely uncontrolled despite numerous eradication attempts (EPA 2000). Algal species abundance and type can vary greatly within the lake and can be altered by excessive predation by uncontrolled exotic species and competition with nonindigenous algae (EPA 2000). Increased salinity and other environmental changes may also support adaptation of non-native species.

The United States and Canada, in consultation with State and Provincial governments, are working to “restore and maintain the chemical, physical, and biological integrity of the water of the Great Lakes Basin Ecosystem” under the provisions of the Great Lakes Water Quality Agreement, signed in 1972 and amended in 1987 (EPA 2000).

As part of this effort, the Lake Michigan Technical Committee developed a Lake Michigan Lakewide Management Plan (EPA 2000) that describes the current state of lake habitats (e.g., open waters, wetlands, and tributary streams), identifies areas of concern, and recommends future steps that should be taken to protect and restore Lake Michigan ecosystems. These recommendations range from controls on ballast water to remediation of contaminated sediment sites, to implementation of Total Maximum Daily Load strategies for tributary streams. The Lake Michigan Lakewide Management Plan lists a number of areas in which improvements have been made (e.g., reduction of point-source pollutants entering the basin and protection and restoration of wetlands) but notes other areas still needing

improvement (e.g., deposition of toxic air pollutants in the watershed and non-point-source pollutants).

Consumers Energy Company's Palisades Nuclear Plant is authorized to discharge water to Lake Michigan under an NPDES permit administered by the MDEQ. As described in the current NPDES permit (MDEQ 2004), Palisades has one outfall, Outfall 001, and three monitoring points: 001A, 001D, and 001F.

At monitoring point 001A, the discharge is a combination of noncontact cooling water, cooling-tower blowdown, and the miscellaneous treated low-volume wastewaters from monitoring points 001D and 001F, which may include steam generator blowdown, demineralization backwash, regeneration waste, reverse osmosis filter backwash, turbine sump drainage, floor drainage, laboratory waste, and radwaste wastewater. Water from the three monitoring points discharges to Lake Michigan through five pipes at Outfall 001. The NPDES permit for Palisades (MDEQ 2004) describes the limits for discharges at monitoring point 001A. The daily limit for TRO is 38 µg/L for continuous discharge (greater than 160 min/day) and 200 µg/L for intermittent discharge (less than or equal to 160 min/day). During bromine use, the discharge must be less than or equal to 120 min/day, and the TRO daily limit is 50 µg/L. The heat addition limit is 2.1×10^9 Btu/hr. The pH should range between 6.5 and 9.0. Flow and TRO discharge time are to be recorded daily, and outfall observations are to be made five times per week.

Monitoring point 001D is radwaste wastewater, up to 0.1 million gpd. The flow and total suspended solids (TSS) are monitored at this point, with a grab sample for TSS analysis for each batch of wastewater. TSS limits are 30 mg/L monthly and 100 mg/L daily. As discussed in Section 2.1.4.1, this radwaste wastewater must meet criteria prior to discharge at monitoring point 001D. Monitoring point 001F is turbine sump water, also up to 0.1 million gpd. The flow and oil and grease content are monitored, with two grab samples per month for oil and grease analysis. Oil and grease limits are 15 mg/L monthly and 20 mg/L daily. Discharges from monitoring points 001D and 001F are monitored prior to discharge to the mixing basin, where the discharge comingles with other wastewater.

Palisades applies treatments to control microbiological organisms and the zebra mussel (*Dreissena polymorpha*) in the SWS and CWS. NMC uses approved biocides in these systems to control biofouling problems in accordance with use and discharge requirements, including provisions of the NPDES permit and special MDEQ approvals required for discharge of water treatment additives (MDEQ 2004). NMC currently is permitted by MDEQ to use chlorination, bromination, and application of a quaternary amine formulation for biofouling control (MDEQ 2004; Consumers Energy 2003a). Compliance with NPDES permit limits for discharge of these biocides and associated residuals is confirmed by monitoring.

Discharge Monitoring Reports (DMRs) include daily data on TRO discharge time, oxidants, flow, pH, visual inspection, and dechlorination agent, all at monitoring point 001A. Oxidants are noted as "not used" on many monthly reports. Betz Clam-Trol treatments are no longer required to be reported in DMRs for Palisades, but monitoring during Clam-Trol treatments is performed in accordance with the NPDES permit. Temperature data collection at monitoring point 001A is conducted in accordance with the NPDES permit. The actual temperature data are not logged on the DMRs, but rather the Btu/hr data are presented, as a function of temperature and flow data. The permitted maximum for heat addition is 2.1×10^9 Btu/hr (MDEQ 2004).

Several violations of NPDES permitting requirements have been issued by the MDEQ in the last 5 years. One was a minor oily sheen and discharge to Lake Michigan on April 6, 2001. The sheen was within 2 to 5 ft of the lakeshore and was remediated with an oil boom. Another was a septic lift station pump failure on February 12, 2002, during which about 300 gal of liquid sewage (no solids) overflowed into storm drains, which drained onto beach sands (Consumers Energy 2002). According to a notification submitted to the MDEQ, the incident did not cause adverse impact to the environment or the public (Consumers Energy 2002).

EPA Region 5 manages a Web site of quarterly listings of facilities in noncompliance (EPA 2005a). In the second quarter of 2001, violations such as "report overdue" and "compliance schedule overdue" are posted for the Palisades plant, and "incomplete/deficient report" is listed for each compliance parameter. In subsequent quarters, "continuing noncompliance" notices are listed for the compliance parameters. The initial violations stem from a delinquent annual review of the Storm Water Pollution Prevention Plan (SWPPP) (NMC 2001b). The MDEQ (2005c) has documented that the noncompliance notices in the online database are erroneous, and the facility is in compliance.

Seven field surveys conducted from August 2000 to June 2003 provide information on the thermal characteristics of the cooling water discharged to Lake Michigan and the resulting thermal plume in the lake. The surveys include temperature measurements while the plant was operating at near-maximum power levels at a discharge flow rate of 92,500 gpm. Results of the surveys indicate that the thermal plume is much smaller than it was when Palisades had its initial once-through cooling system and that the plume is generally at the surface. The area of the plume (the 3°F isotherm) ranged seasonally from 40 to 286 ac at the lake surface and from 0 to 19 ac at a depth of 3 ft. The 3°F isotherm was seldom noted to extend at or below a depth of 5 ft. The temperature of the plant cooling-water discharge during the surveys ranged from 77 to 98°F, corresponding to approximately 25 to 34°F above the ambient lake temperature in all seasons except winter. During the winter survey, conducted March 19, 2001, the ambient lake temperature was 34°F, the discharge temperature was approximately 78°F, or 44°F above ambient, and the plume area at the surface was approximately 76 ac. According to the NPDES permit, Palisades must make gradual changes to thermal inputs to the lake to avoid fish mortality due to cold shock during the winter months (MDEQ 2004).

The applicant monitors the septic sludge twice per year. A 1-L dip sample is taken at each sampling event, and it is analyzed through a gamma scan. Septic waste is hauled to the Benton Harbor-St. Joseph Wastewater Plant. Septic field effluent is not monitored.

The Palisades SWPPP notes that the septic system has the potential to overflow and reach storm water outflow SW-4 by way of a catch basin (Consumers Energy 2003b). To prevent this, an alarm system, structural curb, and backup pump have been installed. The SWPPP also notes that storm water outflow SW-6, which discharges to monitoring point 001A, includes floor drains in the Turbine Building. Therefore, the building has sediment bags or socks to collect debris and sediment, and an oil boom is installed across the mixing basin.

2.2.4 Air Quality

The Palisades site is located in the Moist Continental Climate zone, characterized by the dominance of tropical air masses in summer and polar air masses in winter and by the presence of deciduous forest that covers the Great Lakes region of the United States and Canada. Seasonal changes between summer and winter are very large, with an average seasonal temperature change of 46°F. Daily temperatures also change often. Abundant precipitation falls throughout the year but increases in the spring and summer seasons due to invading tropical air masses. Cold winters are caused by polar and arctic air masses moving south. Local precipitation occurs throughout the year, with a typical increase in rainfall in summer. Meteorological records for southwestern Michigan (i.e., the South Haven area) are generally representative of the Palisades site. The data from this area indicate that the lowest precipitation amounts for the year generally last for about a month or two, typically in February. Mean or normal monthly temperatures for southwestern Michigan range from 13.4 to 35.3°F in January to 65.5 to 77.6°F in July and August (MRCC 2005). The mean annual precipitation for the region is 35.8 in. Normal monthly precipitation ranges from 1.7 to 2.5 in. in the dry season (January to March) to 3.6 to 4.1 in. in the wet season (July to September) (NOAA 2002).

Onsite meteorological conditions at Palisades are monitored at three levels: 10, 30, and 100 m from the main meteorological tower. The tower winds (speed and direction) and temperature are measured at two levels, 10 and 30 m, including horizontal wind direction variations. Atmospheric stability is calculated from temperature differences taken from readings between the 30- and 10-m levels. Hourly data from readings recorded from both levels and annual summaries, including wind roses, can be found in the Palisades meteorological monitoring semiannual report (Consumers Energy 2005a). Winds during the winter season tend to be stronger, with mean winds at the 100-m level exceeding 9 mph, and are predominately out of the southwest. During the summer, winds are more often from the southwest and are from the north-northwest more than 20 percent of the time; in the fall, they are from the southeast to south-southeast about 19 percent of the time (Consumers Energy 2005a).

Over the past 55 years, severe thunderstorms with winds exceeding 58 mph or with resulting property damage occurred on average about once per year (NOAA 2005). During the period from the middle of March to the middle of November, the daily occurrence of thunderstorms and high winds is less than once every 2 months, with a total of 103 thunderstorm and wind damage reports filed for Van Buren County from January 1, 1950, to May 31, 2005. Through the last half of the last century to the present, 1950 to 2005, a total of 16 tornadoes touched down in Van Buren County (NOAA 2005). The majority of these (13 strikes) produced slight or moderate property damage, less than $25,000 and less than $250,000, respectively. These storm events were categorized in the low-to-moderate intensity range of the Fujita Tornado Scale, that is, F-0, F-1, and F-2 category tornados.[(a)] Three F-3 tornado strikes, two that occurred on March 3, 1956, and one on May 13, 1980, caused a total of 21 injures and produced major property damage totaling approximately $2.5 million for each storm (NOAA 2005). On the basis of statistics for the 30 years from 1954 through 1983 (NRC 2005a), the probability of a tornado striking a point in a 1 degree latitude-longitude square at the site is expected to be about 7 to 8 $\times 10^{-4}$ per year.

Wind resources are expressed in terms of wind power classes, ranging from Class 1 to Class 7 (PNL 1986). Each class represents a range of mean wind power density or approximate mean wind speed at specified heights above the ground. The wind energy resource for most of the Lake Michigan shoreline region in the State of Michigan, including Van Buren County, has good wind power potential. The annual average wind power for this part of the State is rated Class 3 (PNL 1986). Areas designated Class 3 or greater are suitable for most wind energy applications, whereas Class 2 areas are marginal, and Class 1 areas are generally not wind power suitable.

Air quality in a given area is a function of the air pollutant emissions (type of pollutant; rate, frequency, and duration; and exit conditions and location of release), atmospheric conditions (climate and meteorology), the area itself (size of airshed and topography of the area), and the pollutants transported from outside the area. Air quality within a 31-mi radius of Palisades is generally considered good, with the exception of areas within 16 mi of designated ozone nonattainment areas (EPA 2005b). Localized sources of emissions include man-made sources of commercial, residential, and transportation-related emissions. Natural sources of windblown dust contribute to temporary increases in air pollution.

The MDEQ is responsible for air quality in six Air Quality Control Regions (AQCRs) within the State of Michigan. Palisades is located in Van Buren County, Michigan, and is within AQCR 82

(a) Tornado wind speeds for the F-0 to F-4 categories are in the following ranges: F-0: 40 to 72 mph; F-1: 73 to 110 mph; F-2: 113 to 157 mph; F-3: 158 to 206 mph; and F-4: 207 to 260 mph (Fujita 1987).

located in the southwestern corner of the State. AQCR 82 includes two other counties, Berrien and Cass, just south of Van Buren. This region, with the exception of the 8-hour ozone standard, is designated as being in attainment or unclassifiable for all criteria pollutants (40 CFR 81.333). The AQCR 82 is designated as the Kalamazoo-Battle Creek 8-hour nonattainment area for ozone (Clean Air Act Amendments of 1990, Title 1, Part D, Subpart 1). No Prevention of Significant Deterioration Class I areas are located within 62 mi of Palisades.

Two emergency diesel generators serve the Palisades plant. The two small generators are identical and are rated at a nominal capacity of approximately 2500 kilowatts electric (kW(e)). The diesels are used for emergency backup power and provide a standby source of electric power for equipment required for mitigation of the consequences of an accident, for safe shutdown, and for maintenance of the station in a safe condition under postulated event and accident scenarios (NMC 2005d). The diesel generators are tested once a month for 1-, 2-, 3-, and 4-hour test burn durations. Maintenance tests for each generator (e.g., to replace pumps and test for leaks) last 24 hours and are run as needed. Twenty-four hour endurance runs are performed on a staggered test schedule, once every 18 months.

Under the air pollution rules and regulations of the MDEQ, Part 2, R 336.1212, insignificant activities exemptions, emergency diesel generators meeting certain operating criteria are exempt from State operating permit requirements. The rules define emergency power generating units as stationary internal combustion engines that operate as a mechanical or electrical power source only when the usual supply of power is unavailable. These sources are provided a permit exemption if their annual emissions are less than significance levels as defined in R 336.1119. This would apply to operations during emergency situations, routine maintenance, and routine exercising (e.g., test firing the engine for 1 hour a week to ensure reliability). Since all of the emergency diesel generators at Palisades operate for a small number of test hours per year, emissions from these sources are not regulated under Michigan's Permit Operating Program. In addition to the emergency diesel generators, Palisades has three No. 2 diesel oil-fired boilers that are used for evaporator heating, plant space heating, and feedwater purification. Two units are rated at 6.8 MW/hr and the third at 7.4 MW/hr. All three units are permitted to operate under Michigan's Air Pollution Control Rule 336.1210(1) (MDEQ 2003).

There are no mandatory Federal Class 1 areas within 100 mi of the Palisades site in which visibility is an important value, as designated in 40 CFR Part 81.

2.2.5 Aquatic Resources

Palisades is located on the southeastern shoreline of Lake Michigan, which is the source and receiving body for the plant's cooling system. The 40-mi-long Palisades-Argenta 345-kV transmission line associated with Palisades crosses several streams, including the South Branch of the Black River, Extension Drain, Veley Drain (a Clear Lake tributary), Pine Creek

(a tributary to the Kalamazoo River), and the Kalamazoo River (NMC 2005a). No streams are crossed by the 0.6-mi-long Palisades-Cook transmission line. Transmission line right-of-way maintenance activities in the vicinity of stream and river crossings include procedures to minimize erosion and shoreline disturbance while encouraging vegetative cover. In addition, aerial application of herbicides is restricted from riparian areas (NRC 1978).

Water depths in the southeastern portion of Lake Michigan are up to 10 ft within 500 ft of the shore and up to 50 ft at 1 mi offshore. Lake substrates range from coarse and very coarse sand in the surf zone, medium sand at the 5-ft-depth zone, and fine sand in deeper waters (NMC 2005a). Open-lake temperatures range from 35°F in January and February to about 75°F in mid August. Temperatures near the Palisades intake range from a monthly minimum of about 34°F in January to a monthly maximum of about 70°F in August, with a daily minimum and maximum of about 33°F and 80°F, respectively (NMC 2005a). In the Palisades area, the lake is thermally stratified in summer but is generally isothermic in early winter and early spring. Inshore waters may be substantially warmer than offshore waters in early winter, while being colder in early spring. These conditions limit mixing of inshore and offshore waters during these periods. Intermittent ice cover extends 1 to 2 mi offshore during winter (NMC 2005a; AEC 1972).

Lake Michigan is used for a variety of purposes, including navigation, recreation, tourism, and conservation. The major changes and modifications that have had the greatest impact on aquatic resources of Lake Michigan include (1) industrial, urban, and residential developments on the lakefront; (2) water quality impairment from industrial, municipal, agricultural, navigational, and recreational water uses; (3) overfishing; and (4) invasion of exotic species (EPA 2004). Overall, the status of Lake Michigan habitats, including open water, wetlands, coastal shore, and tributaries, is considered “mixed” to “deteriorating” (EPA 2004). Dams, agricultural and urban development activities, drainage and filling of wetlands, and invasive species have adversely affected the aquatic resources of the tributary streams to Lake Michigan (e.g., the Kalamazoo River) (Wesley 2005).

Contamination is emerging as an important concern in fish in Lake Michigan and its tributary streams (EPA 2004). Some fish cannot be sold commercially because of high levels of PCBs, mercury, or other substances (Fuller, Shear, and Witting 1995). The State of Michigan has published advisories governing the consumption of fish from these water bodies. Within the southeastern portion of Lake Michigan, there are advisories for brown trout (*Salmo trutta*), lake trout (*Salvelinus namaycush*), rainbow trout (*Oncorhynchus mykiss*), chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), common carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), rainbow smelt (*Osmerus mordax*), lake sturgeon (*Acipenser fulvescens*), walleye (*Sander vitreus*), lake whitefish (*Coregonus clupeaformis*), and yellow perch (*Perca flavescens*). PCB advisories have also been issued for common carp, northern pike (*Esox*

lucius), and white sucker (*Catostomus commersoni*) in the Black River, and for all fish species for some portions of the Kalamazoo River (MDCH 2003).

Despite the modifications and multiple competing uses of Lake Michigan, the overall fish community is fairly diverse. Almost 100 species of fish occur in Lake Michigan (UWSGI 2001a). Lake Michigan supports commercial, recreational, and tribal fishing. Commercial and tribal production totals more than 14.6 million lb of fish annually (EPA 2004). Lake whitefish is the primary commercial species, while both lake whitefish and lake trout comprise the tribal fisheries (Stein et al. 2003). Some commercial fishing also targets bloater (*Coregonus hoyi*) and rainbow smelt (Madenjian et al. 2004). Sport fishing within the southeastern portion of Lake Michigan is for lake trout, rainbow trout or steelhead (the migratory form of rainbow trout), brown trout, coho salmon, chinook salmon, northern pike, smallmouth bass (*Micropterus dolomieu*), various sunfish (e.g., bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*), and rock bass (*Ambloplites rupestris*)), yellow perch, and walleye (MDNR 2005d; IDNR 2005). Important forage species in Lake Michigan include alewife (*Alosa pseudoharengus*), bloater, rainbow smelt, and deepwater sculpin (*Myoxocephalus thompsoni*) (Madenjian et al. 2002, 2005).

Top-level predators in Lake Michigan are dominated by the introduced trout and salmon, while the native burbot (*Lota lota*) and lake trout (the original top predators in the lake) (Madenjian et al. 2004) are recovering. The lake trout is recovering mostly through stocking rather than natural reproduction. About 2.4 million yearling lake trout are stocked annually into Lake Michigan (Bronte and Schuette 2002). Reasons that self-sustaining populations of lake trout have yet to be reestablished in Lake Michigan may include loss of suitable spawning habitat, environmental contamination, predation on larval lake trout by alewife, thiamine deficiency from a diet of alewife, and a loss of genetically distinct strains (EPA 2004). About 70 percent of the Great Lakes trout and salmon fishery is dependent upon fish stocking (MDNR 2004).

Forty fish species were collected during preoperational and early years of operation at Palisades. The dominant species included alewife (the major component of the catch), rainbow smelt, yellow perch (the most numerous game species), spottail shiner (*Notropis hudsonius*, the most abundant minnow species), slimy sculpin (*Cottus cognatus*, which inhabits the rip-rap around the intake crib), trout-perch (*Percopsis omiscomaycus*), longnose dace (*Rhinichthys cataractae*), longnose sucker (*Catostomus catostomus*), and white sucker (NMC 2005a; NRC 1978; AEC 1972). Coho and chinook salmon, steelhead, and lake and brown trout were also collected during preoperational studies (NMC 2005a).

At least 160 species have been introduced into the Great Lakes since the early 1800s through the canal system interconnection with the Atlantic Ocean (e.g., sea lamprey (*Petromyzon marinus*), alewife, and white perch (*Morone americana*)), ship ballast (e.g., Asiatic clam (*Corbicula fluminea*), zebra mussel (*Dreissena polymorpha*), spiny water flea (*Bythotrephes cederstroemi*), and round goby (*Neogobius melanostomus*)), or as intentionally introduced

species (e.g., common carp, rainbow smelt, and various salmonids) (EPA 2004; Peeters 1998). The non-native salmonids that were introduced to the Great Lakes between 1870 and 1960 include Atlantic species (Atlantic salmon (*Salmo salar*) and brown trout); Pacific species (chinook salmon, coho salmon, rainbow trout, kokanee (*Oncorhynchus nerka*), chum salmon (*O. keta*), cutthroat trout (*O. clarkii*), masu salmon (*O. masou*), and pink salmon (*O. gorbuscha*)); and Arctic species (Arctic charr (*Salvelinus alpinus*)) (Crawford 2001).

Since the mid-1970s, salmonid stocking in Lake Michigan has included the brook trout, brown trout, lake trout, rainbow trout/steelhead, chinook salmon, coho salmon, and splake (hybrid between lake trout and brook trout). Nearly 14.5 million trout and salmon are stocked annually in Lake Michigan. Atlantic salmon have not been stocked in the lake since 1989 (Bronte and Schuette 2002). Currently, the only major objective for salmonid stocking is the development and maintenance of recreational fisheries (Crawford 2001). The stocking of salmonids may have resulted in the introduction of some non-native fish diseases and parasites to the Great Lakes and caused genetic alteration of native salmonids through hybridization and introgression and/or through declines in the abundance of native salmonids. Also, stocked salmonids may present a direct threat to native and non-native forage fish and invertebrates, while placing competitive pressure upon native fish species for food and habitat resources (Crawford 2001).

The native fish species of Lake Michigan have been affected by introduced aquatic species, most notably the sea lamprey and alewife. Both species have adversely affected native fish species, including commercially and/or recreationally important species such as the cisco (*Coregonus artedi*), lake whitefish, burbot, and lake trout (Madenjian et al. 2002). Combined with overfishing, the introduction of the sea lamprey led to the extirpation of the longjaw cisco (*C. alpanae*), deepwater cisco (C. *johannae*), and blackfin cisco (*C. nigripinnis*) from Lake Michigan (Fuller and Nico 2000). Sea lamprey abundance remains higher than desired in Lake Michigan. This limits rehabilitation efforts for lake trout, despite the stocking program previously mentioned (Stein et al. 2003). Other impediments to sustainable reproduction of lake trout in Lake Michigan relate to the following: (1) the lakewide population is too low, (2) spawning aggregations are too diffuse and in inappropriate locations, and (3) there is poor survival of early life stages (Bronte et al. 2003).

The alewife was first reported from Lake Michigan in 1949, and by 1967 it made up about 85 percent of the fish biomass of the lake (Peeters 1998). Its increase was aided by the decrease in its main predators (lake trout and burbot) caused by the sea lamprey. The population explosion of alewives led to the decline of native planktivorous fishes such as the emerald shiner (*Notropis atherinoides*), lake whitefish, cisco, and a number of coregonine species (Peeters 1998; Fuller and Nico 2000). The alewife is the most important prey species for salmonids in Lake Michigan. The alewife's estimated lakewide biomass decreased from 42,876 metric tons in 2003 to 13,721 metric tons in 2004 (Madenjian et al. 2005). Currently, there is no commercial fishery for alewives in Lake Michigan (Madenjian et al. 2004).

Alewives are easily stressed, and during peak population levels, stress can result in large die-offs in the spring. They are affected by both osmotic stress associated with life in freshwater and exposure to fluctuating water temperatures when they move to inshore waters (e.g., exposure to colder waters during an upwelling event can cause the fish to die; UWSGI 2002). Susceptibility to cold is related to inadequate fat reserves (Eshenroder et al. 1995). In spring, alewives are also in a weakened condition because of a lack of forage in the winter and by stress related to spawning (UWSGI 2001b). Adult alewives feed little, if at all, during their spawning migration (DFO 2004). Large numbers of spawning alewives can occur in nearshore waters as a result of strong year classes produced in the prior 3 or more years. Fish that become weak or die during rapid temperature change can be blown into windrows close to shore or can wash onto beaches (UWSGI 2002). Adult mortality following spawning may be as high as 40 to 60 percent (DFO 2004). Therefore, potentially large numbers of both moribund and dead alewives can be found in inshore waters during the spawning season. The alewife spawning season generally occurs from late May to early August, peaking in June and July, in the southeastern portion of the lake (Jude 1995).

The white perch preys on eggs of walleye and other species (including its own), zooplankton, macroinvertebrates, and minnows. It may compete with yellow perch, emerald shiner, and spottail shiner for food resources (Fuller 2003).

The round goby first appeared in southern Lake Michigan in 1994 (Fuller and Benson 2003). It feeds on the eggs and young of other bottom-dwelling fish species, zebra mussels, snails, soft-shelled crayfish, aquatic insects, and zooplankton. The round goby inhabits a wide variety of habitats but prefers rock, cobble, or rip-rap (Manz 1998). This is the type of habitat found around the Palisades intake. The round goby has a long spawning season (it may spawn up to six times during the breeding season) and aggressively defends its spawning area. It displaces native sculpins and darters and impacts recreationally important centrarchids (sunfish and bass) and lake trout (GLSC 2003; Marsden and Chotkowski 1995; Manz 1998; Ray and Corkum 1997). However, to date, no lakewide changes in the abundance of any Lake Michigan species have been ascribed to the round goby invasion (Madenjian et al. 2002).

The ruffe (*Gymnocephalus cernuus*), native to Europe and Asia, was introduced to the Great Lakes in ship ballast. This species also has the potential to disrupt fish community structure within the lake through competition or modification of plankton and macroinvertebrate populations (Jude 1995).

The plankton community of Lake Michigan may be changing as a result of the presence of contaminants and nutrients in the water and sediment as well as the presence of exotic species such as the zebra mussel and spiny water flea (EPA 2004). Phytoplankton abundance and production in nearshore areas have decreased since 1970, probably due to a reduction in phosphorus loading (Madenjian et al. 2002). Phytoplankton in southeastern Lake Michigan is dominated by diatoms, while green algae and blue-green algae were not found to be abundant

near Palisades (AEC 1972; NRC 1978). Periphyton (attached algae) and rooted aquatic plant growth is limited in the Palisades area because of shifting sandy-gravel substrates (NRC 1978; NMC 2005a). The water intake structure and other underwater components provide artificial habitats for periphyton.

The zooplankton community in Lake Michigan near Palisades is abundant and fairly diverse. Copepods and cladocerans dominated the zooplankton community near Palisades (NRC 1978). Predation by the spiny water flea has caused a significant decline in three offshore *Daphnia* spp. that are a prey source for young-of-year fish (Lehman 1991). The spiny water flea population grows rapidly, partly due to its parthenogenic asexual reproduction. Its rapid population growth allows it to monopolize the zooplankton food supply, which can be detrimental to fishes such as the bloater (GLSGN 1991).

The benthic macroinvertebrate community near Palisades was dominated by *Diporeia* spp. (formerly known as *Pontoporeia* spp., an amphipod), chironomids (midges), aquatic worms, and fingernail clams (NRC 1978; NMC 2005a). Nearshore benthic macroinvertebrate communities have been altered dramatically since the 1960s because of a reduction in phosphorus and other nutrient loads and the establishment of the zebra mussel (Madenjian et al. 2002).

The zebra mussel was first discovered in Lake Michigan in 1988. Its impacts fall into three main categories: (1) biofouling, (2) filter feeding, and (3) nutrient dynamics (Garton 2002). The zebra mussel has impacted aquatic communities by consuming zooplankton and phytoplankton (fundamentally altering the foodchain) and by displacing native mussels (Garton 2002; Madenjian et al. 2002). Zebra mussels have eliminated native mussels from some areas of the Great Lakes and can exclude gastropods (snails) and net-spinning caddisflies from hard substrates through competition for food and space (Stewart et al. 1998a). However, they consistently cause increases in the total macroinvertebrate biomass and densities of hydrozoans, flatworms, and amphipods on hard benthic substrates because their shells enhance surface area, substrate heterogeneity, and accumulation of benthic organic matter (Horvath et al. 1999; Stewart et al. 1998a).

It is suspected that the lakewide population decline of *Diporeia* spp. is linked to the introduction of the zebra mussel, which has severely limited the food available to *Diporeia* spp. (EPA 2004). Declines of *Diporeia* spp. might be the cause of decline in the abundance of lake whitefish and slimy sculpin (Madenjian et al. 2004; Stein et al. 2003) and decline in alewife condition (Madenjian et al. 2002). Reduced biomass of phytoplankton, zooplankton, and *Diporeia* spp. caused by zebra mussels may adversely affect rainbow smelt and young salmonids, which in turn would affect predators of these fishes. However, freshwater drum (*Aplodinotus grunniens*), rock bass, yellow perch, and other benthivorous fish species consume large numbers of gammarid amphipods, crayfish, zebra mussels, and other benthic macroinvertebrates that have increased in abundance (Stewart et al. 1998a,b).

The zebra mussel is cold-tolerant and is considered a potential serious biofouling problem at power plants. Zebra mussels can accumulate on the inside of intake tunnels; intake cribs; and screenhouse walls, floors, and trash racks. Large piles of zebra mussels that slough off from other areas can accumulate on screenhouse floors in areas of low flow and against out-of-service traveling screens. Approved biocides are used, in accordance with NPDES permit requirements (MDEQ 2004), to control zebra mussels (Consumers Energy 2003a; NMC 2005a).

The amphipod *Echinogammarus ischnus* and the quagga mussel (*Dreissena bugensis*), a species similar to the zebra mussel, have recently been reported in Lake Michigan. Both species will likely contribute to further food-web modifications in the lake. The quagga mussel may further decrease the abundance of *Diporeia* spp. in offshore areas, while *E. ischnu*s may become an important food item for many fish species (Nalepa et al. 2001).

No Federally listed threatened, endangered, proposed, or candidate aquatic species occur in Lake Michigan in the vicinity of Palisades. In addition, no Federally listed aquatic species are listed for Allegan, Kalamazoo, and Van Buren Counties within which the Palisades-Argenta transmission line occurs (FWS 2005a; MNFI 2005a,b). Also, no designated critical habitat for aquatic species occurs in the site vicinity. State-listed aquatic species that have the potential to occur in the vicinity of Palisades and its associated transmission lines are presented in Table 2-1.

2.2.6 Terrestrial Resources

The Palisades site is located in the glacial plain of Lake Michigan, where sand dunes up to 200 ft high occur in a band along the lakeshore, and generally flat to gently rolling glacial features occur eastward (NMC 2005a). Forests dominated by American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and eastern hemlock (*Tsuga canadensis*) made up much of the original vegetation of the region (MNFI 2005c); however, timber harvest, sand mining, and drainage of wetlands have greatly altered the landscape (NMC 2005c). Most of the land in the region is now devoted to agriculture, including blueberry farming on poorly drained sites and orchards and vineyards on better drained soils (NMC 2005a).

The entire Palisades site is protected under the CZMA and Michigan's Coastal Zone Management Program (MDEQ 2005a). About 80,000 ac of Lake Michigan sand dunes in Michigan, including those within the Palisades site, are classified and protected as Critical Dune Areas under authority of Michigan's Natural Resources and Environmental Protection Act, Part 353 (MDEQ 2005b). Development activities in designated critical dune areas, including those on the site, require an environmental impact assessment and permit from MDEQ (MDEQ 2005b).

Table 2-1. State-Listed Aquatic Species Potentially Occurring in the Vicinity of Palisades and Associated Transmission Lines

Scientific Name	Common Name	Michigan Status[(a)]	County[(a)]	Habitat
Plants				
Lemna valdiviana	pale duckweed	X	K, V	Ponds, marshes
Insects				
Stenelmis douglasensis	Douglas stenelmis riffle beetle	SC	K	On wood in lakes, streams, and rivers
Mussels and Snails				
Alasmidonta viridis	slippershell mussel	SC	A	Small to medium lakes; small tributaries to large rivers
Cyclonaias tuberculata	purple wartyback	SC	A	Moderate gradient of medium to large rivers
Funtigens nickliniana	watercress snail	SC	K	Ponds, small lakes, small streams
Fish				
Acipenser fulvescens	lake sturgeon	T	A	Large rivers and shallow water of large lakes
Lepisosteus oculatus	spotted gar	SC	A, K	Nearshore areas of medium to large lakes; medium to large rivers
Coregonus artedi	lake herring	T	A, K	Nearshore areas of medium to large lakes; large rivers
Hiodon tergisus	mooneye	T	A	Nearshore areas of medium to large lakes; large rivers
Erimyzon oblongus	creek chubsucker	E	A, K	Low-gradient creeks
Notropis anogenus	pugnose shiner	SC	K, V	Small to medium lakes; small tributaries to medium rivers
Notropis texanus	weed shiner	X	A, K	Sand-bottomed creeks; sloughs and large rivers

(a) A = Allegan County, E = endangered, K = Kalamazoo County, SC = special concern, T = threatened, V = Van Buren County, X = probably extirpated.

Sources: Brown 1976; Carman 2002a,b; Consumers Energy and NMC 2001; Cummings and Mayer 1992; Eagle et al. 2005; FWS 2003; MNFI 2005a,b; Page and Burr 1991; NatureServe 2005; Scott and Crossman 1973; Smith 1979.

Developed or maintained areas occupy about 80 ac of the 432-ac Palisades site. Most (about 68 percent) of the undeveloped portions of the Palisades site are dominated by forest. The most extensive forest community type is a red oak (*Quercus rubra*), sassafras (*Sassafras albidium*), sugar maple, and American beech association. This forest is typical of many rear-dune areas along the Lake Michigan shoreline and appears to have a well-balanced, all-age structure (NMC 2005a). A portion of this community near the southern site boundary is recognized as important habitat by the Michigan Natural Features Inventory (MNFI) (Higman and Goff 1991; Goff 1992). Most of the remaining forest on the site is a second-growth community dominated by red oak, white ash (*Fraxinus americana*), sassafras, and sugar maple.

Early successional plant communities on the Palisades site include old-field and upland scrub-shrub, which occupy portions of transmission line rights-of-way, abandoned railroad bed, disturbed sites around buildings, forest openings, borders of forested areas, and dune blowouts (NMC 2005a). These communities occupy about 10 percent of the site.

Portions of steep dunes and flats at the base of dunes that are on or adjacent to developed areas have been stabilized with plantings of beach grass (*Ammophila breviligulata*) and dune grass (*Calamovilfa longifolia*) or are stabilized by natural colonization of these species (NMC 2005a). These areas occupy about 10 percent of the site. Sand dune blowouts (4 percent of the site) occur where wind action has disturbed established vegetation and resulted in dune destabilization. About 3 percent of the site is open sand (beach and other unvegetated flat areas).

Wetland communities occupy a total of about 9 ac (2 percent of the site area) but are generally small and widely scattered (NMC 2005a). The largest wetland on site is located just north of the Palisades Substation and is a seasonally inundated wetland dominated by black gum (*Nyssa sylvatica*), willow (*Salix* spp.), and reedgrass (*Calamogrostis* spp.). Similar small wetlands occur in the transmission right-of-way on the eastern border of the site, and a small forested wetland dominated by black gum is located north of the Outage Building sanitary waste drainfield.

Approximately 5 ac of vegetation (1 percent of the site) on dune ridges adjacent to and southeast of the cooling towers have been affected by condensate plumes and drift (NMC 2005a). Drift from operation of the two mechanical draft cooling towers has resulted in the replacement of the original mature trees with an early succession dense scrub-shrub community. Some standing dead trees remain from the original forest. Rochow (1978a) described the sequence of vegetation change in drift-impacted areas at Palisades. Three to four months after cooling tower start-up, white pines began to show signs of chemically induced injury in areas up to 295 ft from the towers. Deciduous trees began showing visible signs of injury during the second summer of operation. High deposition rates of sulfate were considered responsible for this damage (Rochow 1978a,b). Severe icing of vegetation in the winter of 1976

to 1977 resulted in extensive damage of trees, and by the third summer of operations, the forest canopy had been nearly eliminated in the most severely impacted areas.

Site surveys have documented a variety of terrestrial vertebrates on the site, including 4 amphibian, 3 reptile, 113 bird, and 14 mammal species. Amphibians include northern leopard frog (*Rana pipiens*), spring peeper (*Pseudacris crucifer*), American toad (*Bufo americanus*), and red-backed salamander (*Plethodon cinereus*). Reptiles on the site include the eastern box turtle (*Terrapene carolina*), eastern hognose snake (*Heterodon platyrhinos*), and blue racer (*Coluber constrictor*). Birds on the site include killdeer (*Charadrius vociferus*), ring-billed gull (*Larus delawarensis*), northern flicker (*Colaptes auratus*), blue jay (*Cyanocitta cristata*), black-capped chickadee (*Poecile atricapillus*), gray catbird (*Dumetella carolinensis*), American robin (*Turdus migratorius*), red-winged blackbird (*Agelaius phoeniceus*), American goldfinch (*Carduelis tristis*), and eastern towhee (*Pipilo erythrophthalmus*). Mammals on the site include white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), white-footed mouse (*Peromyscus leucopus*), eastern chipmunk (*Tamias striatus*), and thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*).

The landscape crossed by the Palisades-Cook transmission line and the western portion of the Palisades-Argenta line is similar to that of the Palisades site; however, the eastern portion of the Palisades-Argenta transmission line in Van Buren County crosses an area with moderate to steep slopes and scattered kettle depressions that are poorly drained (NMC 2005a). Most of the original vegetation of this portion of the project area was forest dominated by American beech, sugar maple, and white oak (*Quercus alba*). However, swamp hardwoods, tamarack (*Larix laricina*), wetland shrubs, and bogs occurred in kettle depressions, and wet prairie and emergent marsh were found in other poorly drained sites (MNFI 2005c; NMC 2005a). Most of the area is now used for agriculture. In Kalamazoo County, the Palisades-Argenta line traverses a glacial outwash plain with flat to gently sloping terrain. Prior to settlement, tallgrass prairies, oak savannas, wet prairies, marshes, and extensive wet meadows were present (MNFI 2005c; NMC 2005a). Most uplands and large areas of wetland in this region have been converted to agriculture. Although prairie fens remain common in the region, tallgrass prairie, wet prairie, and oak savanna are now quite rare (NMC 2005a).

Approximately 38 percent of the land within transmission line rights-of-way associated with Palisades is classified as active agricultural land (NMC 2005a). Approximately 28 percent and 25 percent of the rights-of-way are forest (mostly hardwoods) and rangeland (mostly shrubland), respectively, and about 7 percent of the area traversed consists of urban and developed areas such as roadways.

The percent of area within Palisades rights-of-way occupied by wetland communities was estimated by the applicant as 2 percent (primarily scrub-shrub) by using State land-use data but as 18 percent by using the U.S. Fish and Wildlife Service (FWS) National Wetland Inventory

(NMC 2005a). Nearly all of these wetlands are seasonally or temporarily flooded palustrine emergent and, to a lesser extent, seasonally flooded palustrine scrub-shrub habitat. Wetlands within the corridors are generally associated with unnamed streams in the Brandywine Creek, South Branch Black River, Paw Paw River, and Kalamazoo River watersheds.

Areas of natural vegetation traversed by the lines are maintained to ensure compatibility with the line by using a vegetation-management protocol that involves periodic selective removal of woody vegetation to promote and maintain herbaceous plant communities beneath the conductors and low-growing shrubs and other compatible vegetation in the border zones. Vegetation maintenance beyond the border zone is limited to selective removal of trees that could come into contact with the line (NMC 2005a). Right-of-way maintenance activities are on an approximate 4- to 6-year schedule; although mowing is occasionally used for vegetation maintenance, selective application of registered herbicides is the preferred method of vegetation control. Compatible land uses (e.g., cropland, pastureland) are allowed to continue on the right-of-way. No access road exists along the right-of-way, and access is gained on foot and with the use of all-terrain vehicles.

Federally listed and State-listed, proposed, or candidate terrestrial species found in Allegan, Kalamazoo, and Van Buren Counties and, therefore, possibly present on the Palisades site or the transmission line rights-of-way associated with Palisades are included in Table 2-2. No designated critical habitat occurs on the Palisades site or vicinity, or on the associated transmission line rights-of-way.

The NRC contacted the FWS and requested information on Federally listed and proposed threatened and endangered species, candidate species, and critical habitat on and near the Palisades site (NRC 2005b). In its response, the FWS stated that four Federally listed species and one Federal candidate for listing could occur in the project area (FWS 2005c). These include the Pitcher's thistle (*Cirsium pitcheri*; threatened), Karner blue butterfly (*Lycaeides melissa samuelis*; endangered), Mitchell's satyr butterfly (*Neonympha mitchelli mitchelli*; endangered), Indiana bat (*Myotis sodalis*; endangered), and eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*; candidate).

Pitcher's thistle is the only Federally listed species known to exist on the Palisades site (NMC 2005a). It occurs on the site in open habitats on the dunes, including dune blowouts. The species is a perennial, herbaceous plant that is endemic to the nonforested dunes of the western Great Lakes and requires active dune processes to maintain early successional habitat (FWS 2005c). In Michigan, Pitcher's thistle is most common in the dunes of the northern and northeastern shores of Lake Michigan and exists in scattered populations along the perimeter of southeastern Lake Michigan (MNFI 2005c).

Table 2-2. Federally Listed and State-Listed Terrestrial Species Potentially Occurring on or in the Vicinity of Palisades and Associated Transmission Lines

Scientific Name	Common Name	Federal Status[(a)]	Michigan Status[(a)]	Habitat and Location in Project Area[(b)]
Plants				
Agalinis gattingeri	Gattinger's gerardia	–	E	Sandy, rocky, or clayey slopes; open woods; barrens; Kalamazoo County
Aristida tuberculosa	beach three-awned grass	–	T	Sandy barrens; Van Buren County
Aristolochia serpentaria	Virginia snakeroot	–	T	Southern floodplain forests, rich dry-mesic forests; Van Buren County
Aster sericeus	western silvery aster	–	T	Prairies, dry banks, fields; Kalamazoo County
Astragalus canadensis	Canadian milk-vetch	–	T	Oak barrens, moist openings, wet ground, sandy lake shores; Kalamazoo County
Baptisia leucophaea	cream wild indigo	–	E	Openings of dry to dry-mesic forest; Kalamazoo County
Bartonia paniculata	panicled screw-stem	–	T	Coastal plain marsh; Allegan and Van Buren Counties
Berula erecta	cut-leaved water-parsnip	–	T	Cold spring-fed drainages; recorded within 1 mi of Palisades-Argenta line (1940s); Allegan, Kalamazoo, and Van Buren Counties
Besseya bullii	kitten-tails	–	T	Oak savanna remnants on steep hillsides; Kalamazoo and Van Buren Counties
Calamagrostis stricta	narrow-leaved reedgrass	–	T	Streams, marshes, fens, mudflats; Kalamazoo County
Carex albolutescens	greenish-white sedge	–	T	Intermittent wetlands, lake margins, wet prairies; Allegan and Kalamazoo Counties
Carex lupuliformis	false hop sedge	–	T	Deciduous and mixed swamps in southern Michigan; Kalamazoo County

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Carex platyphylla	broad-leaved sedge	–	T	Mesic forests formed on dunes; Van Buren County
Carex oligocarpa	eastern few-fruited sedge	–	T	Rich deciduous woods; Kalamazoo County
Carex seorsa	sedge	–	T	Swamps and buttonbush depressions; recorded (1985) within 1 mi of Palisades site; Kalamazoo and Van Buren Counties
Carex straminea	straw sedge	–	E	Low ground, marshes, and swamps; Kalamazoo County
Castanea dentata	American chestnut	–	E	Upland forest; Kalamazoo County
Cirsium pitcheri	Pitcher's thistle	T	T	Great Lakes shorelines and sand dunes; found in dune blowouts and other open dune habitats on the site; more than 100 individual plants found onsite in July 2005 in the northwestern portion of the site near Van Buren State Park (NMC 2006c); Allegan and Van Buren Counties
Coreopsis palmata	prairie coreopsis	–	T	Mesic prairies along railroad rights-of-way; Kalamazoo and Van Buren Counties
Corydalis flavula	yellow fumewort	–	T	Oak savannas and floodplain forests; Kalamazoo County
Cypripedium candidum	white lady-slipper	–	T	Alkaline wetlands; Kalamazoo and Van Buren Counties
Diarrhena americana	beak grass	–	T	Floodplain forests; Kalamazoo County
Draba reptans	creeping whitlow-grass	–	T	Oak savanna and prairie; Kalamazoo County

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Dryopteris celsa	log fern	–	T	Acidic, humus-rich soils in hardwood swamps and floodplain forests; Kalamazoo and Van Buren Counties
Echinodorus tenellus	dwarf burhead	–	E	Intermittent, seasonally inundated wetlands within oak barrens; Allegan County
Eleocharis compressa	flattened spike-rush	–	T	Limestone pavement and grassland; Kalamazoo County
Eleocharis microcarpa	small-fruited spike-rush	–	E	Intermittent, seasonal wetlands; Allegan County
Eleocharis tricostata	three-ribbed spike-rush	–	T	Wetlands with a fluctuating water table; Allegan County
Eryngium yuccifolium	rattlesnake-master	–	T	Sedge and grass-dominated portions of prairie fens; Kalamazoo and Van Buren Counties
Eupatorium sessilifolium	upland boneset	–	T	Slopes of oak savannas; Kalamazoo County
Euphorbia commutata	tinted spurge	–	T	Sandy areas of riparian hillsides and open woods; Allegan County
Filipendula rubra	queen-of-the-prairie	–	T	Prairie fen; Kalamazoo County
Fuirena squarrosa	umbrella-grass	–	T	Coastal plain marshes, sandy lake edges, dune swales, seepages, and sandy marshes; Kalamazoo and Van Buren Counties
Galearis spectabilis	showy orchis	–	T	Rich deciduous woods, often near temporary spring ponds; Kalamazoo and Van Buren Counties
Gentiana flavida	white gentian	–	E	Dry or moist prairies and oak woodlands; Kalamazoo County

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Gentiana puberulenta	downy gentian	–	E	Edges of coastal plain marshes in oak barrens; Allegan County
Gentianella quinquefolia	stiff gentian	–	T	Wet meadows; Kalamazoo County
Geum triflorum	prairie-smoke	–	T	Lower slopes of dry sand prairie; Allegan County
Gillenia trifoliata	Bowman's root	–	T	Oak barrens; Kalamazoo County
Helianthus mollis	downy sunflower	–	T	Prairie remnants and oak barrens; Kalamazoo County
Hydrastis canadensis	goldenseal	–	T	Southern hardwood forests and moist ravines and portions of riparian forests; Allegan, Kalamazoo, and Van Buren Counties
Isoetes engelmannii	Appalachian quillwort	–	E	Intermittent wetlands; Allegan County
Isotria verticillata	whorled pogonia	–	T	Successional oak and red maple forest; Kalamazoo and Van Buren Counties
Juncus brachycarpus	short-fruited rush	–	T	Coastal plain marshes, sandy lake edges, dune swales, seepages, and sandy marshes; Allegan County
Juncus scirpoides	scirpus-like rush	–	T	Coastal plain marshes, sandy lake edges, dune swales, seepages, and sandy marshes; recorded within 1 mi of Palisades-Argenta line (1983); Allegan, Kalamazoo, and Van Buren Counties
Juncus vaseyi	Vasey's rush	–	T	Wet prairies, moist sandy barrens, and open marshy flats or swales; Allegan County

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Lechea pulchella	Leggett's pinweed	–	T	Seasonally inundated intermittent wetlands; Allegan and Kalamazoo Counties
Linum virginianum	Virginia flax	–	T	Open oak forests, upland woods, and lakeside and riparian forests; Kalamazoo and Van Buren Counties
Ludwigia sphaerocarpa	globe-fruited seedbox	–	T	Muddy shores of lakes, marshes, and streams; Allegan and Van Buren Counties
Lygodium palmatum	climbing fern	–	E	Moist thickets and woods; Kalamazoo County
Morus rubra	red mulberry	–	T	Southern floodplain forest; Kalamazoo County
Muhlenbergia richardsonis	mat muhly	–	T	Limestone pavement communities; Kalamazoo County
Nelumbo lutea	American lotus	–	T	Marshes and large rivers; Kalamazoo County
Panax quinquefolius	ginseng	–	T	Rich shaded forests; Allegan, Kalamazoo, and Van Buren Counties
Panicum leibergii	Leiberg's panic-grass	–	T	Dry prairies and open areas in savannas; Kalamazoo and Van Buren Counties
Panicum longifolium	long-leaved panic-grass	–	T	Seasonally flooded wetlands in shallow depressions; Allegan County
Panicum verrucosum	warty panic-grass	–	T	Coastal plain marshes, sandy lake edges, dune swales, seepages, and sandy marshes; Van Buren County
Platanthera ciliaris	orange or yellow fringed orchid	–	T	Acid swamps; Allegan, Kalamazoo, and Van Buren Counties

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Poa paludigena	bog bluegrass	–	T	Bogs, swamps, and wet woods; Kalamazoo County
Polygonum careyi	Carey's smartweed	–	T	Coastal plain marshes and intermittent wetlands; Allegan and Van Buren Counties
Populus heterophylla	swamp or black cottonwood	–	E	Swamp forest; Kalamazoo County
Potamogeton bicupulatus	waterthread pondweed	–	T	Coastal plain marshes and intermittent wetlands; Allegan and Van Buren Counties
Psilocarya scirpoides	bald-rush	–	T	Coastal plain marshes, sandy lake edges, dune swales, seepages, and sandy marshes; Allegan, Kalamazoo, and Van Buren Counties
Rhynchospora globularis	globe beak-rush	–	E	Coastal plain marshes, sandy lake edges, dune swales, seepages, and sandy marshes; Allegan County
Sabatia angularis	rose-pink	–	T	Moist sandy shores, depressions in dunes, marshy ground and edges of lakes; Kalamazoo and Van Buren Counties
Schoenoplectus hallii	Hall's bulrush	–	T	Intermittent wetlands within oak barrens; Allegan County
Scleria pauciflora	few-flowered nut-rush	–	E	Sandy edges of intermittent wetlands; Van Buren County
Scleria reticularis	netted nut-rush	–	T	Seasonally flooded wetlands in glacial lakeplain landscapes; Allegan and Van Buren Counties
Silene stellata	starry campion	–	T	Dry, open woodlands on sandy soils; Kalamazoo County
Silphium integrifolium	rosinweed	–	T	Mesic prairie; Kalamazoo and Van Buren Counties

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Silphium laciniatum	compass-plant	–	T	Mesic prairies; Kalamazoo County
Silphium perfoliatum	cup-plant	–	T	Openings in floodplain forests; Kalamazoo County
Sisyrinchium atlanticum	Atlantic blue-eyed-grass	–	T	Moist sandy shores; Allegan County
Solidago missouriensis	Missouri goldenrod	–	T	Dry sand prairie; Kalamazoo County
Spiranthes ovalis	lesser ladies'-tresses	–	T	Open, sandy soil, old roads, and open fields; Kalamazoo County
Stellaria crassifolia	fleshy stitchwort	–	T	Cold springs and seeps along rivers; Kalamazoo County
Trichostema dichotomum	bastard pennyroyal	–	T	Oak savannas; Allegan, Kalamazoo, and Van Buren Counties
Trillium sessile	toadshade	–	T	Floodplains and mesic forests; recorded within 1 mi of Palisades-Argenta line (1981); Kalamazoo and Van Buren Counties
Triphora trianthophora	three-birds orchid	–	T	Rich oak-hickory forests; Allegan, Kalamazoo, and Van Buren Counties
Valerianella chenopodiifolia	goosefoot corn-salad	–	T	Wet sites in forested floodplains; Kalamazoo County
Viola pedatifida	prairie birdfoot violet	–	T	Mesic prairie; Kalamazoo County
Utricularia subulata	zigzag bladderwort	–	T	Damp sand at the margins of interdunal wetlands; Allegan County
Zizania aquatica var. *aquatica*	wild-rice	–	T	Rivers, streams, lakes, and ponds; Kalamazoo County

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Insects				
Erynnis persius persius	Persius duskywing	–	T	Oak savannas and pine barrens (Shepard et al. 2005); Allegan and Kalamazoo Counties
Hesperia ottoe	Ottoe skipper	–	T	Remnant dry sand prairies and open oak barrens with native warm season grasses; Allegan County
Incisalia irus	frosted elfin	–	T	Oak savannas and pine barrens (Shepard et al. 2005); Allegan and Kalamazoo Counties
Lepyronia gibbosa	great plains spittlebug	–	T	Prairies; Van Buren County
Lycaeides melissa samuelis	Karner blue butterfly	E	T	Oak or oak-pine savanna, openings, old fields, and rights-of-way surrounded by close-canopied oak forest; Allegan County
Neonympha mitchellii mitchellii	Mitchell's satyr butterfly	E	E	Calcareous wetlands; Kalamazoo and Van Buren Counties
Nicrophorus americanus	American burying beetle	E	E	Wide variety of habitats with significant humus and topsoil suitable for burying of carrion (FWS 1989); Kalamazoo County, last observation 1961; no recent State sightings (MDNR 2005a).
Speyeria idalia	regal fritillary	–	E	Tall-grass prairie, meadows, marshes, and pastures (Shepard et al. 2005); Kalamazoo County

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Amphibians				
Ambystoma opacum	marbled salamander	–	T	Sandy, upland deciduous forests most of the year; lowland forest in the fall to breed (MDNR 2005b); Allegan and Van Buren Counties
Reptiles				
Clemmys guttata	spotted turtle	–	T	Shallow wetlands; recorded within 1 mi of Palisades-Argenta line (2002); Allegan, Kalamazoo, and Van Buren Counties
Clonophis kirtlandii	Kirtland's snake	–	E	Damp meadows, vacant lots, and open swampy woodlands (MDNR 2005c); Kalamazoo and Van Buren Counties
Sistrurus catenatus catenatus	eastern massasauga rattlesnake	C	–	Wetlands, including bogs, fens, shrub swamps, wet meadows, marshes, moist grasslands, wet prairies, and floodplain forests; recorded within 1 mi of Palisades-Argenta line (1995); Allegan, Kalamazoo, and Van Buren Counties
Birds				
Buteo lineatus	red-shouldered hawk	–	T	Mature, forested floodplains and upland forest; Allegan County
Dendroica discolor	prairie warbler	–	E	Upland scrub-shrub; recorded within 1 mi of Palisades-Argenta line (1997); Allegan and Van Buren Counties

Table 2-2. (contd)

Scientific Name	Common Name	Federal Status[a]	Michigan Status[a]	Habitat and Location in Project Area[b]
Lanius ludovicianus migrans	migrant loggerhead shrike	–	E	Grasslands and open, agricultural areas characterized by short vegetation and scattered trees, shrubs, or hedgerows; Allegan County
Rallus elegans	king rail	–	E	Freshwater marshes; Allegan and Van Buren Counties
Mammals				
Cryptotis parva	least shrew	–	T	Grassy, weedy, or brushy fields; Allegan, Kalamazoo, and Van Buren Counties
Microtus ochrogaster	prairie vole	–	E	Open prairie and savanna; recorded on Palisades site (1978); Kalamazoo and Van Buren Counties
Myotis sodalis	Indiana bat	E	E	Riparian, bottomland, and upland forest habitats; Allegan, Kalamazoo, and Van Buren Counties (FWS 2005b)

(a) C = candidate for listing; E = listed as endangered, T = listed as threatened, – = no listing.
(b) Habitat information from MNFI 2005b,c or NMC 2005a unless otherwise noted. Location on Palisades site or near transmission lines from NMC 2005a. County occurrence from MNFI 2005d unless otherwise noted.

The Pitcher's thistle has been found in dune blowouts and in semistabilized, but dynamic, full-sun dune habitats throughout the Palisades site (NMC 2006c). The species' distribution on the site can change over time in response to changes in habitat suitability and the location of seed sources offsite. From the early 1980s until the late 1990s, the Pitcher's thistle was found onsite in suitable habitat near the cooling towers. No Pitcher's thistle were found near the cooling towers during the NRC staff's site audit in July 2005. A survey on July 28, 2005, found no Pitcher's thistle in suitable habitat south or north of Palisades site; however, a population comprised of 113 individuals (9 mature plants and 104 first-year plants) were found in the beach grass stabilized dune community and flats located on the northern end of the site adjacent to Van Buren State Park (NMC 2006c).

On the basis of county distributions published in FWS (2005b), the Karner blue butterfly occurs in Allegan County and the Mitchell's satyr butterfly occurs in Kalamazoo and Van Buren

Counties. However, Czarnecki (FWS 2005c) stated that the Karner blue butterfly may occur near the Argenta-E. Elkhart transmission line in eastern Van Buren County, and the Mitchell's satyr butterfly may be found near the Palisades-Cook transmission line in Berrien County. It should be noted that neither the Argenta-E. Elkhart transmission line nor the portion of the Palisades-Cook transmission line in Berrien County were part of the original licensing of the plant and, therefore, are not considered in this SEIS. Neither species was observed during field surveys of the Palisades site and transmission line corridors conducted in 1979 (Asplundh 1979) and 1991 (Higman and Goff 1991; Goff 1992).

The Karner blue butterfly is dependent on its only known larval food plant, wild lupine (*Lupinus perennis*), grasses, and a variety of nectar plants (FWS 2005a). These plants and the butterfly's habitat occur in areas of sandy soil in oak and oak-pine savanna habitat, as well as other locations such as highway and transmission line rights-of-way, especially those surrounded by close-canopied oak forest (FWS 2005c; MNFI 2005b). The Mitchell's satyr butterfly is closely affiliated with wetlands that are dominated by sedges, especially *Carex stricta*, with scattered deciduous or coniferous trees such as tamarack and red cedar (*Juniperus virginiana*) (FWS 2005c; MNFI 2005b).

There is a possibility that the Indiana bat occurs within suitable habitat on or near the Palisades site or transmission lines associated with the plant (FWS 2005c). The summer range of this species includes the southern half of Michigan and most of the western coastal counties of the Lower Peninsula. Although the MNFI does not have records of occurrence in the three counties in the project area (MNFI 2005d), the FWS lists the Indiana bat as occurring in all three of the counties associated with the proposed action (FWS 2005b). Suitable habitat for the Indiana bat consists of riparian, bottomland, and upland forest habitats with trees that have crevices or exfoliating bark that can be used as roosting sites.

The eastern massasauga rattlesnake is known from Allegan, Kalamazoo, and Van Buren Counties and could occur on the Palisades site and within the rights-of-way of its associated transmission lines (FWS 2005b,c). Four records of eastern massasauga occur within 1 mi of the Palisades-Argenta transmission line within Van Buren County. Across the species' range, Michigan has the most recent recordings, and the State may represent the massasauga's last stronghold (MNFI 2005b). Recent sightings have been clustered in several portions of the Lower Peninsula, including Allegan and Kalamazoo Counties of the project area (MNFI 2005b). Eastern massasauga habitat includes a variety of wetland habitats, including bogs, fens, shrub swamps, wet meadows, marshes, moist grasslands, wet prairies, and floodplain forests (MNFI 2005b). In southern Michigan, populations are typically associated with open wetlands, particularly prairie fens. In the summer, snakes migrate from wetlands to drier, upland sites that include forest openings, old fields, agricultural lands, and prairies. Preferred sites have the following characteristics: (1) open, sunny areas intermixed with shaded areas, presumably for

thermoregulation; (2) a water table near the surface for hibernation; and (3) variable elevations between adjoining lowland and upland habitats (MNFI 2005b).

2.2.7 Radiological Impacts

NMC has conducted a radiological environmental monitoring program (REMP) around the Palisades site since 1971. Through this program, radiological impacts on workers, the public, and the environment are monitored, documented, and compared with the appropriate standards. The objectives of the REMP are the following:

- Identify and measure radiation and radioactivity in the plant environs for the calculation of potential dose to the population.
- Verify the effectiveness of in-plant measures used for controlling the release of radioactive materials.
- Provide reasonable assurance that the predicted doses, based on effluent data, have not been substantially underestimated and are consistent with applicable standards.
- Comply with regulatory requirements and plant technical specifications and provide records to document compliance.

Each year, radiological releases are summarized in the *Palisades Annual Radioactive Effluent Release and Waste Disposal Report* (e.g., NMC 2005b). The limits for all radiological releases are specified in the ODCM (NMC 2004a), and these limits are designed to meet Federal standards and requirements. The primary radiological standards applicable to Palisades are contained in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 50, Appendix I. Section 3.8.1.1 "Regulatory Requirements" of the GEIS (NRC 1996) also provides a summary and specific numerical dose limits associated with these standards and requirements. The REMP includes monitoring of the waterborne environment (groundwater, surface water, and sediments), ingestion pathways (milk, fish, and vegetation), direct radiation (gamma dose on thermoluminescent dosimeter locations), and atmospheric environment (airborne radioiodine, particulates, gross beta, and gamma). The results of the REMP are summarized in the *Palisades Annual Radiological Environmental Operating Reports* (e.g., NMC 2005c and 2006b). The REMP data indicate that the operation of Palisades has minimal impact on the environment, and most isotopic activity measured in the environmental media around Palisades is at environmental background levels (NMC 2006b).

NMC performs an annual assessment of radiation dose to the general public from radioactive effluents. Dose estimates are calculated on the basis of actual liquid and gaseous effluent release data. Calculations are performed by using the plant effluent release data, onsite meteorological data, and appropriate pathways identified in the ODCM (NMC 2004a).

The EPA's 40 CFR Part 190 is the most limiting generic requirement regarding allowable radiation dose to a member of the public. This regulation limits annual dose to a member of the public to 25 mrem total effective dose equivalent (TEDE) per year from the entire nuclear fuel cycle including power reactors. For the 5-year period 2000 through 2004, the annual TEDE calculated each year for the MEI by NMC was well within the annual limit of 25 mrem for members of the public as specified in the ODCM (TEDE is the sum total of the external dose and the sum of the weighted internal dose) (NMC 2001a, 2002, 2003a, 2004b, 2005b). Over this 5-year period, the maximum annual TEDE for the MEI was estimated to be 7.53×10^{-3} mrem with an annual average TEDE of 3.73×10^{-3} mrem (NMC 2001a, 2002, 2003a, 2004b, 2005b). These doses represent approximately 0.03 percent and 0.015 percent of the 25-mrem limit, respectively. In 2005, the TEDE for the MEI was calculated to be 7.36×10^{-3} mrem (NMC 2006a). The TEDE estimates include exposure from liquid and gaseous effluents and direct radiation. These results confirm that Palisades is operating in compliance with 10 CFR Part 50, Appendix I, 10 CFR Part 20, and 40 CFR Part 190.

A modification to the Liquid Radioactive Waste System was completed in December 2005, as discussed in Section 2.1.4.1. However, the TEDEs are still expected to remain much lower than the applicable standards.

2.2.8 Socioeconomic Factors

The NRC staff reviewed the NMC ER (NMC 2005a) and information obtained from county, city, school district, and local economic development staff. The following sections describe the housing market, community infrastructure, population, and economy in the region surrounding the Palisades site.

2.2.8.1 Housing

The majority of plant employees live in Van Buren County (44 percent) and in Berrien County (33 percent), and most of the remaining employees are located in Ottawa, Allegan, and Kalamazoo Counties (Table 2-3). Given the residential location of Palisades employees, the most significant impacts of plant operations are likely to occur in Van Buren and Berrien Counties. The analysis in this SEIS focuses on the impacts of Palisades operations in these two counties.

NMC refuels Palisades every 18 months. During refueling, approximately an additional 380 workers are employed for a 30- to 40-day period (NMC 2005a). The majority of these workers reside in the same communities as the permanent employees at the plant (NMC 2005b).

Table 2-3. Permanent Employee Residence Information for Palisades by County and City

County and City[a]	Number of Employees	Percent of Total
VAN BUREN COUNTY		
South Haven	156	30
Bangor	14	3
Grand Junction	13	2
Paw Paw	12	2
Hartford	8	2
Others	30	6
Total Van Buren County	233	44
BERRIEN COUNTY		
St. Joseph	73	14
Coloma	24	5
Benton Harbor	23	4
Stevensville	21	4
Watervliet	14	3
Others	17	3
Total Berrien County	172	33
Other counties	119	23
Grand total	524	100[b]

(a) Addresses are for both unincorporated (counties) and incorporated (cities and towns) areas.
(b) Total may not equal 100% because of rounding.
Source: NMC 2004c.

The number of housing units and housing vacancies in Van Buren and Berrien Counties are shown in Table 2-4. In Van Buren County, the total number of housing units grew at an annual rate of 0.7 percent over the period 1990 to 2000, while the number of occupied units grew at an average annual rate of 0.9 percent over the same period. With an annual average population growth rate of almost 1 percent during this period, there was a slight decline in the annual rate of growth in the number of vacant units. In Berrien County, total and occupied housing over the period 1990 to 2000 grew at an average annual rate of approximately 0.5 percent, exceeding the growth rate in population during this period, leading to a 1.5 percent annual growth in vacant housing units.

Table 2-4. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990	2000	Percentage Change 1990 to 2000
VAN BUREN COUNTY			
Housing units	31530	33975	7.8
Occupied units	25402	27982	10.2
Vacant units	6128	5993	-2.2
BERRIEN COUNTY			
Housing units	69532	73445	5.6
Occupied units	61025	63569	4.2
Vacant units	8507	9876	16.1

Source: U.S. Census Bureau 2000b.

2.2.8.2 Public Services

Water Supply

Water supplies in Van Buren and Berrien Counties come from both surface and groundwater sources, although surface water (especially Lake Michigan) is the main source (NMC 2005a). While Lake Michigan water meets the water quality standards set by the State, water from the lake is under localized threat of degradation from surface runoff, construction, and industrial activity.

Currently, Van Buren County has 28 water suppliers, although these suppliers currently only provide 28 percent of capacity and water supply (NMC 2005a). Residents in Van Buren County not served by municipal systems receive water from individual onsite wells or through wells accessed by small private providers. In Berrien County, 50 suppliers provide 57 percent of water supplies, with the majority of capacity and water supply in the county provided by municipal systems located in St. Joseph, Benton Harbor, Niles, and Lake Charter. Access to water by using individual onsite wells or through private supply systems is less important as a source of water supply in Berrien County. Table 2-5 shows the largest water supply systems in both counties.

According to estimates, excess water capacity in both Van Buren and Berrien Counties is high, and existing water suppliers would be able to satisfy new residential, commercial, and industrial demands (NMC 2005a).

Table 2-5. Major Public Water Supply Systems in Van Buren and Berrien Counties, 2004

Water System	Source	Average Daily Use (million gpd)	Maximum Capacity (million gpd)
VAN BUREN COUNTY			
South Haven	Surface water	1.7	4
Lawton	Groundwater	1.3	3.9
Mattawan	Groundwater	0.8	1.6
BERRIEN COUNTY			
Benton Harbor	Surface water	4.9	12
St. Joseph	Surface water	5.2	16
Niles	Groundwater	1.7	9.5
Lake Charter Township	Surface water	1.6	5
Buchanan	Groundwater	0.5	2.2

Source: NMC 2005a.

South Haven Municipal Water Authority provides potable water to Palisades at an average daily rate of 18,000 gpd (Section 2.2.2). Fire protection services for the plant are provided by the Covert Township Fire Department and the South Haven Fire Department.

Education

Palisades is located in the Covert Public School District, which has a current enrollment of 739 students (Standard and Poor's 2005). Fifty-four teachers are currently employed in the district (MEDC 2005), and current expenditures are $6222 per student (Standard and Poor's 2005). Enrollment has declined slightly in recent years, together with expenditures per student, while the number of teachers in the district has remained stable over the same period (MEDC 2005; Standard and Poor's 2005; greatschools.net 2005).

Including the Covert Public School District, there are 12 public school districts in Van Buren County, with a current total enrollment of 17,696 students (Standard and Poor's 2005). Average expenditure per student in the public school districts in the county is $5013, compared with $8653 for Michigan as a whole in 2002 (Standard and Poor's 2005). There were an additional six private schools in the county in 2004 with a total enrollment of 550 students (NCES 2005).

Berrien County has 15 public school districts, which had a total enrollment of 27,012 students in 2002. Average expenditure per student in the county was $4841. There are also

30 private/parochial schools with a current total enrollment of 4030 students, and two public school academies (Berrien County 2005).

Transportation

Access to Palisades is via Blue Star Memorial Highway, approximately 1 mi east of the plant. Blue Star Memorial Highway runs parallel to I-196 and US 31. Most employees traveling from Benton Harbor and St. Joseph from the south, and South Haven to the north use these roads.

Moderate increases in traffic have occurred on many of the roads in the vicinity of the plant; in particular, I-196, which has seen large increases in commercial traffic. Four segments of I-196 for which traffic counts are available, were assessed in the NMC ER (NMC 2005a). These segments are located both north and south of the plant. Traffic conditions on this stretch of roadway vary between medium density, stable flow, to high-capacity traffic where congestion is likely. Blue Star Memorial Highway also experiences relatively high daily traffic flow (NMC 2005a).

2.2.8.3 Offsite Land Use

Land use in Van Buren County (623 mi^2) is primarily agricultural (47 percent of total land area) and residential (44 percent), with a smaller land area occupied by industrial (2 percent) and commercial (2 percent) land uses (Table 2-6). Berrien County (583 mi^2) is also rural in character, with approximately 84 percent of the land area used for agriculture or classified as unused. About 9 percent of county land is residential and 3 percent is devoted to manufacturing, commercial, and sand and gravel mining activities (NMC 2003b). Fruit production, particularly berries, apples, and cherries, and food processing are an important part of the agricultural economy in both counties. Tourism also provides a significant source of

Table 2-6. Land Use in Van Buren County, 2005[(a)]

Land Use	Percent of Total
Residential	44
Commercial	2
Industrial	2
Agriculture	47
Other	5
Total	5

(a) Interview with K. Getman and M. Thomas, Michigan Economic Development Corporation (July 2005).

employment and income in both counties. The Lake Michigan lakefront, parks, and recreational areas are strong attractions for summer and fall visitors and seasonal residents, even though less than 4 percent of the land is devoted to public and semipublic uses in both counties.

Although Van Buren County's population has grown relatively slowly over the past 30 years, it has experienced moderate residential, industrial, and commercial growth during that period. Residential development has moved away from the urban cores, notably the Kalamazoo area (NMC 2005a), and through the development of lakefront locations for summer and retirement homes, notably in the South Haven area. As a result of these developments, both the Lake Michigan lakefront and prime farmland in the county are confronting growth pressure. In an attempt to manage new development, the county has developed an overall land-use decision-making strategy that encourages the implementation of a "smart growth" methodology by municipalities within the county. To conform with the strategy, each municipality has attempted to create development and planning tools that are compatible with local infrastructure, encourage clustering of new mixed use developments to foster the preservation of open space, farmland, natural beauty, and critical environmental areas.[(a)]

2.2.8.4 Visual Aesthetics and Noise

Palisades is located on the southeastern shoreline of Lake Michigan. The Lake Michigan shoreline in Van Buren County serves as a strong draw to summer tourists and seasonal residents who enjoy the recreational and environmental attractions of the area.

The Palisades site covers 432 ac of beach and high-wooded sand dunes. Plant buildings include a rectangular turbine building (94 ft high); a cylindrical, domed-top reactor containment building (92 ft high); a rectangular auxiliary building (108 ft high); and two cooling towers (65 ft high). All of the plant's structures and the reactor dome are equal to or below the height of the surrounding sand dunes. While the plant is readily visible from Lake Michigan and the shoreline, the distance from the north and south property lines, and the property's dominating sand dunes and trees obscure buildings from view of adjacent properties and I-196. The transmission lines can be seen from both the interstate highway and Blue Star Memorial Highway.

Noise measurements are not available for the Palisades site. However, noise generated by Palisades operations is mitigated at the site boundary because the plant is located approximately 2500 ft from the northern and southern boundaries of the site and is surrounded by sand dunes and vegetation, and most equipment is located within the plant buildings. In

(a) Interview with K. Getman and M. Thomas, Michigan Economic Development Corporation (July 2005).

addition, I-196 encloses the eastern portion of the site and reduces the conspicuousness of any noise generated by Palisades operations.

2.2.8.5 Demography

In 2000, 118,667 people were living within 20-mi of Palisades, for a density of 238 persons/mi^2. This density translates to Category 4 (least sparse), using the GEIS measure of sparseness (NMC 2005a). At the same time, there were 1,287,558 persons living within 50 mi of the plant, for a density of 283 persons/mi^2. The NRC sparseness and proximity matrix assigns a Category 4 rating (high density) for this measure as well. There are currently no mandatory growth controls that would limit housing development in this area (NMC 2005a).

Table 2-7 shows population trends for the two counties where the majority of Palisades employees live. Annual average growth rates in Van Buren County show moderate growth during the 1970s, followed by slight increases during the 1980s and 1990s. The annual average growth rate in Michigan over this period was 0.4 percent.

Growth is forecasted to continue at moderate levels over the period 2000 to 2020. In Berrien County, relatively slow growth in population in the 1970s was followed by declining population in the 1980s and slight increases in the 1990s. Population is forecasted to decline in both decades between 2000 and 2020.

Table 2-7. Population Growth in Van Buren and Berrien Counties, 1970 to 2020

	Van Buren County		Berrien County	
Year	Population	Annual Growth Percent[(a)]	Population	Annual Growth Percent
1970	56,173	–[(b)]	163,875	–
1980	66,814	1.7	171,276	0.5
1990	70,060	0.5	161,378	-0.6
2000	76,263	0.9	162,453	0.1
2010	87,100	1.3	160,800	-0.1
2020	95,800	1.0	158,900	-0.1

(a) Annual percent growth rate is calculated over the previous decade.
(b) – indicates no data available.
Sources: NMC 2005a; U.S. Census Bureau 2000a.

Transient Population

The transient population in the vicinity of Palisades consists primarily of tourists visiting South Haven, St. Joseph, Benton Harbor, and various recreational facilities (NMC 2005a). It is estimated that peak visitation levels reach almost 10,000 associated with campgrounds and beaches in the area (NMC 2005a). People visiting summer homes and attendance at local colleges in the area also represent a substantial source of transient population in the area.

Migrant Farm Labor

Seasonal and migrant workers are employed during the summer and fall months in many of the counties in the area surrounding the plant. In 2002, there were 4696 hired farm workers in Berrien County and 7527 in Van Buren County (USDA 2002). Of these workers, 3677 (78%) in Berrien County and 6733 (89%) in Van Buren County were temporary, having worked less than 150 days in the year.

2.2.8.6 Economy

Employment and Income

Total employment in Van Buren County was 23,982 in 2002 (U.S. Census Bureau 2000b; USDA 2002). Agriculture is the most important sector in Van Buren County, with 7537 people employed (31% of the total employed; the county is one of the most important in the state in the production of fruit and vegetables (NMC 2005a)). Service industries are also an important part of the economy of the county, with 28 percent of total employment (6635 people). The largest employer in the county is Consumers Energy, with 484 employees (Table 2-8). Manufacturing also plays an important part in the local economy, with 21 percent of local employment (4934 people); a number of manufacturing firms have a large local labor force, including Double J Moulding and Pullman Industries. Wholesale and retail trade employs 12 percent (2974 people) of the county workforce.

Of the 65,340 employed in Van Buren County in 2002, almost 45 percent of employment (29,214 people) is in the various service sectors (U.S. Census Bureau 2000b). Manufacturing has a relatively small share of county employment (22 percent), with 14,435 people employed.

Wholesale and retail trade has more than 15 percent of the county workforce, with 9836 people.

Personal income in Berrien County was $2.0 billion in 2002 (in 2004 dollars), with a per capita income of $25,514 (2004 dollars) (DOC 2002). In Berrien County, total personal income was $4.7 billion, with a per capita income of $29,081.

Table 2-8. Major Employment Facilities Within 10 mi of Palisades

Firm	Number of Employees
Consumers Energy	484
Double J Moulding	240
Pullman Industries	240
Wal-Mart	230
South Haven Community Hospital	160
De Grandchamp Blueberry Farms	154
Wyckoff Chemical	140
South Haven Public Schools	126
Bangor Industries	110

Source: MEDC 2005.

Unemployment

Unemployment in Van Buren County was moderately high at 7.2 percent in December 2004. The rate for Michigan as a whole for the same month was 7.1 percent. In Berrien County, the rate for December 2004 was lower, at 4.2 percent (DOL 2004).

Taxes

Palisades pays property taxes to Covert School District, Covert Township, Van Buren Intermediate School District, Van Buren County, the District Library, South Haven Community Hospital District, and Lake Michigan College, and it contributes to the Michigan State Education fund. Because Palisades is located in Covert Township, the township collects sufficient tax revenues from the plant to cover local expenditures and forwards the balance to the other jurisdictions. Revenues are used to fund local and county emergency management programs, public safety, local public schools, local government operations, local road maintenance, and the local library system.

The plant is a significant source of tax revenue for local and county government. In 2004, 56 percent (about $1 million in 2004 dollars) of tax revenues raised by Covert Township came from Palisades property taxes, and 29 percent ($2.7 million) of revenues raised by Covert School District came from the plant (Table 2-9). Roughly 4 percent (about $0.8 million in 2004 dollars) of Van Buren County tax revenues in 2004 came from Palisades.

Table 2-9. Contribution of Palisades to County Property Tax Revenues

Year	Total Covert School District Property Tax Revenues (millions $ 2004)	Property Tax Paid to Covert School District for Palisades (millions $ 2004)	Percent of Total Property Taxes
	COVERT SCHOOL DISTRICT		
2002	7.4	2.8	37
2003	8.7	2.7	31
2004	9.2	2.7	29
Year	**Total Covert Township Property Tax Revenues (millions $ 2004)**	**Property Tax Paid to Covert Township for Palisades (millions $ 2004)**	**Percent of Total Property Taxes**
	COVERT TOWNSHIP		
2002	1.6	0.9	58
2003	1.5	0.9	60
2004	1.6	0.9	56
Year	**Total Van Buren County Property Tax Revenues (millions $ 2004)**	**Property Tax Paid to Van Buren County for Palisades (millions $ 2004)**	**Percent of Total Property Taxes**
	VAN BUREN COUNTY		
2002	17.6	0.9	5
2003	18.7	0.9	5
2004	19.7	0.8	4
Year	**Total Van Buren Intermediate School District Property Tax Revenues (millions $ 2004)**	**Property Tax Paid to Van Buren Intermediate School District for Palisades (millions $ 2004)**	**Percent of Total Property Taxes**
	VAN BUREN INTERMEDIATE SCHOOL DISTRICT		
2002	26.3	0.9	3
2003	26.9	0.8	3
2004	28.4	0.8	3

Source: VerBermones 2005.

Utility restructuring legislation has been in place in Michigan since 2000. However, the long-term impact of the restructuring of the electric power industry in the State and its impact on Palisades are not yet known. Any changes in assessed valuation of plant property and equipment that may potentially occur could affect property tax payments to the township, county, and local school districts. However, any impacts on tax revenues as a result of restructuring would not occur as a direct result of license renewal.

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at the Palisades site and in the surrounding area.

2.2.9.1 Cultural Background

Evidence of human occupation within the region is found in archaeological sites dated according to the following chronological sequence that reflects cultural change through time: Paleo-Indian Period (10000 BC to 8000 BC); Archaic Period (8000 BC to 1000 BC); Woodland Period (1000 BC to AD 1050); and Upper Mississippian Period (1050 to 1600). The Paleo-Indian Period marks the beginning of human occupation within the region. These were highly mobile bands of hunters and gatherers, with a heavy reliance on late Pleistocene animals for food, clothing, and shelter. Archaeological sites tend to be found in upland areas along ancient lakebeds and may consist of a single projectile point or other stone tool of a style characteristic of the period (Mason 1981).

During the Archaic Period, human populations adapted to the postglacial environment by adopting a more sedentary way of life based upon hunting, fishing, and gathering, and a heavy dependence upon waterways for travel, transport, and settlement (Funk 1978; Quimby 1960). Archaeological sites from this period are larger, more numerous, and richer in occupation debris than previous periods, reflecting larger, denser populations and a more abundant and reliable subsistence base. New types of raw material were used for tool production as the techniques of pecking, grinding, and polishing stone gained importance (Mason 1981).

In the Woodland Period, earthenware pottery appears in archaeological sites. Burials are characteristically earthen mounds and contain an abundance of grave offerings. The beginnings of undisputed plant domestication and agriculture also mark this period (Mason 1981). Widespread exchange networks existed and there is evidence of a dramatic increase in the frequency and scale of warfare (Fitting 1978; Mason 1981). The Upper Mississippian Period in southwestern Michigan is characterized by mostly Late Woodland cultural traits with the addition of shell- and grit-tempered cord-marked and plain ceramics (Brose 1978).

The historic period begins in the late 1600s with the arrival of French explorers, missionaries, and fur traders. Fort Miami (in present-day St. Joseph) and Fort St. Joseph (in present-day Niles) were the first European settlements in the area. Native American groups that inhabited the area during the historic period were predominantly the Potawatomi, Mascouten, Miami, and Ottawa. During the early historic period, their villages were situated on the edge of forested land, adjacent to prairies and convenient to streams and the lakeside; temporary winter camps were established in sheltered areas. By the beginning of the nineteenth century, the Potawatomi had established 11 known villages in southern Michigan. Most were near the shorelines of Lake Michigan and Lake Erie, generally along the streams that flow into their waters (Clifton 1978; Goddard 1978; Callender 1978; Feest and Feest 1978).

After 1783, the official beginning of the American period, Indian lands were rapidly absorbed by expanding American settlements; by 1821, most of these lands were ceded by treaty or purchase (Feest and Feest 1978). In the 1830s, lumbering was an important regional industry and drew many settlers (Brennan 2004). One of the earliest settlements in the Palisades area was Paulville, a logging town established in 1857, and several logging operations were established in the area between 1866 and 1880. While the 1840s and 1850s was a period of agricultural settlement of much of southern lower Michigan (Great Lakes Research 2000), the dune formations present at the Palisades site rendered this area unsuitable for agriculture. As late as 1927, only six structures were located in the Palisades vicinity and they were south of the site along Brandywine Creek (Weir et al.1980).

Five historic properties within Van Buren County are listed on the National Register of Historic Places (NRHP; NPS 2005a); there are no National Historic Landmarks listed for the county (NPS 2005b). Properties listed on the NRHP that are closest to the Palisades site (Liberty Hyde Bailey Birthplace in South Haven and the Navigation Structures at South Haven Harbor) are located approximately 6 mi to the north. In addition, one property in Allegan County (the James Noble Sherwood House in Plainwell) is located approximately 0.5 mi from the Palisades-Argenta transmission line right-of-way (NPS 2005a). The Michigan State Historic Preservation Office's (SHPO's) inventory of historic properties for Van Buren County lists 29 properties. Those nearest the Palisades site are Ward School, Hartman School, and Haven Peaches Informational Designation, all in South Haven, and the First Congregational Church in Covert (State of Michigan 2005).

The Southwest Michigan Underwater Preserve stretches along the Lake Michigan shoreline from just north of Holland to just north of the Indiana border, including the 1-mi stretch of the lakeshore that lies within the Palisades site boundaries. Seventeen sites are documented in and near the preserve that include shipwrecks, geologic features, and historic structures: most lie offshore from South Haven. The closest to the Palisades site is the shipwreck site of the *City of Greenbay*, which sank in 1887. It lies at a depth of 10 ft (Michigan Underwater Preserve Council 2004), approximately 0.5 mi north of the Palisades site.

At least seven previous archaeological surveys came within 1 mi of the Palisades site and transmission line rights-of-way. These surveys resulted in the recordation of 15 archaeological sites within 1 mi of the Palisades site and transmission line rights-of-way. These 15 sites consist of prehistoric lithic scatters and camp sites, one dating to the Archaic Period; isolated prehistoric artifacts, including two Paleo-Indian Period fluted points; one prehistoric village site, Pell Village; two prehistoric sites of undetermined function; and one historic trading post site. One of the prehistoric sites of unknown type, 20-VA-28, is located about 0.3 mi south of the Palisades site and the other, 20-VA-4, is recorded just outside the Palisades site's eastern boundary (Weir et al. 1980).

2.2.9.2 Historic and Archaeological Resources at the Palisades Site

The Palisades site encompasses approximately 432 ac of land, including about 1 mi of Lake Michigan shoreline. The site consists primarily of sand dunes, mostly forested, that extend from the shoreline inland approximately 1 mi. Approximately 80 ac of the site are developed or maintained. The developed or maintained areas include power production and support facilities, roads, and related infrastructure. Most of these facilities are located along the main and north access roads. Also within this area are the power corridor from the main station transformer to the Palisades Substation and transmission rights-of-way from the substation extending offsite. Service and circulating water are withdrawn from Lake Michigan via pipeline from a submerged intake crib structure located 3300 ft offshore (NMC 2005a; Consumers Energy 2005b). In addition to the land disturbance caused by these developments, more than 4 ac of additional land in the northern portion of the Palisades site have been disturbed by former use of the land for sand quarrying operations. Intact archaeological sites could be present within the remaining undeveloped areas as well as in soils below the depth of ground disturbance in most areas of the site. As discussed in Section 2.2.9.1, Native American villages are known to have been situated within physiographic settings similar to portions of the Palisades site: on the shorelines of Lake Michigan and on the edge of forested land, adjacent to prairies and convenient to streams and the lakeside.

A file search conducted on July 27, 2005, at the Michigan SHPO indicates that one cultural resources assessment (Weir et al. 1980) was undertaken at the Palisades site but that no archaeological field surveys have been conducted either at the Palisades site or for original transmission line construction or maintenance. The cultural resource assessment, which was undertaken in 1979, concluded that without accurate knowledge of the cultural resources present at the Palisades site, it must be assumed that power plant construction has the potential to adversely impact significant resources that may exist on the plant site. The report recommends that an intensive survey be undertaken of the undisturbed portions of the site.

In addition to the assessment report on file at the Michigan SHPO, Consumers Energy files contain a second report that documents a brief cultural resource field visit to the Palisades site

by archaeologists in 1982. The purpose of the field visit was to determine the likelihood of the existence of archaeological sites at the locations of three proposed facilities: a drainage pond, a parking lot, and a warehouse (CAI 1982). The report concluded that the likelihood of encountering archaeological sites at the three locations was minimal because of the generally steep terrain and distance from the Lake Michigan shore.

Agency consultation undertaken by the U.S. Atomic Energy Commission (AEC) in 1972 for issuance of an OL for Palisades operation generated comment letters from the U.S. Department of the Interior and from the Michigan State Liaison Officer for Historic Preservation (AEC 1972). The Department of the Interior letter states that it does not appear that the existing plant should directly affect any site eligible for registration as a National Historic Landmark (DOI 1972). The Michigan State Liaison Officer's letter concludes that as far as could be determined at that time, Palisades would not adversely affect known historical or archaeological resources of the State of Michigan (MDNR 1972).

Consumers Energy and NMC corresponded with the Michigan SHPO in early 2005 regarding the current license permit renewal application (Consumers Energy and NMC 2005). The Consumers Energy and NMC letter to the SHPO states that NMC, Consumers, and the Palisades Environmental Review Team conclude the operation of Palisades through the license renewal term will not have an adverse effect on any historic or cultural property in the region and, therefore, a survey of the project area is not necessary. Their conclusion was based upon the small extent of potential land-disturbing activities, the absence of known historic properties in the vicinity of Palisades, and the existence of adequate environmental controls to ensure protection of cultural resources. A response letter from the SHPO dated March 14, 2005, concurred with these conclusions (Michigan SHPO 2005). The NRC staff forwarded a copy of the draft SEIS to the Michigan SHPO for review and comment. In a letter dated June 19, 2006, the Michigan SHPO stated that no historic properties are affected in the project area (Michigan SHPO 2006).

Correspondence between the Michigan SHPO and the NRC, dated June 30, 2005, and June 19, 2006, are provided in Appendix E.

Government-to-government consultation with appropriate Federally recognized Native American Tribes has been initiated. Copies of the consultation letters are provided in Appendix E. To date, no known sites of significance to Native Americans have been identified at Palisades.

2.2.10 Related Federal Project Activities and Consultations

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

The NRC staff has determined that there are no Federal project activities that would make it desirable for another Federal agency to become a cooperating agency for preparing this SEIS. There are no known Federal facilities or land or Native American land within 50 mi of Palisades. The D.C. Cook Nuclear Plant, owned by the Indiana and Michigan Power Company, is located approximately 28 mi south-southwest of Palisades.

The NRC is required under Section 102(c) of the National Environmental Policy Act of 1969 as amended (NEPA) 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 consulted with the FWS; the consultation is described in Sections 2.2.6 and 4.6, and correspondence is included in Appendix E.

2.3 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

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 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 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, *Energy*, Part 81, "Designation of Areas for Air Quality Planning Purposes."

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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 characteristics.

(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 in this Supplemental Environmental Impact Statement (SEIS) 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 Sections
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
GROUNDWATER USE AND QUALITY	
Impacts of refurbishment on groundwater 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 the Palisades Nuclear Plant (Palisades) because they are related to plant design features or site characteristics not found at Palisades are listed in Appendix F.

The potential environmental impacts of refurbishment actions would be identified, and the analysis would be summarized within this section, if such actions were planned. Nuclear Management Company, LLC (NMC), indicated that it has performed an evaluation of structures and components pursuant to Section 54.21 of Title 10 of the *Code of Federal Regulations* (10 CFR 54.21) to identify activities that are necessary to continue operation of Palisades during the requested 20-year period of extended operation. These activities include replacement of certain components as well as new inspection activities and are described in the Environmental Report (ER) (NMC 2005).

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE–10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	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 an applicant plans to undertake refurbishment activities for license renewal, environmental justice must be addressed in the applicant's environmental report and the U.S. Nuclear Regulatory Commission staff's environmental impact statement.

However, NMC stated that the replacement of these components and the additional inspection activities are within the bounds of normal plant component replacement and inspections; therefore, they are not expected to affect the environment outside the bounds of plant operations as evaluated in the Final Environmental Statement for Palisades (AEC 1972). In addition, NMC's evaluation of structures and components as required by 10 CFR 54.21 did not identify any major plant refurbishment activities or modifications necessary to support the continued operation of Palisades beyond the end of the existing operating license. Therefore, refurbishment is not considered in this SEIS.

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."

Nuclear Management Company, LLC (NMC). 2005. *Applicant's Environmental Report – Operating License Renewal Stage, Palisades Nuclear Plant.* Docket No. 50-255, Covert, Michigan (March 2005).

U.S. Atomic Energy Commission (AEC). 1972. *Final Environmental Statement Related to the Operation of Palisades Nuclear Generating Plant, Consumers Power Company*. Docket No. 50-255. Directorate of Licensing. Washington, D.C.

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

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 characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, OR LARGE) has been assigned to the impacts (except for collective off-site 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 Part 51 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 51), Subpart A, Appendix B, and are applicable to the Palisades Nuclear Plant (Palisades). Section 4.1 addresses issues applicable to the Palisades cooling system. Section 4.2 addresses issues related to transmission lines and onsite land use. Section 4.3 addresses the radiological impacts of normal operation, and Section 4.4 addresses issues related to the socioeconomic impacts of normal operation during the renewal term. Section 4.5 addresses issues related to groundwater use and quality, while Section 4.6 discusses the impacts of renewal-term operations on threatened and endangered species. Section 4.7 addresses

(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.

potential new information that was raised during the scoping period, and Section 4.8 discusses cumulative impacts. The results of the evaluation of environmental issues related to operation during the renewal term are summarized in Section 4.9. Finally, Section 4.10 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable to Palisades because they are related to plant design features or site characteristics not found at Palisades 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 the Palisades cooling system operation during the renewal term are listed in Table 4-1. Nuclear Management Company, LLC (NMC), stated in its Environmental Report (ER) (NMC 2005a) that it is not aware of any new and significant information associated with the license renewal and continued operation of Palisades. The U.S. Nuclear Regulatory Commission (NRC) staff has not identified any new and significant information during its independent review of the NMC ER (NMC 2005a), the site visit, the scoping process, the evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS. For all of the issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the NRC 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of altered current patterns at intake and discharge structures during the renewal term beyond those discussed in the GEIS.

Table 4-1. Category 1 Issues Applicable to the Operation of the Palisades Cooling System During the Renewal Term

ISSUE–10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SURFACE-WATER QUALITY, HYDROLOGY, AND USE	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Altered thermal stratification of lakes	4.2.1.2.2
Temperature effects on sediment transport capacity	4.2.1.2.3
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
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4
Discharge of other metals in wastewater	4.2.1.2.4
AQUATIC ECOLOGY	
Accumulation of contaminants in sediments or biota	4.2.1.2.4
Entrainment of phytoplankton and zooplankton	4.2.2.1.1
Cold shock	4.2.2.1.5
Thermal plume barrier to migrating fish	4.2.2.1.6
Distribution of aquatic organisms	4.2.2.1.6
Premature emergence of aquatic insects	4.2.2.1.7
Gas supersaturation (gas bubble disease)	4.2.2.1.8
Low dissolved oxygen in the discharge	4.2.2.1.9
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10
Stimulation of nuisance organisms	4.2.2.1.11
AQUATIC ECOLOGY (PLANTS WITH COOLING-TOWER-BASED HEAT DISSIPATION SYSTEMS)	
Entrainment of fish and shellfish in early life stages	4.3.3
Impingement of fish and shellfish	4.3.3
Heat shock	4.3.3
TERRESTRIAL RESOURCES	
Cooling-tower impacts on crops and ornamental vegetation	4.3.4
Cooling-tower impacts on native plants	4.3.5.1
Bird collisions with cooling towers	4.3.5.2
HUMAN HEALTH	
Microbiological organisms (occupational health)	4.3.6
Noise	4.3.7

- Altered thermal stratification of lakes. Based on information in the GEIS, the Commission found that

  > Generally, lake stratification 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, the review of monitoring programs, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of altered thermal stratification of lakes 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, the review of monitoring programs, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, the review of monitoring programs, and its evaluation of other available information (including plant monitoring data and technical reports) and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information (including the National Pollutant Discharge Elimination System (NPDES) permit for Palisades and discussion with the Michigan Department of Environmental Quality (MDEQ) compliance office) and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 the NPDES permit, and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information (including the NPDES permit for Palisades and discussion with the MDEQ compliance office) and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 wastewater. 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information (including the NPDES permit for Palisades and discussion with the MDEQ compliance office) and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of discharges of other metals in wastewater 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.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, the review of monitoring programs, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of thermal plume barriers on 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, the review of monitoring programs, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts on 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, the review of monitoring programs, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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. 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of stimulation of nuisance organisms during the renewal term beyond those discussed in the GEIS.

- Entrainment of fish and shellfish in early life stages (cooling-tower-based heat dissipation). Based on information in the GEIS, the Commission found that

  > Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of entrainment of fish and shellfish in early life

stages for cooling-tower-based systems during the renewal term beyond those discussed in the GEIS.

- Impingement of fish and shellfish (cooling-tower-based heat dissipation). Based on information in the GEIS, the Commission found that

  > The impingement has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of impingement of fish and shellfish for cooling-tower-based systems during the renewal term beyond those discussed in the GEIS.

- Heat shock (cooling-tower-based heat dissipation). Based on information in the GEIS, the Commission found that

  > Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of heat shock for cooling-tower-based systems during the renewal term beyond those discussed in the GEIS.

- Cooling-tower impacts on crops and ornamental vegetation. Based on information in the GEIS, the Commission found that

  > Impacts from salt drift, icing, fogging, or increased humidity associated with cooling-tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no cooling-tower impacts on crops and ornamental vegetation during the renewal term beyond those discussed in the GEIS.

- Cooling-tower impacts on native plants. Based on information in the GEIS, the Commission found that

  > Impacts from salt drift, icing, fogging, or increased humidity associated with cooling-tower operation 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no cooling-tower impacts on native vegetation during the renewal term beyond those discussed in the GEIS.

- Bird collisions with cooling towers. Based on information in the GEIS, the Commission found that

  > These collisions 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of bird collisions with cooling towers 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of microbiological organisms 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of noise during the renewal term beyond those discussed in the GEIS.

No Category 2 issues related to cooling system operation during the renewal term are applicable to Palisades.

4.2 Transmission Lines

The Final Environmental Statement (FES) for Palisades (AEC 1972) describes two transmission lines that connect Palisades with the transmission system. The transmission lines, as well as their ownership and responsibilities for their maintenance, are described in Section 2.1.7 of this Supplemental Environmental Impact Statement (SEIS). The 0.6-mi-long Palisades-Cook 345-kV transmission line connects to the American Electric Power (AEP) system, while the 40-mi-long Palisades-Argenta 345-kV transmission line connects to the Michigan Electric Transmission Company, LLC (METC), system and the Michigan Power Pool (NMC 2005a).

The Palisades-Cook transmission line is situated on land similar to that of the Palisades site. Its construction involved the clearing of a 150-ft-wide right-of-way totaling 10.9 ac over sand dunes (AEC 1972). The Palisades-Argenta transmission line right-of-way is 1320 ft wide for the first 4.5 mi, 350 ft wide for the next 34 mi, and 471 ft wide for the final 1.5 mi, totaling 2250 ac. This line crosses mostly flat to gently rolling terrain used primarily for agriculture (AEC 1972).

Vegetation control along Palisades transmission lines is accomplished through the use of herbicides, mowing, and cutting, or pruning of tall-growing tree species that are considered danger trees. Danger trees are typically outside the cleared right-of-way but could cause a line outage from windfall of healthy or diseased trees. Procedures are in place to ensure that vegetation management along rights-of-way is carried out in a manner to protect local water bodies and aquatic organisms that could be adversely impacted from herbicide application in the immediate vicinity of stream and river crossings. Herbicides that are used comply with Federal and State regulations and are applied by licensed applicators.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to Palisades transmission lines are listed in Table 4-2. NMC stated in its ER that it is not aware of any new and significant information associated with the renewal of the Palisades operating

license (OL) (NMC 2005a). The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS (NRC 1999). For all of those issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-2. Category 1 Issues Applicable to the Palisades Transmission Lines During the Renewal Term

ISSUE–10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
TERRESTRIAL RESOURCES	
Power line right-of-way management (cutting and herbicide application)	4.5.6.1
Bird collisions 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 wetlands 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 NRC staff's review and GEIS conclusions, as codified in Table B-1, 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, consultation with the U.S. Fish and Wildlife Service (FWS) and the Michigan Department of Natural Resources (MDNR), and its evaluation of other available information and public comments on the draft SEIS.

Therefore, the NRC staff concludes that there would be no impacts of power line right-of-way maintenance during the renewal term beyond those discussed in the GEIS.

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

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

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, consultation with the FWS and MDNR, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 rights-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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, consultation with the FWS and MDNR, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of power line rights-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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no air quality impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

- Onsite land use. Based on the 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no onsite land-use impacts during the renewal term beyond those discussed in the GEIS.

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

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

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of power line rights-of-way on land use during the renewal term beyond those discussed in the GEIS.

There is one Category 2 issue related to transmission lines, and another issue related to transmission lines is being treated as a Category 2 issue. These issues are listed in Table 4-3 and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-3. Category 2 and Uncategorized Issues Applicable to the Palisades Transmission Lines 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
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[(a)]	4.2.2

(a) Not addressed.

4.2.1 Electromagnetic Fields – Acute Effects

Based on the GEIS, the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been found to be a problem at most operating plants and generally is not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of this SEIS.

In the GEIS (NRC 1996), the NRC staff found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) (IEEE 2002) criteria, 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.

Both transmission lines associated with Palisades were constructed in accordance with NESC and industry guidance in effect at that time. The transmission facilities are maintained to ensure continued compliance with current standards. Since the lines were constructed, a new criterion has been added to the NESC for power lines with voltages exceeding 98 kV. This

criterion states that the minimum clearance for a line must limit induced currents due to static effects to 5 mA.

NMC (2005a) has reviewed the power lines for compliance with this criterion. Spans where the potential for induced current would be the greatest were identified. The electric field strengths

and potential induced currents for these spans were calculated by using Version 2.5 of the ENVIRO computer code (EPRI 1996). Input to the code included line sag at a 120°F conductor temperature, maximum operating voltage during normal load conditions, and a large tractor-trailer parked under the line in a position to maximize the induced current. The calculated induced currents for both Palisades 345-kV lines at six locations ranged from 1.6 to 4.9 mA, all below the NESC 5-mA criterion (NMC 2005a).

The NRC staff has reviewed the available information, including the applicant's evaluation and computational results. Based on this information, the NRC staff has evaluated the potential impacts for electric shock resulting from operation of Palisades and its associated transmission lines. The NRC staff concludes that the impacts of electric shock during the renewal period would be SMALL, and that no further mitigation measures would be warranted.

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). The report by 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 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 noncancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the NRC staff to change its position with respect to the chronic effects of electromagnetic fields. The NRC 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 Palisades in regard to radiological impacts are listed in Table 4-4. NMC stated in its ER (NMC 2005a) that it is not aware of any new and significant information associated with the renewal of the Palisades OL. The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the NRC 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 4-4. 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 Sections
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 NRC staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Radiation exposures to the 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 4-5. NMC stated in its ER (NMC 2005a) that it is not aware of any new and significant information associated with the renewal of the Palisades OL. The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the NRC 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 Socioeconomics During the Renewal Term

ISSUE–10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
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 NRC 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 on public safety, social services, and tourism and recreation are expected to be of SMALL significance at all sites.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no aesthetic impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

Table 4-6 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and environmental justice, which was not addressed in the GEIS.

Table 4-6. 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 Sections	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 NRC 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)). Sparseness measures population density within 20 mi of the site, and proximity measures population density and city size within 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).

In 2000, 118,667 people were living within 20 mi of the Palisades site. Based on the GEIS measure of sparseness, the area within 20 mi has a density of 238 persons/mi^2, placing it in the least sparse (high-density) category, Category 4 (NMC 2005a; U.S. Census Bureau 2004). In 2000, 1,287,558 persons lived within 50 mi of the plant, giving the area a density of

283 persons/mi^2. According to the NRC sparseness and proximity matrix, the area falls into Category 4 for both measures, meaning that the area is classified as a high-density area.

Part 51 of 10 CFR, Subpart A, Appendix B, Table B-1 states 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. The Palisades site is located in a high-population area, and Van Buren County is not subject to growth-control measures that would limit housing development. Based on the NRC criteria, NMC anticipates that housing impacts would be SMALL during continued operation of Palisades (NMC 2005a).

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 NMC ER (NMC 2005a) assumes that a small number of additional workers might be needed during the license renewal period to perform routine maintenance and other activities.

The housing vacancy rate in 2000 was 17.6 percent in Van Buren County and 13.4 percent in Berrien County. If these vacancy rates continue, small increases in the number of workers required at the plant would not require any new housing construction.

The NRC staff reviewed the available information relative to housing impacts and NMC's conclusions. Based on this review, the NRC staff concludes that the impact on housing during the license renewal period would be SMALL, and additional 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 Palisades permitted withdrawal rate and actual use of water.

The NRC staff has reviewed the available information, including permitted and actual water use rates at Palisades, and water use and water supply capacities for the major water supply systems in Van Buren County. Based on this information, the NRC staff concludes that the

potential impacts of Palisades operation during the license renewal period would be SMALL. During the course of its evaluation, the NRC staff considered mitigation measures for continued operation of Palisades. Based on this evaluation, the NRC staff expects that mitigation measures in place at Palisades are appropriate, and that no additional mitigation measures are warranted.

4.4.3 Offsite Land Use During Operations

Offsite land use during the license renewal term is a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 of 10 CFR Part 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 a result of plant operation during the license renewal term as follows:

SMALL – Little new development and minimal changes to an area's land-use pattern.

MODERATE – Considerable new development and some changes to the land-use pattern.

LARGE – Large-scale new development and major changes in the land-use pattern.

NMC expects to use existing employees, possibly adding a maximum of two employees, to support Palisades operations during the license renewal term. In Section 3.7.5 of the GEIS (NRC 1996), the NRC staff stated 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, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 persons/mi^2, and at least one urban area with a population of 100,000 or more within a 50-mi radius. In this case, population growth would be 0 percent of the total 2000 population of 1,287,558 within the 50-mi radius. The area has established patterns of residential and commercial development, a population density of 283 persons/mi^2, and at least one urban area (Kalamazoo-Battle Creek Metropolitan Statistical Area) with a population of 100,000 or more within the 50-mi radius. Consequently, the NRC staff concludes that population changes resulting from renewal of the Palisades OL would likely result in SMALL impacts on offsite land use.

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. In Section 4.7.4.1 of the GEIS, the NRC staff 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 jurisdictions 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. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use changes would be LARGE. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development.

Covert Township and Covert School District receive significant tax payments from Consumers Energy property tax payments. As discussed in Section 2.2.8.6 and shown in Table 2-9, Consumers Energy paid $0.9 million in property taxes to the township in 2004, or approximately 56 percent of the township's revenues. The Covert School District received $2.7 million from taxes paid by Consumers Energy in 2004. These payments represent a substantial, positive impact on the fiscal condition of the township and the school district. In addition to the Covert School District, Covert Township forwards the balance of the property tax revenues to the Van Buren Intermediate School District and Van Buren County. Both the Van Buren Intermediate School District and Van Buren County received $0.8 million, respectively, in property tax payments in 2004, or 3 and 4 percent, respectively, of revenues in each jurisdiction.

Because no refurbishment or new construction activities are associated with the license renewal, no additional sources of plant-related tax payments are expected that could influence land use in the township or the county. The continued collection of property taxes from Consumers Energy for Palisades will result in moderate indirect tax-driven land-use impacts through sewer and water system improvements and expansion, lower property taxes, and improved educational services and facilities. This source of revenue allows the township, school district, and county to keep tax rates below the levels they would otherwise have in order to fund the higher levels of public infrastructure and services, schools, and government services.

Van Buren County's population growth rates over the last 30 years have been both moderate and stable (Table 2-8). NMC projects the addition of one or two additional employees to support the operation of Palisades during the license renewal term; thus, land-use changes from Palisades population-related growth would be negligible. While the county has experienced significant residential, industrial, and commercial growth during this 30-year period, Van Buren County has developed an overall land-use decision-making strategy that encourages

municipalities to implement a "smart growth" methodology that relies on a mix of development and planning tools.[(a)]

NMC projects that annual property taxes from Palisades to Covert Township, Covert School District, Van Buren County Intermediate School District, and Van Buren County will remain relatively constant throughout the license renewal period. However, the Michigan Public Service Commission is currently implementing the electric utility restructuring legislation that was enacted in June 2000, and the impacts are not fully known at this time. Any changes to tax rates for the Palisades property due to the restructuring would be independent of license renewal (NMC 2005a).

No adverse impacts on offsite land use would occur because of license renewal. Consequently, the NRC staff concludes that offsite land-use impacts would likely be SMALL, and additional mitigation is not warranted.

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.

Given the small number of additional workers required during the renewal period, there would be no additional impacts on the transportation network in the vicinity of the Palisades site. Therefore, the NRC staff concludes that during the license renewal period, transportation impacts during operation would likely be SMALL. Additional mitigation is not warranted.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act of 1966 (NHPA), as amended through 2000, 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 at 36 CFR Part 800. The renewal of an OL for a nuclear power plant is an undertaking that could potentially affect either known or potential historic properties that may be located at the plant's site. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the potentially affected areas and notify the State Historic Preservation Office

(a) Interview with K. Getman and M. Thomas, Michigan Economic Development Corporation (July 2005).

(SHPO) before proceeding. If historic properties are determined to be present, an assessment is required to resolve any possible adverse effects of the undertaking.

At Palisades, the potential exists that presently unknown significant archaeological resources may be present on or below the ground surface at the site and along the transmission line corridors. Any such resources could be inadvertently disturbed or destroyed by construction or other ground-disturbing activities. The applicant has indicated that no major refurbishment or replacement activities at Palisades or along the transmission line corridors are associated with its license renewal request (NMC 2005a). However, routine operations and maintenance activities that will take place during the renewal period could potentially affect presently unknown archaeological resources. The applicant has procedures in place to protect any resources from such inadvertent disturbance or destruction from these activities.

The NRC staff reviewed the applicant's environmental review procedures for Palisades during the site audit. These procedures are in place to ensure that any archaeological resources that may be present receive consideration and protection. The procedures require that an archaeological survey be undertaken for any construction and modification activities that involve all ground-disturbing activities in the owner-controlled area of NMC operated nuclear facilities and to those activities including, but not limited to the construction or expansion of buildings, facilities, substations, parking lots, roads, or overhead or underground utility lines. In the event that items of potential historic significance are discovered during surveys, NMC and Consumers Energy would consult with the SHPO prior to proceeding. The NRC staff's independent review of records on file at the SHPO office did not locate records related to project-specific archaeological surveys conducted at Palisades for ground-disturbing activities. However, Consumers Energy did locate in its records one such report that documented a cultural resource field visit to the Palisades site by archaeologists in 1982 for three proposed projects (CAI 1982).

During the site audit, the NRC staff also reviewed the applicant's excavation and trenching control procedures, which require that any planned excavation activities that occur at a depth greater than 6 in. within previously undisturbed land be reviewed by the NMC Environmental Coordinator. The Environmental Coordinator's responsibilities (as defined in NMC's Archaeological, Cultural & Historic Resources procedures) include reviewing excavation and trenching plans to determine if any known archaeological resources are located within the proposed ground disturbance area, assessing the potential importance of any archaeological resources discovered during construction, and coordinating with the SHPO when potentially culturally important resource discoveries are made. The procedures also include a list of the types of archaeological materials that could be encountered during construction. During the site audit, the NRC staff expressed concerns about the NMC procedures not requiring a qualified archaeologist to survey the proposed ground disturbance area for archaeological resources prior to construction. In addition, the NRC staff noted that the procedure did not specify the training, experience, or credential requirements for the site's Environmental Coordinator to

recognize archaeological materials or assess the potential significance of historic or archaeological resources. Subsequent to the NRC staff's comments, the applicant revised and implemented its procedures in January 2006 (NMC 2006a) to reflect these concerns.

Based on the NRC staff's review of agency files, published literature, and information provided by the applicant, the NRC staff concludes that potential impacts on historic and archaeological resources would be SMALL. This conclusion is based on the fact that (1) no major refurbishment or replacement activities would occur during the renewal period; and (2) the applicant has environmental review procedures in place to ensure that any archaeological resources that may be present receive consideration and protection.

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy that requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental impacts of its actions on minority[(a)] or low-income populations. The memorandum accompanying Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act of 1969 (NEPA). The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice (CEQ 1997). Although the Executive Order is not mandatory for independent agencies, the NRC has voluntarily committed to undertake environmental justice reviews. Specific guidance is provided in NRC Office of Nuclear Reactor Regulation Office Instruction LIC-203, *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues Rev. 1* (NRC 2004a). In 2004, the Commission issued a final *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (NRC 2004b).

The scope of the review, as defined in NRC guidance (NRC 2004a), includes identification 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 information pertaining to mitigation. It also includes evaluation of whether these impacts are likely to be disproportionately high and adverse. The NRC staff looks for minority and low-income populations within the 50-mi radius of the site. For the NRC staff's review, a minority

(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 2004a).

population exists in a census block group[(a)] if the percentage of each minority and aggregated minority category within the census block group exceeds the percentage of minorities in the state of which it is a part by 20 percentage points, or the corresponding percentage of minorities within the census block group is at least 50 percent. A low-income population exists 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 the Palisades review, the NRC staff examined the geographic distribution of minority and low-income populations within 50-mi of the site, employing data from the 2000 census for low-income populations and for minority populations (NMC 2005a). The analysis was supplemented by discussions with the planning department and social service agencies in Van Buren County.

Figures 4-1 and 4-2 show the geographic distribution of minority and low-income groups within 50 mi of the plant. A number of tracts within Van Buren County exceed the NRC thresholds defining low-income; these are located in Covert. Other tracts within the 50-mi region are located in Kalamazoo to the east of Palisades and South Bend to the southeast. Census block groups with a minority population within the 50-mi region in Michigan are located in Covert and Keeler in Van Buren County, and in Berrien, Cass, Van Buren, and Allegan Counties. In Indiana, minority populations are located in South Bend, Mishawaka, and Elkhart.

With the locations of minority and low-income populations identified, the NRC staff proceeded to evaluate whether any of the environmental impacts of the proposed action could affect these populations in a disproportionately high and adverse manner. Based on NRC staff guidance (NRC 2004a), air, land, and water resources within about 50-mi of the Palisades site were examined. Within that area, a few potential environmental impacts could affect human populations; all of these were considered SMALL for the general population.

The pathways through which the environmental impacts associated with license renewal for Palisades can affect human populations are discussed throughout this SEIS. The NRC staff evaluated whether minority and low-income populations could be disproportionately affected 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 U.S. 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 U.S. Census Bureau guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts (U.S. Census Bureau 2004).

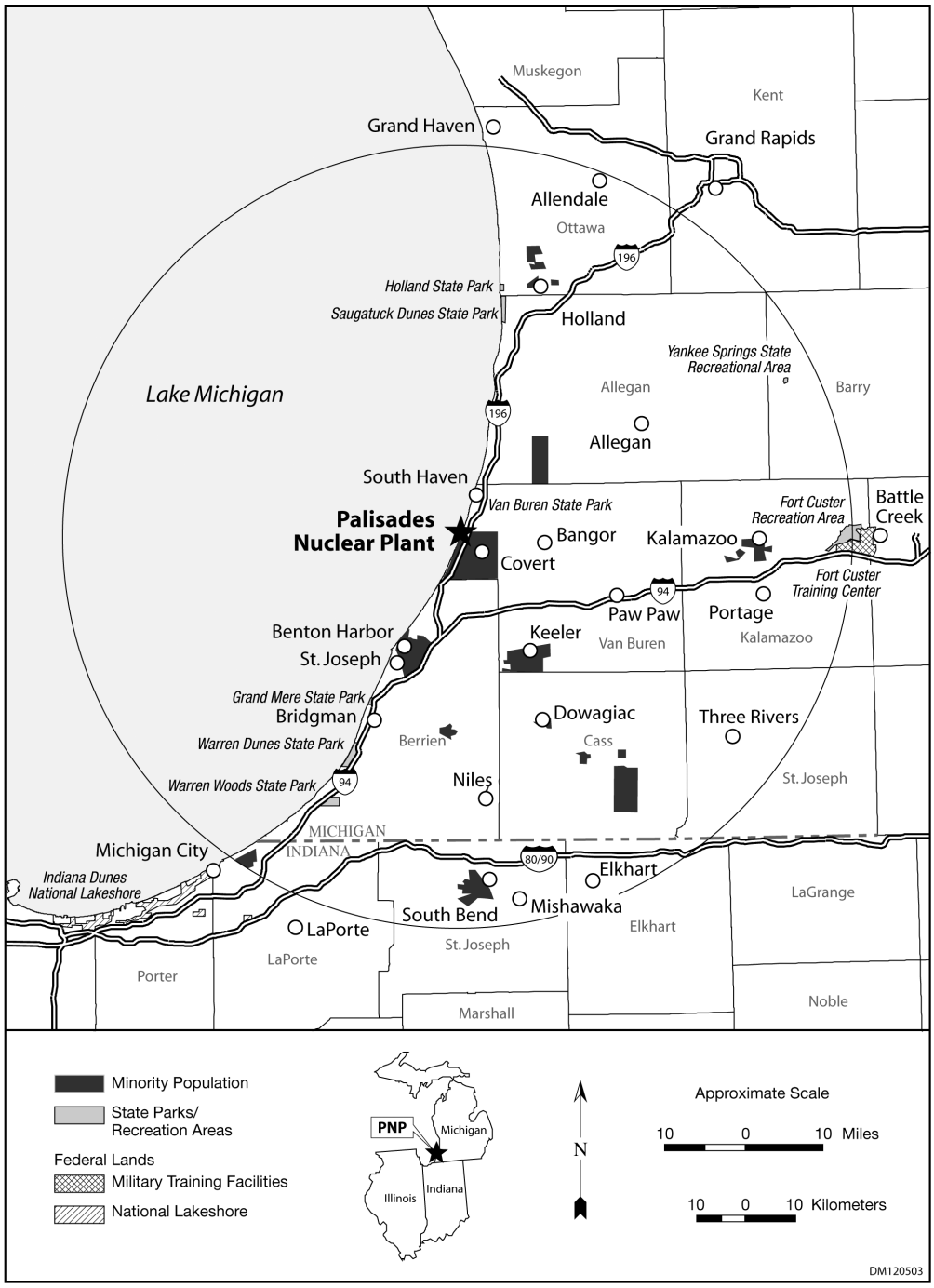

Figure 4-1. Geographic Distribution of Minority Populations (shown in shaded areas) Within 50 mi of Palisades Based on Census Block Group Data

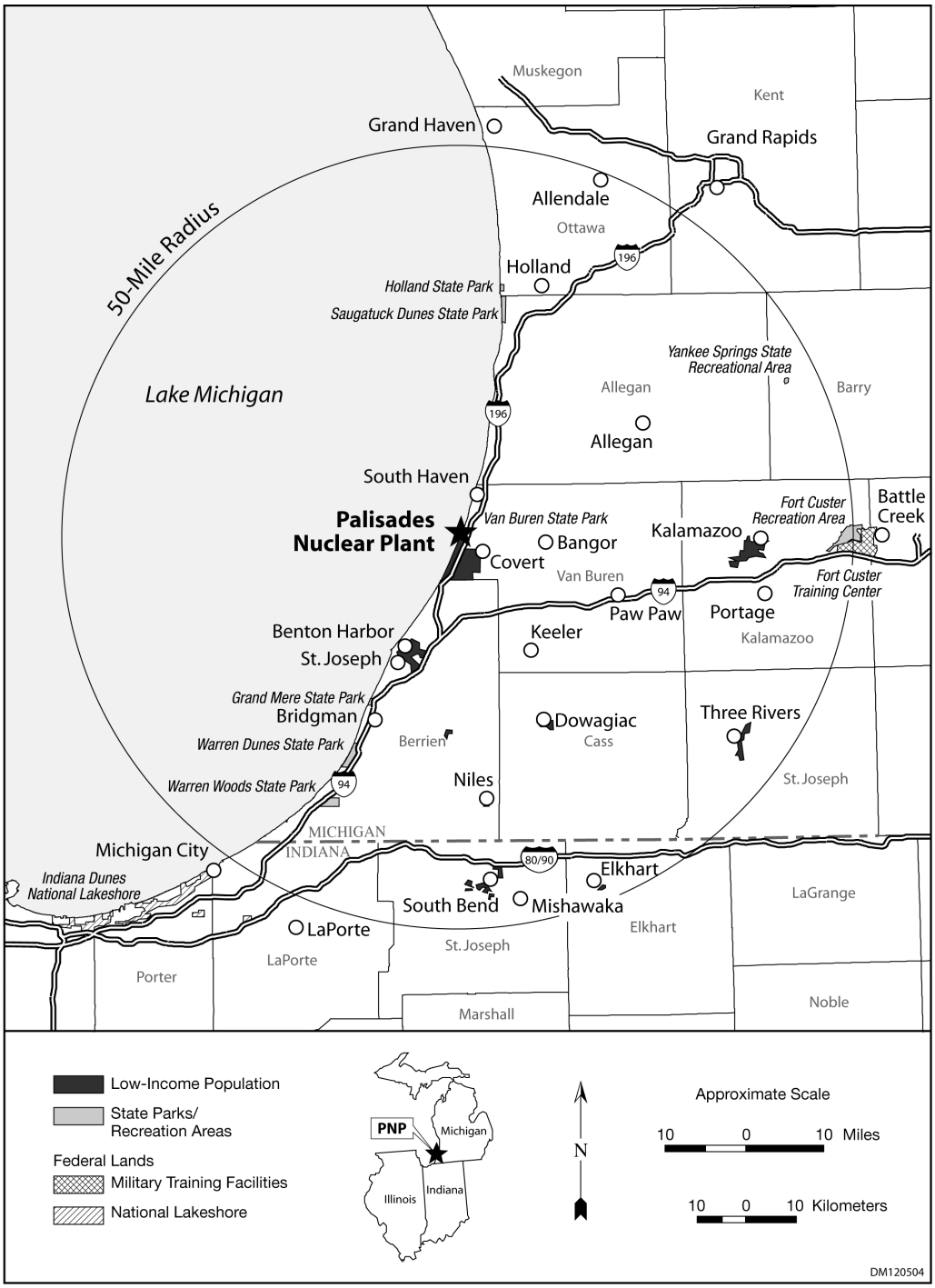

Figure 4-2. Geographic Distribution of Low-Income Populations (shown in Shaded areas) Within 50 mi of Palisades Based on Census Block Group Data

these impacts. The NRC staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing, through which the populations could be disproportionately high and adversely affected. In addition, the NRC staff did not identify any location-dependent disproportionately high and adverse impacts affecting these minority and low-income populations, including impacts on the seasonal migrant farm labor force, many of whom could be minority. The NRC staff concludes that offsite impacts from Palisades on minority and low-income populations would be SMALL, and no special mitigation actions are warranted.

4.5 Groundwater Use and Quality

Of the Category 1 issues related to groundwater use and quality that are identified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, only one is applicable to Palisades and it is listed in Table 4-7.

Table 4-7. 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
GROUNDWATER USE AND QUALITY	
Groundwater use conflicts (potable and service water; plants that use <100 gpm).	4.8.1.1

A brief description of the NRC staff's review regarding this issue and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, follows.

- Groundwater 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, Palisades has three operable groundwater production wells for grounds maintenance or other miscellaneous uses. Their combined pumping rate is 24 gpm, which is below the 100-gpm threshold.

The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts related to this issue beyond those discussed in the GEIS. For this

issue, the GEIS concluded that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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 4-8.

Table 4-8. 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

This issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of the nuclear plant during the license renewal term. The presence of Federally listed threatened or endangered species in the vicinity of the Palisades site and its associated transmission lines is discussed in Sections 2.2.5 and 2.2.6.

On June 30, 2005, the NRC contacted the FWS to request information on Federally listed threatened and endangered species and the impacts of relicensing (NRC 2005). In response, on July 29, 2005, the FWS provided information regarding Federally listed species that could occur in the vicinity of Palisades or along the transmission line rights-of-way (FWS 2005b).

4.6.1 Aquatic Species

The NRC staff has reviewed the information provided by the applicant and public information and has contacted the FWS and the MDNR. No Federally listed threatened or endangered aquatic species occur in Lake Michigan in the vicinity of the Palisades site, and no Federally listed threatened or endangered species occur in the streams crossed by the Palisades-Argenta transmission line. Therefore, license renewal would have no effect on any Federally listed aquatic species.

4.6.2 Terrestrial Species

The FWS identified four Federally listed and one candidate terrestrial species that they believe could occur on the Palisades site or along the associated transmission line rights-of-way: Pitcher's thistle (*Cirsium pitcheri*; threatened), Karner blue butterfly (*Lycaeides melissa samuelis*; endangered), Mitchell's satyr butterfly (*Neonympha mitchelli mitchelli*; endangered), Indiana bat (*Myotis sodalis*; endangered), and eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*; candidate) (FWS 2005b). These species, their preferred habitat, and county distributions are described in Section 2.2.6.

Pitcher's thistle is the only Federally listed species known to exist on the Palisades site, where it occurs in open dune habitats (NMC 2005a).[(a)] License renewal and continued operation of Palisades are not likely to adversely affect the Pitcher's thistle for several reasons. No refurbishment is considered necessary during the license renewal period at the Palisades site (NMC 2005a); therefore, significant land disturbance during that period is not considered likely. However, any activities during the renewal period that could result in land disturbance would undergo a predisturbance evaluation and consideration of impacts to threatened and endangered species (NMC 2005a). In addition, all dune areas on the site where the Pitcher's thistle is most likely to occur are protected under authority of Michigan's Natural Resources and Environmental Protection Act, Part 353, and any action that would disturb dune habitats would require a permit from the State (MDEQ 2005). The Pitcher's thistle does not occur in areas affected by current operations, including those areas affected by cooling-tower drift. On the basis of these considerations, continued operation of Palisades during the license renewal period would not be expected to adversely affect the Pitcher's thistle.

Of the counties in the project area, the Karner blue butterfly is known only from Allegan County (MNFI 2005; FWS 2005a), which is crossed by a very short length of the Palisades-Argenta line (NMC 2005a). However, Czarnecki (FWS 2005b) suggests that the species could also occur near the Argenta-E. Elkhart line in the eastern portion of Van Buren County. This species was not observed during field surveys of the Palisades site and transmission line corridors conducted in 1979 (Asplundh 1979) and 1991 (Higman and Goff 1991; Goff 1992). The applicant's vegetation-management practices that maintain habitat within transmission line rights-of-way in early successional stages (NMC 2005a) are consistent with protecting habitats occupied by this species, and continued maintenance over the license renewal period is not expected to adversely affect this species or its habitat. The owner of Palisades is partnering with the MDNR, the Nature Conservancy, and others to develop a habitat conservation plan for the Karner blue butterfly (NMC 2005a).

(a) Interview with G. Dawson, Consumers Energy Company, Environmental and Laboratory Services (July 26, 2005).

The Mitchell's satyr butterfly may occur in wetland areas along portions of the transmission lines in Kalamazoo and Van Buren Counties (FWS 2005a; MNFI 2005); however, this species was not observed during field surveys conducted in 1979 (Asplundh 1979) and 1991 (Higman and Goff 1991; Goff 1992). License renewal and continued operations of Palisades are not likely to adversely affect the Mitchell's satyr butterfly for several reasons. Preferred habitat for this species (calcareous wetlands) is not known to occur within or adjacent to transmission line rights-of-way associated with Palisades (NMC 2005a). The applicant's vegetation-management practices that maintain habitat within transmission line rights-of-way as herbaceous or low-growing shrub communities (NMC 2005a) are consistent with protecting habitats occupied by this species. Therefore, continued maintenance of rights-of-way over the license renewal period would not be expected to adversely affect this species or its habitat.

The Indiana bat is not known to occur at the Palisades site or along associated transmission lines, but potential habitat occurs within the project area (FWS 2005b). It should be noted, however, that this species is difficult to detect without conducting specialized surveys, and such surveys of the site have not been conducted. The Indiana bat is reported to occur in suitable habitat during the summer months in all counties crossed by the Palisades transmission line (FWS 2005a). Tree species, such as the shagbark hickory (*Carya ovata*), red oak (*Quercus rubra*), and bur oak (*Quercus macrocarpa*), often have loose or decaying bark that provide nursery habitat for females with young. License renewal and continued operations of Palisades are not likely to adversely affect the Indiana bat for several reasons. No refurbishment is considered necessary during the license renewal period at the Palisades site (NMC 2005a), and, therefore, significant land disturbance during that period is not considered likely. However, any activities during the renewal period that could result in land disturbance would undergo a predisturbance evaluation and consideration of impacts on threatened and endangered species (NMC 2005a). Vegetation management within the transmission line rights-of-way prevents the establishment of large trees within the rights-of-way that could be used by the Indiana bat. Only danger trees in the border zone of the rights-of-way are removed during routine vegetation management (NMC 2005a). This greatly limits the likelihood that a tree used by Indiana bats for roosting or nursery habitat would be affected. On the basis of these considerations, continued operation of Palisades during the license renewal period would not be expected to adversely affect the Indiana bat.

The eastern massasauga rattlesnake, a Federal candidate for listing, could occur in wetland areas such as bogs, ponds, or swamps, and prefers open canopy with a sedge or grass ground cover (FWS 2005b). It is unlikely that the eastern massasauga would be adversely affected by continued operation of Palisades during the license renewal period because no land-disturbing refurbishment activities are planned at the Palisades site, and vegetation maintenance procedures for Palisades transmission line rights-of-way (NMC 2005a) maintain the open habitats preferred by this species.

Based on the NRC staff's review of the applicant's environmental report and the NRC staff's independent analysis, the NRC staff has concluded that continued operation of Palisades during the license renewal term would not likely adversely affect any species that are Federally listed, proposed for listing, or candidates for listing as endangered or threatened within the immediate vicinity of the Palisades site and its associated transmission lines. The applicant currently plans no power plant refurbishment activities. The NRC staff anticipates that best management practices for protecting Federally listed species and their habitats, while carrying out vegetation-management activities, will be implemented by the applicant and its contractors. Therefore, it is the NRC staff's finding that the impact on threatened or endangered species of an additional 20 years of operation of Palisades and associated transmission lines would be SMALL, and further mitigation is not warranted.

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

The NRC staff has not identified any new and significant 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 NRC staff also determined that information provided during the public comment period did not identify any new issue that requires site-specific assessment. The NRC staff reviewed the discussion of environmental impacts associated with operation during the renewal term in the GEIS and has conducted its own independent review, including public scoping meetings, to identify issues with new and significant information. Processes for identification and evaluation of new information are described in Section 1.2.2.

4.8 Cumulative Impacts of Operations During the Renewal Term

4.8.1 Cumulative Impacts Resulting from Operation of the Plant Cooling System

For the purposes of this analysis, the geographic area considered for cumulative impacts resulting from operation of the Palisades cooling system is primarily the southeastern portion of Lake Michigan, particularly that portion bounded by South Haven to the north and Hagar Shore to the south and extending to about 1.9 mi from shore (i.e., the location of the thermal bar separating the inshore and offshore water masses during spring (Thurber and Jude 1985)). As discussed in Section 4.1, the NRC staff found no new and significant information that would indicate that the conclusions regarding any of the cooling-system-related Category 1 issues related to Palisades are inconsistent with the conclusions in the GEIS (NRC 1996). Because Palisades has a closed-cycle cooling system, impacts from Category 2 plant cooling system

issues (i.e., entrainment, impingement, and heat shock) that would have an impact on local water quality and aquatic resources are not addressed in Section 4.1. Nevertheless, entrainment, impingement, and heat shock have not been found to have greater than a minimal impact on aquatic biota (Consumers Energy and NMC 2001; NRC 1978). Therefore, operation of the Palisades cooling system would not contribute significantly to the cumulative impacts that would impact water quality and aquatic resources of southeastern Lake Michigan.

The cumulative impacts of past actions have resulted in the existing conditions of local water quality and aquatic resources. Section 2.2.5 discusses the major changes and modifications within Lake Michigan that have had the greatest impacts on aquatic resources. These include physical and chemical stresses, lakefront developments, overfishing, and introduction of non-native species. Physical and chemical stresses that have impacted Lake Michigan and its tributaries include urban, industrial, and agricultural contaminants (e.g., nutrients, toxic chemicals, and sediments); stream modifications (e.g., dams); land-use changes (e.g., residential, recreational, agricultural, and industrial development); dredging; shoreline modifications; wetland elimination and modification; water diversions (e.g., canals); impingement and entrainment in water-intake structures; thermal loading from cooling water; ice control for navigation; and major degradative incidents or catastrophes (Francis et al. 1979; Fuller et al. 1995). These in turn can affect fish, benthos, and plankton populations; cause a loss of habitat; cause deformities or tumors in fish and other biota; and contaminate fish, which leads to restrictions on human consumption (Eshenroder et al. 1995).

The dramatic changes that have occurred in the fish communities due to habitat modification and development, overfishing, and non-native species introductions have been reviewed for the period from the 1800s to 1970 (Wells and McLain 1973) and from 1970 to 2000 (Madenjian et al. 2002). Disruptions in the native fish community (primarily caused by introduction of the sea lamprey (*Petromyzon marinus*) and alewife [*Alosa pseudoharengus*]), coupled with habitat alterations and degradation, contributed to the decline of important commercial and sport fisheries by the end of the 1950s (IDNR 2004). In the 1960s, programs to extend control of sea lamprey and stock trout and salmon species began to rehabilitate the Lake Michigan fish community, control alewife numbers, and provide recreational fisheries (Eshenroder et al. 1995).

Future contributions to cumulative impacts on aquatic resources within Lake Michigan would generally occur from those actions that currently cause impacts (e.g., human habitation, urban and industrial development, agriculture, commercial and recreational fisheries, and spread of non-native species). Primary management challenges will be to keep the salmonid community in balance with an available forage base, while keeping alewife levels suppressed at a level that does not threaten native species (Eshenroder et al. 1995). Remaining problems include inadequate natural reproduction of salmonids, low abundance or complete loss of many native fish stocks, continued problems with exotic species, continued difficulties in suppressing sea

lampreys, and continued unacceptable levels of pollution and toxic chemicals (Eshenroder et al. 1995).

Large oil or chemical spills could potentially severely impact aquatic resources within Lake Michigan; the probability of such spills, however, is relatively small. The probability of smaller spills is higher, but the impacts from such spills would probably be small, temporary, additive, and unlikely to severely affect aquatic resources, especially if spill response activities are undertaken when such events occur.

The potential exists for the expansion of non-native species, which has already begun to occur in Lake Michigan, and for additional non-native species to become established within the lake (Ricciardi and MacIsaac 2000; Ricciardi and Rasmussen 1998). Any future ecological changes that may be associated with global climate change would occur much more slowly than those induced by invasions of non-native species (Madenjian et al. 2002).

The lake water supply is adequate to meet the needs of the facility for cooling purposes under all conditions. The NRC staff, while preparing this assessment, assumed that other industrial, commercial, or public installations could be located in the general vicinity of the Palisades site prior to the end of plant operations. The discharge of water to Lake Michigan from these facilities would be regulated by the MDEQ. The discharge limits are set considering the overall or cumulative impact of all other regulated activities in the area. Compliance with the Clean Water Act of 1977 and the NPDES permit for Palisades minimizes cumulative impacts on aquatic resources. Continued operation of Palisades would require renewed discharge permits from the MDEQ, which could address changing requirements so that cumulative water quality objectives are served.

The NRC staff concludes that the SMALL impacts of the Palisades cooling system operations, including entrainment and impingement of fish and shellfish, heat shock, or any of the cooling system-related Category 1 issues, would not contribute to an overall decline in water quality or the status of the fishery or other aquatic resources. Therefore, the NRC staff concludes that the potential cumulative impacts of operation of the cooling system of Palisades would be SMALL, and that no further mitigation measures would be warranted.

4.8.2 Cumulative Impacts Resulting from Continued Operation of the Transmission Lines

Continued operation of the electrical transmission facilities associated with license renewal for Palisades was evaluated to determine if there is the potential for interactions with other past, present, and future actions that could result in adverse cumulative impacts on terrestrial resources (e.g., wildlife populations, the size and distribution of habitat areas), wetlands, floodplains, or aquatic resources. For the purposes of this analysis, the geographic area that

encompasses the past, present, and foreseeable future actions that could contribute to adverse cumulative impacts includes those Michigan counties that contain the transmission lines associated with Palisades (Allegan, Kalamazoo, and Van Buren Counties).

As described in Section 4.2, the NRC staff found no new and significant information indicating that the conclusions regarding any of the transmission-line-related Category 1 issues as related to Palisades are inconsistent with the conclusions within the GEIS. The applicant uses vegetation-management procedures over all of its rights-of-way that are protective of wildlife and habitat resources (NMC 2005a). These vegetation-management practices are not expected to change during the license renewal period and, therefore, are not expected to result in any changes to current levels of cumulative impacts. None of the management procedures alter wetland or floodplain hydrology or adversely affect vegetation characteristics of these habitats or other habitats. Vegetation-maintenance procedures within rights-of-way ensure minimal disturbance to ecological systems and species. In addition, these procedures maintain habitats that are beneficial to some of the Federally listed threatened and endangered species that could occur within them. Continued operation and maintenance of these rights-of-way are not likely to contribute to a regional decline in wildlife and habitat resources.

As discussed in Section 2.2.6, four Federally listed threatened or endangered species are known to occur or could occur within this area. These species include the Pitcher's thistle, Karner blue butterfly, Mitchell's satyr butterfly, and Indiana bat. The eastern massasauga rattlesnake, a candidate for Federal listing, could also occur in habitats traversed by Palisades transmission lines. No critical habitat, as designated in the Endangered Species Act of 1973, occurs in the area affected by Palisades or its associated transmission lines. The NRC staff's findings, presented in Section 4.6, are that continued operation of Palisades during the license renewal period would not likely adversely affect listed, proposed, or candidate species; therefore, the impact on these species would be SMALL. Consequently, the continued operation of Palisades during the renewal term would not contribute to cumulative impacts on these species. Therefore, the cumulative impacts on these species would be SMALL, and additional mitigation measure would not be warranted.

Based on these considerations, the NRC staff has determined that the cumulative impacts of the continued operation of the Palisades transmission lines would be SMALL, and no additional mitigation is warranted.

4.8.3 Cumulative Radiological Impacts

The radiological dose limits for protection of the public and workers have been developed by the U.S. Environmental Protection Agency and the NRC to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 40 CFR Part 190, 10 CFR Part 20, and 10 CFR Part 50, Appendix I. For the purpose of this analysis, the area within a 50-mi radius region of interest (ROI) of the Palisades site was

included. The Indiana and Michigan Power Company's Donald C. Cook Nuclear Plant (D.C. Cook) Units 1 and 2 are located approximately 28 mi south-southwest of Palisades on the shore of Lake Michigan.

As stated in Section 2.2.7, NMC has conducted a radiological environmental monitoring program (REMP) around the Palisades site since 1971, with results presented annually in the Palisades Annual Radiological Environmental Operating Report (NMC 2001, 2002, 2003a, 2004, 2005b, 2006b). The REMP measures radiation and radioactive materials from all sources, including Palisades and D.C. Cook. The results presented in the reports, therefore, do consider the cumulative radiological impacts within the 50-mi ROI. On the basis of our evaluation, in Sections 2.2.7 and 4.3, the NRC staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of Palisades during the renewal term would be SMALL. With respect to the future, the REMP has not identified increasing levels or the accumulation of radioactivity in the environment over time. In addition, the NRC staff is not aware of any plans or proposals for new nuclear facilities in the vicinity of Palisades that would potentially contribute to cumulative radiological impacts. The NRC and the States of Michigan and Indiana would regulate any future actions in the vicinity of the Palisades site that could contribute to cumulative radiological impacts. Therefore, the NRC staff concludes that future cumulative radiological impacts would be SMALL, and that no further mitigation measures are warranted.

4.8.4 Cumulative Socioeconomic Impacts

Continued operation of Palisades would not likely result in significant cumulative impacts for any of the socioeconomic impact measures assessed in Section 4.4 of this SEIS (public services, housing, and offsite land use). This is because operating expenditures, NMC staffing levels, and local tax payments during renewal would be similar to those during the current license period. Similarly, the proposed action would not likely result in significant cumulative impacts on historic and archaeological resources.

When combined with the impact of other potential activities likely in the area surrounding the plant, socioeconomic impacts resulting from license renewal for Palisades would not produce an incremental change in any of the impact measures used. The NRC staff, therefore, determined that the impacts on employment, personal income, housing, local public services, utilities, and education occurring in the local socioeconomic environment as a result of license renewal activities, in addition to the impacts of other potential economic activity in the area, would be SMALL. The NRC staff determined that the impact on offsite land use would be SMALL because no refurbishment activities are planned at Palisades, and no new incremental changes to plant-related tax payments are expected that could influence land use by fostering considerable growth. The impacts of license renewal on transportation and environmental

justice would also be SMALL. There are no reasonably foreseeable scenarios that would alter these conclusions in regard to cumulative impacts.

Although no archaeological or architectural surveys have been conducted to date at the Palisades site, and the potential exists for significant cultural resources to be present within the site boundaries, it does not appear likely that the proposed license renewal would adversely affect these resources. The applicant has indicated that no refurbishment or replacement activities, including additional land-disturbing activities, at the plant site (or along existing transmission corridors) are planned for the license renewal period (NMC 2005a). Absent land-disturbing activities, continued operation of Palisades would likely protect any cultural resources present within the Palisades site boundary by protecting those lands from development and providing secured access. If prior to ground-disturbing activity in an undisturbed area, the applicant would evaluate the potential for impacts on cultural resources in consultation with the SHPO and appropriate Native American Tribes, as required under Section 106 of the NHPA, the contribution to a cumulative impact on cultural resources by continued operation of Palisades during the license renewal period would be SMALL.

4.8.5 Cumulative Impacts on Groundwater Use and Quality

Regional geology in Van Buren County consists of 300 to 400 ft of glacial and post-glacial deposits overlying sedimentary bedrock consisting of shale or limestone of the lower Mississippian Coldwater Formation (STS 1987; NMC 2003b). A drilling program conducted at Palisades in the 1960s indicated that the uppermost material is dune sand, which ranges in thickness from about 10 ft in the switchyard area to well over 100 ft near the lake (NMC 2003b). Below the dune sand is dense to very dense gray silty sand or sandy silt, stiff gray clay, and stiff to hard gray glacial till. The bedrock underlies these glacial sediments. The early site studies indicate that unconfined groundwater in the vicinity of Palisades has a hydraulic gradient of approximately 13 ft/mi in a westerly direction, flowing to Lake Michigan at an estimated rate of 650 ft/yr. Field permeability tests during exploratory drilling in 1965 yielded values ranging from 30 to 1720 ft/yr in the site area.

At the power block area, groundwater elevations averaged 580 ft above mean sea level (MSL), approximately equal to the mean level of Lake Michigan. In the eastern portion of the property, groundwater was at approximately 601 ft MSL; beneath the substation, it was at approximately 604 ft MSL (NMC 2003b). These elevations correspond to depths below ground surface of approximately 45 ft at the power block to approximately 10 to 15 ft near the eastern end of the site (NMC 2003b). Hydrogeologic analysis, focused on the sanitary drainfield located just south of the power block, showed the water table to be approximately 30 ft below the surface of the drainfield. The calculated groundwater flow velocity at this site is westward at approximately 23 ft/yr. Groundwater sampling and analysis found no halogenated or aromatic hydrocarbons or metals above detection limits; all parameters detected were present at concentrations well below recommended maximum contaminant levels (STS 1987).

Municipal water has been available at Palisades since approximately 2002. Groundwater use at Palisades since then has been only by three small production wells with a combined production capacity of 24 gpm. The pumped water is for grounds maintenance or other miscellaneous uses. NMC does not expect to develop or use any additional groundwater resources at Palisades in the future.

Several releases to site groundwater and soil have occurred and been remediated. One was a hydrocarbon release at a fuel depot. MDEQ has concurred that the remediation of this site is completed. Another was a release of solvents (trichloroethylene and perchloroethylene) from barrels stored onsite. Following a remediation that included pumping and vapor extraction, MDEQ approved closure of this site (MDEQ 2000). In a 1995 incident, 5 to 10 gal of hydraulic oil were released from mechanical equipment due to a line break. The contaminated soil was removed, and MDNR concurred that no further action was necessary (Consumers Power 1995). Groundwater monitoring wells are now only at the Steam Generator Storage Building, which houses former equipment.

Groundwater is no longer used significantly as a resource at Palisades. The facility relies on municipal water, and the three remaining production wells are used for landscape watering at low withdrawal rates. Potential impacts on local groundwater have included fuel and solvent leaks, which have been remediated adequately. Septic systems were constructed with approved methods. Their sludge is monitored for detectable radioactivity twice per year on a voluntary basis. The downgradient groundwater flow direction from facilities at Palisades is west, toward Lake Michigan.

Because of the lack of groundwater receptors, the remediation of past sources of groundwater contamination, and good management practices relative to groundwater quality, the cumulative impact on groundwater resources during the license renewal period would be SMALL, and additional mitigation would not be warranted.

4.8.6 Conclusions Regarding Cumulative Impacts

The NRC staff considered the potential impacts resulting from operation of Palisades during the license renewal term and other past, present, and future actions in the vicinity of Palisades. The NRC staff's determination is that the potential cumulative impacts resulting from operation of Palisades during the license renewal term would be SMALL.

4.9 Summary of Impacts of Operations During the Renewal Term

Based on its analysis, NMC has stated that it is not aware of information that is both new and significant related to any of the applicable Category 1 issues associated with operation of Palisades during the renewal term. The NRC staff, after reviewing the application and performing the site audit, also did not find any new and significant information related to any of the applicable Category 1 issues associated with operations of Palisades during the renewal term. Consequently, the NRC 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 eight Category 2 issues applicable to operation of Palisades during the renewal term and for environmental justice and chronic effects of electromagnetic fields. For all eight issues and environmental justice, the NRC staff concludes that the potential environmental impact of operation of Palisades during the renewal term would be of SMALL significance in the context of the standards set forth in the GEIS, and that additional mitigation would not be warranted. In addition, the NRC staff determined that a conclusion has not been reached by the appropriate Federal health agencies regarding chronic adverse effects from electromagnetic fields. Therefore, the NRC staff did not conduct an evaluation of this issue.

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of any other action undertaken by agencies or persons. For purposes of this analysis, where Palisades license renewal impacts are deemed to be SMALL, the NRC staff concluded that these impacts would not result in significant cumulative impacts on potentially affected resources.

4.10 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

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."

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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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 characteristics.

(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 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 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 U.S. Nuclear Regulatory Commission (NRC) approval to operate a nuclear power facility, an applicant for an initial operating license (OL) must submit a Safety Analysis Report (SAR) as part of its 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.

Design-basis accidents (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 Part 50 and Part 100 of Title 10 of the *Code of Federal Regulations* (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 OL. The results of these evaluations are found in license documentation such as the applicant's Final Safety Analysis Report (FSAR), the NRC staff's Safety Evaluation Report (SER), the Final Environmental Statement (FES), and Section 5.1 of this Supplemental Environmental Impact Statement (SEIS). A 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 maximally 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, DBAs 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 makes 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 the Palisades Nuclear Plant (Palisades), 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 Sections
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.

Nuclear Management Company, LLC (NMC) stated in its Environmental Report (ER) (NMC 2005a) that it is not aware of any new and significant information associated with the renewal of the Palisades OL. The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there are no impacts related to DBAs 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, regardless of offsite consequences. In the GEIS, the NRC staff assessed the impacts of severe accidents 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.

Severe accidents initiated by external phenomena, such as tornadoes, floods, earthquakes, fires, and sabotage, have not traditionally been discussed in quantitative terms in FESs and were not specifically considered for the Palisades site in the GEIS (NRC 1996). However, in the GEIS, the NRC staff did evaluate existing impact assessments performed by the NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is SMALL. Additionally, compliance with the NRC regulatory requirements under 10 CFR Part 73 provide reasonable assurance that the risk from sabotage is SMALL. Even if such events were to occur, the Commission would expect that resultant core damage and radiological releases would be no worse than those expected from internally initiated events. Based on the above, the Commission concludes that the risk from sabotage and beyond design basis earthquakes at existing nuclear power plants is

small and additionally, that the risks from other external events, are adequately addressed by a generic consideration of internally initiated severe accidents.

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 groundwater, 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 Palisades, 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; 5.3.4; 5.4; 5.5.2	L	5.2

The NRC staff has not identified any new and significant information with regard to the consequences from severe accidents during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC 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 NRC staff has reviewed severe accident mitigation alternatives (SAMAs) for Palisades. The results of its review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives

Section 51.53(c)(3)(ii)(L) of 10 CFR requires that license renewal applicants consider alternatives to mitigate severe accidents if the NRC staff has not previously evaluated SAMAs for the applicant's plant in an 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 Palisades; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

This section presents a summary of the SAMA evaluation for Palisades conducted by NMC, as described in the ER, and the NRC staff's review of this evaluation. The details of the review are described in the NRC staff evaluation that was prepared with contract assistance from Pacific Northwest National Laboratory. The entire evaluation for Palisades is presented in Appendix G.

The SAMA evaluation for Palisades was conducted with a four-step approach. In the first step, NMC quantified the level of risk associated with potential reactor accidents using the plant-specific Probabilistic Safety Assessment (PSA) and other risk models.

In the second step, NMC examined the major risk contributors and identified possible ways (i.e., SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. NMC initially identified 23 potential SAMAs for Palisades. NMC then screened out 14 SAMAs from further consideration because of non-applicability at Palisades due to (1) design differences; (2) the required extensive changes that would involve implementation costs known to exceed any possible benefit; (3) the excessive dollar value associated with completely eliminating all internal and external event severe accident risk at Palisades, or (4) having only effects on systems with low risk significance based on the plant-specific PSA. The remaining 9 SAMAs were subjected to further evaluation. During the second phase of the evaluation, NMC screened out one additional SAMA based on risk insights and other factors, leaving 8 SAMAs to be evaluated.

In the third step, NMC estimated the benefits and the costs associated with each of the remaining SAMAs. Estimates were made of how much each SAMA could reduce risk. Those estimates were developed in terms of dollars in accordance with NRC guidance for performing regulatory analyses (NRC 1997). The cost of implementing the proposed SAMAs was also estimated.

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost-beneficial, meaning the benefits of the SAMA were greater than the cost (positive cost-benefit). NMC found five SAMAs to be potentially cost-beneficial in the baseline analysis, and one additional SAMA to be potentially cost-beneficial when alternative discount rates and analysis uncertainties are considered (NMC 2005a).

None of the SAMAs evaluated relate directly to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54. NMC has indicated that it plans to further evaluate the potentially cost-beneficial SAMAs for possible implementation. NMC's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.1 Estimate of Risk

NMC submitted an assessment of SAMAs for Palisades as part of its ER (NMC 2005a) for license renewal. This assessment was based on the most recent Palisades PSA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the Palisades Individual Plant Examination (IPE) (Consumers Power 1993) and Individual Plant Examination of External Events (IPEEE) (Consumers Power 1995, 1996).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 4.05×10^{-5} per year. This CDF is based on the risk assessment for internally-initiated events. NMC did not include the contribution to risk from external events within the Palisades risk estimates; however, it did account for the potential risk reduction benefits associated with external events by increasing the estimated benefits for internal events by a factor of 2. The breakdown of CDF by initiating event is provided in Table 5-3.

As shown in Table 5-3, events initiated by loss of offsite power, small break loss of coolant accidents (LOCAs), and steam generator tube rupture (SGTR) are the dominant contributors to CDF.

In the ER, NMC estimated the dose to the population within 50 mi of the Palisades site to be approximately 0.319 person-Sv per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-4. Basemat failures SGTRs dominate the population dose risk at Palisades.

The NRC staff has reviewed NMC's data and evaluation methods and concludes that the quality of the risk analyses is adequate to support an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDFs and offsite doses reported by NMC.

5.2.2 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, NMC searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, NMC considered insights from the plant-specific PSA (i.e., SAMA analyses performed for other operating plants that have submitted license renewal applications, as well as SAMAs that could further reduce the risk of the dominant fire areas and seismic risk contributors). NMC identified 23 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training.

Table 5-3. Palisades Core Damage Frequency for Internal Events

Initiating Event	CDF (Per Year)	% Contribution to CDF
Loss of offsite power (including station blackout)	1.24×10^{-5}	31
Small break loss of coolant accident	1.02×10^{-5}	25
SGTR	6.06×10^{-6}	15
General transient with main condenser available	2.94×10^{-6}	7
Loss of instrument air	2.41×10^{-6}	6
Loss of service water	1.84×10^{-6}	5
Loss of main feedwater	9.07×10^{-7}	2
Loss of the main condenser	6.46×10^{-7}	2
Pressurizer safety valve spurious opening	4.08×10^{-7}	1
Other initiators	2.69×10^{-7}	6
Total CDF (internal events)	4.05×10^{-5}	100[a]

(a) Total may not equal 100% because of rounding.

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

Containment Release Mode	Population Dose (Person-Rem[a] per Year)	% Contribution
SGTR	7.6	23.9
Early containment failure	1.6	5
Late containment failure	0.3	0.9
Intact containment	0.6	1.9
Basemat failure	21.6	67.8
Containment isolation failure	0.2	0.6
Total population dose	31.9	100[b]

(a) One person-rem = 0.01 person-Sv.
(b) Total may not equal 100% because of rounding.

Fourteen SAMAs were removed from further consideration because of nonapplicability at Palisades due to (1) design differences; (2) the required extensive changes that would involve implementation costs known to exceed any possible benefit, or (3) the excessive dollar value associated with completely eliminating all internal and external event severe accident risk at Palisades, or (4) having only effects on systems with low risk significance based on the plant-

specific PSA. The remaining nine SAMAs were subjected to further evaluation. During the second phase of the evaluation, NMC screened out one additional SAMA based on risk insights and other factors. A detailed cost-benefit analysis was performed for each of the eight remaining SAMAs.

The NRC staff concludes that NMC used a systematic and comprehensive process for identifying potential plant improvements for Palisades, and that the set of potential plant improvements identified by NMC is reasonably comprehensive and, therefore, acceptable.

5.2.3 Evaluation of Risk Reduction and Costs of Improvements

In the third step of its SAMA evaluation, NMC evaluated the risk-reduction potential for each of the remaining eight SAMAs. Most of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement.

NMC estimated the costs of implementing the eight candidate SAMAs through the application of engineering judgment, use of other licensees' estimates for similar improvements, and development of site-specific cost estimates. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency costs associated with unforeseen implementation obstacles.

The NRC staff reviewed NMC'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 conservative (i.e., the estimated risk reduction is similar to or higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on NMC's risk reduction estimates.

The NRC staff reviewed the bases for the applicant's cost estimates. For certain improvements, the NRC staff also compared the cost estimates 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. The NRC staff found the cost estimates to be consistent with estimates provided in support of other plants' analyses.

Subsequently, the NRC staff concludes that the risk reduction and the cost estimates provided by NMC are sufficient and appropriate for use in the SAMA evaluation.

5.2.4 Cost-Benefit Comparison

The cost-benefit analysis performed by NMC was based primarily on NUREG/BR-0184 (NRC 1997) and was executed consistent with this guidance. NUREG/BR-0058 has recently been revised to reflect the NRC's revised policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed – one at 3 percent and one at 7 percent (NRC 2004). NMC provided both sets of estimates (NMC 2005a).

NMC identified five potentially cost-beneficial SAMAs in the baseline analysis contained in the ER (using a 7 percent discount rate). Based on an analysis using a 3 percent real discount rate, as recommended in NUREG/BR-0058 (NRC 2004), no additional SAMA candidates were determined to be potentially cost-beneficial. The potentially cost-beneficial SAMAs are:

- SAMA 10 – Modify the turbine-driven auxiliary feedwater (AFW) system so that it can operate indefinitely without alternating current (AC), direct current (DC), or pneumatic support. This SAMA involves a procedural revision and analysis to direct AFW flow adjustments based on decay heat level so that the steam generator level can be maintained when instrumentation fails on DC power depletion.

- SAMA 13 – Add a nitrogen station. This SAMA involves the use of a nitrogen station to automatically provide backup air supply for critical instrumentation and reduce the importance of loss of instrument air.

- SAMA 16 – Add insulation to the emergency diesel generator (EDG) exhaust ducts. This SAMA involves insulating the EDG exhaust ducts and making procedural modifications to prevent overheating of the EDGs engines.

- SAMA 22 – Replace undervoltage relays with seismically qualified model. This SAMA involves replacing relays to reduce the likelihood of failure of automatic start of the EDGs and reduce the contributions from loss of power due to the relays.

- SAMA 23 – Modify procedures for primary coolant system cooldown and provide associated training. This SAMA involves procedural modifications to reduce the probability of reactor coolant pump seal failures related to long-term high temperature exposure after recovery of component cooling water.

NMC performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment (NMC 2005a). With the benefits increased by a factor of 2.3 to account for uncertainties, one additional SAMA (SAMA 3 – Add a direct drive diesel-driven injection pump) was determined to be potentially cost-beneficial.

NMC noted in its ER that while the above results are believed to accurately reflect areas for improvement at the plant, additional engineering reviews are necessary to determine ultimate implementation. NMC stated that it will implement or continue to consider the six SAMAs identified in the analysis through the appropriate Palisades design process (SAMAs 3, 10, 13, 16, 22, and 23). In response to requests for additional information by the NRC staff (NMC 2005b, 2005c), NMC also committed to further evaluate possible lower cost alternatives for two SAMAs originally eliminated in the Phase 1 screening analysis (SAMAs 1 and 18), and to further evaluate two additional SAMAs determined to be applicable to Palisades but not yet evaluated by NMC (adding capability to flash the field on the EDG and replacing an existing air-operated containment sump valve with a motor-operated valve). NMC has entered these 10 potentially cost-beneficial items into the Palisades corrective action system for further review. If determined to be cost-beneficial, these alternatives will be evaluated for possible implementation in accordance with Palisades plant design processes.

The NRC staff, therefore, concludes that with the exception of the 10 potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than the associated benefits.

5.2.5 Conclusions

The NRC staff reviewed NMC's analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs supports the general conclusion that the SAMA evaluations performed by NMC are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was limited by the unavailability of an external event PSA, the likelihood of there being cost-beneficial enhancements in this area was minimized by including several candidate SAMAs related to dominant seismic and fire events and increasing the estimated SAMA benefits for internal events by a factor of 2 to account for potential benefits in external events.

Based on its review of the SAMA analysis, the NRC staff concurs with NMC's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all or a subset of the identified, potentially cost-beneficial SAMA. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by NMC is warranted. However, none of the potentially cost-beneficial SAMAs directly relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

5.3 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 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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U.S. Nuclear Regulatory Commission (NRC). 2004. *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission*. NUREG/BR-0058, Rev. 4, Washington, D.C.

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 characteristics.

(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 that are listed in Table B-1 of Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), Subpart A, Appendix B, and are applicable to the Palisades Nuclear Plant (Palisades). 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

(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.

Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor." The U.S. Nuclear Regulatory Commission (NRC) 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 Palisades 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	6.1; 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
Onsite 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

Nuclear Management Company, LLC (NMC), stated in its Environmental Report (ER) (NMC 2005) that it is not aware of any new and significant information associated with the renewal of the Palisades operating license (OL). The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft Supplemental Environmental Impact Statement (SEIS). Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the NRC 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 NRC 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 HLW). Based on information in the GEIS, the Commission found that

  Offsite 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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, HLW and spent fuel disposal excepted, is calculated to be about 14,800 person rem, 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 United States. 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 that will not ever be mitigated (e.g., 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 judgment 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 judgment 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 HLW disposal). Based on information in the GEIS, the Commission found that

  For the HLW 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 mrem 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 mrem 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 mrem per year. The lifetime individual risk from a 100-mrem 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, the 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 the 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, worldwide for a 100,000 metric tonne (MTHM) repository.

Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment 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.

On February 15, 2002, based on a recommendation by the Secretary of the 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 high-level nuclear waste. The U.S. Congress approved this recommendation on July 9, 2002, in Joint Resolution 87, which

designated Yucca Mountain as the repository for spent nuclear waste. On July 23, 2002, the President signed Joint Resolution 87 into law; Public Law 107-200, 116 Stat. 735 (2002) designates Yucca Mountain as the repository for spent nuclear waste. This development does not represent new and significant information with respect to the offsite radiological impacts from license renewal related to disposal of spent nuclear fuel and high-level nuclear waste.

The U.S. Environmental Protection Agency (EPA) developed Yucca-Mountain-specific repository standards, which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion issued July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated the EPA's radiation protection standards for the candidate repository, which required compliance with certain dose limits over a 10,000-year period. The Court's decision also vacated the compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63. In response to the Court's decision, the EPA issued its proposed revised standards on August 22, 2005 (*Federal Register*, Volume 40, page 49014 (70 FR 49014)). In order to be consistent with the EPA's revised standards, the NRC proposed revisions to 10 CFR Part 63 on September 8, 2005 (70 FR 53313).

Therefore, for the HLW and spent fuel disposal component of the fuel cycle, there is some uncertainty with respect to regulatory limits for offsite releases of radioactive nuclides for the current candidate repository site. However, prior to promulgation of the affected provisions of the Commission's regulations, the NRC staff assumed that limits would be developed along the lines of the 1995 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 that would comply with such limits could and likely would be developed at some site.

Despite the current uncertainty with respect to these rules, some judgment as to the regulatory NEPA implications of offsite radiological impacts of spent fuel and HLW disposal should be made. The NRC staff concludes that these impacts are acceptable in that the impacts would not be sufficiently large to require the NEPA conclusion that the option of extended operation under 10 CFR Part 54 should be eliminated.

The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that

there would be no impacts of mixed waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Onsite 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 onsite with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 the 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 the summary table.

Palisades meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information, and public comments on the draft SEIS. Therefore, the NRC staff

concludes that there would be 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."

Joint Resolution Approving the Site at Yucca Mountain, Nevada, for the Development of a Repository for the Disposal of High-Level Radioactive Waste and Spent Nuclear Fuel, pursuant to the Nuclear Waste Policy Act of 1982. 2002. Public Law 107-200. 116 Stat. 735.

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.

Nuclear Management Company, LLC (NMC). 2005. *Applicant's Environmental Report – Operating License Renewal Stage, Palisades Nuclear Plant*. Docket No. 50-255. Covert, Michigan. (March 2005).

U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste*, DOE/EIS-0046F, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 2005. "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada." *Federal Register*, Vol. 70, No. 161, pp. 49014–49068. Washington, D.C. (August 22, 2005).

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

U.S. Nuclear Regulatory Commission (NRC). 2005. "Implementation of a Dose Standard After 10,000 Years." *Federal Register,* Vol. 63, No. 173, pp. 53313–53320. Washington, D.C. (September 8, 2005).

7.0 Environmental Impacts of Decommissioning

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*, NUREG-0586, Supplement 1 (NRC 2002). The U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, identifies a range of impacts for each environmental issue.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are evaluated 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 were 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 characteristics.

(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.

(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.

7.1 Decommissioning

Category 1 issues in Table B-1 of Part 51 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 51), Subpart A, Appendix B, that are applicable to Palisades Nuclear Plant (Palisades) decommissioning following the renewal term are listed in Table 7-1. Nuclear Management Company, LLC (NMC), stated in its Environmental Report (ER) (NMC 2005) that it is aware of no new and significant information regarding the environmental impacts of license renewal for Palisades. The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and comments on the draft Supplemental Environmental Impact Statement (SEIS). Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the NRC 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 Palisades 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 NRC 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 person-rem caused by buildup of long-lived radionuclides during the license renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, the evaluation of other available

information, or public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no radiation dose impacts associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts from 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts on air quality associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts on water quality associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts on ecological resources associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the NMC ER, the site visit, the scoping process, and its evaluation of other available information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 References

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

Nuclear Management Company, LLC (NMC). 2005. *Applicant's Environmental Report – Operating License Renewal Stage, Palisades Nuclear Plant.* Docket No. 50-255, Covert, Michigan (March 2005).

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

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Washington, D.C.

8.0 Environmental Impacts of Alternatives to License Renewal

This chapter examines the potential environmental impacts associated with denying the renewal of an operating license (OL) (i.e., the no-action alternative); the potential environmental impacts from electric-generating sources other than Palisades Nuclear Plant (Palisades); the possibility of purchasing electric power from other sources to replace power generated by Palisades 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 power generated by Palisades. 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 the footnotes to Table B-1 of Part 51 of Title 10 of the *Code of Federal Regulations* (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 and transportation.

8.1 No-Action Alternative

The NRC's regulations implementing the National Environmental Policy Act of 1969 (NEPA), 10 CFR Part 51, Subpart A, Appendix A(4), specify that the no-action alternative be discussed in an NRC Environmental Impact Statement (EIS). For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the Palisades OL, and Nuclear Management Company, LLC (NMC), would then cease plant operations by the end 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.

the current license and initiate the decommissioning of the plant. NMC would be required to shut down Palisades and to comply with NRC decommissioning requirements in 10 CFR 50.82, whether or not the OL is renewed. If the Palisades OL is renewed, shutdown of the unit and decommissioning activities would not be avoided, but would be postponed for up to an additional 20 years.

The environmental impacts associated with decommissioning under a license renewal or the no-action alternative would be bounded by the discussion of impacts in Chapter 7 of the license renewal GEIS (NRC 1996), Chapter 7 of this Supplemental Environmental Impact Statement (SEIS), and the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC 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.

Impacts from the decision to permanently cease operations are not considered in NUREG-0586, Supplement 1.[(a)] Therefore, immediate impacts that occur between plant shutdown and the beginning of decommissioning are considered here. These impacts would occur when the unit shuts down regardless of whether the license is renewed or not and are discussed below, with the results presented in Table 8-1. Plant shutdown would result in a net reduction in power production capacity. The power not generated by Palisades during the license renewal term would likely be replaced by (1) power purchased from other electricity providers, (2) generating alternatives other than Palisades, (3) demand-side management (DSM) and energy conservation, or (4) some combination of these options. The environmental impacts of these options are discussed in Section 8.2.

- **Land Use**

  In Chapter 4, the NRC staff concluded that the impacts of continued plant operation on land use would be SMALL. Onsite land use would not be affected immediately by the cessation of operations. Plant structures and other facilities are likely to remain in place until decommissioning. The transmission lines associated with the project are expected to remain in service after the plant stops operating. As a result, maintenance of the rights-of-way will continue as before. Therefore, the NRC staff concludes that the impacts on land use from plant shutdown would be SMALL.

(a) Appendix J of NUREG-0586, Supplement 1, discusses the socioeconomic impacts of plant closure. The results of the analysis in Appendix J, however, were not incorporated into the analysis presented in the main body of the NUREG.

Table 8-1. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Land use	SMALL	Impacts are expected to be SMALL because plant shutdown would not be expected to result in changes to onsite or offsite land use.
Ecology	SMALL	Impacts are expected to be SMALL because aquatic impacts would be reduced, and terrestrial impacts are not expected because there would not be any changes in rights-of-way maintenance practices.
Water use and quality – surface water	SMALL	Impacts are expected to be SMALL because surface-water intake and discharges would be eliminated.
Water use and quality – groundwater	SMALL	Impacts are expected to be SMALL because discharge to the sanitary drain field would be eliminated.
Air quality	SMALL	Impacts are expected to be SMALL because emissions related to plant operation and worker transportation would decrease.
Waste	SMALL	Impacts are expected to be SMALL because generation of high-level waste would stop, and generation of low-level and mixed waste would decrease.
Human health	SMALL	Impacts are expected to be SMALL because radiological doses to workers and members of the public, which are within regulatory limits, would be further reduced.
Socioeconomics	SMALL to LARGE	Impacts are expected to range from SMALL to LARGE because of a decrease in employment and tax revenues.
Transportation	SMALL	Impacts are expected to be SMALL because the decrease in employment would reduce traffic.
Aesthetics	SMALL	Impacts are expected to be SMALL because plant structures would remain in place, and the visibility of plumes from the cooling towers would be eliminated.
Historic and archaeological resources	SMALL	Impacts are expected to be SMALL because shutdown of the plant would not result in land disturbance.
Environmental justice	SMALL to LARGE	Impacts are expected to range from SMALL to LARGE because a loss of employment opportunities would be expected.

- **Ecology**

In Chapter 4 of this SEIS, the NRC staff concluded that the ecological impacts of continued plant operation would be SMALL. Cessation of operations would be accompanied by a reduction in cooling-water flow and the thermal plume from the plant. These changes would reduce environmental impacts on aquatic species. The transmission lines associated with Palisades are expected to remain in service after Palisades stops operating. As a result, maintenance of the rights-of-way and subsequent impacts on the terrestrial ecosystem would continue as before. Therefore, the NRC staff concludes that ecological impacts from shutdown of the plant would be SMALL.

- **Water Use and Quality – Surface Water**

In Chapter 4 of this SEIS, the NRC staff concluded that impacts of continued plant operation on surface-water use and quality would be SMALL. When the plant stops operating, there would be an immediate reduction in the consumptive use of water because of reduction in cooling-water flow and in the amount of heat rejected to Lake Michigan. Therefore, the NRC staff concludes that the impacts on surface-water use and quality from plant shutdown would be SMALL.

- **Water Use and Quality – Groundwater**

In Chapter 4 of this SEIS, the NRC staff concluded that impacts of continued plant groundwater use on groundwater availability and quality would be SMALL. Groundwater use is limited to that used only for maintenance of the grounds. When the plant stops operating, there would be virtually no change in groundwater use at the site as the facilities would remain until decommissioning. In addition, domestic water disposal would no longer occur at the three onsite sanitary drain fields. Therefore, the NRC staff concludes that groundwater use and quality impacts from shutdown of the plant would be SMALL.

- **Air Quality**

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on air quality would be SMALL. When the plant stops operating, there would be a reduction in emissions from activities related to plant operation, such as the use of diesel generators and worker transportation. Therefore, the NRC staff concludes that the impacts on air quality from shutdown of the plant would be SMALL.

- **Waste**

The impacts of waste generated by continued plant operation are discussed in Chapter 6. The impacts of low-level and mixed waste from plant operation are characterized as SMALL. When Palisades stops operating, it would stop generating high-level waste (HLW), and the

generation of low-level and mixed waste associated with plant operation and maintenance would be reduced. Therefore, the NRC staff concludes that the impact of waste generated after shutdown of the plant would be SMALL.

- **Human Health**

  In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on human health would be SMALL. After the cessation of operations, the amount of radioactive material released to the environment in gaseous and liquid forms would be reduced. Therefore, the NRC staff concludes that the impact of shutdown of the plant on human health would be SMALL. In addition, the variety of potential accidents at the plant would be reduced to a limited set associated with shutdown events and fuel handling. In Chapter 5 of this SEIS, the NRC staff concluded that the impacts of accidents during operation would be SMALL. Therefore, the NRC staff concludes that the impacts of potential accidents following shutdown of the plant would be SMALL.

- **Socioeconomics**

  In Chapter 4 of this SEIS, the NRC staff concluded that the socioeconomic impacts of continued plant operation would be SMALL. There would be immediate socioeconomic impacts associated with the shutdown of the plant because of the reduction in the staff at the plant. There may also be an immediate reduction in property tax revenues for Covert Township and Van Buren County. The overall impacts would depend on the state of the economy, the net change in workforce at the plant, and the changes in local government tax receipts. Appendix J of Supplement 1 to NUREG-0586 (NRC 2002) shows that the overall socioeconomic impact of plant closure plus decommissioning could be greater than SMALL. The NRC staff concludes that the socioeconomic impacts of plant shutdown would range from SMALL to LARGE. Some of these impacts could be offset if new power-generating facilities are built at or near the current site.

- **Transportation**

  In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on transportation would be SMALL. Cessation of operations would be accompanied by a reduction of traffic in the vicinity of the plant. Most of the reduction would be associated with a reduction in the plant workforce, but there would also be a reduction in shipment of material to and from the plant. Therefore, the NRC staff concludes that the impacts of plant closure on transportation would be SMALL.

- **Aesthetics**

In Chapter 4 of this SEIS, the NRC staff concluded that the aesthetic impacts of continued plant operation would be SMALL. Cessation of operations would be accompanied by the elimination of visible plumes from the cooling towers. Plant structures and other facilities are likely to remain in place until decommissioning. Therefore, the NRC staff concludes that the aesthetic impacts of plant closure would be SMALL.

- **Historic and Archaeological Resources**

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on historic and archaeological resources would likely be SMALL. Onsite land use would not be affected immediately by the cessation of operations. Plant structures and other facilities would likely remain in place until decommissioning. The transmission lines associated with the project are expected to remain in service after the plant stops operating. As a result, maintenance of transmission line rights-of-way would continue as before. Therefore, the NRC staff concludes that the impacts on historic and archaeological resources from plant shutdown would be SMALL.

- **Environmental Justice**

In Chapter 4 of this SEIS, the NRC staff concluded that the environmental justice impact of continued operation of the plant would be SMALL. Continued operation of the plant would not have a disproportionately high and adverse impact on minority and low-income populations. Shutdown of the plant could have disproportionately high and adverse impacts on minority and low-income populations because of the loss of employment opportunities at the site and because of secondary socioeconomic impacts (e.g., loss of patronage at local businesses). The NRC staff concludes that the environmental justice impacts of plant shutdown could range from SMALL to LARGE. Some of these impacts could be offset if new power-generating facilities are built at or near the current site. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with alternative sources of electric power to replace the power generated by Palisades, assuming that the OL for Palisades 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 an alternate site (Section 8.2.1),
- Natural-gas-fired generation at the Palisades site and an alternate site (Section 8.2.2), and
- Nuclear generation at the Palisades site and an alternate site (Section 8.2.3).

The alternative of purchasing power from other sources to replace power generated at Palisades is discussed in Section 8.2.4. Other power-generation alternatives and conservation alternatives considered by the NRC staff and found not to be reasonable replacements for Palisades are discussed in Section 8.2.5. Section 8.2.6 discusses the environmental impacts of a combination of generation and conservation alternatives.

Each year, the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an Annual Energy Outlook. In its *Annual Energy Outlook 2006 with Projections to 2030*, the EIA projects that more than 57 percent of new electric-generating capacity between 2006 and 2030 will be coal-fired plants (EIA 2006). The amount of electricity produced by coal-fired plants will rise slowly in the near future but will grow considerably compared with other types of plants because of reliability and rising natural gas prices. Natural-gas-fired plants accounted for 18 percent of the total supply in 2004, but the EIA predicts that their contribution will decline to 17 percent by 2030 (EIA 2006). A slight rise in the percentage of natural-gas-fired plants in the near term is predicted because of new, more efficient technologies; however, the rising cost of natural gas will eventually reduce this share. Renewable fuel technologies, such as wind, solar, and hydropower, provided 9 percent of the total electricity consumed in 2004 and this is expected to rise to only 9.4 by 2030 (EIA 2006). Of the renewable fuels, hydropower provides the most power at 6.8 percent in 2004 and is expected to fall to 5.1 percent in 2030 (EIA 2006). The drop in hydropower is due to the lack of new locations for development. The share of power resulting from other renewable sources of power is expected to rise from 2.2 in 2004 to 4.3 percent in 2030 because of technological advances and State and Federal support (EIA 2006).

Nuclear plants currently provide 20 percent of the power in the United States (EIA 2006). New nuclear plants are expected to be built partly due to Energy Policy Act of 2005 tax incentives. By 2030, nuclear power is expected to drop to only 15 percent of the total power produced in the United States (EIA 2006). Despite that projection, there has been an increased interest in constructing new nuclear power facilities, as evidenced by the certification of three standard nuclear power plant designs and recent activities involving the review of other plant designs and potential sites (see Section 8.2.3). In addition, the NRC established a new reactor licensing program organization in 2001 to prepare for and manage future reactor and site licensing applications (NRC 2001). Furthermore, the Energy Policy Act contains provisions to ensure that nuclear energy continues to be a major component of the nation's energy supply. This Act also establishes a production tax credit for new nuclear power facilities. Therefore, despite the EIA

projection, a new nuclear plant alternative for replacing power generated by Palisades is considered in this SEIS.

Palisades has a net summer capacity of 786 megawatts electric (MW(e)) (NMC 2005). For the coal-fired and natural gas alternatives, the NRC staff assumed construction of an approximately 800-MW(e) plant, which is consistent with NMC's Environmental Report (ER) (NMC 2005). For the new nuclear alternative, the staff assumed the same capacity as Palisades.

The Palisades site does not have sufficient land suitable for siting a coal-fired plant; thus, only an alternate site is considered under this alternative. Approximately 30 ac is available in the northeast quadrant of the Palisades site, which could be developed to house a gas-fired plant; therefore, both the Palisades site and an alternate site are evaluated under the gas-fired alternative. No specific alternate sites were identified by the applicant in the ER for the coal-fired or gas-fired plants; however, it was assumed that a suitable location could be found in the region (NMC 2005). A new nuclear alternative was not considered by the applicant. Therefore, this SEIS evaluates both the Palisades site and an alternate generic site for the analysis of environmental impacts for the nuclear alternative.

8.2.1 Coal-Fired Generation

The coal-fired alternative is analyzed for a generic alternate site. Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.1 are from the NMC ER (NMC 2005). The staff reviewed the information in the NMC ER and compared it with environmental impact information in the GEIS for license renewal. 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 NRC staff assumed the Palisades plant would remain in operation while the alternative coal-fired plant was constructed.

The NRC staff assumed the construction of two standard 400-MW(e) units for a total capacity of 800 MW(e), as potential replacements for Palisades, which is consistent with the NMC ER (NMC 2005). The coal-fired plant would consume approximately 3.2 million tons per year of pulverized bituminous coal with an ash content of approximately 7.66 percent (NMC 2005). NMC assumes a heat rate[(a)] of 9800 Btu/kWh and a capacity factor[(b)] of 0.85 in its ER (NMC 2005).

(a) Heat rate is a measure of generating station thermal efficiency. In English units, it is generally expressed in British thermal units (Btus) per net kilowatt-hour (kWh). It is computed by dividing the total Btu content of the fuel burned for electric generation by the resulting kWh generation.

(b) 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.

In addition to the impacts discussed below for a coal-fired plant at an alternate site, impacts would occur offsite as a result of the mining of coal and limestone. Impacts of mining operations would include an increase in fugitive dust emissions; surface-water runoff; erosion; sedimentation; changes in water quality; disturbance of vegetation and wildlife; disturbance of historic and archaeological resources; changes in land use; and impacts on employment.

The magnitude of these offsite impacts would largely be proportional to the amount of land affected by mining operations. In the GEIS, the staff estimated that approximately 22,000 ac would be affected for mining the coal and disposing of the waste to support a 1000-MW(e) coal-fired plant during its operational life (NRC 1996). Proportionally, less land would be affected with the construction of an 800-MW(e) plant. Partially offsetting this offsite land use would be the elimination of the need for uranium mining to supply fuel for Palisades. In the GEIS, the NRC staff estimated that approximately 1000 ac would be affected for mining the uranium and processing it during the operating life of a nuclear power plant.

8.2.1.1 Closed-Cycle Cooling System

In this section, the NRC staff evaluates the impacts of a coal-fired plant located at a generic alternate site that uses a closed-cycle cooling system.

The overall impacts of the coal-fired generating system are discussed in the following sections and summarized in Table 8-2. The magnitude of impacts for an alternate site would depend on the particular site selected.

- **Land Use**

  The GEIS estimates that approximately 1700 ac would be needed for a 1000-MW(e) coal-fired plant (NRC 1996). This estimate would be scaled down for the 800-MW(e) capacity of the proposed coal-fired alternative (i.e., 1360 ac). Additional land might be needed for transmission lines and rail lines, depending on the location of the site relative to the nearest intertie connection and rail spur.

  Up to 160 ac could be needed for a rail spur if the alternative site is within 10 mi of the nearest railway connection. Additional land would likely be needed for a transmission line to connect to existing lines to transmit power to NMC customers in the area. NMC estimated that approximately 5 mi of a new 345-kV transmission line would be needed (NMC 2005).

Table 8-2. Summary of Environmental Impacts of Coal-Fired Generation Using Closed-Cycle Cooling at an Alternate Site

Impact Category	Impact	Comments
Land use	MODERATE to LARGE	Uses approximately 1460 ac for plant, offices, parking, and waste disposal. Additional land (amount dependent on site chosen) needed for rail spur and transmission line.
Ecology	MODERATE to LARGE	Impact would depend on location and ecology of the site, surface-water body used for intake and discharge, and transmission line and rail spur routes; potential habitat loss and fragmentation; reduced productivity and biological diversity.
Water use and quality – surface water	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged and the characteristics of the surface-water body.
Water use and quality – groundwater	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged and the characteristics of the aquifers.
Air quality	MODERATE	Sulfur oxides • 2750 tons/yr Nitrogen oxides • 690 tons/yr Particulates • 120 tons/yr of total suspended particulates • 28 tons/yr of PM_{10} Carbon monoxide • 800 tons/yr Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials – mainly uranium and thorium.
Waste	MODERATE	Total waste volume would be approximately 319,000 tons/yr of ash and scrubber sludge, requiring approximately 100 ac for disposal during the 40-year life of the plant. Debris would be generated and removed during construction.
Human health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data.

Table 8-2. (contd)

Impact Category	Impact	Comments
Socioeconomics	SMALL to LARGE	Construction impacts depend on location, but could be LARGE if plant is located in an area that is rural. Up to 1500 workers during the peak period of the 5-year construction period. Operation would result in a workforce of 75 to 120 full-time employees, which is a net loss of approximately 500 jobs. Van Buren County's tax base would experience a loss and an additional reduction in employment if the alternate site is not located within the county. Employment impacts could be offset by other economic growth in the area.
Transportation	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site dependent, but can be characterized as SMALL to MODERATE. For rail transportation of coal and lime, the impact is considered MODERATE to LARGE.
Aesthetics	MODERATE to LARGE	Aesthetic impacts due to the presence of plant units, cooling towers, plume stacks, and coal piles. Intermittent noise from construction, commuter traffic, and waste disposal; continuous noise from cooling towers and mechanical equipment. Rail transportation of coal and lime would result in MODERATE noise impacts. Additional impacts would occur from the new transmission line and rail spur that would be needed. Depending on the location of the site chosen, these impacts could be LARGE.
Historic and archaeological resources	SMALL to MODERATE	An alternate location would necessitate cultural resource studies to identify, evaluate, and mitigate potential impacts of new plant construction at developed and undeveloped sites.
Environmental justice	SMALL to MODERATE	Impacts would vary depending on population distribution and makeup at the site. Impacts should be similar to those experienced by the population as a whole. Some impacts on housing could occur during construction. Loss of jobs could reduce employment prospects. Impacts could be offset by economic growth in the area and the ability of affected workers to commute to other jobs.

The waste would be disposed of onsite, accounting for approximately 100 ac of land area over the 40-year plant life.[a]

Depending particularly on the location and length of the transmission line and rail line routing, this alternative would result in MODERATE to LARGE land-use impacts.

- **Ecology**

Locating a coal-fired plant at an alternate site would result in construction and operational impacts. Approximately 1460 ac of land would be converted to industrial use. Even assuming siting at a previously disturbed area, the impacts would affect ecological resources. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface-water body could cause entrainment and impingement of fish and other aquatic organisms, and result in adverse impacts on aquatic resources. If needed, construction and maintenance of an electric power transmission line and a rail spur also would have ecological impacts. There would be some additional impact on terrestrial ecology from drift from the cooling towers. Overall, the ecological impacts of constructing a coal-fired plant with a closed-cycle cooling system at an alternate site are considered to be MODERATE to LARGE and would be greater than renewal of the Palisades OL.

- **Water Use and Quality**

Surface water. The coal-fired generation alternative at an alternate site is assumed to use a closed-cycle cooling system with cooling towers. 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 Michigan. The impacts would be SMALL to MODERATE and dependent on the receiving body of water.

Groundwater. Groundwater use is possible for a coal-fired plant at an alternate site if surface-water resources are limited for makeup and potable water. Groundwater withdrawal could require a permit. Impacts on groundwater use and quality of a coal-fired plant with a closed-cycle cooling system at an alternate site would be SMALL to MODERATE, depending on the volume of groundwater withdrawn.

(a) Only half of the land area needed for by-product disposal is directly attributable to the alternative of renewing the Palisades OL for 20 years.

- **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), particulate matter, carbon monoxide (CO), hazardous air pollutants such as mercury, and naturally occurring radioactive materials.

  A new coal-fired generating plant located in southern Michigan would likely need a prevention of significant deterioration (PSD) permit and an operating permit under the Clean Air Act. The plant would need to comply with the new source performance standards for such plants as set forth in 40 CFR Part 60, Subpart D(a). The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), sulfur dioxide (SO_2) (40 CFR 60.43(a)), and NO_x (40 CFR 60.44(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 review of any new major stationary source in an area designated as attainment or unclassified under the Clean Air Act. All of Michigan has been classified as attainment or unclassified for criteria pollutants (40 CFR 81.323). In the posted amendment to that classification, dated April 30, 2004, there are several instances of nonattainment for ozone, including one for Van Buren County (EPA 2004a).

  Section 169A of the Clean Air Act 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. The EPA issued a new regional haze rule in 1999 (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 toward 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 coal-fired plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. Isle Royale National Park and Seney National Wildlife Refuge are Class I areas where visibility is an important value (40 CFR 81.407). Both of these areas are located in the Upper Peninsula of Michigan. Air quality in these areas would not likely be affected by a coal-fired plant at an alternate site in southern Michigan in the vicinity of Palisades.

  In 1998, the EPA issued a rule requiring 22 eastern states, including Michigan, to revise their state implementation plans to reduce NO_x emissions. Nitrogen oxide emissions contribute to violations of the national ambient air quality standard for ozone (40 CFR 50.9).

The total amount of NO_x that can be emitted by each of the 22 states in the year 2007 ozone season (May 1 to September 30) is presented in 40 CFR 51.121(e). For Michigan, the amount is 229,702 tons.

Anticipated impacts for particular pollutants that would result from a coal-fired plant at an alternate site are as follows:

Sulfur oxides. A new coal-fired power plant would be subject to the requirements in Title IV of the Clean Air Act. Title IV was enacted to reduce SO_2 and NO_x emissions, 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 are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore acquire allowances from owners of other power plants by purchase or reduce SO_2 emissions at other power plants they own. 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.

NMC estimates that by using wet limestone flue gas desulfurization to minimize SO_x emissions (90 percent removal), the total annual stack emissions would be approximately 2750 tons of SO_x (NMC 2005).

Nitrogen oxides. Section 407 of the Clean Air Act 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 (EPA 1998), limits the discharge of any gases that contain NO_x (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.

NMC estimates that by using NO_x burners with overfire air and selective catalytic reduction (SCR) (95 percent reduction), the total annual NO_x emissions for a new coal-fired power plant would be approximately 690 tons (NMC 2005). This level of NO_x emissions would be greater than the Palisades OL renewal alternative.

Particulate matter. NMC estimates that the total annual stack emissions would include 120 tons of filterable total suspended particulates and 28 tons of particulate matter having an aerodynamic diameter less than or equal to 10 μm (PM_{10}) (40 CFR 50.6). Fabric filters (99.9 percent removal) would be used for control. In addition, coal-handling equipment would introduce fugitive particulate emissions. Particulate emissions would be greater under the coal alternative than under the Palisades 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. NMC estimates that the total CO emissions would be approximately 800 tons per year (NMC 2005). This level of emissions is greater than that under the Palisades OL renewal alternative.

Hazardous air pollutants, including mercury. In December 2000, the EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (EPA 2000a). The EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants. The EPA found that coal-fired power plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000a). 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 consumption of contaminated fish (EPA 2000a). Accordingly, on March 15, 2005, the EPA issued the Clean Air Mercury Rule to permanently cap and reduce mercury emissions from coal-fired power plants (EPA 2005).

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 5.2 tons of uranium and 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. The level of emissions from a coal-fired plant would be greater than that under the OL renewal alternative.

Summary. The GEIS analysis did not quantify emissions from coal-fired power plants, but 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 at an alternate site would be MODERATE. The impacts would be clearly noticeable but would not destabilize air quality.

- **Waste**

  Debris would be generated during construction activities. During operations, coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash and scrubber sludge. Two 400-MW(e) coal-fired plants would generate approximately 319,000 tons of this waste annually for 40 years (NMC 2005). The ash and scrubber sludge would be disposed of onsite, accounting for approximately 100 ac of land area over the 40-year plant life. Waste impacts on groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs. Disposal of the waste could noticeably affect land use and groundwater quality; however, with appropriate management and monitoring, it would not destabilize any resources. After closure of the waste site and revegetation, the land could be available for other uses.

  In May 2000, the EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (EPA 2000b). The EPA concluded that some form of national regulation is warranted to address coal combustion waste products because: (a) the composition of these wastes could present danger to human health and the environment under certain conditions; (b) 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; (c) 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 (d) the EPA identified gaps in State oversight of coal combustion wastes. Accordingly, the EPA announced its intention to issue regulations for disposal of coal combustion waste under Subtitle D of the Resource Conservation and Recovery Act of 1976.

  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 would not destabilize any important resource.

- **Human Health**

  Coal-fired power generation introduces worker risks from fuel and limestone mining, from fuel and lime/limestone transportation, and from disposal of coal combustion waste. In addition, there are public risks from inhalation of stack emissions. Emission impacts can be widespread and health risks difficult to quantify. The coal alternative also introduces the risk of coal-pile fires and attendant inhalation risks.

  In the GEIS, the NRC staff stated that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates, but it 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. As discussed previously, 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.

- **Socioeconomics**

Construction of a coal-fired plant would take approximately 5 years. The NRC staff assumed that construction would take place while Palisades continues operation and would be completed by the time Palisades permanently ceases operations. The workforce would be expected to vary between 600 and 1500 workers during the 5-year construction period (NRC 1996). These workers would be in addition to the approximately 644 workers employed at Palisades (534 permanent employees and 110 contractors as of the writing of the ER; NMC 2005). 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 Van Buren and Berrien Counties or from other counties in the Kalamazoo area. After construction, the communities would be impacted by the loss of the construction jobs, although this loss would be possibly offset by other growth currently being projected for the Kalamazoo area.

Construction of a replacement coal-fired power plant at an alternate site would impact the communities around Palisades as they would experience the impact of operational job loss. The communities around the new site would have to absorb the impacts of a large, temporary workforce (up to 1500 workers at the peak of construction) and a permanent workforce of approximately 75 to 120 workers. In the GEIS, the NRC staff stated that socioeconomic impacts at a rural site would be larger than at an urban site, because more of the peak construction workforce would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis, and socioeconomic impacts could range from SMALL to LARGE.

- **Transportation**

  During the 5-year construction period of replacement coal-fired units, up to 1500 construction workers would be working at the site. The addition of these workers could affect traffic loads on existing highways. Transportation-related impacts associated with commuting construction workers at an alternate site are site dependent, but could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site dependent, but can be characterized as SMALL to MODERATE.

  At an alternate site, coal and lime would likely be delivered by rail. Transportation impacts would depend upon the site location. Socioeconomic impacts associated with rail transportation would likely be MODERATE to LARGE.

- **Aesthetics**

  The two coal-fired power plant units could be as much as 200 ft tall with cooling towers, stacks, and coal piles visible in daylight hours. The exhaust stacks could be as much as 650 ft high. The units and associated stacks would also be visible at night because of outside lighting. Visual impacts of a new coal-fired plant could be mitigated by landscaping and color selection for buildings that is consistent with the environment. Visual impact at night could be mitigated by reduced use of lighting, providing that the lighting meets Federal Aviation Administration requirements (FAA 2000), and appropriate use of shielding. There could be a significant impact if construction of a new transmission line and/or rail spur is needed. Overall, the addition of a coal-fired plant and the associated stacks at an alternate site would likely have a MODERATE aesthetic impact.

  Coal-fired plant generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to total noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations, such as cooling towers. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to coal and lime delivery, use of outside loudspeakers, and the commuting of plant employees. These impacts are considered to be MODERATE.

  Noise impacts associated with rail delivery of coal and lime to a plant at an alternate site would be most significant for residents living in the vicinity of the facility and along the rail route. Although noise from passing trains significantly raises noise levels near the rail corridor, the short duration of the noise reduces the impact. Nevertheless, given the frequency of train transport and the many residents likely to be within hearing distance of the rail route, the impacts of noise on residents in the vicinity of the facility and the rail line are considered MODERATE.

Aesthetic impacts associated with the construction and presence of the new transmission line and rail spur could be LARGE, depending on the location of the site chosen. Overall, the aesthetic impacts associated with locating a coal-fired plant at an alternate site can be categorized as MODERATE to LARGE.

- **Historic and Archaeological Resources**

  Before construction or any ground disturbance at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on historic and archaeological resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other rights-of-way). Other lands, if any, that are acquired to support the plant would also likely need an inventory of cultural resources to identify and evaluate existing historic and archaeological resources and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

  Historic and archaeological resources must be evaluated on a site-specific basis. The impacts can generally be effectively managed under current laws and regulations, and as such, the categorization of impacts could range from SMALL to MODERATE, depending on what resources are present, and whether mitigation is necessary.

- **Environmental Justice**

  Environmental justice impacts would depend upon the site chosen and the nearby population distribution. Construction activities would offer new employment possibilities. This could affect housing availability and prices during construction, which could disproportionately affect minority and low-income populations. The closure of Palisades would result in a decrease in employment of approximately 644 operating employees. However, these projected job losses could be offset by economic growth in the Kalamazoo area. Overall, environmental justice impacts would range from SMALL to MODERATE.

8.2.1.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a coal-fired generation system using once-through cooling at an alternate site. The impacts (SMALL, MODERATE, or LARGE) of this option are the same as the impacts for a coal-fired plant using the closed-cycle system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8.3 summarizes the incremental differences. However, the design and operation of the intake would need to comply with Phase II performance standards of the EPA's 316(b) regulations to minimize adverse impacts associated with water withdrawal, and heated discharges would need to comply with 316(a) regulations.

Table 8-3. Summary of Environmental Impacts of Coal-Fired Generation Using Once-Through Cooling at an Alternate Site

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land use	Impacts may be less (e.g., through elimination of cooling towers) or greater (e.g., if a reservoir is required).
Ecology	Impacts would depend on ecology at the site. Possible impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock. No impact on terrestrial ecology from cooling-tower drift.
Water use and quality – surface water	Increased water withdrawal leading to possible water-use conflicts; thermal load higher on receiving body of water than with closed-cycle cooling; no discharge of cooling-tower blowdown.
Water use and quality – groundwater	No change
Air quality	No change
Waste	No change
Human health	No change
Socioeconomics	No change
Transportation	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and archaeological resources	No change
Environmental justice	No change

8.2.2 Natural-Gas-Fired Generation

The environmental impacts of the natural-gas-fired generation alternative are examined in this section for both the Palisades site and an alternate site. The NRC staff assumed that the plant would use a closed-cycle cooling system (Section 8.2.2.1). In Section 8.2.2.2, the staff also evaluated the impacts of an open-cycle cooling system at an alternate site.

The existing switchyard, offices, and transmission lines would be used for the gas-fired alternative at the Palisades site. For purposes of analysis, NMC estimates that approximately 5 mi of buried gas supply pipeline would need to be constructed (NMC 2005).

If a new natural-gas-fired plant were built at an alternate site in southern Michigan to replace Palisades, construction of a new natural gas supply pipeline and a new transmission line would be needed. NMC estimated 5 mi of new gas pipeline would be needed and approximately 10 mi of new 345-kV transmission line (NMC 2005). In the GEIS, the NRC staff estimated disturbance of up to 2500 ac for construction of a 60-mi transmission line to an alternate greenfield site (NRC 1996).

The NRC staff assumed that a replacement natural-gas-fired plant would use combined-cycle technology (NMC 2005). 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.

NMC assumed two standard-sized units – a 530-MW(e) unit and a 263-MW(e) unit – with a total capacity of 793 MW(e), as the gas-fired alternative at Palisades (NMC 2005). This capacity is approximately equivalent to the Palisades total net capacity of 786 MW(e). NMC estimates that the plant would consume approximately 38.4 billion ft^3 of gas annually (NMC 2005).

Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.2 are from the NMC ER (NMC 2005). The NRC staff reviewed this information and compared it with environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating a natural-gas-fired plant for 40 years is considered (as a reasonable projection of the operating life of a natural-gas-fired plant).

8.2.2.1 Closed-Cycle Cooling System

The overall impacts of the natural-gas-generating system are discussed in the following sections and summarized in Table 8-4. The extent of impacts at an alternate site would depend on the location of the particular site selected.

Table 8-4. Summary of Environmental Impacts of Natural-Gas-Fired Generation Using Closed-Cycle Cooling at the Palisades Site and at an Alternate Site

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Land use	MODERATE to LARGE	Uses approximately 30 ac for power block, cooling towers, roads, and parking areas. Additional impact of up to approximately 120 ac for construction of 5 mi of underground gas pipeline.	MODERATE to LARGE	Uses approximately 87 ac for power block, cooling towers, offices, roads, and parking areas. Additional land needed for new transmission line (amount dependent on site chosen) and for construction and/or upgrade of an underground gas pipeline.
Ecology	MODERATE to LARGE	Uses undeveloped areas at current Palisades site, plus construction of a gas pipeline. Impacts on terrestrial ecology from cooling-tower drift are expected.	MODERATE to LARGE	Impacts depend on the location and ecology of the site, surface-water body used for intake and discharge, and transmission and pipeline routes; potential habitat loss and fragmentation; reduced productivity and biological diversity.
Water use and quality – surface water	SMALL	Discharge of cooling tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides would be released to Lake Michigan. Temporary erosion and sedimentation could occur in streams crossed by rights-of-way during pipeline construction.	SMALL to MODERATE	Impacts depend on volume of water withdrawn and discharged and characteristics of surface-water body. Discharge of cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides would be released to surface water. Temporary erosion and sedimentation could occur in streams crossed by rights-of-way during pipeline construction.

Table 8-4. (contd)

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Water use and quality – groundwater	SMALL	Use of groundwater limited to grounds maintenance. Adequate surface water available from Lake Michigan.	SMALL to MODERATE	Impacts depend on location of site, volume of water withdrawn and discharged, and characteristics of the aquifer.
Air quality	MODERATE	Sulfur oxides • 12 tons/yr Nitrogen oxides • 190 tons/yr Carbon monoxide • 292 tons/yr PM_{10} particulates • 37 tons/yr Some hazardous air pollutants.	MODERATE	Same emissions as Palisades site, although pollution control standards may vary depending on location.
Waste	SMALL	Minimal waste from fuel production. Debris would be generated and removed during construction.	SMALL	Same waste produced as if produced at the Palisades site. Waste disposal constraints may vary.
Human health	SMALL	Human health risks associated with gas-fired plants may result from NO_x emissions, which are regulated. Impacts are expected to be SMALL.	SMALL	Same impacts as the Palisades site.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be MODERATE. Up to 420 additional workers during the peak of the 3-year construction period, followed by a reduction of the current Palisades workforce from 644 to 30. Van Buren County would experience reduced demand on socioeconomic resources as well as a loss in its tax base and employment, but potentially offset by projected economic growth in the area. Impacts during operation would be SMALL.	SMALL to MODERATE	During construction, impacts would be MODERATE. Up to 420 additional workers during the peak of the 3-year construction period. Van Buren County would experience a loss in its tax base and employment, potentially offset by projected economic growth in the area.

Table 8-4. (contd)

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Transportation	SMALL to MODERATE	Transportation impacts associated with construction workers would be MODERATE as 644 Palisades workers and 420 construction workers would be commuting to the site. Impacts during operation would be SMALL as the workforce would be reduced to 30 commuters.	SMALL to MODERATE	Transportation impacts associated with 420 construction workers and 30 plant workers would be MODERATE and SMALL, respectively.
Aesthetics	MODERATE	MODERATE aesthetic impacts due to impact of plant units, exhaust stacks, and gas compressors. Intermittent noise from construction and continuous noise from cooling towers and mechanical equipment would result in MODERATE impacts.	MODERATE to LARGE	Impacts would be similar to the Palisades site with additional impact from the new 345-kV transmission line that would be needed.
Historic and archaeological resources	SMALL to MODERATE	Some construction would affect previously developed parts of the Palisades site; a cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new plant construction on cultural resources in undeveloped areas.	SMALL to MODERATE	Cultural resource studies would be needed to identify, evaluate, and mitigate potential impacts of new plant construction at developed and undeveloped sites.
Environmental justice	SMALL to MODERATE	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 614 operating jobs at Palisades could reduce employ-ment prospects for minority and low-income populations. Impacts could be offset by projected economic growth and ability of affected workers to commute to other jobs.	SMALL to MODERATE	Impacts would vary depending on population distribution and makeup at site.

In addition to the impacts discussed below for a gas-fired plant at either the Palisades site or at an alternate site, impacts would occur offsite as a result of gas production and transportation.

Impacts of production operations would include an increase in fugitive dust emissions, surface-water runoff, erosion, and sedimentation; changes in water quality; disturbance of vegetation and wildlife; disturbance of historic and archaeological resources; changes in land use; and impacts on employment. The magnitude of these offsite impacts would largely be proportional to the amount of land affected by the production and distribution.

- **Land Use**

  For siting at Palisades, existing facilities and infrastructure would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that the natural-gas-fired replacement plant alternative would use the switchyard, offices, and transmission lines. Much of the land that would be used has been previously disturbed. At Palisades, the staff assumed that approximately 30 ac would be needed for the plant and associated infrastructure. There would be an additional impact of up to approximately 120 ac for construction of a gas pipeline. Approximately 30 ac of undeveloped land at the Palisades site is available in the northeastern portion of the site. However, there would be insufficient buffer available between the plant and Van Buren State Park (adjacent to the Palisades site to the north).

  For construction at an alternate site, the NRC staff assumed in the GEIS that 110 ac would be needed for a 1000-MW(e) plant and associated infrastructure (NRC 1996). This estimate would be scaled down for the 793-MW(e) capacity of the proposed gas-fired alternative (i.e., 87 ac). The additional amount of land impacted by the construction of a new transmission line and a gas pipeline is dependent on the site location chosen. The NRC staff assumed in the GEIS that approximately 2500 ac would be impacted for construction of a 60-mi transmission line (NRC 1996), although NMC estimates only 10 mi of transmission line might be needed. In addition, approximately 120 ac could be disturbed during construction and/or upgrade of an underground pipeline, assuming an alternate site would be located within 5 mi of a gas pipeline connection.

  Regardless of where a gas-fired plant is built, additional land (approximately 3600 ac) would be required for natural gas wells and collection stations (NRC 1996). Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Palisades. In the GEIS (NRC 1996), the NRC staff estimated that approximately 1000 ac would be affected for mining the uranium and processing it during the operating life of a nuclear power plant. Overall, land-use impacts would be MODERATE to LARGE.

- **Ecology**

  At the Palisades site, there would be ecological impacts related to possible habitat loss and to cooling-tower drift associated with siting of the gas-fired plant. There would also be ecological impacts associated with bringing a new underground gas pipeline to the Palisades site. Impacts due to habitat loss could be reduced through the use of previously impacted land. Ecological impacts at an alternate site would depend on the nature of the land converted for the plant and the possible need for a new gas pipeline and/or transmission line. Construction of the transmission line and construction and/or upgrading of the gas pipeline to serve the plant would be expected to have temporary ecological impacts. Ecological impacts on the plant site and utility easements could include impacts on threatened or endangered species, wildlife habitat loss and reduced productivity, habitat fragmentation, and a local reduction in biological diversity. The cooling makeup water intake and discharge could have aquatic resource impacts. Overall, the ecological impacts are considered MODERATE to LARGE at either location.

- **Water Use and Quality**

  Surface water. Each of the natural-gas-fired units would include a heat-recovery boiler, using a portion of the waste heat from the combustion turbines to make steam. The steam would then turn an electric generator. The net result would be an overall reduction in the amount of waste heat rejected from the plant, with an associated reduction in the amount of cooling water required by the plant. Thus, the cooling-water requirements for the natural-gas-fired combined-cycle units would be much less than those for conventional steam-electric generators, including the existing nuclear unit. Plant discharge would consist mostly of cooling-tower blowdown, with the discharge having a higher temperature and increased concentration of dissolved solids relative to the receiving body of water and intermittent low concentrations of biocides (e.g., chlorine). In addition to the cooling-tower blowdown, treated process waste streams and sanitary wastewater might also be discharged. All discharges would be regulated by the State of Michigan through a permit. There would be consumptive use of water due to evaporation from the cooling towers. Construction could cause temporary erosion and sedimentation in streams crossed by the rights-of-way. Overall, the surface-water impacts of the natural-gas-fired alternative at the Palisades site are considered SMALL.

  A natural-gas-fired plant at an alternate site is assumed to use a closed-cycle cooling system with cooling towers. The staff assumed that surface water would be used for cooling makeup water and discharge. Intake and discharge would involve relatively small quantities of water compared with the coal alternative. 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. Discharges would be the same as those described above for the Palisades site. Construction could cause temporary erosion and sedimentation in streams crossed by the rights-of-way. Intake from and discharge to any

surface body of water would be regulated by the State of Michigan. The impacts would be SMALL to MODERATE.

Water-quality impacts from sedimentation during construction were characterized in the GEIS as SMALL (NRC 1996). The NRC staff also noted in the GEIS that operational water-quality impacts would be similar to, or less than, those from other generating technologies.

Groundwater. Any groundwater withdrawal would require a permit from the local permitting authority. Impacts on groundwater would depend on the volume and other characteristics of the source water budget. Use of groundwater at the Palisades site is unlikely because adequate surface water is available from Lake Michigan. Therefore, groundwater impacts at the Palisades site would be SMALL. Impacts at an alternate site would be SMALL to MODERATE depending on site-specific conditions.

- **Air Quality**

Natural gas is a relatively clean-burning fuel. The gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative.

A new gas-fired generating plant located in Michigan would likely need a PSD permit and an operating permit under the Clean Air Act. A new combined-cycle natural gas power plant would also be subject to the new source performance standards for such units at 40 CFR Part 60, Subparts D(a) and GG. These regulations establish emission limits for particulates, opacity, SO_2, and NO_x.

In 1998, the EPA issued a rule requiring 22 eastern states, including Michigan, to revise their state implementation plans to reduce NO_x emissions. Nitrogen oxide emissions contribute to violations of the national ambient air quality standard (40 CFR 50.9) for ozone. The total amount of NO_x that can be emitted by each of the 22 states in the 2007 ozone season (May 1 to September 30) is presented in 40 CFR 51.121(e). For Michigan, the amount is 229,702 tons.

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated attainment or unclassified under the Clean Air Act. All of Michigan has been classified as attainment or unclassified for criteria pollutants (40 CFR 81.323). In the posted amendment to that classification dated April 30, 2004, there are several instances of nonattainment for ozone, including one for Van Buren County (EPA 2004a).

Section 169A of the Clean Air Act 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. The EPA issued a new regional haze rule

in 1999 (64 FR 35714; July 1,1999 (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 toward 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 natural-gas-fired plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. Isle Royale National Park and Seney National Wildlife Refuge are Class I areas where visibility is an important value (40 CFR 81.407). Both of these areas are located in the Upper Peninsula of Michigan, and air quality in these areas would not likely be affected by a gas-fired plant at the Palisades site or at an alternate site in southern Michigan.

NMC projects the following emissions for the natural gas-fired alternative (NMC 2005):

Sulfur oxides – 12 tons/yr
Nitrogen oxides – 190 tons/yr
Carbon monoxide – 292 tons/yr
PM_{10} particulates – 37 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 (EPA 2000a). The EPA found that natural-gas-fired power plants emit arsenic, formaldehyde, and nickel (EPA 2000a). 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 Clean Air Act.

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 Palisades or at an alternate site. Impacts from the above emissions would be clearly noticeable but would not be sufficient to destabilize air resources as a whole.

Therefore, the overall air quality impact for a new natural-gas-fired plant sited at Palisades or at an alternate site is considered MODERATE.

- **Waste**

  There will be spent SCR catalyst from NO_x emissions control and small amounts of solid-waste products (i.e., ash) from burning natural gas fuel. In the GEIS, the NRC staff concluded that waste generation from 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 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 Palisades or at an alternate site.

- **Human Health**

  In Table 8-2 of the GEIS, the NRC staff identifies cancer and emphysema as potential health risks from gas-fired plants (NRC 1996). The risk may be attributable to NO_x emissions that contribute to ozone formation, which in turn contribute to health risks. NO_x emissions from any gas-fired plant would be regulated. For a plant sited in Michigan, NO_x emissions would be regulated by the Michigan Department of Environmental Quality (MDEQ). Human health effects would not 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 Palisades or at an alternate site are considered SMALL.

- **Socioeconomics**

  Construction of a natural-gas-fired plant would take approximately 3 years. Peak employment would be approximately 420 workers (NMC 2005). The NRC staff assumed that construction would take place while Palisades continues operation and would be completed by the time it permanently ceases operations. During construction, the communities surrounding the Palisades site 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 Van Buren and Berrien Counties or from other counties. After construction, the communities would be impacted by the loss of jobs. The current Palisades workforce (approximately 644 workers) would decline through a decommissioning period to a minimal maintenance size. The gas-fired plant would introduce a replacement tax base at Palisades or at an alternate site and approximately 30 new permanent jobs. This would represent a net loss of 614 jobs at the Palisades site.

In the GEIS (NRC 1996), the NRC staff concluded that socioeconomic impacts from constructing a natural-gas-fired plant would not be very noticeable and that the small operational workforce would have the lowest socioeconomic impacts of any nonrenewable technology. Compared with the coal-fired and nuclear alternatives, the smaller size of the construction workforce, the shorter construction time frame, and the smaller size of the operations workforce would mitigate socioeconomic impacts. The loss of 614 permanent jobs (up to 644 jobs if an alternate site is not located in Van Buren County) may be partially tempered by the projected economic growth of the Kalamazoo area. For these reasons, gas-fired generation socioeconomic impacts associated with construction and operation of a natural-gas-fired power plant would be SMALL to MODERATE for siting at Palisades or at an alternate site. Depending on other growth in the area, socioeconomic effects could be noticed, but they would not destabilize any important socioeconomic attribute.

- **Transportation**

  Transportation impacts associated with construction and operating personnel commuting to the plant site would depend on the population density and transportation infrastructure in the vicinity of the site. The impacts can be classified as SMALL to MODERATE for siting at Palisades or at an alternate site.

- **Aesthetics**

  The turbine buildings (approximately 100 ft tall) and exhaust stacks (approximately 125 ft tall) would be visible during daylight hours from offsite. The gas pipeline compressors would also be visible. Noise and light from the plant would be detectable offsite. Intermittent noise from construction and continuous noise from cooling towers and mechanical equipment would result in MODERATE impacts. Noise impacts would be similar to those described for the Palisades site. Overall, the aesthetic impacts associated with construction and operation of a gas-fired plant at the Palisades site are categorized as MODERATE to LARGE.

  At an alternate site, the buildings, cooling towers, cooling-tower plumes, and the associated transmission line and gas pipeline compressors would be visible offsite. There would also be a visual impact from a new 345-kV transmission line. Aesthetic impacts would be mitigated if the plant were located in an industrial area adjacent to other power plants. Noise impacts would be similar to those described for the Palisades site. Overall, the aesthetic impacts associated with an alternate site are categorized as MODERATE to LARGE. Depending on the site chosen, the greatest contributor to aesthetic impact would be the new transmission line.

- **Historic and Archaeological Resources**

  Before construction or any ground disturbance at Palisades or at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on historic and archaeological resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission and pipeline corridors, or other rights-of-way). Other lands, if any, that are acquired to support the plant would also likely need an inventory of cultural resources to identify and evaluate existing historic and archaeological resources and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

  Historic and archaeological resources must be evaluated on a site-specific basis. The impacts can generally be effectively managed under current laws and regulations, and as such, the categorization of impacts ranges from SMALL to MODERATE, depending on what resources are present and whether mitigation is necessary.

- **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 Palisades site. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect minority and low-income populations. Closure of Palisades would result in a decrease in employment of approximately 644 operating employees, possibly offset by general growth in the Kalamazoo area. Following construction, it is possible that the ability of local government to maintain social services could be reduced at the same time as diminished economic conditions reduce employment prospects for minority or low-income populations. Overall, impacts are expected to be SMALL to MODERATE. Projected economic growth in the Kalamazoo area and the ability of minority and low-income populations to commute to other jobs outside the area could mitigate any adverse effects.

  Impacts at an alternate site would depend upon the site chosen and the nearby population distribution; therefore, impacts could range from SMALL to MODERATE.

8.2.2.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a natural-gas-fired generation system at an alternate site using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are the same as the impacts for a natural-gas-fired plant using the closed-cycle system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8.5 summarizes the incremental differences. However, the design and operation of the intake would need to comply with Phase II

performance standards of EPA's 316(b) regulations to minimize adverse impacts associated with water withdrawal, and heated discharges would need to comply with 316(a) regulations.

8.2.3 Nuclear Power Generation

Since 1997, the NRC has certified four new standard designs for nuclear power plants under 10 CFR Part 52, Subpart B. These designs are the 1300-MW(e) U.S. Advanced Boiling Water Reactor (10 CFR Part 52, Appendix A), the 1300-MW(e) System 80+ Design (10 CFR Part 52, Appendix B), the 600-MW(e) AP600 Design (10 CFR Part 52, Appendix C), and the advanced 1117- to 1154-MW(e) AP1000 design (10 CFR Part 52, Appendix D). All these plants are light-water reactors. Although no applications for a construction permit or a combined license

Table 8-5. Summary of Environmental Impacts of Natural-Gas-Fired Generation Using Once-Through Cooling at an Alternate Site

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land use	Impacts may be less (e.g., through elimination of cooling towers) or greater (e.g., if a reservoir is required).
Ecology	Impacts would depend on the ecology at the site. Potential impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock. No impact on terrestrial ecology from cooling-tower drift.
Water use and quality – surface water	Increased water withdrawal leading to possible water-use conflicts, thermal load higher on receiving body of water than with closed-cycle cooling; no discharge of cooling-tower blowdown.
Water use and quality – groundwater	No change
Air quality	No change
Waste	No change
Human health	No change
Socioeconomics	No change
Transportation	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and archaeological resources	No change
Environmental justice	No change

based on these certified designs have been submitted to the NRC, the submission of the design certification applications indicates continuing interest in the possibility of licensing new nuclear power plants. In addition, recent escalation in prices of natural gas and electricity have made new nuclear power plant construction more attractive from a cost standpoint. In addition, System Energy Resources, Inc., Exelon Generations Company, LLC, and Dominion Nuclear North Anna, LLC, have recently submitted applications for early site permits for new advanced nuclear power plants under the procedures in 10 CFR Part 52, Subpart A (SERI 2003; Exelon 2003; Dominion 2003). Consequently, construction of a new nuclear power plant at either the Palisades site or at an alternate site is considered in this section. The NRC staff assumed that the new nuclear plant would have a 40-year lifetime. Consideration of a new nuclear generating plant to replace Palisades was not included in the NMC ER (NMC 2005).

The NRC has 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 Palisades or at 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 786 MW(e) generated by Palisades. 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 consideration of environmental impacts associated with the operation of a replacement nuclear power plant. Additional environmental impact information for a replacement nuclear power plant using closed-cycle cooling is presented in Section 8.2.3.1, and using open-cycle cooling is presented in Section 8.2.3.2.

8.2.3.1 Closed-Cycle 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 site will depend on the location of the particular site selected.

In addition to the impacts discussed below, impacts would occur offsite as a result of uranium mining. Impacts of mining would include an increase in fugitive dust emissions, surface-water runoff, erosion, sedimentation, changes in water quality, disturbance of vegetation and wildlife, disturbance of historic and archaeological resources, changes in land use, and impacts on employment.

The magnitude of these offsite impacts would largely be proportional to the amount of land affected by mining. However, there would be no net change in land needed for uranium mining

Table 8-6. Summary of Environmental Impacts of New Nuclear Power Generation Using Closed-Cycle Cooling at the Palisades Site and at an Alternate Site

	Palisades Site		Alternate Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land use	MODERATE to LARGE	Requires approximately 500 to 1000 ac for the plant; would likely require the acquisition of additional land.	MODERATE to LARGE	Same as Palisades site plus additional land for transmission line.
Ecology	MODERATE to LARGE	Uses undeveloped areas at current Palisades site and additional undeveloped land adjacent to the site. Impacts dependent on specific location and ecology of the site. Impacts on terrestrial ecology from cooling-tower drift are expected. Use of cooling makeup water could affect aquatic resources.	MODERATE to LARGE	Impacts would depend 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. Impacts on terrestrial ecology from cooling-tower drift are expected.
Water use and quality – surface water	SMALL	Discharge of cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides would be released to Lake Michigan.	SMALL to MODERATE	Impacts would depend on the volume of water withdrawn and discharged and the characteristics of the surface-water body. Discharge of cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides would be released to surface water.
Water use and quality – groundwater	SMALL	Use of groundwater is unlikely because the Palisades site has adequate surface water available from Lake Michigan.	SMALL to MODERATE	Impacts would depend on the volume of water withdrawn and discharged and the characteristics of the aquifer.
Air quality	SMALL to MODERATE	Fugitive emissions and emissions from vehicles and equipment during construction would be MODERATE. Small amount of emissions from diesel generators and possibly other sources during operation would be similar to current operation of Palisades.	SMALL to MODERATE	Same impacts as Palisades site.

Table 8-6. (contd)

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Waste	SMALL	Waste impacts for an operating nuclear power plant are presented in 10 CFR Part 51, Appendix B, Table B-1. Debris would be generated and removed during construction.	SMALL	Same impacts as Palisades site.
Human health	SMALL	Human health impacts for an operating nuclear power plant are presented in 10 CFR Part 51, Appendix B, Table B-1.	SMALL	Same impacts as Palisades site.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be MODERATE. Up to 2500 workers during peak period of the 6-year construction period. Operating workforce assumed to be similar to Palisades; tax base preserved. Impacts during operation would be SMALL.	SMALL to LARGE	Construction impacts would depend on location. Impacts at a rural location could be LARGE. Van Buren County would experience a loss in its tax base and employment if the chosen site is located outside of the county, possibly offset by economic growth in the area.
Transportation	SMALL to LARGE	Transportation impacts associated with 2500 construction workers in addition to 644 Palisades workers would be LARGE. Transportation impacts of commuting plant personnel would be SMALL.	SMALL to LARGE	Impacts would depend on the location of the site. Transportation impacts of 2500 construction workers could be MODERATE to LARGE. Transportation impacts of 644 commuting plant personnel could be SMALL to MODERATE.
Aesthetics	SMALL to MODERATE	Aesthetic impacts due to addition of containment and other associated buildings would be SMALL. No exhaust stacks would be needed, and existing cooling towers would be used, if possible. Intermittent noise from construction and commuter traffic and continuous noise from cooling towers and mechanical equipment could result in impacts ranging from SMALL to MODERATE.	MODERATE to LARGE	Impacts would depend on the characteristics of the alternate site but would be similar to those at the Palisades site. Impacts would be less if the site selected is next to an industrial area. Impacts would be greater if a non-industrial site is selected. Additional visual impacts would occur from the new transmission line that would be needed.

Table 8-6. (contd)

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Historic and archaeological resources	SMALL to MODERATE	Some construction would affect previously developed parts of the Palisades site; a cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new plant construction on cultural resources in undeveloped areas.	SMALL to MODERATE	Cultural resource studies would be needed to identify, evaluate, and mitigate potential impacts of new plant construction at developed and undeveloped sites.
Environmental justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. MODERATE impacts on housing may occur during construction. Employment impacts would be similar to the current operation of Palisades.	SMALL to LARGE	Impacts would vary depending on population distribution and makeup at the site.

because land needed for the new nuclear plant would offset land needed to supply uranium for fuel at Palisades.

- **Land Use**

  The existing facilities and infrastructure at the Palisades site would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the NRC staff assumed that a replacement nuclear power plant would use the existing cooling towers, switchyard, offices, and transmission line rights-of-way. Much of the land that would be used has been previously disturbed. A replacement nuclear power plant at the Palisades site would alter approximately 500 to 1000 ac of land, excluding power lines (NRC 1996).

  The impact of a replacement nuclear generating plant on land use at the existing Palisades site is best characterized as MODERATE to LARGE, because the existing site is not large enough to accept the additional land requirements for construction. Additional land would have to be obtained outside of the existing boundaries, or Palisades would have to be dismantled before new construction began. The impact would be greater than the OL renewal alternative.

  Land-use impacts at an alternate site would be similar to siting at Palisades except for the land needed for a 345-kV transmission line to connect to existing lines to transmit power to NMC's customers in Michigan. The amount of land needed for the transmission line is dependent upon the location of the alternate site. In addition, it may be necessary to

construct a rail spur to an alternate site to bring in equipment during construction. Depending particularly on transmission line routing, siting a new nuclear plant at an alternate site would result in MODERATE to LARGE land-use impacts.

- **Ecology**

  Locating a replacement nuclear power plant at the Palisades site would alter ecological resources because of the need to convert roughly 500 to 1000 ac of land to industrial use. Some of this land, however, would have been previously disturbed.

  Siting at Palisades would have a MODERATE to LARGE ecological impact that would be greater than renewal of the Palisades 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 affect ecological resources. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface-water body could have adverse aquatic resource impacts. Impacts on terrestrial ecology could result from cooling-tower drift. Construction and maintenance of the transmission line, if needed, would have ecological impacts. Overall, the ecological impacts at an alternate site would be MODERATE to LARGE and would depend on the ecological conditions at the site.

- **Water Use and Quality**

  Surface water. The replacement nuclear plant alternative at the Palisades site is assumed to use the existing closed-cycle cooling tower system, which would minimize incremental water-use and quality impacts. Plant discharge would consist mostly of cooling-tower blowdown, with the discharge having a higher temperature and increased concentration of dissolved solids relative to the receiving body of water and intermittent low concentrations of biocides (e.g., chlorine). In addition to the cooling-tower blowdown, treated process waste streams and sanitary wastewater might also be discharged. All discharges would be regulated by the State of Michigan through a permit. Surface-water impacts are expected to remain SMALL; the impacts would be sufficiently minor that they would not noticeably alter any important attribute of the resource.

  Cooling towers would likely be used at an alternate site. For an alternate 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 Michigan. The impacts would be SMALL to MODERATE.

Groundwater. The NRC staff assumed that a new nuclear power plant located at Palisades would obtain potable, process, and fire-protection water from the South Haven Municipal Water Authority, similar to the current practice for Palisades (see Section 2.2.2).

No groundwater is currently used for operation of Palisades other than for maintenance of the grounds. It is unlikely that groundwater would be used for an alternative nuclear power plant sited at Palisades. 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.

Overall, the impacts on groundwater use and quality from a closed-cycle new nuclear alternative at the Palisades site is considered SMALL. Impacts from a similar plant at an alternate site are considered to be SMALL to MODERATE, depending on the volume of groundwater used and characteristics of the aquifer.

- **Air Quality**

Construction of a new nuclear plant sited at Palisades or at an alternate site would result in fugitive emissions during the 6-year construction period. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process. Air quality impacts from construction could be MODERATE. An operating nuclear plant would have minor air emissions associated with diesel generators and other minor intermittent sources and would be similar to the current impacts associated with operation of Palisades (i.e., SMALL). These emissions are not regulated. Emissions for a plant sited in Michigan would be regulated by the MDEQ. Overall, emissions and associated impacts are considered SMALL to MODERATE.

- **Waste**

The waste impacts associated with operation of a nuclear power plant are presented in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B. Construction-related debris would be generated during construction activities and removed to an appropriate disposal site. Overall, waste impacts are considered SMALL.

Siting the replacement nuclear power plant at a site other than Palisades would not alter waste generation. Therefore, the impacts would be SMALL.

- **Human Health**

Human health impacts for an operating nuclear power plant are presented 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 Palisades would not alter human health impacts. Therefore, the impacts would be SMALL.

- **Socioeconomics**

  The construction period and the peak workforce associated with construction of a new nuclear power plant are currently unquantified (NRC 1996). In the absence of quantitative data, NRC staff assumed a construction period of 6 years and a peak workforce of 2500. Additional land would have to be acquired to construct a new nuclear plant at the Palisades site, or Palisades would have to be decommissioned and dismantled before construction began. During construction, the communities surrounding the Palisades site 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 Van Buren and Berrien Counties or from other counties.

  The replacement nuclear unit is assumed to have an operating workforce comparable to the 644 workers currently working at Palisades. The replacement nuclear unit would provide a new tax base to offset the loss of tax base associated with decommissioning of Palisades. For all of these reasons, the appropriate characterization of nontransportation socioeconomic impacts for replacement nuclear units constructed at Palisades would be SMALL to MODERATE; the socioeconomic impacts would be noticeable, but would be unlikely to destabilize the area.

  If a new nuclear power plant were constructed at an alternate site, the communities around the Palisades site would experience the impact of Palisades' operational job loss (although potentially tempered by projected economic growth in the area). 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 644 workers. In the GEIS (NRC 1996), the NRC staff indicated that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction workforce would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis, and impacts could range from SMALL to LARGE.

- **Transportation**

  During the 6-year construction period, up to 2500 construction workers and 644 Palisades workers would be commuting to the Palisades site. The addition of the construction workers could place significant traffic loads on existing highways. Such impacts would be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would be similar to current impacts associated with operation of Palisades and are considered SMALL.

Transportation-related impacts associated with commuting construction workers at an alternate site are site dependent, but could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site dependent, but can be characterized as SMALL to MODERATE.

- **Aesthetics**

The containment buildings for a replacement nuclear power plant sited at Palisades and other associated buildings would likely be visible in daylight hours over many miles. Natural draft towers could be up to 500 ft high. Mechanical-draft towers could be up to 100 ft high and would also have an associated noise impact and condensate plumes. The replacement nuclear units would also likely be visible at night because of outside lighting. Visual impacts could be mitigated by landscaping and selecting a color for buildings that is consistent with the environment. Visual impact at night could be mitigated by reduced use of lighting and appropriate use of shielding. No exhaust stacks would be needed. Existing cooling towers would be used, if possible.

Intermittent noise impacts from construction and commuter traffic is likely. More continuous noise from a new nuclear plant would potentially be audible offsite in calm wind conditions or when the wind is blowing in the direction of the listener. Noise impacts from a new nuclear plant would be similar to those from the existing Palisades unit. Mitigation measures, such as reduced or no use of outside loudspeakers, can be employed to reduce noise impacts to levels that would ranges from SMALL to MODERATE.

At an alternate site, there would be an aesthetic impact from the buildings, cooling towers, and the plume associated with the cooling towers. There would also be a significant aesthetic impact associated with construction of a new transmission line. The length of the transmission line would be dependent upon the location of the plant. Noise and light from the plant would be detectable offsite. The impact of noise and light would be less if the plant were located in an industrial area adjacent to other power plants. Overall, the aesthetic impacts associated with locating at an alternative site can be categorized as MODERATE to LARGE. Depending on the location chosen, the greatest contributor to this categorization could be the aesthetic impact of the new transmission line.

- **Historic and Archaeological Resources**

Before construction or any ground disturbance at Palisades or at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on historic and archaeological resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission and pipeline corridors, or other rights-of-way). Other lands, if any, that are acquired to support the plant would also likely need an inventory of cultural resources to identify and evaluate

existing historic and archaeological resources and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Historic and archaeological resources must be evaluated on a site-specific basis. The impacts can generally be effectively managed under current laws and regulations, and as such, the categorization of impacts ranges from SMALL to MODERATE, depending on what resources are present and whether mitigation is necessary.

- **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 the Palisades site. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect the minority and low-income populations. After completion of construction, it is possible that the ability of the local government to maintain social services could be reduced at the same time as diminished economic conditions reduce employment prospects for the minority and low-income populations. Overall, impacts are expected to be SMALL to MODERATE. Projected economic growth in the Kalamazoo area and the ability of minority and low-income populations to commute to other jobs outside the Van Buren County area could mitigate any adverse effects.

Impacts at an alternate site would depend upon the site chosen and the nearby population distribution and are likely to vary from SMALL to LARGE.

8.2.3.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a nuclear power plant at an alternate site using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are the same as the impacts for a nuclear power plant using a closed-cycle system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-7 summarizes the incremental differences. However, the design and operation of the intake would need to comply with Phase II performance standards of the EPA's 316(b) regulations to minimize adverse impacts associated with water withdrawal, and heated discharges would need to comply with 316(a) regulations.

Table 8-7. Summary of Environmental Impacts of a New Nuclear Power Plant Using Once-Through Cooling at an Alternate Site

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land use	Impacts may be less (e.g., through elimination of cooling towers) or greater (e.g., if a reservoir is required).
Ecology	Impacts would depend on the ecology at the site. Possible impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock. No impact on terrestrial ecology from cooling-tower drift.
Water use and quality – surface water	Increased water withdrawal leading to possible water-use conflicts, thermal load higher on receiving body of water than with closed-cycle cooling; no discharge of cooling-tower blowdown.
Water use and quality – groundwater	No change
Air quality	No change
Waste	No change
Human health	No change
Socioeconomics	No change
Transportation	No change
Aesthetics	Less aesthetic impact because cooling towers are not used.
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 Palisades OL. It is unlikely, however, that sufficient baseload, firm power supply would be available to replace the Palisades capacity.

Imported power from Canada or Mexico is unlikely to be available for replacement of Palisades capacity. In Canada, 60 percent of the country's electrical generation capacity is derived from renewable energy sources, principally hydropower (EIA 2004). Canada plans to expand hydroelectric capacity, including large-scale projects (EIA 2004). Canada's nuclear generation is projected to increase from 10,000 MW in 2001 to 15,200 MW in 2020 before reaching a forecasted decline to 12,400 MW in 2025 (EIA 2004). The EIA projected that total gross U.S. imports of electricity from Canada and Mexico will gradually increase from 38.4 billion kWh in 2001 to 47.2 billion kWh in 2010 and then gradually decrease to 15.2 billion kWh in 2025 (EIA 2004). Consequently, it is unlikely that electricity imported from Canada or Mexico would be able to replace the capacity of Palisades.

If power to replace the capacity of Palisades were to be purchased from sources within the United States or a foreign country, the generating technology would likely be one of those described in this SEIS and in the GEIS (probably coal, natural gas, or nuclear). The description of the environmental impacts of other technologies in Chapter 8 of the GEIS is representative of the purchased electrical power alternative to renewal of the Palisades OL. Thus, the environmental impacts of imported power would still occur but would be located elsewhere within the region, nation, or another country.

8.2.5 Other Alternatives

Other generation technologies considered by the NRC are discussed in the following paragraphs.

8.2.5.1 Oil-Fired Generation

EIA projects that oil-fired plants will account for very little of the new generation capacity in the United States during the 2004 to 2025 time period because of higher fuel costs and lower efficiencies (EIA 2004). Nevertheless, an oil-fired generating alternative at the Palisades site for replacement of power generated by Palisades is considered in this section.

Consumers Energy has two oil/gas coal-fired units. These units produce about 1 percent of Consumers Energy's total power (NMC 2005). 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 license renewal for Palisades.

Construction and operation of an oil-fired plant would have environmental impacts. For example, in Section 8.3.11 of the GEIS, the NRC staff estimated that construction of a 1000-MWe oil-fired plant would require about 120 acres (NRC 1996). In addition, 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 power, by itself, is not a suitable alternative to replace the large baseload electrical generating capacity of Palisades. As discussed in Section 8.3.1 of the GEIS, wind has a high degree of intermittency, and average annual capacity factors for wind plants are relatively low (on the order of 30 percent) (NRC 1996). Wind power, in conjunction with energy storage mechanisms, might serve as a means of providing baseload power. However, current energy storage technologies are too expensive for wind power to serve as a large baseload generator.

The Lake Michigan shoreline region in the State of Michigan, including Van Buren County, has good wind power potential. The annual average wind power for this part of the state is rated as Class 3. Areas designated Class 3 or greater are suitable for most wind energy applications (DOE 2004a). However, the wind power class attenuates rapidly to Class 2 inland from the lake's coastline. Michigan also has good wind resources in the northern part of the Lower Peninsula. These areas, however, are confined to exposed hilltops and ridge crests, which makes them unsuitable for utility-scale wind energy applications. Further, land-use conflicts, such as urban development and environmentally sensitive areas, minimize the amount of land suitable for wind energy applications (PNL 1986).

DOE's National Renewable Energy Laboratory (NREL) estimates that the footprint of a 1.5-MW wind turbine is between 0.25 and 0.5 ac. In addition, a spacing interval of 5 to 10 turbine rotor diameters between wind turbines is typically maintained to prevent interferences between turbines (NREL 2006). Five turbine rotor diameters would be suitable for optimal wind conditions, increasing to 10 depending on the amount of wind turbulence and other potential topographic disturbances. Land disturbance during construction to install the turbine is estimated to be between 1 to 3 ac per turbine related to grading the site for installation, laydown areas for equipment and materials, and staging areas for construction equipment used to hoist the turbines and their towers into place. The area surrounding the turbine is then reclaimed after construction is completed. These estimates do not include land used for substations, control buildings, access roads, and other related facilities. Assuming the largest available land-based turbine is used (currently, 1.5 MW), 524 turbines are estimated to be needed in land areas with a wind class of Class 3 or greater to produce 786 MW(e), using the NREL's Wind Farm Area Calculator (NREL 2006). Assuming a rotor diameter of roughly 200 ft for a 1.5-MW turbine, the total acreage for a wind farm with 524 turbines in optimal wind conditions could require more than 2,000 ac; 262 ac would be dedicated to the turbine footprint (assuming a spacing interval of five turbine rotor diameters and approximately 0.5 ac per turbine base), and the remaining land between turbines could be available for other uses, such as grazing or agricultural land. These numbers do not take into account the low annual capacity factor of approximately 30 percent that is associated with wind energy.

Consequently, the NRC staff concludes that the current Palisades site is too small to support a baseload level of wind generation capacity. At an alternate site, this large amount of land required along the coastline could result in a LARGE environmental impact. Larger turbines could be used for offshore wind development where the wind class is greater, but even a 4-MW turbine (the largest currently available turbine for offshore use is 3.6 MW) would require about 196 turbines, with greater spacing required between turbines because of the greater rotor lengths, to produce 786 MW(e). Although impacts would depend on the site chosen, common issues of concern include visual impacts, noise, potential interferences with aircraft operations, and bird and bat collisions.

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. In the GEIS, the NRC staff noted that by its nature, solar power is intermittent. Therefore, solar power by itself is not suitable for baseload capacity and is not a feasible alternative to license renewal of Palisades. The average capacity factor of photovoltaic cells is about 25 percent, and the capacity factor for solar thermal systems is about 25 to 40 percent. Solar power, in conjunction with energy storage mechanisms, might serve as a means of providing baseload power. However, current energy storage technologies are too expensive to permit solar power to serve as a large baseload generator.

Therefore, solar power technologies (photovoltaic and thermal) cannot currently compete with conventional fossil-fueled technologies in grid-connected applications, due to high costs per kilowatt of capacity (NRC 1996).

There are substantial impacts on natural resources (wildlife habitat, land-use, and aesthetic impacts) from construction of solar-generating facilities. As stated in the GEIS, land requirements are high – 35,000 ac per 1000 MW(e) for photovoltaic and approximately 14,000 ac per 1000 MW(e) for solar thermal systems. Neither type of solar electric system would fit at the Palisades site, and both would have large environmental impacts at an alternate site.

Michigan receives between approximately 2.5 to 3.5 kWh of solar radiation per square meter per day, compared with 6 to 8 kWh of solar radiation per square meter per day in areas of the southwestern United States, such as Arizona and California, which are most promising for solar technologies (DOE 2005). Because of the natural resource impacts (land and ecological), the area's relatively low rate of solar radiation, and high cost, solar power is not deemed a feasible baseload alternative to renewal of the Palisades OL. 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 Palisades would likely result in LARGE environmental impacts.

8.2.5.4 Hydropower

There are no remaining sites in Michigan that would be environmentally suitable for a hydroelectric facility (INEEL 1998). In Section 8.3.4 of the GEIS, the NRC staff points out that hydropower's percentage of U.S. generating capacity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern about flooding, destruction of natural habitat, and alteration of natural river courses.

The NRC staff estimated in the GEIS that land requirements for hydroelectric power are approximately 1 million ac per 1000 MW(e). Replacement of Palisades generating capacity would require flooding more than this amount of land. Because of the lack of suitable sites in Michigan and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to replace Palisades, the NRC staff concludes that local hydropower is not a feasible alternative to renewal of the Palisades OL on its own. Any attempts to site hydroelectric facilities large enough to replace Palisades 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 baseload power where available. However, geothermal technology is not widely used as baseload generation due to the limited geographical availability of the resource and 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 location in Michigan for geothermal capacity to serve as an alternative to Palisades. The NRC staff concludes that geothermal energy is not a feasible alternative to renewal of the Palisades OL.

8.2.5.6 Wood Waste

The use of wood waste to generate electricity is largely limited to those states with significant wood resources, such as California, Maine, Georgia, Minnesota, Oregon, Washington, and Michigan. Electric power is generated in these states by the pulp, paper, and paperboard industries, which consume wood and wood waste for energy, benefitting from the use of waste materials that could otherwise represent a disposal problem.

DOE estimates that Michigan has good resources for wood fuels consisting of urban, mill, and forest residues; at least 3,720,000 dry tons/yr are available in Michigan (Walsh et al. 2000). NREL has estimated that 1100 kWh of electricity can be produced by one dry ton of wood residue. Therefore, 1.9 TWh of electricity can be generated from wood residue in Michigan (NREL 2004).

A wood-burning facility can provide baseload power and 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. Like coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

While wood resources in Michigan are adequate, wood energy is not considered as a reasonable alternative to renewal of the Palisades OL because of the disadvantages of low heat content, handling difficulties, and high transportation costs. There is also no significant environmental advantage.

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 2004b). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (EIA 2001). Mass-burning technologies are most commonly used in the United States. This group of technologies processes raw municipal solid waste “as is,” with little or no sizing, shredding, or separation before combustion.

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 (EIA 2001).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of unfavorable economics, particularly with electricity prices declining in real terms. U.S. electricity prices in 2002 dollars are expected to

decline by 8 percent between 2002 and 2008 and remain stable until 2011 (EIA 2004). Prices are expected to increase by 0.3 percent per year from 2011 until 2025, following the trend of the generation component of electricity price (EIA 2004).

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 that portion of the 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 or scrubbers (EIA 2001).

Currently, there are approximately 89 waste-to-energy plants operating in the United States. These plants generate approximately 2500 MW(e), or an average of approximately 28 MW(e) per plant (Integrated Waste Services Association 2004), a much smaller capacity than that needed to replace the 786 MW(e) of Palisades.

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. In addition, 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 still larger than the environmental effects of license renewal of Palisades. Therefore, municipal solid waste would not be a feasible alternative to renewal of the Palisades 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 NRC staff points out that none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as Palisades. For these reasons, such fuels do not offer a feasible alternative to renewal of the Palisades 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. Natural gas is typically used as the source of hydrogen.

Phosphoric acid fuel cells are generally considered first-generation technology. These fuel cells are commercially available at a cost of approximately $4000 to $4500 per kW of installed capacity (DOE 2004b). 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.

It is unlikely that the costs of existing fuel cell systems will drop below $1000/kW; therefore, the DOE has formed the Solid State Energy Conversion Alliance (SECA), with the goal of producing new fuel cell technologies at a cost of $400/kW or lower by 2010 (DOE 2004c). Fuel cells have the potential to become economically competitive if SECA can reach its goal. For comparison, the installed capacity cost for a natural-gas-fired, combined-cycle plant is about $500 to $600/kW (Northwest Power Planning Council 2000). At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Consequently, fuel cells are not a feasible alternative to renewal of the Palisades OL.

8.2.5.10 Delayed Retirement

NMC has no current plans to retire any existing generating units. For this reason, delayed retirement of other NMC generating units would not be a feasible alternative to renewal of the Palisades OL. NMC concluded in its ER (NMC 2005) that the environmental impacts of delayed retirement are similar to those of the coal- and gas-fired alternatives.

8.2.5.11 Utility-Sponsored Conservation

Market conditions that initially favored utility-sponsored conservation programs (i.e., DSM), including educational programs, energy efficiency programs, and load management programs, have changed significantly and are no longer cost-effective. The viability of new or expanded DSM programs has decreased in recent years because of increased competition in the electric utility industry, mandated energy efficiency standards, and years of customer education programs that have made efficiency the normal practice. The implementation of deregulation resulted in the discontinuation of many of the DSM programs that Consumers Energy once implemented (NMC 2005). A peak load management program is still in effect, but it serves a broader purpose of maintaining system reliability. The environmental impacts of implementing a DSM program would be SMALL, but implementation would not be able to realistically replace the 786 MW(e) of net generating capacity of Palisades. Therefore, the conservation alternative by itself is not considered a reasonable alternative to renewing the Palisades OL.

8.2.6 Combination of Alternatives

Even though individual alternatives to Palisades might not be sufficient on their own to replace the capacity of Palisades due to the small size of the resource or lack of cost-effective opportunities, it is conceivable that a combination of alternatives might be cost-effective.

As discussed previously, Palisades has a combined net summer rating of 786 MW(e). For the coal- and natural gas-fired alternatives, the NMC ER (NMC 2005) assumes the use of standard-sized units as potential replacements for Palisades. This approach is followed in this SEIS.

There are many possible combinations of alternatives. Table 8-8 contains a summary of the environmental impacts of one assumed combination of alternatives consisting of 530 MW(e) of combined-cycle natural gas-fired generation using closed-cycle cooling, a 40-MW wind power facility, and 216 MW in purchased power. The NRC staff considered a natural-gas-fired plant over a coal-fired plant because a comparison of the impacts indicates that a coal-fired plant would have greater impacts than a similar-sized gas-fired plant (see Tables 8-2 and 8-4). Also, the footprint of the natural-gas-fired plant is smaller and could be accommodated within the Palisades site. Consumers Energy does not anticipate any new or expanded DSM programs (Section 8.2.5.11); therefore, DSM is not considered part of the combination of alternatives. Although Michigan was identified in Section 8.2.5.6 as a state with significant wood resources, the use of wood waste was not considered in a combination of alternatives because a wood-burning facility is not as efficient as the other electrical generation plants considered by the NRC, and the cost of transporting the fuel would be very high. The impacts are based on the gas-fired generation impact assumptions discussed in Section 8.2.2, adjusted for the reduced generating capacity.

Operation of a new natural-gas-fired plant would result in increased emissions (compared with the OL alternative) and other environmental impacts. Installation of new wind power facilities would have land-use, ecology, and aesthetic impacts. The environmental impacts of power generation associated with power purchased from other generators would still occur, but would be located elsewhere in the region, nation, or another country (Canada) as discussed in Section 8.2.4. The environmental impacts associated with purchased power are not shown in Table 8-8.

Table 8-8. Summary of Environmental Impacts of Combination of Alternatives at the Palisades Site and at an Alternate Site

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Land use	MODERATE to LARGE	Uses 20 ac for power block, offices, roads, and parking areas. Additional impact of up to approximately 120 ac for construction of a 5-mi underground gas pipeline. Approximately 175 ac of additional land offsite for wind farm.	MODERATE to LARGE	Uses 58 ac for power-block, offices, roads, and parking areas. Approximately 175 ac for wind farm. Additional land needed for transmission line (amount dependent on site chosen) and for construction and/or upgrade of an underground gas pipeline.
Ecology	MODERATE to LARGE	Uses developed and undeveloped areas at current Palisades site, plus construction of a gas pipeline. Impacts dependent on the specific location and ecology of the site. See Table 8-4 for impacts on terrestrial and aquatic ecology for a gas-fired plant. Impacts on ecological resources from wind power development would include the potential for bird and bat collisions with turbines.	MODERATE to LARGE	Impacts depend on location and ecology of the site, surface-water body used for intake and discharge, and transmission and pipeline routes; potential habitat loss and fragmentation; reduced productivity and biological diversity. Likely plant sites already have power generation facilities.
Water use and quality – surface water	SMALL to MODERATE	Discharge of cooling-tower blowdown containing dissolved solids and intermittent low concentrations of biocides would be released to Lake Michigan. Temporary erosion and sedimentation could occur in streams during pipeline and wind farm construction.	SMALL to MODERATE	Impacts depend on volume of water withdrawn and discharged and characteristics of surface-water body. Discharge of cooling-tower blowdown containing dissolved solids and intermittent low concentrations of biocides would be released to surface water. Temporary erosion and sedimentation could occur in streams during pipeline and wind farm construction.

Table 8-8. (contd)

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Water use and quality – groundwater	SMALL	Use of groundwater very unlikely because the Palisades site has adequate surface water available from Lake Michigan.	SMALL to MODERATE	Impacts depend on volume of water withdrawn and discharged and the characteristics of the aquifer.
Air quality	MODERATE	Natural-gas-fired units Sulfur oxides • 8 tons/yr Nitrogen oxides • 127 tons/yr Carbon monoxide • 195 tons/yr PM_{10} particulates • 25 tons/yr Some hazardous air pollutants. For wind power, fugitive emissions and emissions from vehicles and equipment during construction.	MODERATE	Same as siting at Palisades, although pollution control standards may vary depending on location.
Waste	SMALL	Minimal waste product from fuel production. Debris would be generated and removed during construction.	SMALL	Same waste produced as if produced at Palisades site. Waste disposal constraints may vary.
Human health	SMALL	Human health risks associated with gas-fired plants may be attributable to NO_x emissions, which are regulated. Impacts considered SMALL.	SMALL	Same impacts as Palisades site.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be MODERATE. Up to 420 additional workers during the peak of the 3-year construction period, followed by reduction in the current Palisades workforce of 644 to 30. Impacts during operation would be SMALL.	SMALL to MODERATE	Construction impacts depend on location, but could be significant if location is in a more rural area than Palisades. Van Buren County would experience a loss in its tax base and employment, potentially offset by projected economic growth.

Table 8-8. (contd)

Impact Category	Palisades Site		Alternate Site	
	Impact	Comments	Impact	Comments
Transportation	SMALL to MODERATE	Transportation impacts associated with construction workers would be MODERATE. Impacts during operation would be SMALL.	SMALL to MODERATE	Transportation impacts associated with construction workers would be SMALL to MODERATE, depending on the site chosen.
Aesthetics	MODERATE to LARGE	MODERATE aesthetic impacts due to impacts of plant units, cooling towers, plume stacks, gas pipeline compressors, and wind turbines and ancillary facilities.	MODERATE to LARGE	Impacts would be similar to the Palisades site with additional impact from the new transmission line that would be needed.
Historic and archaeological resources	SMALL to MODERATE	Some construction would affect previously developed parts of the Palisades site; a cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new plant construction on cultural resources in undeveloped areas.	SMALL to MODERATE	Cultural resource studies needed to identify, evaluate, and mitigate potential impacts of new plant construction at developed and undeveloped sites.
Environmental justice	SMALL to MODERATE	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 644 operating jobs at Palisades 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 to MODERATE	Impacts would vary, depending on population distribution and makeup at site.

The NRC 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 renewal of the Palisades OL.

8.3 Summary of Alternatives Considered

The environmental impacts of the proposed action, renewal of the Palisades OL, would be SMALL for all impact categories, except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal. Collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal were not assigned a single significance level but were determined by the Commission to be Category 1 issues nonetheless. The alternative actions, that is, 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 the replacement of electrical generating capacity by (1) DSM and energy conservation, (2) power purchased from other electricity providers, (3) generating alternatives other than Palisades, or (4) some combination of these options. 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 construction of any new facility would be greater than the impacts of continued operation of Palisades. The impacts of purchased electrical power (imported power) would still occur, but 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 renewal of the Palisades OL.

The NRC 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

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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 50. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 50, "National Primary and Secondary Ambient Air Quality Standards."

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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9.0 Summary and Conclusions

By letter dated March 22, 2005, Nuclear Management Company, LLC (NMC), submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license (OL) for the Palisades Nuclear Plant (Palisades) for an additional 20-year period (NMC 2005a). If the OL is renewed, State regulatory agencies and NMC 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 not renewed, then the plant must be shut down at or before the expiration of the current OL, which expires on March 24, 2011.

Section 102 of the National Environmental Policy Act (NEPA) 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 Part 51 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 51). Part 51 of 10 CFR identifies licensing and regulatory actions that require an EIS. In 10 CFR 51.20(b)(2), the Commission requires preparation of an EIS or a supplement to an EIS for 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 Plant*s (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[(a)]

Upon acceptance of the NMC 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 (*Federal Register*, Volume 70, page 36967 (70 FR 36967) (NRC 2005a)) on June 27, 2005. The NRC staff visited the Palisades site in July 2005 and held public scoping meetings on July 28, 2005, in South Haven, Michigan (NRC 2005b). The NRC staff reviewed the NMC Environmental Report (ER) (NMC 2005b) and compared it with the GEIS, consulted with other agencies, and conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 2000). The NRC staff also considered the public comments received during the scoping process for preparation of this Supplemental Environmental Impact Statement (SEIS) for Palisades. 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 NRC staff held two public meetings in South Haven, Michigan, on April 5, 2006, to describe the preliminary results of the NRC environmental review and to answer questions to provide

(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.

members of the public with information to assist them in formulating their comments on this SEIS. The comment period ended May 18, 2006. All the comments received on the draft SEIS were considered by the NRC 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, including cumulative impacts, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. This SEIS also includes the NRC 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) decision makers.

The evaluation criterion for the NRC 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 decision makers 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 impacts 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. It evaluates 92 environmental issues using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using Council on Environmental Quality guidelines. The following 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:

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 staff 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 characteristics.

(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.

(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."

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the NRC 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. The staff also determined that information provided during the public comment period did not identify any new issue that requires site-specific assessment.

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 was prepared.

This SEIS documents the NRC staff's consideration of all 92 environmental issues identified in the GEIS. The NRC 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 Palisades) and alternative methods of power generation. These alternatives were evaluated assuming that the replacement power-generation plant is located at either the Palisades site or at some other unspecified location.

9.1 Environmental Impacts of the Proposed Action – License Renewal

NMC 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 NMC nor the NRC 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, the NRC staff did not identify, during the scoping process, any new issue applicable to Palisades that had a significant environmental impact. Therefore, the NRC staff relies upon the conclusions of the GEIS for all Category 1 issues that are applicable to Palisades.

NMC's license renewal application presents an analysis of the Category 2 issues that are applicable to Palisades. The NRC staff has reviewed the NMC analysis for each issue and has conducted an independent review of each issue plus environmental justice and chronic effects from electromagnetic fields. Nine Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at Palisades. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. NMC (NMC 2005a) 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 Palisades 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 Operation of Palisades Nuclear Plant (AEC 1972).

Eight 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. Four of the Category 2 issues and environmental justice apply to both refurbishment and operation during the renewal term and are discussed in this SEIS only in relation to operation during the renewal term. For all eight of the Category 2 issues and environmental justice, the NRC staff concludes that the potential environmental effects would be of SMALL significance in the context of the standards set forth in the GEIS. In addition, the NRC 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 NRC staff concurs with NMC's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all or a subset of the identified, potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by NMC is warranted. However, none of the potentially cost-beneficial SAMAs directly relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of any other actions taken by agencies or persons. For purposes of this analysis, the overall conclusion of the NRC staff is that these impacts would not result in significant cumulative impacts on potentially affected resources.

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 overall adverse impacts of continued operation identified are considered to be of SMALL significance. The adverse impacts of likely alternatives if Palisades ceases operation at or before the expiration of the current OL would not be smaller than those associated with continued operation of this unit, 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 Palisades during the current license period was made when the plant was built. The resource commitments to be considered in this SEIS are associated with 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. Palisades replaces a portion of the fuel assemblies in its unit during every refueling outage, which occurs on an 18-month cycle.

The likely power generation alternatives if Palisades ceases operation on or before the expiration of the current OL would require a commitment of resources for construction of the replacement plant as well as for fuel to run the plant.

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 Palisades site was set when the unit was approved and construction began. That balance is now well-established. Renewal of the OL for Palisades and continued operation of the plant would not alter the existing balance, but may postpone the availability of the site for other uses. Denial of the application to renew the OL would lead to shutdown of the plant and would alter the balance in a manner that depends on subsequent uses of the site. For example, the environmental consequences of turning the Palisades site into a park or an industrial facility would be quite different.

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives

The proposed action is renewal of the OL for Palisades. Chapter 2 describes the site, the plant, and interactions of the plant with the environment. As noted in Chapter 3, no refurbishment and no refurbishment impacts are expected at Palisades. Chapters 4 through 7 discuss environmental issues associated with renewal of 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 renewal of the OL); the no-action alternative (denial of the application); alternatives involving nuclear, coal, or gas generation of power at the Palisades site and an unspecified alternate site; and a combination of alternatives are compared in Table 9-1. Closed-cycle cooling systems are assumed for all alternatives.

Table 9-1 shows that the significance of the environmental impacts of the proposed action would be SMALL, except in one instance: 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 impacts in at least some impact categories that reach MODERATE or LARGE significance.

9.3 NRC Staff Conclusions and Recommendations

Based on (1) the analysis and findings in the GEIS (NRC 1996, 1999), (2) the ER submitted by NMC (NMC 2005b), (3) consultation with Federal, State, and local agencies, (4) the NRC staff's own independent review, and (5) the NRC staff's consideration of public comments received during the scoping process, the recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for Palisades would not be so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable.

Table 9-1. Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Methods of Generation Using Closed-Cycle Cooling

	Proposed Action	No-Action Alternative	Coal-Fired Generation	Natural-Gas-Fired Generation		New Nuclear Generation		Combination of Alternatives	
Impact Category	License Renewal	Denial of Renewal	Alternate Site	Palisades Site	Alternate Site	Palisades Site	Alternate Site	Palisades Site	Alternate Site
Land use	SMALL	SMALL	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE
Ecology	SMALL	SMALL	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE
Water use and quality–surface water	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water use and quality–groundwater	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE
Air quality	SMALL	SMALL	MODERATE	MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE	MODERATE	MODERATE
Waste	SMALL	SMALL	MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Human health	SMALL[(a)]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Socio-economics	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE
Aesthetics	SMALL	SMALL	MODERATE to LARGE	MODERATE	MODERATE to LARGE	SMALL to MODERATE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE
Historic and archaeological resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Environmental justice	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE

(a) Except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, for which a significance level was not assigned. See Chapter 6 for details.

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."

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

Nuclear Management Company, LLC (NMC). 2005a. *Palisades Nuclear Plant*. *Application for Renewed Operating License.* Covert, Michigan. (March 22, 2005).

Nuclear Management Company (NMC). 2005b. *Applicant's Environmental Report – Operating License Renewal Stage, Palisades Nuclear Plant*. Docket No. 50-255. Covert, Michigan. March, 2005).

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

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U.S. Nuclear Regulatory Commission (NRC). 2005a. "Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register,* Vol. 70, No. 122, pp. 36967-36968. Washington, D.C. (June 27, 2005).

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