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NUREG-1437, Supplement 38,
Vol. 1

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 38

Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3

Final Report
Main Report and Comment Responses

Office of Nuclear Reactor Regulation

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) considered the environmental impacts of renewing nuclear power plant operating licenses for a 20-year period in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS),[(1)] and codified the results in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). In the GEIS (and its Addendum 1), the NRC staff identified 92 environmental issues and reached 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 Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC (all applicants will be jointly referred to as Entergy) to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20 years under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This SEIS includes the NRC staff's analysis which 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 Entergy nor the NRC staff has identified information that is both new and significant for any issues that apply to IP2 and/or IP3. In addition, the NRC staff determined that information provided during the scoping process was not new and significant with respect to the conclusions in the GEIS. Therefore, the NRC staff concludes that the impacts of renewing the operating licenses for IP2 and IP3 will 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[(2)] significance (except for the 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 IP2 and IP3 are addressed in this SEIS. The NRC staff determined that several of these issues were not applicable because of the type of facility cooling system or other reasons detailed within this SEIS. For the remaining applicable issues, the NRC staff concludes that the significance of potential environmental impacts related to operating license renewal is SMALL, with three exceptions—entrainment, impingement, and heat shock from the facility's heated discharge. Overall effects from entrainment and impingement are likely to be MODERATE. Impacts from heat shock potentially

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(1) 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.

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

range from SMALL to LARGE depending on the conclusions of thermal studies proposed by the New York State Department of Environmental Conservation (NYSDEC). Based on corrected data received since completing the draft SEIS, NRC staff concludes that impacts to the endangered shortnose sturgeon – which ranged from SMALL to LARGE in the draft SEIS – are likely to be SMALL.

The NRC staff's recommendation is that the Commission determine that the adverse environmental impacts of license renewals for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental report and other information submitted by Entergy, (3) consultation with other Federal, State, Tribal, 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 and in response to the draft SEIS.

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Table of 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..1-4
1.3 The Proposed Federal Action...1-6
1.4 The Purpose and Need for the Proposed Action...1-7
1.5 Compliance and Consultations...1-7
1.6 References 1-8
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 2-2
2.1.2 Reactor Systems 2-5
2.1.3 Cooling and Auxiliary Water Systems..2-8
2.1.4 Radioactive Waste Management Systems and Effluent Control Systems 2-14
2.1.4.1 Liquid Waste Processing Systems and Effluent Controls.......2-15
2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls..2-17
2.1.4.3 Solid Waste Processing...2-20
2.1.5 Nonradioactive Waste Systems..2-21
2.1.5.1 Nonradioactive Waste Streams 2-22
2.1.5.2 Pollution Prevention and Waste Minimization 2-23
2.1.6 Facility Operation and Maintenance 2-23
2.1.7 Power Transmission System 2-23
2.2 Plant Interaction with the Environment 2-24
2.2.1 Land Use 2-24
2.2.2 Water Use...2-24
2.2.3 Water Quality 2-24
2.2.4 Meteorology and Air Quality 2-27
2.2.4.1 Climate 2-27
2.2.4.2 Meteorological System 2-28
2.2.4.3 Air Quality 2-29
2.2.5 Aquatic Resources..2-31
2.2.5.1 The Hudson River Estuary 2-31

2.2.5.2 Significant Environmental Issues Associated with the Hudson River Estuary....2-39
2.2.5.3 Regulatory Framework and Monitoring Programs....2-48
2.2.5.4 Potentially Affected Fish and Shellfish Resources....2-52
2.2.5.5 Special Status Species and Habitats....2-77
2.2.5.6 Other Potentially Affected Aquatic Resources....2-80
2.2.5.7 Nuisance Species....2-82
2.2.6 Terrestrial Resources....2-84
2.2.6.1 Description of Site Terrestrial Environment....2-85
2.2.6.2 Threatened and Endangered Terrestrial Species....2-86
2.2.7 Radiological Impacts....2-104
2.2.8 Socioeconomic Factors....2-114
2.2.8.1 Housing....2-115
2.2.8.2 Public Services....2-116
2.2.8.3 Offsite Land Use....2-121
2.2.8.4 Visual Aesthetics and Noise....2-123
2.2.8.5 Demography....2-124
2.2.8.6 Economy....2-131
2.2.9 Historic and Archeological Resources....2-134
2.2.9.1 Cultural Background....2-134
2.2.9.2 Historic and Archeological Resources at the IP2 & IP3 Site....2-138
2.2.10 Related Federal Project Activities and Consultations....2-139
2.3 References....2-142

3.0 Environmental Impacts of Refurbishment....3-1

3.1 Potential Refurbishment Activities....3-1
3.2 Refurbishment Impacts....3-4
3.2.1 Terrestrial Ecology—Refurbishment Impacts....3-7
3.2.2 Threatened or Endangered Species—Refurbishment Impacts....3-8
3.2.3 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)....3-9
3.2.4 Housing Impacts—Refurbishment....3-10
3.2.5 Public Services: Public Utilities—Refurbishment....3-10
3.2.6 Public Services: Education—Refurbishment....3-11
3.2.7 Offsite Land Use—Refurbishment....3-11
3.2.8 Public Services: Transportation—Refurbishment....3-11
3.2.9 Historic and Archeological Resources—Refurbishment....3-12
3.2.10 Environmental Justice—Refurbishment....3-13
3.3 Evaluation of New and Potentially Significant Information on Impacts of Refurbishment....3-13
3.4 Summary of Refurbishment Impacts....3-13
3.5 References....3-13

4.0 Environmental Impacts of Operation....4-1

4.1 Cooling System....4-2
4.1.1 Impingement of Fish and Shellfish....4-10

4.1.2 Entrainment of Fish and Shellfish in Early Lifestages 4-14
4.1.3 Combined Effects of Impingement and Entrainment 4-15
4.1.3.1 Assessment of Population Trends—The First Line of Evidence 4-19
4.1.3.2 Assessment of Strength of Connection—The Second Line of Evidence 4-20
4.1.3.3 Impingement and Entrainment Impact Summary 4-20
4.1.3.4 Discussion of Uncertainty 4-24
4.1.3.5 Overall Impingement and Entrainment Impact 4-25
4.1.4 Heat Shock 4-26
4.1.4.1 Potential Effects of Heated Water Discharges on Aquatic Biota 4-27
4.1.4.2 Historical Context 4-27
4.1.4.3 Thermal Studies and Conclusions 4-28
4.1.4.4 Assessments of Thermal Impacts 4-30
4.1.4.5 NRC Staff Assessment of Thermal Impacts 4-32
4.1.5 Potential Mitigation Options 4-32
4.2 Transmission Lines 4-36
4.2.1 Electromagnetic Fields—Acute Effects 4-38
4.2.2 Electromagnetic Fields—Chronic Effects 4-40
4.3 Radiological Impacts of Normal Operations 4-40
4.4 Socioeconomic Impacts of Plant Operations during the License Renewal Term 4-42
4.4.1 Housing Impacts 4-43
4.4.2 Public Services—Public Utility Impacts 4-44
4.4.3 Offsite Land Use—License Renewal Period 4-45
4.4.3.1 Population-Related Impacts 4-46
4.4.3.2 Tax-Revenue-Related Impacts 4-46
4.4.4 Public Services: Transportation Impacts during Operations 4-47
4.4.5 Historic and Archeological Resources 4-47
4.4.5.1 Site-Specific Cultural Resources Information 4-48
4.4.5.2 Conclusions 4-48
4.4.6 Environmental Justice 4-49
4.5 Ground Water Use and Quality 4-56
4.6 Threatened or Endangered Species 4-56
4.6.1 Aquatic Special Status Species 4-57
4.6.2 Terrestrial Threatened or Endangered Species 4-60
4.7 Evaluation of New and Potentially Significant Information on Impacts of Operations during the Renewal Term 4-61
4.8 Cumulative Impacts 4-61
4.8.1 Cumulative Impacts on Aquatic Resources 4-62
4.8.2 Cumulative Impacts on Terrestrial Resources 4-66
4.8.3 Cumulative Radiological Impacts 4-67
4.8.4 Cumulative Socioeconomic Impacts 4-68
4.8.5 Cumulative Impacts on Ground Water Use and Quality 4-69
4.8.6 Conclusions Regarding Cumulative Impacts 4-69
4.9 Summary of Impacts of Operations during the Renewal Term 4-69

4.10 References 4-70

5.0 Environmental Impacts of Postulated Accidents 5-1

5.1 Postulated Plant Accidents 5-1
5.1.1 Design-Basis Accidents 5-1
5.1.2 Severe Accidents 5-3
5.2 Severe Accident Mitigation Alternatives 5-4
5.2.1 Introduction 5-4
5.2.2 Estimate of Risk 5-5
5.2.3 Potential Plant Improvements 5-7
5.2.4 Evaluation of Risk Reduction and Costs of Improvements 5-8
5.2.5 Cost-Benefit Comparison 5-8
5.2.6 Conclusions 5-11
5.3 References 5-12

6.0 Environmental Impacts of the Uranium Fuel Cycle, Solid Waste Management, and Greenhouse Gas Emissions 6-1

6.1 The Uranium Fuel Cycle 6-1
6.2 Greenhouse Gas Emissions 6-8
6.2.1 Introduction 6-8
6.2.2 IP2 and IP3 6-9
6.2.3 GEIS 6-9
6.2.4 Other Studies 6-9
6.2.4.1 Qualitative Studies 6-9
6.2.4.2 Quantitative Studies 6-10
6.2.5 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal 6-12
6.2.6 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas 6-13
6.2.7 Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources 6-14
6.2.8 Conclusions 6-15
6.3 References 6-17

7.0 Environmental Impacts of Decommissioning 7-1

7.1 Decommissioning 7-1
7.2 References 7-4

8.0 Environmental Impacts of Alternatives to License Renewal 8-1

8.1 Alternatives to the Existing IP2 and IP3 Cooling-Water System 8-2
8.1.1 Closed-Cycle Cooling Alternative 8-5
8.1.1.1 Description of the Closed-Cycle Cooling Alternative 8-6
8.1.1.2 Environmental Impacts of the Closed-Cycle Cooling Alternative 8-6
8.2 No-Action Alternative 8-20
8.3 Alternative Energy Sources 8-26
8.3.1 Natural Gas-Fired Combined-Cycle (NGCC) Generation 8-28

8.3.2 Purchased Electric Power....8-39
8.3.3 Conservation....8-41
8.3.4 Alternatives Dismissed From Individual Consideration....8-43
8.3.4.1 Wind Power....8-43
8.3.4.2 Wood and Wood Waste....8-44
8.3.4.3 Hydropower....8-45
8.3.4.4 Oil-Fired Generation....8-45
8.3.4.5 Solar Power....8-45
8.3.4.6 New Nuclear Generation....8-46
8.3.4.7 Geothermal Energy....8-46
8.3.4.8 Municipal Solid Waste....8-47
8.3.4.9 Other Biomass Derived Fuels....8-47
8.3.4.10 Fuel Cells....8-48
8.3.4.11 Delayed Retirement....8-48
8.3.4.12 Combined Heat and Power....8-48
8.3.4.13 Supercritical Coal-Fired Generation....8-49
8.3.5 Combination of Alternatives....8-59
8.3.5.1 Impacts of Combination Alternative 1....8-61
8.3.5.2 Impacts of Combined Alternative 2....8-67
8.4 Summary of Alternatives Considered....8-72
8.5 References....8-73

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....9-6
9.1.2 Irreversible or Irretrievable Resource Commitments....9-6
9.1.3 Short-Term Use Versus Long-Term Productivity....9-7
9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives....9-7
9.3 Conclusions and Recommendations....9-8
9.4 References....9-11

Appendices

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

Appendix B: Contributers to the Supplement....B-1

Appendix C: Chronology of NRC Staff Environmental Review Correspondence Related to the Entergy Nuclear Operations, Inc. Application for License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3....C-1

Appendix D: Organizations Contacted....D-1

Appendix E: Indian Point Nuclear Generating Unit Numbers 2 and 3 Compliance Status and Consultation Correspondence....E-1

Appendix F: GEIS Environmental Issues Not Applicable to Indian Point Nuclear Generating Station Unit Nos. 2 and 3....F-1

Appendix G: U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Indian Point Nuclear Generating Unit Nos. 2 and 3 in Support of License Renewal Application Review G-1

Appendix H: U.S. Nuclear Regulatory Commission Staff Evaluation of Environmental Impacts of Cooling System H-1

Appendix I: Statistical Analyses Conducted for Chapter 4 Aquatic Resources and Appendix H I-1

Figures

Figure 2-1. Location of IP2 and IP3, 50-mi (80-km) radius 2-3
Figure 2-2. Location of IP2 and IP3, 6-mi (10-km) radius 2-4
Figure 2-3. IP2 and IP3 property boundaries and environs 2-6
Figure 2-4. IP2 and IP3 site layout..2-7
Figure 2-5. IP2 intake structure..2-10
Figure 2-6. IP3 intake structure..2-11
Figure 2-7. IP2 intake system 2-12
Figure 2-8. IP3 intake system 2-12
Figure 2-9. Topographic features surrounding IP2 and IP3 2-26
Figure 2-10. Hudson study area and river segments..2-32
Figure 2-11. Hudson River area and national estuarine research sites 2-33
Figure 4-1. Percentage of impingement composed of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP2 4-12
Figure 4-2. Percentage of impingement composed of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP3 4-12
Figure 4-3. Percentage of entrainment composed of RIS fish and total identified fish relative to the estimated total entrainment at IP2 and IP3 combined..4-15
Figure 4-4. General weight-of-evidence approach employed to assess the level of impact to population trends attributable to IP cooling system operation.....................................4-16
Figure 4-5. Minority block groups in 2000 within a 50-mi radius of IP2 and IP3 4-52
Figure 4-6. Low-income block groups in 2000 within a 50-mi radius of IP2 and IP3 4-55

Tables

Table 2-1. Historical Impacts on the Hudson River Watershed 2-42

Table 2-2. Facilities Discharging at Least 50 mgd (190,000 m^3/day) into the Lower Hudson River...2-44

Table 2-3. Hudson River Environmental Studies Table 2-52

Table 2-4. Representative Important Aquatic Species..2-53

Table 2-5. Locations in the Hudson River Estuary (see Figure 2-10) Where the Presence of RIS Life Stages Represented at Least 10 Percent of the Total Number Collected in Referenced Surveys or Studies...2-55

Table 2-6. Federally and State-Listed Terrestrial Species Potentially Occurring in Westchester County...2-90

Table 2-7. IP2 and IP3 Employee Residence by County in 2006..2-115

Table 2-8. Housing in Dutchess, Orange, Putnam and Westchester Counties, New York....2-116

Table 2-9. Major Public Water Supply Systems in 2005 (mgd) 2-119

Table 2-10. Average Annual Daily Traffic Counts on US 9 Near IP2 and IP3, 2004 2-121

Table 2-11. Population and Percent Growth in Dutchess, Orange, Putnam, and Westchester Counties, New York, from 1970 to 2000 and Projected for 2010 and 2050 2-125

Table 2-12. Demographic Profile of the Population in the IP2 and IP3 Four-County ROI in 2000 2-126

Table 2-13. Demographic Profile of the Population in the IP2 and IP3 Four-County ROI in 2006 (Estimate)..2-127

Table 2-14. Seasonal Housing within 50 mi (80 km) of the IP2 and IP3..............................2-128

Table 2-15. Migrant Farm Worker and Temporary Farm Labor within 50 mi (80 km) of IP2 and IP3 2-130

Table 2-16. Major Employers in Westchester County in 2006...2-132

Table 2-17. Income Information for the IP2 and IP3 ROI..2-132

Table 2-18. IP2 and IP3 PILOT and Property Tax Paid and Percentage of the Total Revenue of the Town of Cortlandt, Hendrick Hudson Central School District, and Village of Buchanan, 2003 to 2006 2-134

Table 2-19. Cultural Sequence and Chronology..2-135

Table 3-1. Category 1 Issues for Refurbishment Evaluation 3-4

Table 3-2. Category 2 Issues for Refurbishment Evaluation 3-7

Table 4-1. Generic (Category 1) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term...4-2

Table 4-2. Site-Specific (Category 2) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term....4-6

Table 4-3. Cumulative Mortality and Injury of Selected Fish Species after Impingement on Ristroph Screens....4-13

Table 4-4. Impingement and Entrainment Impact Summary for Hudson River RIS....4-23

Table 4-5. Category 1 Issues Applicable to the IP2 and IP3 Transmission Lines during the Renewal Term....4-37

Table 4-6. Category 2 and Uncategorized Issues Applicable to the IP2 and IP3 Transmission Lines during the Renewal Term....4-38

Table 4-7. Category 1 Issues Applicable to Radiological Impacts of Normal Operations during the Renewal Term....4-41

Table 4-8. Category 1 Issues Applicable to Socioeconomics during the Renewal Term....4-42

Table 4-9. Category 2 Issues Applicable to Socioeconomics and Environmental Justice during the Renewal Term....4-43

Table 4-10. Category 2 Issues Applicable to Threatened or Endangered Species during the Renewal Term....4-57

Table 4-11. Impingement Data for Shortnose and Atlantic Sturgeon at IP2 and IP3, 1975–1990....4-59

Table 5-1. Category 1 Issues Applicable to Postulated Accidents during the Renewal Term....5-2

Table 5-2. Category 2 Issues Applicable to Postulated Accidents during the Renewal Term....5-3

Table 5-3. IP2 and IP3 Core Damage Frequency....5-6

Table 5-4. Breakdown of Population Dose by Containment Failure Mode....5-7

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

Table 6-2. Nuclear GHG Emissions Compared to Coal....6-12

Table 6-3. Nuclear GHG Emissions Compared to Natural Gas....6-13

Table 6-4. Nuclear GHG Emissions Compared to Renewable Energy Sources....6-14

Table 7-1. Category 1 Issues Applicable to the Decommissioning of IP2 and IP3 Following the Renewal Term....7-2

Table 8-1. Summary of Environmental Impacts of a Closed-Cycle Cooling Alternative at IP2 and IP3....8-19

Table 8-2. Summary of Environmental Impacts of the No-Action Alternative....8-21

Table 8-3. Summary of Environmental Impacts of the NGCC Alternative Located at IP2 and IP3 and an Alternate Site....8-37

Table 8-4. Summary of Environmental Impacts of Combination Alternatives....8-71

Tables

Table 9-1. Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Methods of Generation 9-9

EXECUTIVE SUMMARY

By letter dated April 30, 2007, Entergy Nuclear Operations, Inc. (Entergy) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20-year period. If the operating licenses are renewed, State regulatory agencies and Entergy will ultimately decide whether the plant will continue to operate based on factors such as the need for power, issues falling under the purview of the owners, or other matters within the State's jurisdiction, including acceptability of water withdrawal. Two state-level issues (consistency with State water quality standards, and consistency with State coastal zone management plans) need to be resolved. On April 2, 2010, the New York State Department of Environmental Conservation (NYSDEC) issued a Notice of Denial regarding the Clean Water Act Section 401 Water Quality Certification. Entergy has since requested a hearing on the issue, and the matter will be decided through NYSDEC's hearing process. If the operating licenses are not renewed, then IP2 and IP3 must be shut down at or before the expiration date of their current operating licenses which expire September 28, 2013, and December 12, 2015, respectively.

The NRC has implemented Section 102 of the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321), in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," 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 operating license. In addition, 10 CFR 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS).(1)

Upon acceptance of the IP2 and IP3 application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping. The NRC staff visited the IP2 and IP3 site in September 2007, held two public scoping meetings on September 19, 2007, and conducted two site audits on September 10–14, 2007, and September 24–27, 2007. In the preparation of this supplemental environmental impact statement (SEIS) for IP2 and IP3, the NRC staff reviewed the IP2 and IP3 environmental report (ER) and compared it to the GEIS; consulted with other agencies; conducted an independent review of the issues following the guidance in NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal," issued October 1999; and considered the public comments received during the scoping process and in response to the draft SEIS. The public comments received during the scoping process that were considered to be within the scope of the environmental review are contained in the Scoping Summary Report for Indian Point Nuclear Generating Unit Nos. 2 and 3, issued by NRC staff in December 2008. In Appendix A of this SEIS, the NRC staff adopts, by reference, the comments and responses in the Scoping Summary Report and provides information on how to electronically access the scoping summary or view a hard copy.

(1) 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 NRC staff held public meetings in Cortlandt Manor, New York, on February 12, 2009 and described the preliminary results of the NRC environmental review, answered questions, and provided members of the public with information to assist them in formulating comments on the draft SEIS. The NRC staff considered and addressed all of the comments received. These comments are reflected in the SEIS or addressed in Appendix A, Part 2, to 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, 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 purpose of the NRC staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine the following:

> …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 operating license (or licenses).

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 10 CFR 51.23(a) ["Temporary storage of spent fuel after cessation of reactor operation–generic determination of no significant environmental impact"] and in accordance with 10 CFR 51.23(b).

The GEIS contains the results of a systematic evaluation of the consequences of renewing an operating license 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 (CEQ) guidelines.

The following definitions of the three significance levels are set forth in footnotes to Table B-1 of Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," to 10 CFR Part 51, Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)":

> 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 (that is, 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 staff relied on conclusions in the GEIS for issues designated as Category 1 in Table B-1 of Appendix B to 10 CFR Part 51, Subpart A.

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 operating licenses for IP2 and IP3), alternative methods of power generation, and conservation. The NRC staff also considered an alternative that included continued operation of IP2 and IP3 with a closed-cycle cooling system. This alternative is considered for several reasons. First, the New York State Department of Environmental Conservation (NYSDEC) issued a preliminary determination in its 2003 draft and 2004 revised draft State Pollutant Discharge Elimination System (SPDES) permits that closed cycle cooling is the site-specific best technology available (BTA) to reduce impacts on fish and shellfish;

currently the revised draft SPDES permit is the subject of NYSDEC proceedings, and the existing SPDES permit continues in effect at this time. Second, NYSDEC affirmed this view in its April 2, 2010, Notice of Denial of Entergy's Clean Water Act Section 401 Water Quality Certification, indicating that closed cycle cooling would minimize aquatic impacts; that determination is currently subject to further State-level adjudication. Third, NYSDEC has published a draft policy on BTA indicating that "Wet closed-cycle cooling or its equivalent" is the "minimum performance goal for existing industrial facilities that operate a CWIS [cooling water intake system] in connection with a point source thermal discharge." Public comments on that draft policy were submitted through July 9, 2010.

Entergy 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 Entergy nor the staff has identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither the scoping process nor the NRC staff has identified any new issue applicable to IP2 and IP3 that has a significant environmental impact. Therefore, the NRC staff relies on the conclusions of the GEIS for all of the Category 1 issues that are applicable to IP2 and IP3.

Entergy's license renewal application presents an analysis of the 21 Category 2 issues that are applicable to IP2 and IP3, plus environmental justice and chronic effects from electromagnetic fields, for a total of 23 issues. The NRC staff has reviewed the Entergy analysis and has conducted an independent assessment of each issue. Six of the Category 2 issues are not applicable because they are related to a type of existing cooling system, water use conflicts, and ground water use not found at IP2 and IP3. Entergy has stated that its evaluation of structures and components, as required by 10 CFR 54.21, "Contents of Application—Technical Information," did not identify any major plant refurbishment activities or modifications as necessary to support the continued operation of IP2 and IP3 for the license renewal period. Entergy did, however, indicate that it plans to replace reactor vessel heads and control rod drive mechanisms at IP2 and IP3. The NRC staff has evaluated the potential impacts of these activities using the framework provided by the GEIS for addressing refurbishment issues.

Seventeen environmental issues related to operational impacts and postulated accidents during the renewal term are discussed in detail in this SEIS. These include 15 Category 2 issues and 2 uncategorized issues, environmental justice and chronic effects of electromagnetic fields. The NRC staff also discusses in detail the potential impacts related to the 10 Category 2 issues that apply to refurbishment activities. The NRC staff concludes that the potential environmental effects for most of these issues are of SMALL significance in the context of the standards set forth in the GEIS with three exceptions—entrainment, impingement, and heat shock from the facility's heated discharge. The NRC staff jointly assessed the impacts of entrainment and impingement to be MODERATE based on NRC's analysis of representative important species. Impacts from heat shock potentially range from SMALL to LARGE depending on the conclusions of thermal studies proposed by the NYSDEC. Based on corrected data received since completing the draft SEIS, the NRC staff concludes that impacts to the endangered shortnose sturgeon – which ranged from SMALL to LARGE in the draft SEIS – are likely to be SMALL.

The NRC staff also determined that appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required.

For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for IP2 and IP3 and the plant improvements already made, the NRC staff concludes that several SAMAs may be cost-beneficial. However, these SAMAs do not relate to adequate management of the effects of aging during the period of extended operation. Therefore, they do not need to be implemented as part of license renewal pursuant to 10 CFR Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. For purposes of this analysis, the NRC staff determined that the cumulative impacts to terrestrial and aquatic resources in the IP2 and IP3 environs would be LARGE, due primarily to past development and pollution, much of which preceded IP2 and IP3 or occurred as a result of other actions (for example, suburban development and hardening of the Hudson River shoreline).

The NRC staff’s analysis indicates that the adverse impacts of potential alternatives will differ from those of the proposed action. Most alternatives result in smaller impacts to aquatic life, while creating greater impacts in other resource areas. Often, the most significant environmental impacts of alternatives result from constructing new facilities or infrastructure.

The recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewals for IP2 and IP3 are not so great that not 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 and other information submitted by Entergy, (3) consultation with other Federal, State, Tribal, and local agencies, (4) the staff’s own independent review, and (5) the staff’s consideration of public comments received during the scoping process and in response to the draft SEIS.

Abbreviations/Acronyms

°	degree(s)
µm	micron(s)
3D	three dimensional
ACAA	American Coal Ash Association
ac	acre(s)
AC	alternating current
ACC	averted cleanup and decontamination
ADAMS	Agencywide Documents Access and Management System
ADAPT	Atmospheric Data Assimilation and Parameterization Technique
ACEEE	American Council for an Energy Efficient Economy
AEC	Atomic Energy Commission
AFW	auxiliary feed water
AGTC	Algonquin Gas Transmission Company
ALARA	as low as reasonably achievable
ANOVA	analysis of variance
AOC	averted off-site property damage costs
AOE	averted occupational exposure costs
AOSC	averted on-site costs
APE	averted public exposure
ASA	Applied Science Associates
ASME	American Society of Mechanical Engineers
ASMFC	Atlantic States Marine Fisheries Commission
ASSS	alternate safe shutdown system
ATWS	anticipated transient without scram
AUTOSAM	Automated Abundance Sampler
BA	biological assessment
BO	Biological Opinion
Board	Atomic Safety and Licensing Board
Bq/L	becquerel per liter
Bq/kg	becquerel per kilogram
BSS	Beach Seine Survey
BTA	best technology available
BTU	British thermal unit(s)
C	Celsius
CAA	Clean Air Act
CAFTA	computer aided fault-tree analysis code
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CCF	common cause failure
CCMP	Comprehensive Conservation and Management Plan
CCW	component cooling water

CCWD	Cortlandt Consolidated Water District
CDF	core damage frequency
CDM	Clean Development Mechanism
CET	Containment Event Tree
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
cfs	cubic foot (feet) per second
CHGEC	Central Hudson Gas & Electric Corporation
Ci	curie(s)
CI	confidence interval
cm	centimeter(s)
CMP	Coastal Management Plan
CMR	conditional mortality rate
CNP	Cook Nuclear Plant
CO	carbon monoxide
CO_2	carbon dioxide
COE	cost of enhancement
COL	Combined License
Con Edison	Consolidated Edison Company of New York
CORMIX	Cornell University Mixing Zone Model
CPUE	catch-per-unit-effort
CRDM	control rod drive mechanism
CST	condensate storage tank
CV	coefficient of variation
CWA	Clean Water Act
CWIS	Circulating Water Intake System
CZMA	Coastal Zone Management Act
dB(A)	decibel(s)
DBA	Design-basis accident
DC	direct current
DDT	dichloro-diphenyl-trichloroethane
DEIS	Draft Environmental Impact Statement
DF	Decontamination Factor
DNA	deoxyribonucleic acid
DNR	Department of Natural Resources
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	U.S. Department of Energy
DOS	Department of State
DOT	U.S. Department of Transportation
DPS	Distinct Population Segment
DSEIS	Draft Supplemental Environmental Impact Statement
EA	Environmental Assessment
ECL	Environmental Conservation Law
EDG	emergency diesel generator

EIA	Energy Information Administration
EIS	environmental impact statement
EFH	Essential Fish Habitat
ELF-EMF	extremely low frequency-electromagnetic field
EMR	entrainment mortality rate
Entergy	Entergy Nuclear Operations, Inc.
EOP	emergency operating procedure
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ER	Environmental Report
ER-M	effects-range-median
ESA	Endangered Species Act
F	Fahrenheit
F&O	Facts and Observations
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FES	Final Environmental Statement
FJS	Fall Juvenile Survey
FPC	Federal Power Commission
fps	feet per second
FPS	fire protection system
FR	*Federal Register*
FSAR	Final Safety Analysis Report
FSS	Fall Shoals Survey
ft	foot (feet)
ft^2	square feet
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
g	gram(s)
gal	gallon(s)
gC_{eq}/kWh	gram(s) of carbon dioxide equivalents per kilowatt-hour
GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437*
GHG	greenhouse gas
GL	Generic Letter
gpm	gallon(s) per minute
GW	gigawatt
ha	hectare(s)
HAP	hazardous air pollutant
HLW	high-level waste
hr	hour(s)
HRA	Human Reliability Analysis

HRERF	Hudson River Estuary Restoration Fund
HRFI	Hudson River Fisheries Investigation
HRPC	Hudson River Policy Committee
HRSA	Hudson River Settlement Agreement
IAEA	International Atomic Energy Agency
IMR	impingement mortality rate
in.	inch(es)
INEEL	Idaho National Energy and Environmental Laboratory
IP1	Indian Point Nuclear Generating Unit No. 1
IP2	Indian Point Nuclear Generating Unit No. 2
IP3	Indian Point Nuclear Generating Unit No. 3
IPE	individual plant examination
IPEEE	individual plant examination of external events
ISFSI	Independent Fuel Storage Installation
ISLOCA	Interfacing Systems Loss of Coolant Accidents
IWSA	Integrated Waste Services Association
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
kWh	kilowatt hour(s)
lb	pound(s)
L	liter(s)
LERF	Large Early Release Frequency
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Library
LOCA	loss of coolant accident
LODI	Lagrangian Operational Dispersion Integrator
LOE	Line(s) of Evidence
lpm	liters per minute
LRA	license renewal application
LR	linear regression
LRS	Long River Survey
LSE	load serving entities
m	meter(s)
mm	millimeter(s)
m^2	square meter(s)
m^3	cubic meter(s)
m^3/sec	cubic meter(s) per second
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
MBq	megabecquerel
mg	milligram(s)

mgd	million gallons per day
mg/L	milligram(s) per liter
mGy	milligray
mi	mile(s)
min	minute(s)
MIT	Massachusetts Institute of Technology
mL	milliliter(s)
MLES	Marine Life Exclusion System
MMBtu	million British thermal unit(s)
mps	meter(s) per second
mrad	millirad(s)
mrem	millirem(s)
mRNA	messenger ribonucleic acid
MSE	mean squared error
MSL	mean sea level
MSPI	Mitigating Systems Performance Indicator
mSv	millisievert
MT	metric ton(s)
MTU	metric ton of uranium
MW	megawatt
MWd	megawatt-days
MW(e)	megawatt(s) electric
MW(h)	megawatt hour(s)
MW(t)	megawatt(s) thermal
MWSF	Mixed Waste Storage Facility
NAAQS	National Ambient Air Quality Standards
NARAC	National Atmospheric Release Advisory Center
NAS	National Academy of Sciences
NEA	Nuclear Energy Agency
NEPA	National Environmental Policy Act of 1969, as amended
NESC	National Electric Safety Code
NGO	Nongovernmental Organization
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NIRS	Nuclear Information and Resource Service
NMFS	National Marine Fisheries Service
NJDEP	New Jersey Department of Environmental Protection
NO_2	nitrogen dioxide
NO_x	nitrogen oxide(s)
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NSSS	nuclear steam supply system
NWJWW	Northern Westchester Joint Water Works
NY/NJ/PHL	New York/New Jersey/Philadelphia

NYCA	New York Control Area
NYCDEP	New York City Department of Environmental Protection
NYCRR	New York Code of Rules and Regulations
NYISO	New York Independent System Operator
NYPA	New York Power Authority
NYPSC	New York Public Service Commission
NYRI	New York Regional Interconnect, Inc.
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSERDA	New York State Energy Research and Development Authority
NYSHPO	New York State Historic Preservation Office
O_3	ozone 8-hour standard
OCNGS	Oyster Creek Nuclear Generating Station
ODCM	Offsite Dose Calculation Manual
OMB	Office of Management and Budget
OPR	Office of Protected Resources
PAB	primary auxiliary building
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
pCi/L	picoCuries per liter
pCi/kg	picoCuries per kilogram
PDS	plant damage state
PILOT	payment-in-lieu-of-taxes
PM	particulate matter
$PM_{2.5}$	particulate matter, 2.5 microns or less in diameter
PM_{10}	particulate matter, 10 microns or less in diameter
POC	particulate organic carbon
PORV	power operated relief valve
POST	Parliamentary Office of Science and Technology
ppm	parts per million
ppt	parts per thousand
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
PV	photovoltaic
PWR	pressurized water reactor
PWW	Poughkeepsie Water Works
PYSL	post yolk-sac larvae
REMP	Radiological Environmental Monitoring Program
R-EMAP	regional environmental monitoring and assessment program
RAI	request for additional information
RCP	reactor coolant pump
RCRA	Resource Conservation and Recovery Act
RCS	reactor cooling system
REMP	radiological environmental monitoring program

RHR	residual heat removal
Riverkeeper	Hudson River Fishermen's Association
RIS	Representative Important Species
RKM	river kilometer(s)
RM	river mile(s)
RMP	Risk Management Plan
ROD	Record of Decision
ROI	region of influence
ROW	right-of-way
RPC	long-term replacement power costs
rpm	revolutions per minute
RRW	risk reduction worth
RWST	refueling water storage tank
s	second(s)
SAFSTOR	safe storage condition
SAMA	severe accident mitigation alternative
SAR	Safety Analysis Report
SAV	submerged aquatic vegetation
SBO	station blackout
Scenic Hudson	Scenic Hudson Preservation Conference
SCR	selective catalytic reduction
SECPOP	sector population, land fraction and economic estimation program
SEIS	Supplemental Environmental Impact Statement
SFP	Spent Fuel Pool
SGTR	Steam Generator Tube Ruptures
SI	Safety Injection
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
SPDES	State Pollutant Discharge Elimination System
SPU	stretch power uprate
sq mi	square mile(s)
SR	segmented regression
SRP	Standard Review Plan
SRT	Status Review Team
SSBR	spawning stock biomass per-recruit
SSE	safe shutdown earthquake
Sv	person-sievert
SWS	service water system
t	ton(s)
TDEC	Tennessee Department of Environment and Conservation
TI-SGTR	thermally-induced Steam Generator Tube Ruptures
TLD	Thermoluminescent dosimeter
TOC	total organic carbon
TRC	TRC Environmental Corporation

U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Atomic Energy Commission
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UWNY	United Water New York
V	volt(s)
VALWNF	value of non-farm wealth
VOC	volatile organic compound
WCDOH	Westchester County Department of Health
WISE	World Information Service on Energy
WJWW	Westchester Joint Water Works
WOE	weight of evidence
WOG	Westinghouse Owner's Group
YSL	yolk-sac larvae
YOY	young of year
yr	year(s)

1.0 INTRODUCTION

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51), which implement the National Environmental Policy Act of 1969, as amended (NEPA), renewal of a nuclear power plant operating license 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 to issue a final statement after considering public comments on the draft. To support the preparation of the EIS, the NRC staff prepared NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[(1)] 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, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," (2) identify and assess the impacts that are expected to be generic to license renewal, and (3) support 10 CFR Part 51 by defining the number and scope of issues that need to 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 operating license renewal process.

Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC, operate the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) nuclear power reactors, respectively, as indirect wholly owned subsidiaries of Entergy Corporation and indirect wholly owned subsidiaries of Entergy Nuclear Operations, Inc. (Entergy). IP2 and IP3 are located in Buchanan, New York.

IP2 has operated under operating license DPR-26 since August 1974. The IP2 operating license will expire on September 28, 2013. IP3 has operated under operating license DPR-64 since August 1976. The IP3 operating license will expire on December 12, 2015. Indian Point Unit No. 1 (IP1) was shut down in 1974 and is currently in SAFSTOR (a decommissioning strategy that includes maintenance, monitoring, and delayed dismantlement to allow radioactivity to decay prior to decommissioning).

Entergy, Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC, are joint applicants for the renewal of the operating licenses (the joint applicants will be referred to as Entergy). Entergy submitted an application to the NRC to renew the IP2 and IP3 operating licenses for an additional 20 years each under 10 CFR Part 54 on April 30, 2007 (Entergy 2007a). Pursuant to 10 CFR 54.23, "Contents of Application—Environmental Information," and 10 CFR 51.53(c), Entergy submitted an environmental report (ER) (Entergy 2007b) as part of the license renewal application in which Entergy analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects. Entergy submitted supplemental information clarifying operating licenses and applicant names in a letter on May 3, 2007 (Entergy 2007c).

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(1) 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.

This report is the plant-specific supplement to the GEIS (the supplemental EIS (SEIS)) for the Entergy license renewal application. This SEIS is a supplement to the GEIS because it relies, in part, on the findings of the GEIS. In August, 2009, the NRC staff issued a separate safety evaluation report in accordance with 10 CFR Part 54.

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 IP2 and IP3 operating licenses, (3) discuss the purpose and need for the proposed action, and (4) present the status of IP2 and IP3 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 and greenhouse gas emissions. 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 appendices. Appendix A contains public comments related to the environmental review for license renewal and the NRC staff's responses to those comments. Appendices B through G include the following:

- the preparers of the supplement (Appendix B)
- the chronology of the NRC staff's environmental review correspondence related to this SEIS (Appendix C)
- the organizations contacted during the development of this SEIS (Appendix D)
- the IP2 and IP3 compliance status in Tables E-1 and E-2 and copies of consultation correspondence prepared and sent during the evaluation process (Appendix E)
- GEIS environmental issues that are not applicable to IP2 and IP3 (Appendix F)
- the NRC staff's evaluation of severe accident mitigation alternatives (Appendix G)
- the NRC staff's evaluation of impacts of the IP2 and IP3 cooling system (Appendix H)
- statistical analyses conducted for Chapter 4 aquatic resources and appendix H (Appendix I)

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 operating licenses under 10 CFR Part 54, and the established license renewal evaluation process, support the thorough evaluation of the impacts of operating license renewal.

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 the NRC staff used 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 both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants, and (6) considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants.

The NRC's standard of significance for impacts was established using the Council on Environmental Quality (CEQ) term "significantly" (40 CFR 1508.27, which requires consideration of both "context" and "intensity"). Using the CEQ terminology, the NRC established three significance levels—SMALL, MODERATE, or LARGE. The definitions of the three significance levels are set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," 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; therefore, additional plant-specific review for these issues is required.

In the GEIS, the staff assessed 92 environmental issues and determined that 69 qualified as Category 1 issues, 21 qualified as Category 2 issues, and 2 issues were not categorized. The two issues not categorized 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 operating license 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 do the following:

- provide an analysis of the Category 2 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, in accordance with 10 CFR 51.53(c)(3)(ii)
- discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action

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

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

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 IP2 and IP3 operating licenses, Entergy developed a process to ensure that (1) information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for IP2 and IP3 would be properly reviewed before submitting the ER and (2) such new and potentially significant information related to renewal of the licenses for IP2 and IP3 would be identified, reviewed, and assessed during the period of NRC review. Entergy 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 remain valid with respect to IP2 and IP3. This review was performed by personnel from Entergy 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 NUREG-1555, “Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal,” issued March 2000 (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, Tribal, and local environmental protection and resource agencies, and (5) review of the technical literature. New information discovered by the NRC staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of the issue that are not affected by the new information.

Chapters 3 through 7 discuss the environmental issues considered in the GEIS that are applicable to IP2 and IP3. At the beginning of the discussion of each set of issues, there is a table that identifies the issues to be addressed and lists the sections in the GEIS where the issue is discussed. Category 1 and Category 2 issues are listed in separate tables. For

Category 1 issues for which there is no new and significant information, the table is followed by a set of short paragraphs that state the GEIS conclusion codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, followed by the staff's analysis and conclusion. For Category 2 issues, in addition to the list of GEIS sections where the issue is discussed, the tables list the subparagraph of 10 CFR 51.53(c)(3)(ii) that describes the analysis required and the SEIS sections where the analysis is presented. The SEIS sections that discuss the Category 2 issues are presented immediately following the table.

The NRC prepares an independent analysis of the environmental impacts of license renewal and compares these impacts with the environmental impacts of alternatives. The evaluation of the Entergy license renewal application began with the publication of a notice of acceptance for docketing, notice of opportunity for a hearing, and notice of intent to prepare an EIS and conduct scoping in the *Federal Register,* May 11, 2007 (NRC 2007; 72 FR 26850). A public scoping meeting was held on June 27, 2007, in Cortlandt Manor, New York. Comments received during the scoping period have been summarized by the NRC in a summary report issued in December of 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML083360115). The NRC staff adopts by reference the scoping summary report in Part 1 of Appendix A to this SEIS.

The NRC staff followed the review guidance contained in NUREG-1555, Supplement 1 (NRC 2000). The NRC staff, and the contractor retained to assist the NRC staff, visited the IP2 and IP3 site on September 11 and 12, 2007, and again on September 24 and 25, 2007, 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, Tribal, regional, and local agencies. A list of the organizations consulted is provided in Appendix D. Other documents related to IP2 and IP3 were reviewed and are referenced within this SEIS.

This SEIS presents the NRC staff's analysis that considers and weighs the environmental effects of the proposed renewal of the operating licenses for IP2 and IP3, the environmental impacts of alternatives to license renewal, and mitigation measures available for avoiding adverse environmental effects. Chapter 9, "Summary and Conclusions," provides the NRC staff's recommendation to the Commission on whether 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.

The NRC staff issued a draft SEIS in December 2008. 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, a public meeting was held in Cortlandt Manor, New York, on February 12, 2009. During this meeting, the NRC staff described the preliminary results of the NRC environmental review and answered questions to provide members of the public with information to assist them in formulating their comments. The comments received, and the NRC staff's responses to those comments, are presented in Appendix A to this SEIS.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the operating licenses for IP2 and IP3 (IP1 was shut down in 1974). IP2 and IP3 are located on approximately 239 acres of land on the east bank of the Hudson River at Indian Point, Village of Buchanan, in upper Westchester County, New York, approximately 24 miles north of the New York City boundary line. The facility has two Westinghouse pressurized-water reactors. IP2 is currently licensed to generate 3216 megawatts thermal (MW(t)) (core power) with a design net electrical capacity of 1078 megawatts electric (MW(e)). IP3 is currently licensed to generate 3216 MW(t) (core power) with a design net electrical capacity of about 1080 MW(e). IP2 and IP3 cooling is provided by water from the Hudson River to various heat loads in both the primary and secondary portions of the plants. The current operating license for IP2 expires on September 28, 2013, and the current operating license for IP3 expires on December 12, 2015. By letter dated April 23, 2007, Entergy submitted an application to the NRC (Entergy 2007a) to renew the IP2 and IP3 operating licenses for an additional 20 years.

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 operating license, 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 operating license 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 matters within the State's jurisdiction—including acceptability of water withdrawal, consistency with State water quality standards, and consistency with State coastal zone management plans—or the purview of the owners, such as whether continued operation makes economic sense.

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, as amended, 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 the operating licenses is to maintain the availability of the nuclear plant to meet system energy requirements beyond the current term of the plant's licenses.

1.5 Compliance and Consultations

Entergy is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, Entergy provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with the IP2 and IP3 license renewals. Authorizations and consultations relevant to the proposed operating license renewal actions are included in Appendix E.

The NRC staff has reviewed Entergy's list and consulted with the appropriate Federal, State, Tribal, 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 states that Entergy is in compliance with applicable environmental standards and requirements for IP2 and IP3. The NRC staff has not identified any environmental issues that are both new and significant.

Two state-level issues, consistency with State water quality standards, and consistency with State coastal zone management plans, have yet to be resolved. On April 2, 2010, the New York State Department of Environmental Conservation (NYSDEC) issued a Notice of Denial regarding the Clean Water Act Section 401 Water Quality Certification. Entergy has since requested a hearing on the issue, and the matter will be decided through NYSDEC's hearing process.

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."

Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Indian Point, Units 2 & 3, License Renewal Application." April 23, 2007. ADAMS Accession No. ML071210512.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to "Indian Point, Units 2 & 3, License Renewal Application".) April 23, 2007. ADAMS Accession No. ML071210530.

Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from Fred Dacimo, Indian Point Energy Center Site Vice President, to the U.S. NRC regarding Indian Point Nuclear Generating Units Nos. 2 and 3. Docket Nos. 50-247, 50-286. May 3, 2007. ADAMS Accession No. ML071280700.

National Environmental Policy Act of 1969 (NEPA). 42 *United States Code* 4321, *et seq*.

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

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." NUREG-1437, Volume 1, Addendum 1, Washington, DC.

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

U.S. Nuclear Regulatory Commission (NRC). 2007. "Entergy Nuclear Operations, Inc.; Notice of Receipt and Availability of Application for Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3; Facility Operating License Nos. DPR-26 and DPR-64 for an Additional 20-Year Period." *Federal Register*, Volume 72, Number 91, p. 26850. May 11, 2007.

U.S. Nuclear Regulatory Commission (NRC). 2009. "Summary Report: Indian Point Nuclear Generating Station Unit Nos. 2 and 3." Washington, DC.

2.0 DESCRIPTION OF NUCLEAR POWER PLANT AND SITE AND PLANT INTERACTION WITH THE ENVIRONMENT

Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) are located on approximately 239 acres (97 hectares (ha)) of land in the Village of Buchanan in upper Westchester County, New York. The facility is on the eastern bank of the Hudson River at river mile (RM) 43 (river kilometer (RKM) 69) about 2.5 miles (mi) (4.0 kilometers (km)) southwest of Peekskill, the closest city, and about 24 mi (39 km) north of New York City.

Both IP2 and IP3 use Westinghouse pressurized-water reactors and nuclear steam supply systems (NSSSs). Primary and secondary plant cooling is provided by a once-through cooling water intake system that supplies cooling water from the Hudson River. The plant and its surroundings are described in Section 2.1, and the plant's interaction with the environment is presented in Section 2.2.

Indian Point Nuclear Generating Station Unit No. 1 (IP1, now permanently shut down) shares the site with IP2 and IP3. IP1 is located between IP2 and IP3. IP1 was shut down on October 31, 1974, and is in a safe storage condition (SAFSTOR) awaiting final decommissioning.

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

The entirety of the Indian Point site is surrounded by a perimeter fence, establishing an area known as the "owner controlled area." Security personnel patrol all roads within the site. Within the fence lies an area of greater security known as the "protected area." The protected area is more heavily guarded and controlled by a second fence and an intrusion detection system. The protected area is accessible only through manned security buildings and gates requiring electronic identification. In addition, spaces within the protected area designated as "vital areas" have additional access controls (Entergy 2006a).

The area within a 6-mi (10-km) radius of the IP2 and IP3 site includes the Village of Buchanan, located about 0.5 mi (0.8 km) southeast of the site, and the City of Peekskill, located 2.5 mi (4.0 km) northeast. In the 2000 U.S. census, populations of these towns were 2,189 and 22,441, respectively. The largest town within a 6-mi (10-km) radius of the site is Haverstraw, New York, with a 2000 population of approximately 33,811 (USCB 2000). Haverstraw is located to the southwest on the western bank of the Hudson River. Several other small villages, including Verplanck and Montrose, lie within a 6-mi (10-km) radius of the IP2 and IP3 site. The area within a 6-mi (10-km) radius of the site also includes several thousand acres of the Bear Mountain State Park located across the Hudson River, the nearly 2000-acre (809-ha) Camp Smith (a New York State military reservation) located 2.3 mi (3.7 km) north of the site, and a portion—about 2000 acres (809 ha)—of the U.S. Military Academy at West Point.

The area within a 50-mi (80-km) radius of the site includes parts of New York, New Jersey, and Connecticut. New York City, located approximately 24 mi (39 km) south of the plant, is the largest city within 50 mi (80 km) with a 2006 population of approximately 8,214,426 (USCB 2006). Other population centers include Danbury and Stamford, Connecticut; Newark, New Jersey; and Poughkeepsie, New York. The area within a 50-mi (80-km) radius also includes all of the U.S. Military Academy at West Point, located 7.5 mi (12 km) northwest of the site, and the Picatinny Arsenal, located 35.5 mi (57.1 km) southwest of the site in New Jersey (Entergy 2007a).

The region surrounding the Indian Point site has undulating terrain with many peaks and valleys. Dunderberg Mountain lies on the western side of the Hudson River 1 mi (1.6 km) northwest of the site. North of Dunderberg Mountain, high grounds reach an elevation of 800 feet (ft) (244 meters (m)) above the western bank of the Hudson River. To the east of the site lie the Spitzenberg and Blue Mountains. These peaks are about 600 ft (183 m) in height. There is also a weak, poorly defined series of ridges that run in a north-northeast direction east of IP2 and IP3. The Timp Mountains are west of the facility. These mountains rise to a maximum elevation of 846 ft (258 m). Elevations south of the site are 100 ft (30.5 m) or less and gradually slope toward the Village of Verplanck (Entergy 2007a).

The site location and features within 50-mi (80-km) and 6-mi (10-km) radii are illustrated in Figures 2-1 and 2-2, respectively.

2.1.1 External Appearance and Setting

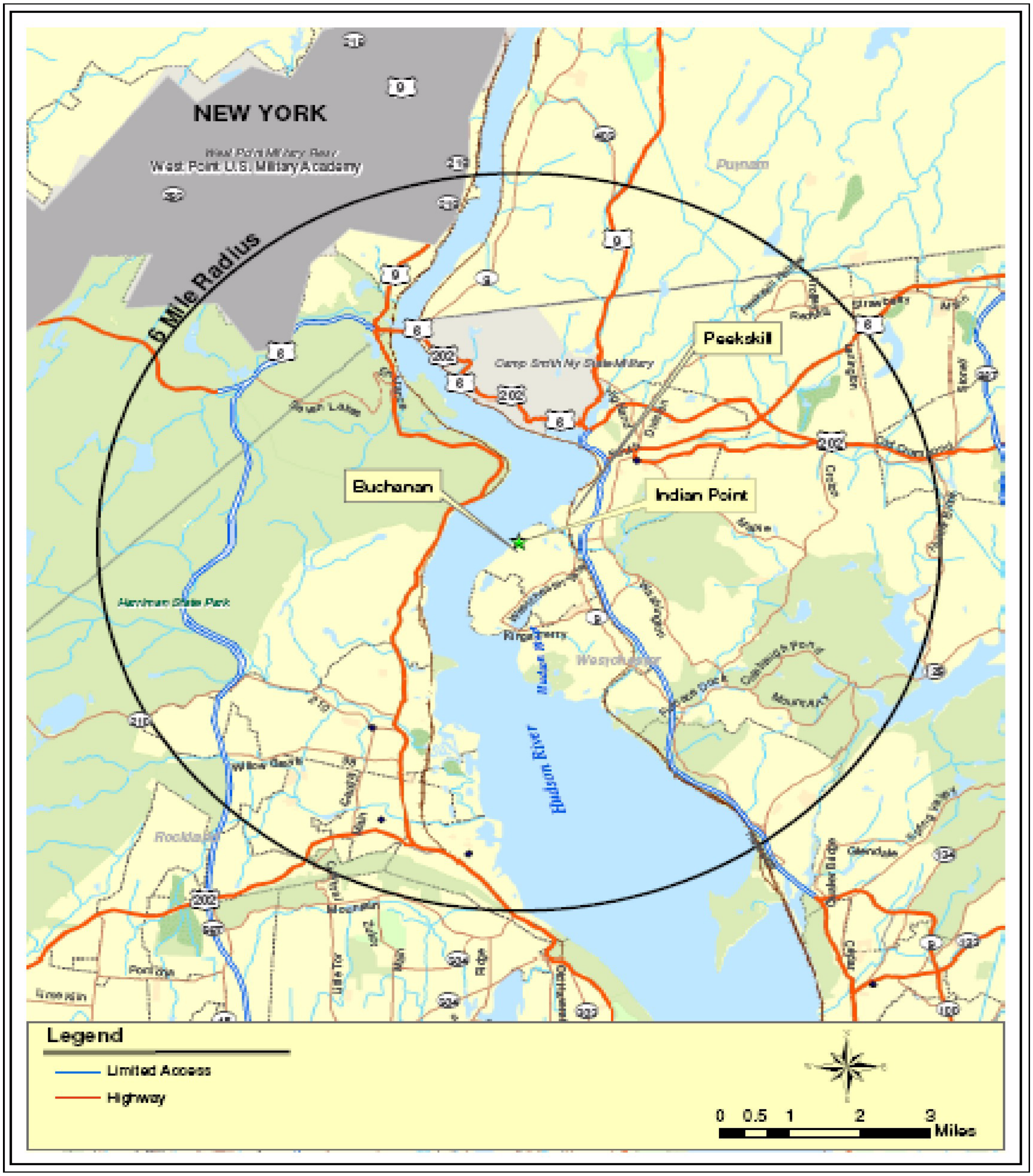
As discussed in Section 2.1, the immediate area around the Indian Point site is completely enclosed by a security fence. Access to the site is controlled at a security gate on Broadway (main entrance). Controlled access to the site is also available using the existing wharf on the Hudson River. The wharf is used to receive heavy equipment shipped to the site by barge. There are no rail lines that service the site. The nearest residence is less than 0.5 mi (0.8 km) from IP2 and IP3 and about 100 m (328 ft) beyond the site boundary to the east-southeast (ENN 2007a).

The facility can be seen easily from the river. Surrounding high ground and vegetation make it difficult to see the facility from beyond the security fence on land, except from Broadway. The 334-ft (102-m) tall superheater stack for IP1, the 134-ft (40.8-m) tall IP2 and IP3 turbine buildings, and the 250-ft (76.2-m) tall reactor containment structures are the tallest structures on the site (Entergy 2007a).

1 Source: Entergy 2007a

2 **Figure 2-1. Location of IP2 and IP3, 50-mi (80-km) radius**

3



Source: Entergy 2007a

Figure 2-2. Location of IP2 and IP3, 6-mi (10-km) radius

Other visible IP2 and IP3 site features include auxiliary buildings, intake structures, the discharge structure, electrical switchyard, and associated transmission lines (Entergy 2007a). The site boundary and general facility layout are depicted in Figures 2-3 and 2-4, respectively.

The facility contains several stationary bulk petroleum and chemical storage tanks. Bulk chemical storage tanks are registered with the New York State Department of Environmental Conservation (NYSDEC) via Hazardous Substance Bulk Storage Registration Certificates. The tanks and their contents are managed in accordance with the NYSDEC Chemical Bulk Storage Regulations. The IP2 bulk petroleum storage tanks are registered with NYSDEC via a Major Oil Storage Facility License, while the IP3 tanks are registered with the Westchester County Department of Health via a Petroleum Bulk Storage Registration Certificate.

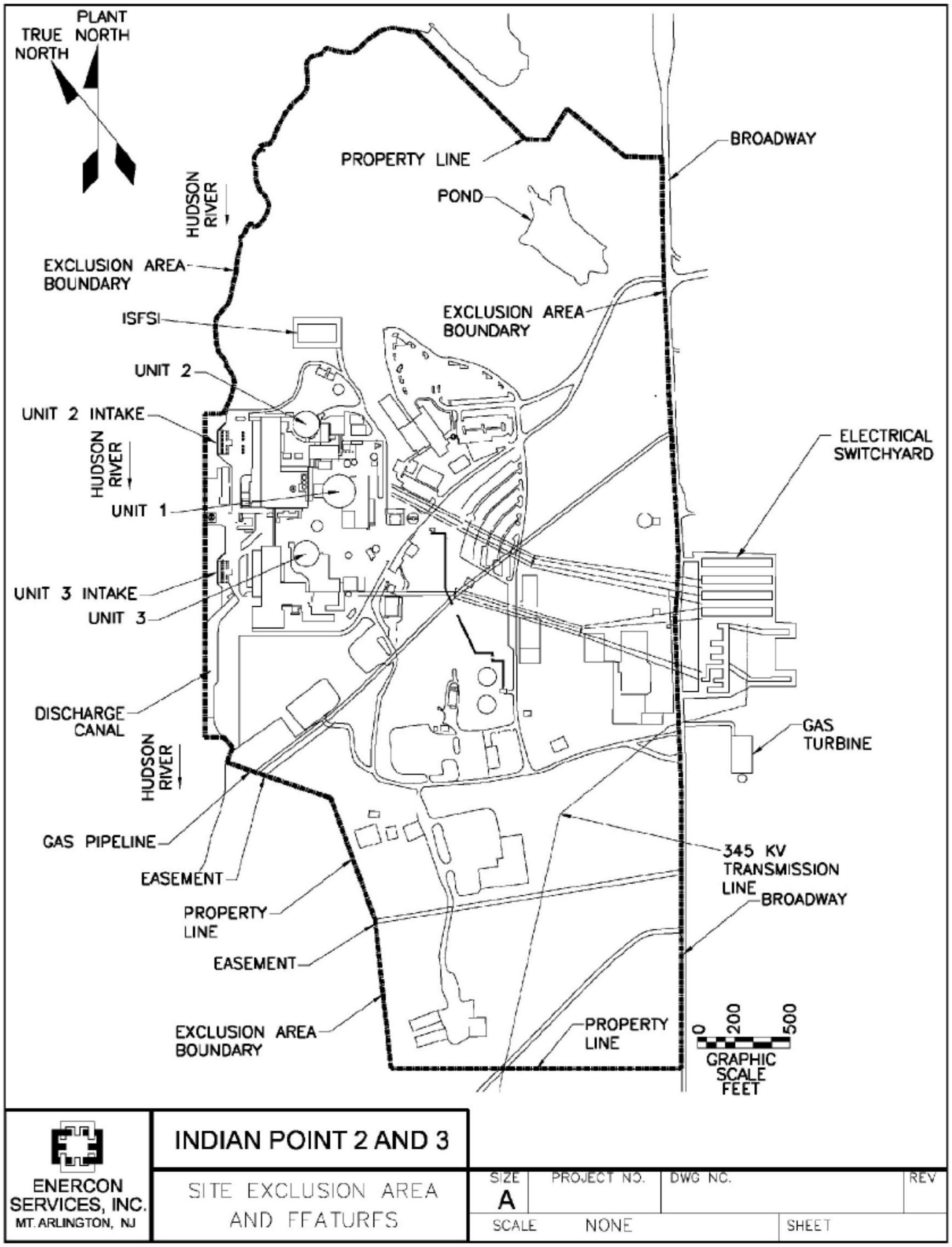
IP2 and IP3 each use two main transformers to increase voltage from their respective turbine generators. The transformers increase generator output from 22 kilovolts (kV) to 345 kV. Power is then delivered to the Consolidated Edison Company (Con Edison) transmission grid by way of two double-circuit 345-kV lines. These lines connect the main onsite transformers to the offsite Buchanan substation which is located immediately across Broadway near the main entrance to the site. The lines that connect the transformers to the substation are about 2000 ft (610 m) in length and, except for the terminal 100 ft where they cross over Broadway (a public road) and enter the substation, lines are located within the site boundary (Entergy 2007a). The 345-kV transmission lines that distribute power from the substation are shown in Figure 2-3.

2.1.2 Reactor Systems

As noted in Section 2.0, both IP2 and IP3 employ Westinghouse pressurized-water reactors and four-loop NSSSs. Each NSSS loop contains a reactor coolant pump and a steam generator. The reactor coolant system transfers the heat generated in the reactor core to the steam generators, which produce steam to drive the electrical turbine generators (Entergy 2007b).

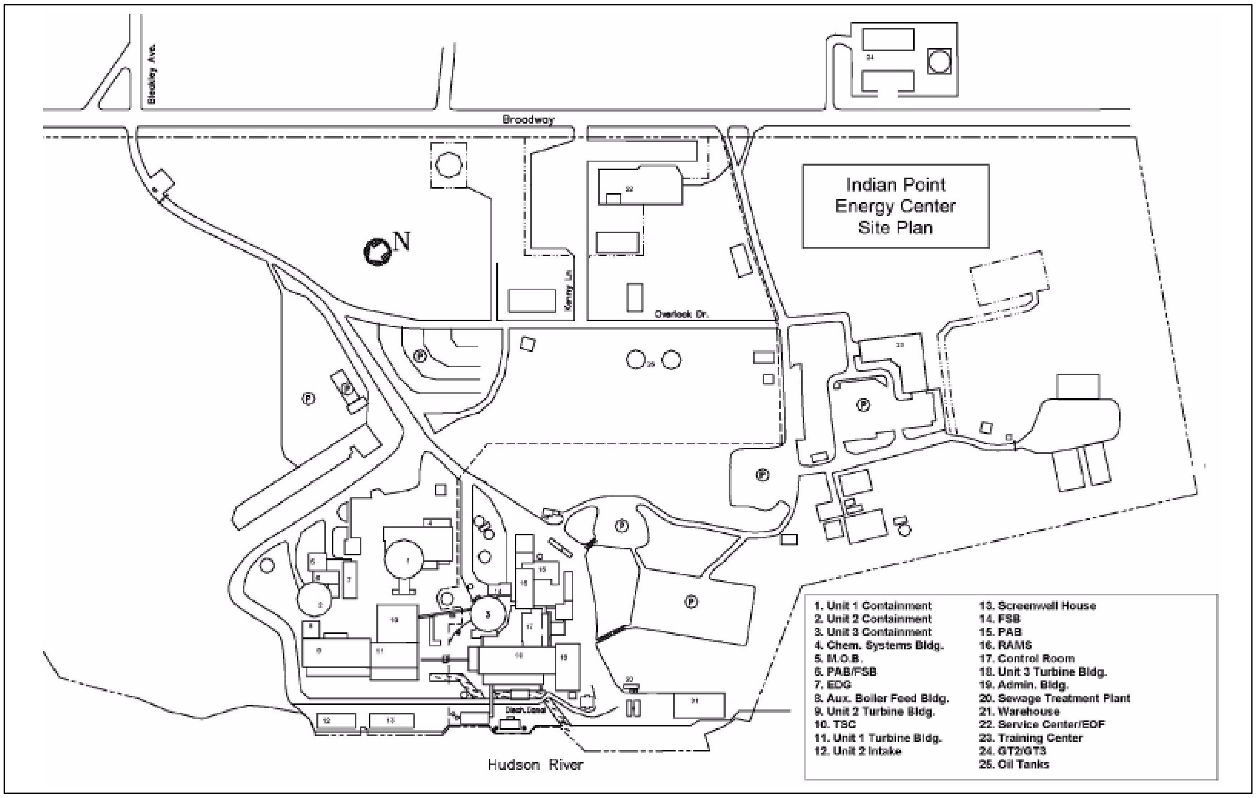
IP2 is currently licensed to operate at a core power of 3216 megawatt thermal (MW(t)), which results in a turbine generator output of approximately 1078 megawatt electric (MW(e)). IP3 is currently licensed to operate at 3216 MW(t), which results in a turbine generator output of approximately 1080 MW(e). IP2 and IP3 have similar designs with independent functional and safety systems. The units share the following systems (Entergy 2007b):

- discharge canal, outfall structure, and associated instrumentation and sampling systems
- electrical supplies and interties
- station air interties
- demineralized water, condensate makeup, and hydrogen interties
- city water and fire protection interties
- dedicated No. 2 fuel oil systems for diesel generators
- sewage treatment facility
- auxiliary steam system intertie



1 Source: Entergy 2007a

2 **Figure 2-3. IP2 and IP3 property boundaries and environs**



Source: Entergy 2007a

Figure 2-4. IP2 and IP3 site layout

- service boiler fuel oil supply system
- liquid steam generator blowdown, radioactive waste processing, and discharge (to IP1) facilities

The nuclear fuel for IP2 and IP3 is made of low-enriched (less than 5 percent by weight uranium-235) uranium dioxide pellets stacked in pre-pressurized tubes made from zircaloy or ZIRLO. The fuel tube rods have welded end plugs. Based on core design values, IP2 and IP3 operate at an individual rod average fuel burnup of no more than 62,000 megawatt-days per metric ton of heavy metal. This ensures that peak burnups remain within the acceptable limits specified in Table B-1 of Appendix B, “Environmental Effect of Renewing the Operating License of a Nuclear Power Plant,” to Subpart A, “National Environmental Policy Act—Regulations Implementing Section 102(2),” of Title 10, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” of the *Code of Federal Regulations* (10 CFR Part 51) (Entergy 2006a). Reactor fuel that has exhausted a certain percentage of its fissile uranium content so that it is no longer an efficient fissile fuel source is referred to as spent fuel. The spent fuel is removed from the reactor core and replaced by fresh fuel during routine refueling outages. Refueling outages at IP2 and IP3 typically occur every 24 months. The spent fuel assemblies are then stored in the spent fuel pool (SFP) in the fuel storage building.

Located north of IP2 inside the protected area fence, the spent fuel will be transferred to dry storage (Entergy 2007a) at an onsite independent spent fuel storage installation (ISFSI). The first fuel was moved from IP2 to the ISFSI pad, which is approximately 100 ft (30.5 m) wide by 200 ft (61.0 m) long, during the first week of January 2008 (Entergy 2008).

IP2 and IP3 containment buildings completely enclose each unit's reactor and the reactor coolant system. The containment buildings are designed to minimize leakage of radioactive materials to the environment if a design-basis loss-of-coolant accident were to occur. The containment structures have an outer shell of reinforced concrete and an inner steel liner (Entergy 2007b).

The IP2 containment building contains a containment purge supply and exhaust system and a containment pressure relief system. The purge supply and exhaust system provides fresh air to the containment and filters air released from containment. The containment pressure relief system regulates normal pressure in the containment during reactor power operation (Entergy 2007b).

The IP3 containment building contains a vapor containment heating and ventilation purge system and a vapor containment pressure relief system. The heating and ventilation system regulates fresh air flow into the containment and filters air before its dispersion to the environment. The vapor containment pressure relief system regulates pressure changes in containment during reactor power operation (Entergy 2007b).

2.1.3 Cooling and Auxiliary Water Systems

IP2 and IP3 have once-through condenser cooling systems that withdraw water from and discharge it to the Hudson River. The systems are described in detail in the IP2 and IP3 environmental report (ER) (Entergy 2007a). This section provides a general description based on the information provided by Entergy in the ER.

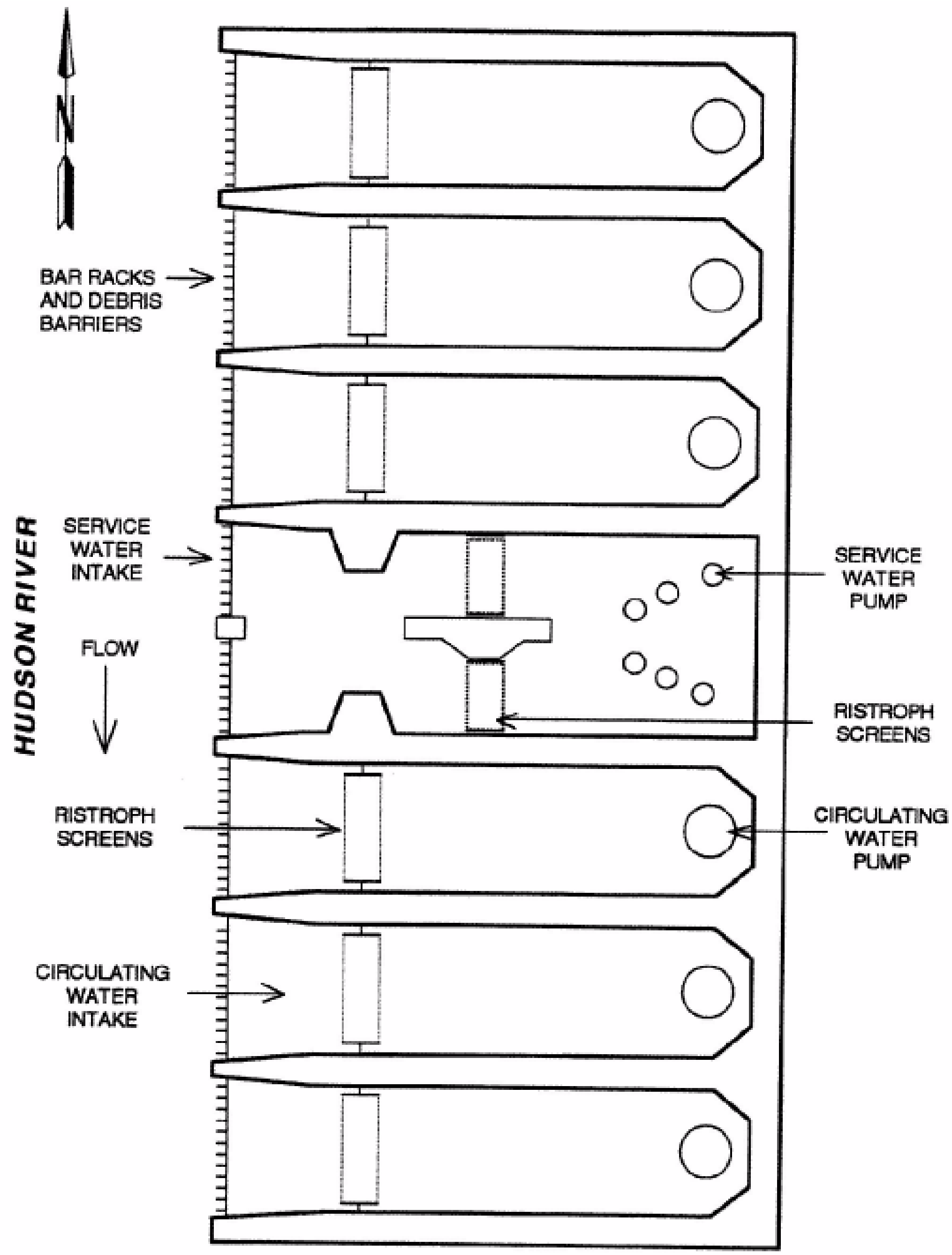
The maximum design flow rate for each cooling system is approximately 1,870 cubic feet per second (cfs), 840,000 gallons per minute (gpm), or 53.0 cubic meters per second (m^3/s).

Two shoreline intake structures—one for each unit—are located along the Hudson River on the northwestern edge of the site and provide cooling water to the site. Each structure consists of seven bays, six for circulating water and one for service water. The IP2 intake structure has seven independent bays, while the IP3 intake structure has seven bays that are served by a common plenum. In each structure, six of the seven bays contain cooling water pumps, and the seventh bay contains service/auxiliary water pumps. Before it is pumped to the condensers, river water passes through traveling screens in the intake structure bays to remove debris and fish.

The six IP2 circulating water intake pumps are dual-speed pumps. When operated at high speed (254 revolutions per minute (rpm)), each pump provides 312 cfs (140,000 gpm; 8.83 m^3/s) and a dynamic head of 21 ft (6.4 m). At low speed (187 rpm), each pump provides 187 cfs (84,000 gpm; 5.30 m^3/s) and a dynamic head of 15 ft (4.6 m). The six IP3 circulating water intake pumps are variable-speed pumps. When operated at high speed (360 rpm), each pump provides 312 cfs (140,000 gpm; 8.83 m^3/s); at low speed, it provides a dynamic head of 29 ft (8.8 m) and 143 cfs (64,000 gpm; 4.05 m^3/s). In accordance with the October 1997 Consent Order (issued pursuant to the Hudson River Settlement Agreement; see

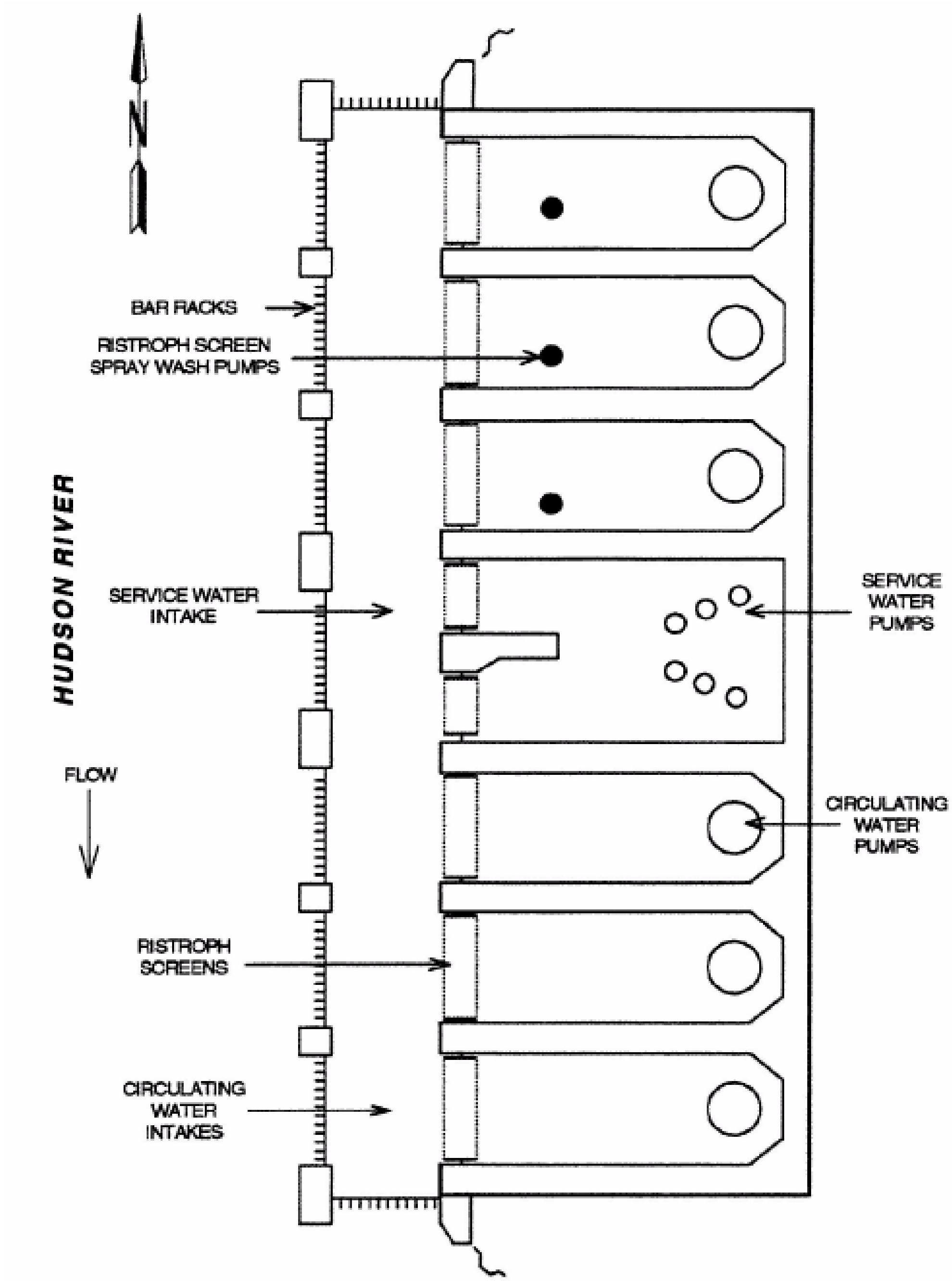
Section 2.2.5.3 for more information), the applicant adjusts the speed of the intake pumps to mitigate impacts to the Hudson River.

Each coolant pump bay is about 15 ft (4.6 m) wide at the entrance, and the bottom is located 27 ft (8.2 m) below mean sea level. Before entering the intake structure bays, water flows under a floating debris skimmer wall, or ice curtain, into the screen wells. This initial screen keeps floating debris and ice from entering the bay. At the entrance to each bay, water also passes through a subsurface bar screen to prevent additional large debris from becoming entrained in the cooling system. Next, smaller debris and fish are screened out using modified Ristroph traveling screens. Figures 2-5 through 2-8 illustrate the IP2 and IP3 intake structures and bays.



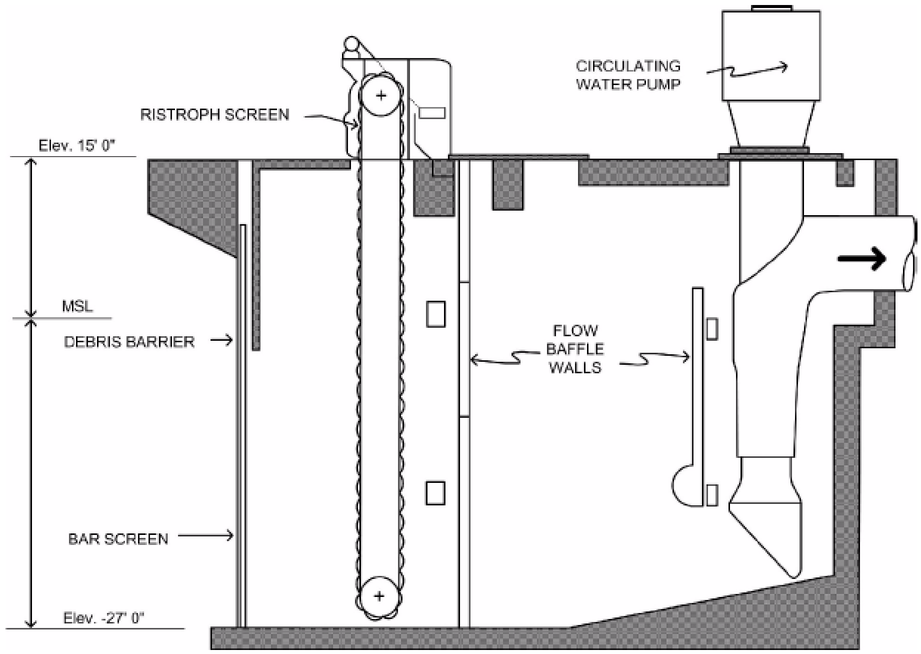
Source: Entergy 2007a

Figure 2-5. IP2 intake structure



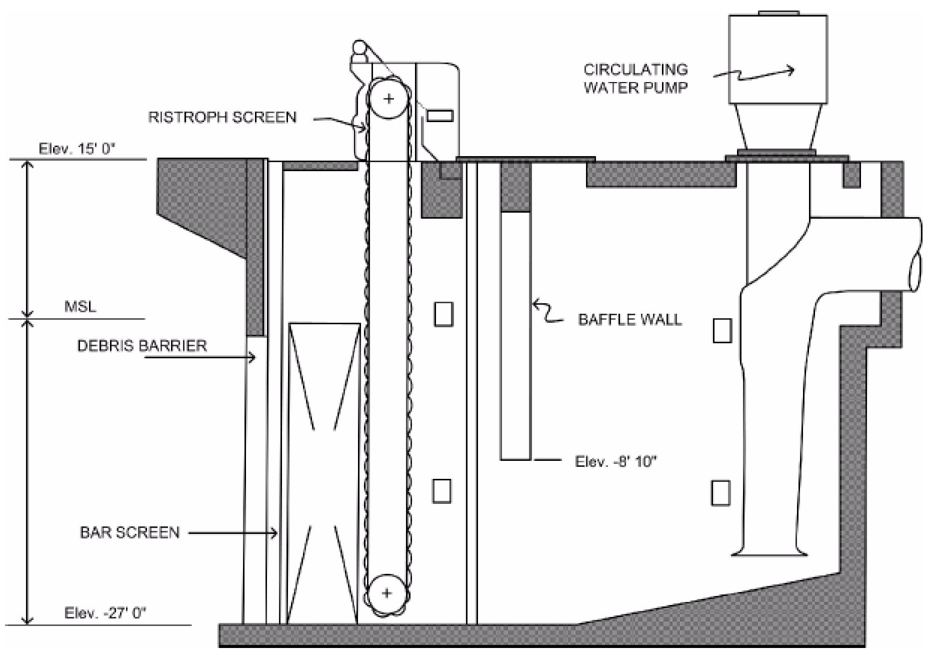
Source: Entergy 2007a

Figure 2-6. IP3 intake structure



Source: Entergy 2007a

Figure 2-7. IP2 intake system



Source: Entergy 2007a

Figure 2-8. IP3 intake system

The modified Ristroph traveling screens consist of a series of panels that rotate continuously. As each screen panel rotates out of the intake bay, impinged fish are retained in water-filled baskets at the bottom of each panel and are carried over the headshaft, where they are washed out onto a mesh using low-pressure sprays from the rear side of the machine. The 0.25-by-0.5-inch (in.) (0.635-by-1.27 centimeters (cm)) mesh is smooth to minimize fish abrasion by the mesh. Two high-pressure sprays remove debris from the front side of the machine after fish removal.

From the mesh, fish return to the river via a 12-in. (30-cm) diameter pipe. For IP2, the pipe extends 200 ft (61.0 m) into the river north of the IP2 intake structure and discharges at a depth of 35 ft (11 m). The IP3 fish return system discharges to the river by the northwest corner of the discharge canal.

After moving through the condensers, cooling water is discharged to the discharge canal via a total of six 96-in. (240-cm) diameter pipes. The cooling water enters below the surface of the 40-ft (12-m) wide canal. The canal discharges to the Hudson River through an outfall structure located south of IP3 at about 4.5 feet per second (fps) (1.4 meters per second (mps)) at full flow. As the discharged water enters the river, it passes through 12 discharge ports (4-ft by 12-ft each (1-m by 3.7-m)) across a length of 252 ft (76.8 m) about 12 ft (3.7 m) below the surface of the river. The increased discharge velocity, about 10 fps (3.0 mps), enhances mixing to minimize thermal impact.

The discharged water is at an elevated temperature, and therefore, some water is lost because of evaporation. Based on conservative estimates, the staff of the U.S. Nuclear Regulatory Commission (NRC) estimates that this induced evaporation resulting from the elevated discharge temperature would be less than 60 cfs (27,000 gpm or 1.7 m^3/s). This loss is about 0.5 percent of the annual average downstream flow of the Hudson River, which is more than 9000 cfs (4 million gpm or 255 m^3/s). The average cooling water transient time ranges from 5.6 minutes for the IP3 cooling water system to 9.7 minutes for the IP2 system.

Auxiliary water systems for service water are also provided from the Hudson River via the dedicated bays in the IP2 and IP3 intake structures. The primary role of service water is to cool components (e.g., pumps) that generate heat during operation. Secondary functions of the service water include the following:

- protect equipment from potential contamination from river water by providing cooling to intermediate freshwater systems
- provide water for washing the modified Ristroph traveling screens
- provide seal water for the main circulating water pumps

The IP2 service water bay has six identical centrifugal sump-type pumps, each having a capacity of at least 11 cfs (5000 gpm; 0.31 m^3/s) at 220-ft (67-m) total design head. The IP3 service water bay also has 6 similar pumps, each rated at 13 cfs (6000 gpm; 0.378 m^3/s) and 195-ft (59.4-m) total design head. The average approach velocity at the entrance to each service water bay when all pumps are operating is about 0.2 fps (0.06 mps). Each service water bay also contains two Ristroph screens to reduce fish entrainment.

Additional service water is provided to the nonessential service water header for IP2 through the IP1 river water intake structure. The IP1 intake includes four intake bays each with a coarse bar screen and a single 0.125-in. (0.318-cm) mesh screen. The intake structure contains two 36-cfs (16,000-gpm; 1.0-m^3/s) spray wash pumps. The screens are washed automatically and materials are sluiced to the Hudson River.

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

IP2 and IP3 radioactive waste systems are designed to collect, treat, and dispose of radioactive and potentially radioactive wastes that are byproducts of plant operations. These byproducts include activation products resulting from the irradiation of reactor water and impurities therein (principally metallic corrosion products) and fission products resulting from their migration through the fuel cladding or uranium contamination within the reactor coolant system. Operating procedures for radioactive waste systems are designed to ensure that radioactive wastes are safely processed and discharged from the plant within the limits set forth in 10 CFR Part 20, “Standards for Protection against Radiation”; Appendix I, “ Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion ‘As Low as is Reasonably Achievable’ for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents,” to 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities”; the plant’s technical specifications; and the IP2 and IP3 Offsite Dose Calculation Manual (ODCM) (Entergy 2007a).

Radioactive wastes resulting from plant operations are classified as liquid, gaseous, or solid. Liquid radioactive wastes are generated from liquids received directly from portions of the reactor coolant system or were contaminated by contact with liquids from the reactor coolant system. Gaseous radioactive wastes are generated from gases or airborne particulates vented from reactor and turbine equipment containing radioactive material. Solid radioactive wastes are solids from the reactor coolant system, solids that came into contact with reactor coolant system liquids or gases, or solids used in the reactor coolant system or steam and power conversion system operation or maintenance.

As indicated in Section 2.1.2, reactor fuel that has exhausted a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages, typically every 24 months. Spent fuel assemblies are then stored for a period of time in the Spent Fuel Pit (SFP) in the fuel storage building and may later be transferred to dry storage at a recently constructed onsite ISFSI. Entergy has constructed an ISFSI in the north end of the IP2 and IP3 site in an area that was previously undeveloped. The facility is planned to hold up to 78 Holtec International HI-STORM 100S(B) casks (Entergy 2007a).

The IP2 and IP3 ODCM contains the methodology and parameters used to calculate offsite doses resulting from radioactive gaseous and liquid effluents and the gaseous and liquid effluent monitoring alarm and trip setpoints used to verify that radioactive discharges meet regulatory limits. The ODCM also contains the radioactive effluent controls and radiological environmental monitoring activities and descriptions of the information that should be included in the annual Radiological Environmental Operating Report and annual Radioactive Effluent Release Report (Entergy 2007a).

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

The liquid waste processing system collects, holds, treats, processes, and monitors all liquid radioactive wastes for reuse or disposal.

IP2

In IP2, the liquid waste holdup system collects low-level radioactive waste from throughout the facility and holds the waste until it can be processed. During normal plant operations the system receives input from numerous sources, such as equipment drains and leak lines, chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak lines, and floor drains. Liquid waste is divided into two general classifications—high-quality liquid waste from the reactor coolant drain tank and routine liquid waste from the waste holdup tank which contains reactor coolant. The IP2 liquid wastes are transferred from the waste holdup tank to the IP1 waste collection system (described later in this section). The liquid waste can also be transferred from the waste holdup tank to the waste condensate tank, where its radioactivity can be analyzed to determine whether the waste is acceptable for discharge into the condenser circulating water and into the Hudson River.

In the event of primary reactor coolant water (radioactive) leakage into the secondary-side water (nonradioactive) system, potentially contaminated water that collects in the secondary-side drains may be collected and sent to a collection point in the auxiliary boiler feedwater building for eventual processing.

IP3

In IP3, the liquid waste holdup system collects low-level radioactive waste from throughout the facility and holds the waste until it can be processed. During normal plant operations, the system receives input from numerous sources, such as equipment drains and leak lines, radioactive chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak-offs, and floor drains. The system consists of three tanks—a 24,500 gallon (gal) (92,700 liter (L)) waste holdup tank located in the waste holdup pit, and the two 62,000 gal (235,000 L) waste holdup tanks located in the liquid radioactive waste storage facility.

The liquid radioactive waste storage facility, which houses the 62,000 gal (235,000 L) waste tanks, is an underground concrete structure. The 62,000 gal (235,000 L) tanks are supported on concrete piers. The building is supported on hard rock. The foundation consists of a rigid 2 in. (5.0 cm) thick slab that is waterproofed. The reinforced concrete walls of the building are also waterproofed. The roof is made of 3 in. (7.6 cm) reinforced concrete poured on a steel deck and beam system.

When the waste has been sampled and analyzed and found to be acceptable for discharge, it is pumped from the waste holdup tank to the monitor tanks. When one monitor tank is filled, it is isolated, and the waste liquid is recirculated and sampled for radioactive and chemical analysis while the second tank is in service accumulating waste. If the waste material in the filled monitor tank meets release standards, the waste liquid is pumped to the service water discharge for release into the Hudson River. If it does not meet applicable release standards, it is returned to the waste holdup tanks for additional processing. Entergy performs radioactive and chemical analyses to determine the amount of radioactivity released. There is also a radiation monitor which provides surveillance over the operation to ensure that the discharge is within applicable radiation standards. If the radioactivity in the liquid waste being discharged exceeds the radiation standard, the discharge is terminated.

IP1

Radioactive waste storage and processing facilities located in IP1 provide additional waste processing services for IP2. IP1 contains four tanks with a capacity of 75,000 gal (284,000 L) each. From these tanks, the liquid can be processed by use of sluicable demineralizer vessels. There is also a portable demineralization system located in the IP1 Chemical System Building to process liquid waste. This system uses a number of inline ion exchanger resin beds and filters to remove radionuclides and chemicals from the waste stream. Once the contents of the waste tanks meet release criteria, the liquid waste is discharged into the river.

Liquid Releases

Liquid releases to the Hudson River are limited to the extent possible to satisfy the dose design objectives of Appendix I to 10 CFR Part 50. IP2 and IP3 have controls, described in their ODCMs, for limiting the release of radioactive liquid effluents. The controls are based on the concentrations of radioactive materials in liquid effluents and the calculated projected dose to a hypothetical member of the public. Concentrations of radioactive material that may be released in liquid effluents are limited to the concentrations specified by 10 CFR Part 20. For the calendar year, the ODCM limits the dose to a member of the public from liquid effluents to 3 millirem (mrem) (0.03 millisievert (mSv)) to the total body and 10 mrem (0.10 mSv) to any organ (Entergy 2007a).

Entergy maintains radioactive liquid effluent discharges in accordance with the procedures and methodology described in the ODCM. The liquid radioactive waste processing system is used to reduce radioactive materials in liquid effluents before discharge to meet the as low as reasonably achievable (ALARA) dose objectives in Appendix I to 10 CFR Part 50.

The NRC staff reviewed the IP2 and IP3 radioactive effluent release reports for 2002 through 2006 for liquid effluents (Entergy 2003a, 2003b, 2004, 2005a, 2006b, 2007c) to determine whether releases were reasonable. In 2006, 5.99×10^{7} gal (2.27×10^{8} L) of radiological liquid effluents diluted with 1.47×10^{12} gal (5.58×10^{12} L) of water were discharged from the IP2 and IP3 site. The amount of radioactivity discharged in the form of fission and activation products from the IP2 and IP3 site in 2006 totaled 5.92×10^{-2} curies (Ci) (2.19×10^{3} megabecquerels (MBq)). A total of 1.56×10^{3} Ci (5.77×10^{7} MBq) of tritium was released from the IP2 and IP3 site in 2006. A total of 3.82×10^{-1} Ci (1.41×10^{4} MBq) of dissolved and entrained gases was released in liquid discharges from the IP2 and IP3 site in 2006 (Entergy 2007c). The liquid discharges for 2006 are consistent with the radioactive liquid effluents discharged from 2002 through 2005. In section 2.2.7, NRC staff reviewed the most-recent effluent release reports (2009; Entergy 2010) and confirmed that radioactive wastes reported by Entergy remain reasonable and are within applicable limits. The NRC staff expects variations in the amount of radioactive effluents released from year to year by Entergy based on the overall performance of the plant and the number and scope of maintenance and refueling outages. The liquid radioactive wastes reported by Entergy are reasonable and are within applicable limits, and the NRC staff noted no unusual trends.

Though Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms during the period of extended operation, such replacement actions are not likely to result in a significant increase of liquid radioactive effluents being discharged compared to the amount discharged during normal plant operations. This is based on consideration that liquids generated, processed, and released during the outage will likely be offset by the amount of liquid waste that would not be generated, processed, and released during normal plant operations during the outage period. Based on the NRC staff's evaluation of recent historical releases in the previous paragraph and based on the NRC staff's expectation that no significant increase in liquid effluents from the potential replacement of the reactor heads and control rod drive mechanisms is likely to occur, the NRC staff expects similar quantities of radioactive liquid effluents to be generated during normal operation and outages from IP2 and IP3 during the period of extended operation.

Releases to Groundwater

In addition to the planned radioactive liquid discharges made through the liquid waste processing system, Entergy identified a new release pathway as a result of the discovery of tritium contamination in the ground outside the IP2 SFP. This release was listed as an abnormal release in the 2006 radioactive effluent release report. The applicant included a detailed radiological assessment of all the liquid effluent releases and the projected doses in its 2006 annual radioactive effluent release report (Entergy 2007c). The following information is from that report.

The applicant estimated that approximately 0.19 Ci (7.03×10^{3} MBq) of tritium migrated directly to the Hudson River by the groundwater flow path in 2006, resulting in an approximate total body dose of 2.10×10^{-6} mrem (2.10×10^{-8} mSv). The amount of tritium released through this pathway is approximately 0.015 percent of the tritium released to the river from routine releases. Tritium releases in total (groundwater as well as routine liquid effluent) represent less than 0.001 percent of the Federal dose limits for radioactive effluents from the site. Strontium-90, nickel-63, and cesium-137 collectively contributed approximately 5.70×10^{-4} Ci (21.1 MBq) from the groundwater pathway, which resulted in a calculated annual dose of approximately 1.78×10^{-3} mrem (1.78×10^{-5} mSv) to the total body, and 7.21×10^{-3} mrem (7.21×10^{-5} mSv) to the critical organ, which was the adult bone (primarily because of strontium-90). Storm drain releases to the discharge canal were conservatively calculated to be approximately 9.40×10^{-2} Ci (3.48×10^{3} MBq) of tritium, resulting in an approximate total body dose of 2.00×10^{-8} mrem (2.00×10^{-10} mSv). Entergy asserts that the annual dose to a member of the public from the combined groundwater and storm water pathways at IP2 and IP3 remains well below NRC and U.S. Environmental Protection Agency (EPA) radiation protection standards (Entergy 2007c). The NRC staff further discusses releases to groundwater, including inspection results, in Section 2.2.7 of this SEIS.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

IP2

The gaseous radioactive waste processing system and the plant ventilation system control, collect, process, store, and dispose of gaseous radioactive wastes generated as a result of normal operations. During plant operations, gaseous waste is generated by degassing the reactor coolant and purging the volume control tank, displacing cover gases as liquid accumulates in various tanks, equipment purging, and sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases. The majority of the gas received by the waste disposal system during normal plant operations is cover gas displaced from the chemical and volume control system holdup tanks as they fill with liquid.

Vented gases flow to a waste gas compressor suction header. One of two compressors is in continuous operation, with the second unit designed to operate as a backup for peak load conditions. From the compressors, gas flows to one of four large gas decay tanks. The control arrangement on the gas decay tank inlet header allows plant personnel to place one large tank in service and to select a second large tank for backup. When the tank in service becomes pressurized to a preset level, a pressure transmitter automatically opens the inlet valve to the backup tank, closes the inlet valve to the filled tank, and triggers an alarm to alert personnel to select a new backup tank. Gas held in the decay tanks can either be returned to the chemical and volume control system holdup tanks or be discharged to the environment, provided that the gas meets radiation limits.

Six additional small gas decay tanks are available for use during degassing of the reactor coolant system before the reactor is brought to a cold shutdown. The reactor coolant fission gas activity is distributed among the six tanks through a common inlet header. A radiation monitor in the sample line to the gas analyzer checks the gas decay tank radioactivity inventory each time a sample is taken for hydrogen-oxygen analysis. An alarm notifies plant personnel when the inventory limit is approached so that another tank can be placed into service.

Before a tank's contents can be discharged into the environment, they must be sampled and analyzed to verify that sufficient decay of the radioactive material has occurred and to document the amount of radioactivity that will be released. If appropriate radioactivity criteria are met, the gas is discharged to a plant vent at a controlled rate and checked by a radiation monitor in the vent. In addition to the radiation monitor, gas samples are manually taken and analyzed to ensure that radiation protection limits are maintained. During a release, a trip valve in the discharge line closes automatically when there is an indication of a high radioactivity level in the plant vent (Entergy 2007a).

<u>IP3</u>

The gaseous radioactive waste processing system and the plant ventilation system control, collect, process, store, and dispose of gaseous radioactive wastes generated as a result of normal operations. During plant operations, gaseous waste is generated by degassing the reactor coolant and purging the volume control tank, displacement of cover gases as liquid accumulates in various tanks, equipment purging, sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases, and venting of actuating nitrogen for pressure control valves.

The majority of the gas received by the waste disposal system during normal operations is cover gas displaced from the chemical and volume control system holdup tanks as they fill with liquid. Since this gas must be replaced when the tanks are emptied during processing, facilities are provided to return gas from the decay tanks to the holdup tanks. A backup supply from the nitrogen header is provided for makeup if the return flow from the gas decay tanks is not available.

Gases vented to the vent header flow to the waste gas compressor header. One of the two compressors is in continuous operation with the second unit as a backup for peak load conditions. From the compressors, gas flows to one of four large gas decay tanks. The control arrangement on the gas decay tanks inlet header allows for the operation of one tank with a second tank as backup. When the tank in service is filled, a pressure transmitter automatically opens the inlet valve to the backup tank and closes the valve of the filled tank and sounds an alarm. Plant personnel then select a new tank to be the backup and repeat the process.

Gases are held in the decay tanks to reduce the amount of radioactivity released into the environment. These gases can either be returned to the chemical and volume control system holdup tanks or discharged to the environment if the radioactivity meets radiation standards.

There are six additional small gas decay tanks for use during degassing of the reactor coolant before the reactor is brought to a cold shutdown. The reactor coolant fission gas activity inventory is distributed equally among the six tanks through the use of a common header. The total radioactivity in any one gas decay tank is controlled in order to limit the potential radiological consequences if any tank ruptures.

Before a tank's contents can be released into the environment, they must be sampled and analyzed to verify that there was sufficient decay and to provide a record of the type and quantity of radioactivity to be released. Once these steps are completed, the gas may be released to the plant vent at a controlled rate and monitored by a radiation monitor. The radiation monitor, upon detecting high radioactivity levels, can automatically close the discharge line to the plant vent. Samples are also taken manually to document releases (Entergy 2007a).

Gaseous Releases

Entergy maintains radioactive gaseous effluents in accordance with the procedures and methodology described in the ODCM. The gaseous radioactive waste processing system is effectively used to reduce radioactive materials in gaseous effluents before discharge to meet the ALARA dose objectives in Appendix I to 10 CFR Part 50.

The NRC staff reviewed the IP2 and IP3 annual radioactive effluent release reports from 2002 through 2006 for gaseous effluents (Entergy 2003a, 2003b, 2004, 2005a, 2006b, 2007c) to determine whether the releases were reasonable. There were no abnormal gaseous releases from IP2 and IP3 in 2006. The amount of radioactivity discharged in the form of fission and activation gases from the operating reactors at the IP2 and IP3 site in 2006 totaled 2.20×10^{2} Ci (8.14×10^{6} MBq). A total of 20.8 Ci (7.69×10^{5} MBq) of tritium was released from the IP2 and IP3 site in 2006. A total of 7.87×10^{-4} Ci (29.1 MBq) of radioiodines and 4.76×10^{-5} Ci (1.76 MBq) of particulates was released from the IP2 and IP3 site in 2006 (Entergy 2007c). The gaseous discharges for 2006 are consistent with the radioactive gaseous effluents discharged from 2002 through 2005. In section 2.2.7, NRC staff reviewed the most-recent effluent release reports (2009; Entergy 2010a) and confirmed that radioactive releases reported by Entergy remain reasonable and within applicable limits. The NRC staff expects variations in the amount of radioactive effluents released from year to year based on the overall performance of the plant and the number and scope of maintenance and refueling outages. The gaseous radioactive wastes reported by Entergy are reasonable and is within applicable limits, and the NRC staff noted no unusual trends.

Though Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms during the period of extended operation, such replacement actions are not likely to result in a significant increase in discharges of gaseous radioactive effluents above the amount discharged during normal plant operations. This is based on consideration that any gaseous effluents released during the outage will be offset by the amount of gaseous effluents that would not be generated, processed, and released during normal plant operations. Based on the NRC staff's evaluation of recent historical releases in the previous paragraph and based on the NRC staff's expectation that no significant increase in gaseous effluents from the potential replacement of the reactor heads and control rod drive mechanisms will occur, the NRC staff expects that similar quantities of radioactive gaseous effluents will be generated during normal operations and outages at IP2 and IP3 during the period of extended operation.

2.1.4.3 Solid Waste Processing

IP2 and IP3 solid radioactive wastes include solidified waste derived from processed liquid and sludge products; spent resins, filters, and paper; and glassware used in the radiation-controlled areas of the plant. Waste resin is stored in the spent resin storage tank to allow radioactive decay. When a sufficient volume of resin is accumulated, it is moved from storage and placed into a high-integrity container. The wet waste is then dewatered and prepared for transportation in accordance with the plant's process control program. The process control program contains the criteria and requirements that the waste must meet to comply with NRC and U.S. Department of Transportation (DOT) requirements for transportation of radioactive waste on the public roads. The other solid radioactive wastes, such as paper, rags, and glassware, are also processed for shipping in accordance with the process control program. Entergy, when possible, sends the solid radioactive waste to a material recovery center or to a facility licensed to incinerate and perform other techniques to reduce the waste volume before disposal. Additional interim radioactive waste storage space is located in the IP1 containment.

<u>IP2</u>

At IP2, the original four steam generators are stored in the Original Steam Generator Storage Facility. The facility is made of reinforced concrete and is designed to contain contaminated materials and allow for decontamination of materials if necessary. The structure is built to prevent both the intrusion of water into the facility and the leakage of contaminated water from the facility. The floor of the facility is sloped to direct any liquids to a sump. The floor slab and lower portion of the walls have a protective coating to facilitate decontamination, if required. A passive high-efficiency filter is used to prevent airborne contamination from being vented outside the facility. This facility is located within the owner-controlled area outside of the protected area.

<u>IP3</u>

At IP3, solid radioactive waste (dry activated waste or solidified resins) may be stored in the IP3 Interim Radioactive Waste Storage Facility before being shipped off site. The facility is a concrete structure designed to minimize the impact of stored materials on the public and the environment. It is shielded to limit the offsite annual radiation dose to less than 5 mrem (0.05 mSv). As at IP2, a reinforced concrete structure is used to store the original four steam generators, which were removed in 1989. This structure, called the Replaced Steam Generator Storage Facility, is shielded to reduce radiation exposure, and all openings are sealed with no provision for ventilation. There is a locked and locally alarmed labyrinth entrance that allows for periodic surveillance of the steam generators. There are no gaseous or liquid releases from this facility.

<u>Solid Waste Shipment</u>

IP2 and IP3 radioactive waste shipments are packaged in accordance with NRC and DOT requirements. The type and quantities of solid radioactive waste generated at and shipped from the site vary from year to year, depending on plant activities (i.e., refueling outage, maintenance work, and fuel integrity). Entergy ships radioactive waste to the Studsvik facility in Erwin, Tennessee, the Race facility in Memphis, Tennessee, or the Duratek facility in Oak Ridge, Tennessee, where the wastes undergo additional processing before being sent to a facility for disposal. In the recent past, Entergy had shipped waste to the Barnwell facility in Barnwell County, South Carolina, or the Envirocare facility in Clive, Utah, for disposal (Entergy 2007a). In July 2008, however, the State of South Carolina closed access to radioactive waste generators in States that are not part of the Atlantic Low-Level Waste Compact. New York is not in this compact. (Envirocare, however, remains open for Class A wastes.)

In the near term, Entergy is working to address the loss of the low-level solid radioactive waste disposal repository in Barnwell, South Carolina. During the NRC environmental site audit, IP2 and IP3 staff indicated that they would be able to safely store their low-level waste on site in existing onsite buildings. Entergy indicates that it is currently developing a comprehensive plan to address the potential need for long-term storage. The radiation dose from the storage of low-level radioactive waste would be required to continue to result in doses to members of the public that are below the limits in 10 CFR Part 20 and 40 CFR Part 190, “Environmental Radiation Protection Requirements for Normal Operations of Activities in the Uranium Fuel Cycle,” which apply to all operations and facilities at the site.

In 2006, Entergy made a total of 49 shipments of Class A, B, and C solid radioactive waste to offsite processing vendors. The solid waste volumes were 5.31×10^4 cubic feet (1.50×10^3 m^3) of resins, filters, evaporator bottoms, and dry active waste, with an activity of 9.49×10^2 Ci (3.51×10^7 MBq). Entergy shipped no irradiated components or control rods in 2006 (Entergy 2007c). The solid waste volumes and radioactivity amounts generated in 2006 are typical of annual waste shipments made by Entergy. The NRC staff expects variations in the amount of solid radioactive waste generated and shipped from year to year based on the overall performance of the plant and the number and scope of maintenance work and refueling outages. The NRC staff finds that the volume and activity of solid radioactive waste reported by Entergy are reasonable, and no unusual trends were noted.

Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms during the period of extended operation (Entergy 2008), and such replacement actions are likely to result in a small increase in the amount of solid radioactive waste generated. This is partly because the number of personnel working at the plant will increase, leading to increased use of protective clothing and safety equipment and an increased use of filters. Also, work activities will create a general increase in debris that will have to be disposed of as radioactive waste. However, the increased volume is expected to be within the range of solid waste that can be safely handled by IP2 and IP3 during the period of extended operation. In the GEIS (NRC 1996), NRC indicated that doses from onsite storage of assemblies removed during refurbishment would be “very small and insignificant.” Retired vessel heads will likely be stored on site in a concrete building (Entergy 2008), subject to regular monitoring and dose limits under 10 CFR Part 20 and 40 CFR Part 190.

2.1.5 Nonradioactive Waste Systems

IP2 and IP3 generate solid, hazardous, universal, and mixed waste from routine facility operations and maintenance activities.

2.1.5.1 Nonradioactive Waste Streams

Nonradioactive waste is produced during plant maintenance, cleaning, and operational processes. Most of the wastes consist of nonhazardous waste oil and oily debris and result from operation and maintenance of oil-filled equipment.

The facility generates solid waste, as defined by the Resource Conservation and Recovery Act (RCRA), as part of routine plant maintenance, cleaning activities, and plant operations. These solid waste streams include nonradioactive resins and sludges, putrescible wastes, and recyclable wastes.

Universal wastes constitute a majority of the remaining waste volumes generated at the facility. Universal waste is hazardous waste that has been specified as universal waste by EPA. Universal wastes, including mercury-containing equipment, batteries, fluorescent bulbs, and pesticides, have specific regulations (40 CFR Part 273, “Standards for Universal Waste Management”) to ensure proper collection and recycling or treatment.

Hazardous wastes routinely make up a small percentage of the total wastes generated at the IP2 and IP3 facility and include spent and expired chemicals, laboratory chemical wastes, and other chemical wastes (Entergy 2007a). Hazardous waste is nonradioactive waste that is listed by EPA as hazardous waste or that exhibits characteristics of ignitability, corrosivity, reactivity, or toxicity (40 CFR Part 261, “Identification and Listing of Hazardous Waste”). RCRA, as well as the NYSDEC regulatory requirements set forth in Title 6 of the New York Codes, Rules, and Regulations (NYCRR) Parts 371-376, that regulate storage and handling of hazardous waste and require a hazardous waste permit for facilities that store large quantities of hazardous waste for more than 90 days.

Low-level mixed waste (LLMW) is waste that exhibits hazardous characteristics and contains low levels of radioactivity. LLMW at IP2 and IP3 is regulated under RCRA and NYSDEC regulatory requirements as set forth in 6 NYCRR Parts 373 and 374.

IP2 has mixed waste storage facilities covered by a Permit, NYD991304411, issued by NYSDEC under 6 NYCRR Part 373, for the accumulation and temporary storage of mixed wastes onsite for more than 90 days. Mixed wastes are temporarily stored onsite for more than 90 days at IP3 based on a mixed waste conditional exemption for Permit NYD085503746, per 6 NYCRR Part 374-1.9.

Some amounts of chemical and biocide wastes are produced at the facility from processes used to control the pH in the coolant, to control scale, to control corrosion, to regenerate resins, and to clean and defoul the condensers. These waste liquids are typically discharged in accordance with the site’s State Pollutant Discharge Elimination System (SPDES) Permit, NY-0004472, along with cooling water discharges (Entergy 2007a).

Hazardous and universal wastes are collected in central collection areas. The materials are received in various forms and are packaged to meet all regulatory requirements before final disposition at an appropriate offsite facility. Entergy tracks wastes like waste oil, oily debris, glycol, lighting ballasts containing polychlorinated biphenyls (PCBs), fluorescent lamps, batteries, and hazardous wastes (i.e., paints, lead abatement waste, broken lamps, off-specification and expired chemicals)—by volume at the facility. The total amount of tracked hazardous and universal wastes for 2006 was 17,987 pounds (lb) (8,158 kilograms (kg)) with waste oil making up 70 percent of the total weight (Entergy 2007a).

Most sanitary wastewater from the IP2 and IP3 facility operations is transferred to the Village of Buchanan publicly owned treatment works system. A few isolated areas at the facility have their own septic tanks. Although the sanitary wastewaters are nonradioactive, a radiation monitoring system continuously monitors the effluent from the protected area (Entergy 2007a).

The testing of the emergency generators and boiler operations generates nonradioactive gaseous effluents. Emissions are managed in accordance with IP2 and IP3 air quality permits, 3-5522-00011/00026 and 3-5522-00105/00009, respectively (Entergy 2007a).

2.1.5.2 Pollution Prevention and Waste Minimization

Entergy's Waste Minimization Plan describes programs that have been implemented at the facility. This plan is used in conjunction with other waste minimization procedures, waste management procedures (including on-site recycling), chemical control procedures, and other site-specific procedures to reduce waste generation (Entergy 2007a).

2.1.6 Facility Operation and Maintenance

Maintenance activities conducted at IP2 and IP3 include inspection, testing, and surveillance to maintain licensing requirements and to ensure compliance with environmental and safety requirements. Various programs and activities currently exist at the facility to maintain, inspect, test, and monitor the performance of facility equipment. These maintenance activities include inspection requirements for reactor vessel materials, in-service inspection and testing of boilers and pressure vessels, the maintenance structures monitoring program, and water chemistry maintenance.

Additional programs include those implemented to meet technical specification surveillance requirements, those implemented in response to the NRC generic communications, and various periodic maintenance, testing, and inspection procedures. Certain program activities are performed during the operation of the unit, while others are performed during scheduled refueling outages. As mentioned in Section 2.1.2, Entergy typically refuels IP2 and IP3 on 24-month cycles.

2.1.7 Power Transmission System

The applicant has identified two 345-kV transmission lines that connect IP2 and IP3 to the Con Edison electrical transmission grid. Feeder W95 and feeder W96 deliver power from IP2 and IP3, respectively, to the Buchanan substation located across Broadway near the entrance to the IP2 and IP3 site. Other than these two transmission lines, no other lines or facilities were constructed specifically to connect the two generating units to the existing transmission grid. Because the Buchanan substation and the regional transmission system to which it connects were designed and constructed before IP2 and IP3 (Entergy 2007a; NRC 1975; USAEC 1972), they are beyond the scope of this evaluation.

Each of the W95 and W96 lines is approximately 2000 ft (610 m) long. The lines are within the site except for the terminal 100-ft (30.5-m) segments that cross Broadway and enter the substation. In addition to transmitting the output power from IP2 and IP3 off site, the transmission system also provides IP2 and IP3 with the auxiliary power necessary for startup and normal shutdown. Offsite (standby) power is supplied to IP2 and IP3 by 138-kV input lines that use the same transmission towers as the W95 and W96 output lines (Entergy 2005b; NRC 1975). The W95 and W96 lines are each within a separate right-of-way (ROW), so the ROWs total approximately 4000 ft (1220 m) in length. About 500 ft (150 m) of this ROW length is vegetated; the remainder crosses roads, parking lots, buildings, and other facilities. In the vegetated segments, the NRC staff observed that the ROW is approximately 150 ft (46 m) wide, the growth of trees is prevented, and a cover of mainly grasses and forbs is maintained.

2.2 Plant Interaction with the Environment

2.2.1 Land Use

Within the 239-acre (97-ha) Indian Point site, IP2 and IP3 (see Figure 2-3) are located north and south, respectively, of IP1, which is in SAFSTOR until it is eventually decommissioned. The developed portion of the IP2 and IP3 site is approximately 124.3 acres (50.3 ha), or over half the site (see Figure 2-3). The remaining portions of the site are unused, undeveloped, and include fields and forest uplands (approximately 112.4 acres (45.5 ha) and wetlands, streams, and a pond (2.4 acres (0.97 ha)). Much of the site (approximately 159 acres (64.3 ha)) has been disturbed at some time during the construction and operation of the three units (ENN 2007b).

The immediate area around the station is completely enclosed by a fence with access to the station controlled at a security gate. The plant site can be accessed by road or from the Hudson River. Land access to the plant site is from Broadway (main entrance). The existing wharf is used to receive heavy equipment as needed, although access to the site from the river is controlled by site access procedures. The plant site is not served by railroad. The exclusion area, as defined by 10 CFR 100.3, “Definitions,” surrounds the site as shown in Figure 2-3 (Entergy 2007a).

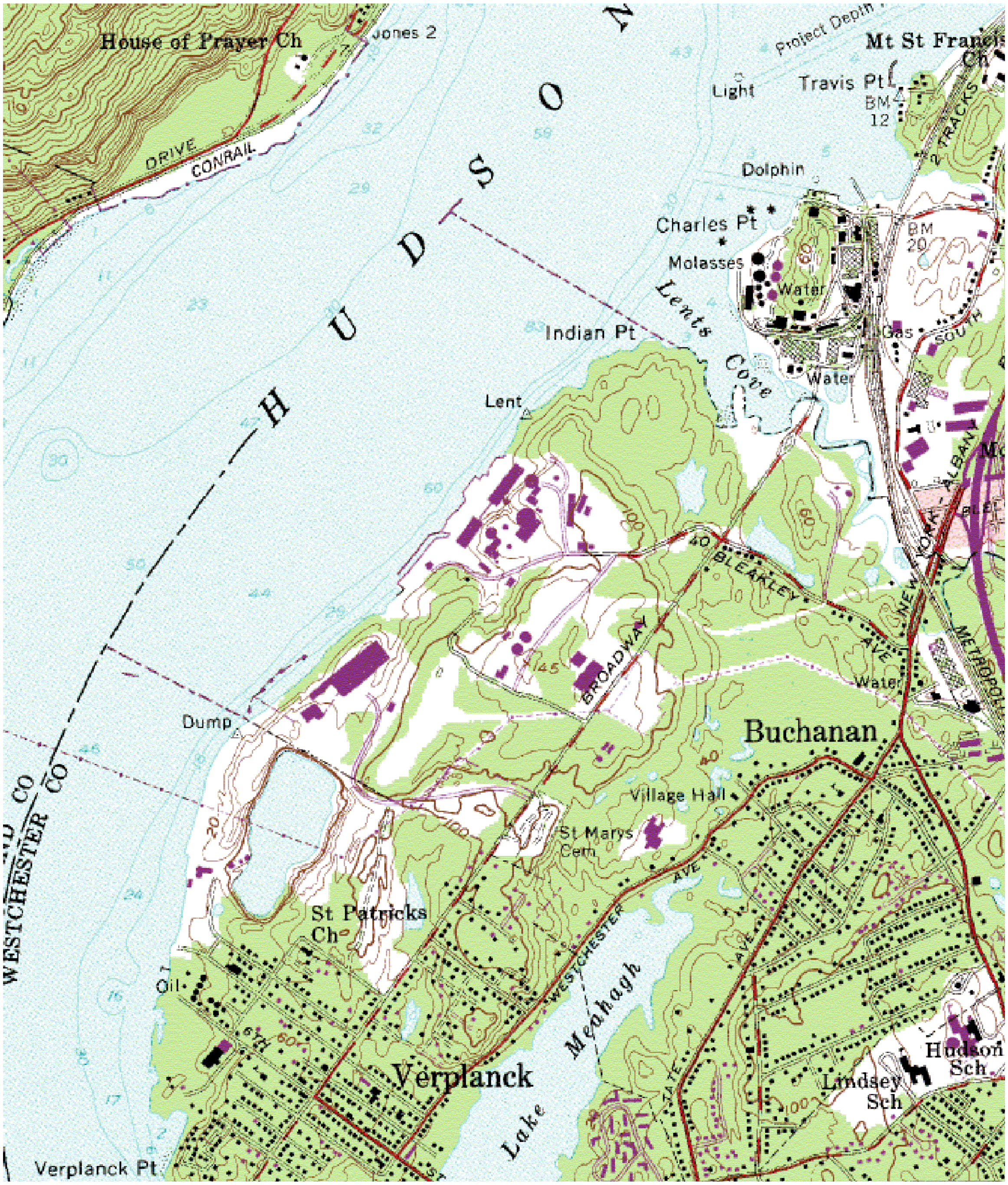
2.2.2 Water Use

The Hudson River is an important regional resource of significant aesthetic value in addition to providing transportation, recreation, and water supply. The Hudson River at IP2 and IP3 is tidally influenced and becomes increasingly so as it proceeds south. IP2 and IP3 have a once-through condenser cooling system that withdraws water from the Hudson River. The same amount of water that is withdrawn for condenser cooling is discharged. However, the discharged water is at an elevated temperature and, therefore, can induce some additional evaporation. The NRC staff conservatively estimates that this induced evaporation from elevated discharge temperature is less than 60 cfs (1.7 m^3/s). The remaining consumptive water uses are insignificant relative to induced evaporation.

2.2.3 Water Quality

Being tidally influenced, the salinity of the Hudson River varies as upstream flows and tides fluctuate. The salinity decreases when stream flows increase and tides drop. The salinity increases during periods of low flow and high tides. The periodic higher salinity levels limit some of the uses that a lower salinity river might support (e.g., drinking water supply).

Discharges to the Hudson River are regulated by the Clean Water Act (CWA). The CWA is administered by EPA. EPA has delegated responsibility for administration of the National Pollutant Discharge Elimination System to NYSDEC. The IP2 and IP3 ownership submitted timely and sufficient applications to renew its SPDES permits before the expiration of those permits in 1992. The 1987 SPDES permit for the facility remains in effect while NYSDEC administrative proceedings continue. Pursuant to the New York State Administrative Procedure Act, the facility SPDES permit does not expire until NYSDEC makes its final determination. To date, this final determination has not been made. In 1991, NYSDEC, the facility owners, and several stakeholder groups entered



Source: Maptech, Inc.

Figure 2-9. Topographic features surrounding IP2 and IP3

into a consent order (issued pursuant to the Hudson River Settlement Agreement; see Section 2.2.5.3 for more information) to mitigate impacts of the thermal plume entering the Hudson River from the plant's discharge. On April 2, 2010, the New York State Department of Environmental Conservation (NYSDEC) issued a Notice of Denial regarding the IP2 and IP3 Clean Water Act Section 401 Water Quality Certification. Entergy has since requested a hearing on the issue, and the matter will be decided through NYSDEC's hearing process.

IP2 and IP3 do not intentionally discharge contaminants in a manner that would contaminate the groundwater beneath the site. However, in 2005, tritium was located beneath the IP2 and IP3 site. During a subsequent subsurface monitoring program at the site, radioactive forms of cesium, cobalt, nickel, and strontium also were found. The radiological impact of these leaks on groundwater is discussed in Section 2.2.7 of this SEIS (the leaks are also mentioned in Section 2.1.4.1 of this SEIS).

2.2.4 Meteorology and Air Quality

2.2.4.1 Climate

IP2 and IP3 are located in the Village of Buchanan, New York, in Westchester County on the eastern bank of the Hudson River at approximately RM 43 (RKM 69). The river bisects the area within a 6-mi (9.7-km) radius of the site and geographically separates Westchester County from Rockland County to the west. The Hudson River flows northeast to southwest at the site but turns sharply northwest approximately 2 mi northeast of the plant. The western bank of the Hudson River is flanked by the steep, heavily wooded slopes of the Dunderberg and West Mountains to the northwest (elevations 1086 and 1257 ft (331 and 383 m) above mean sea level (MSL), respectively) and Buckberg Mountain to the west-southwest (elevation 793 ft (242 m) above MSL). These peaks extend to the west and gradually rise to slightly higher peaks (Entergy 2007a).

The climate is continental, characterized by rapid changes in temperature, resulting in hot summers and cold winters. The area, being adjacent to the St. Lawrence River Valley storm track, is subject to cold air masses approaching from the west and north. It has a variable climate, characterized by frequent and swift changes. The climate is also subject to some modification by the Atlantic Ocean. The moderating effect on temperatures is more pronounced during the warmer months than in winter when bursts of cold air sweep down from Canada. In the warmer seasons, temperatures rise rapidly in the daytime. However, temperatures also fall rapidly after sunset so that the nights are relatively cool. Occasionally, there are extended periods of oppressive heat up to a week or more in duration. Winters are usually cold and sometimes fairly severe. Furthermore, the area is also close to the path of most storm and frontal systems that move across the North American continent. Weather conditions often approach from a westerly direction, and the frequent passage of weather systems often helps reduce the length of both warm and cold spells. This is also a major factor in keeping periods of prolonged air stagnation to a minimum (NOAA 2004).

The State of New York has a climate that varies greatly. For example, the average January temperature ranges from 14° Fahrenheit (F) (-10° Celsius (C)) in the central Adirondack Mountains to 30°F (-1.1°C) on Long Island. The average July temperature in the central Adirondacks is 66°F (19°C), and 74°F (23°C) on Long Island. The highest temperature ever recorded in the State was 108°F (42°C) at Troy on July 22, 1926. The lowest recorded temperature, -52°F (-47°C), occurred at Old Forge, in the Fulton Chain of Lakes area, on February 18, 1979 (World Book Encyclopedia 2006). In Westchester County, where IP2 and IP3 are located, temperatures are mild in the summer and cold in the winter. Buchanan, New York, has a mean daily maximum temperature range from 28°F (-2.2°C) in winter to 87°F (31°C) in summer. The mean daily minimum temperatures range from about 20°F (-6.7°C) in winter to about 72°F (22°C) in summer (Indian Point Energy Center 2004).

Precipitation varies considerably in New York. The areas of Tug Hill, the southwestern slopes of the Adirondacks, the central Catskills, and the southeast areas usually receive 44 in. (110 cm) of rain a year, while other portions of the State get only 36 in. (91 cm). The Great Lakes, with their broad expanse of open water, supply moisture for abundant winter snowfall. Syracuse, Rochester, and Buffalo routinely receive annual snowfalls that are the highest for any major city in the United States (World Book Encyclopedia 2006). Most of the precipitation in this area is derived from moisture-laden air transported from the Gulf of Mexico and cyclonic systems moving northward along the Atlantic coast. The annual rainfall is rather evenly distributed over the year. Also, being adjacent to the track of storms that move through the Saint Lawrence River Valley, and under the influence of winds that sweep across Lakes Erie and Ontario to the interior of the State, the area is subject to cloudiness and winter snow flurries. Furthermore, the combination of a valley location and surrounding hills produces numerous advection fogs which also reduce the amount of sunshine received (NOAA 2004).

In the IP2 and IP3 Buchanan area, precipitation averages 37 in. (94 cm) per year and is distributed rather evenly throughout the 12-month period. The lowest amount is in February, and the highest is in May (Indian Point Energy Center 2004). Although the Village of Buchanan area is subject to a wide range of snowfall amounting to as little as 20 in. (51 cm) or as much as 70 in. (180 cm), Westchester County snowfall amounts typically average between approximately 25 to 55 in. (64 to 140 cm) per year (NRCC 2006).

Wind velocities are moderate. The north-south Hudson River Valley has a marked effect on the lighter winds, and in the warm months, average wind direction is usually southerly. For the most part, the winds at Buchanan have northerly and westerly components. Destructive winds rarely occur. Tornadoes, although rare, have struck the area, causing major damage (NOAA 2004).

On average, seven tornadoes strike New York every year (USDOC 2006a). Westchester County has had a total of eight tornadoes since 1950, seven of which have been F1 or less (“weak” tornadoes). The eighth tornado, which struck portions of Westchester County on July 12, 2006, was rated as an F2 at its maximum intensity (briefly a “strong” tornado) but was an F1 for most of its existence. Based on climatic data compared to other regions of the United States, the probability of a tornado striking the IP2 and IP3 site is small, and tornado intensities in Westchester County are relatively low (USDOC 2006b).

2.2.4.2 Meteorological System

Entergy’s meteorological system consists of three instrumented towers, redundant power and ventilation systems, redundant communication systems, and a computer processor/recorder.

Entergy describes the primary system as a 122-m (400-ft) instrumented tower located on the site that provides the following:

- wind direction and speed measurement at a minimum of two levels, one of which is representative of the 10-m (33-ft) level

- standard deviations of wind direction fluctuations as calculated at all measured levels
- vertical temperature difference for two layers (122–10 m (400–33 ft) and 60–10 m (197–33 ft))
- ambient temperature measurements at the 10-m (33-ft) level
- precipitation measurements near ground level
- Pasquill stability classes as calculated from temperature difference (Indian Point Energy Center 2005)

The meteorological measurement system is located in a controlled environmental housing and connected to a power supply system with a redundant power source. A diesel generator provides immediate power to the meteorological tower system within 15 seconds after an outage trips the automatic transfer switch. Support systems include an uninterruptible power supply, dedicated ventilation systems, halon fire protection, and dedicated communications (Indian Point Energy Center 2005).

Entergy indicates that the meteorological system transmits 15-minute average data simultaneously to two loggers at the primary tower site. One data logger transmits to a computer that determines joint frequency distributions, and the second transmits to a computer in the Buchanan Service Center that allows remote access to the data. Meteorological data can be transmitted simultaneously to emergency responders and the NRC in a format designated by NUREG-0654/FEMA-REP-1. Fifteen-minute averages of meteorological parameters for the preceding 12 hours are available from the system (Indian Point Energy Center 2005).

The backup meteorological system is independent of the primary system and consists of a backup tower located approximately 2700 ft (833 m) north of the primary tower and a data acquisition system located in the Emergency Operations Facility. The backup system provides measurements at the 10-m (33-ft) level of wind direction and speed and an estimate of atmospheric stability (Pasquill category using sigma theta, which is a standard deviation of wind fluctuation). The backup system provides information in real-time mode. Changeover from the primary system to the backup system occurs automatically. In the event of a failure of the backup meteorological measurement system, a standby backup system exists at the 10-m (33-ft) level of the Buchanan Service Center building roof. It also provides measurements of the 10-m (33-ft) level of wind direction and speed and an estimate of atmospheric stability (Pasquill category using sigma theta, which is a standard deviation of wind fluctuations). The changeover from the backup system to the standby system also occurs automatically. As in the case of the primary system, the backup meteorological measurement system and associated controlled environmental housing system are connected to a power system which is supplied from redundant power sources. In addition to the backup meteorological measurement system, a backup communications line to the meteorological system is operational. During an interim period, the backup communications are provided via telephone lines routed through a telephone company central office separate from the primary circuits (Indian Point Energy Center 2005).

2.2.4.3 Air Quality

Under the Clean Air Act, EPA established National Ambient Air Quality Standards (NAAQS) for specific concentrations of certain pollutants, called criteria pollutants. Areas in the United States having air quality as good as or better than these standards (i.e., pollutant levels lower than the

NAAQS) were designated as attainment areas for the various pollutants. Areas with monitored pollutant levels greater than these standards are designated as nonattainment areas. Areas in the United States whose pollutant levels were greater than the NAAQS and are now lower than the NAAQS are designated as maintenance areas.

Four states are located within a 50-mi (80-km) radius of the site. These include Pennsylvania's, Connecticut, New York, and New Jersey. The 50-mi (80-km) radius includes nonattainment areas for the ozone (O_3) 8-hour standard, particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). The portion of Pennsylvania (Pike County) located within the 50-mi (80-km) radius is in attainment for all criteria pollutants.

The currently designated nonattainment areas for Connecticut counties within a 50-mi (80-km) radius of the site are as follows:

- Fairfield and New Haven*—O_3 and $PM_{2.5}$
- Litchfield—O_3

The currently designated nonattainment areas for New Jersey counties within a 50-mi (80-km) radius of the site are as follows:

- Bergen, Essex, Hudson, Morris, Passaic, Somerset, and Union*—O_3 and $PM_{2.5}$
- Sussex*—O_3

The currently designated nonattainment areas for New York counties within a 50-mi (80-km) radius of the site are as follows:

Bronx, Kings, Nassau, Orange, Queens, Richmond, Rockland, Suffolk, and Westchester*—O_3 and $PM_{2.5}$

- Dutchess and Putnam—O_3
- New York*—O_3, PM_{10}, and $PM_{2.5}$

Note that the counties labeled with an "*" are part of the EPA-designated "New York—New Jersey—Long Island Nonattainment Area" (EPA 2006a).

New York State air permits for IP2 and IP3, 3-5522-00011/00026 and 3-5522-000105/00009, respectively, regulate emissions from boilers, turbines, and generators. These permits restrict nitrogen oxides (NOx) emissions to 23.75 tons (t) (22 metric tons (MT)) per year per station by restricting engine run time and fuel consumption. IP2 and IP3 are not subject to the Risk Management Plan (RMP) requirements described in 40 CFR Part 68, as no RMP-regulated chemicals stored on site exceed the threshold values listed in 40 CFR Part 68 (Entergy 2007a).

There are no Mandatory Class I Federal areas designated by the National Park Service, U.S. Fish and Wildlife Service (FWS), or the U.S. Forest Service within 50 mi (80 km) of the site. Class I areas are locations in which visibility is an important attribute. As defined in the Clean Air Act, they include several types of areas that were in existence as of August 7, 1977—national parks over 6000 acres (2430 ha), national wilderness areas, and national memorial parks over 5000 acres (2020 ha), and international parks (NPS 2006a). The closest Class I

Area is Lye Brook Wilderness Area, Vermont, approximately 150 mi (240 km) east-northeast of IP2 and IP3 (NPS 2006b).

2.2.5 Aquatic Resources

In this section, the NRC staff describes the physical, chemical, and biological characteristics of the Hudson River estuary. In addition, the NRC staff describes the major anthropogenic events that have influenced the estuary and the history of regulatory action over the past 50 years.

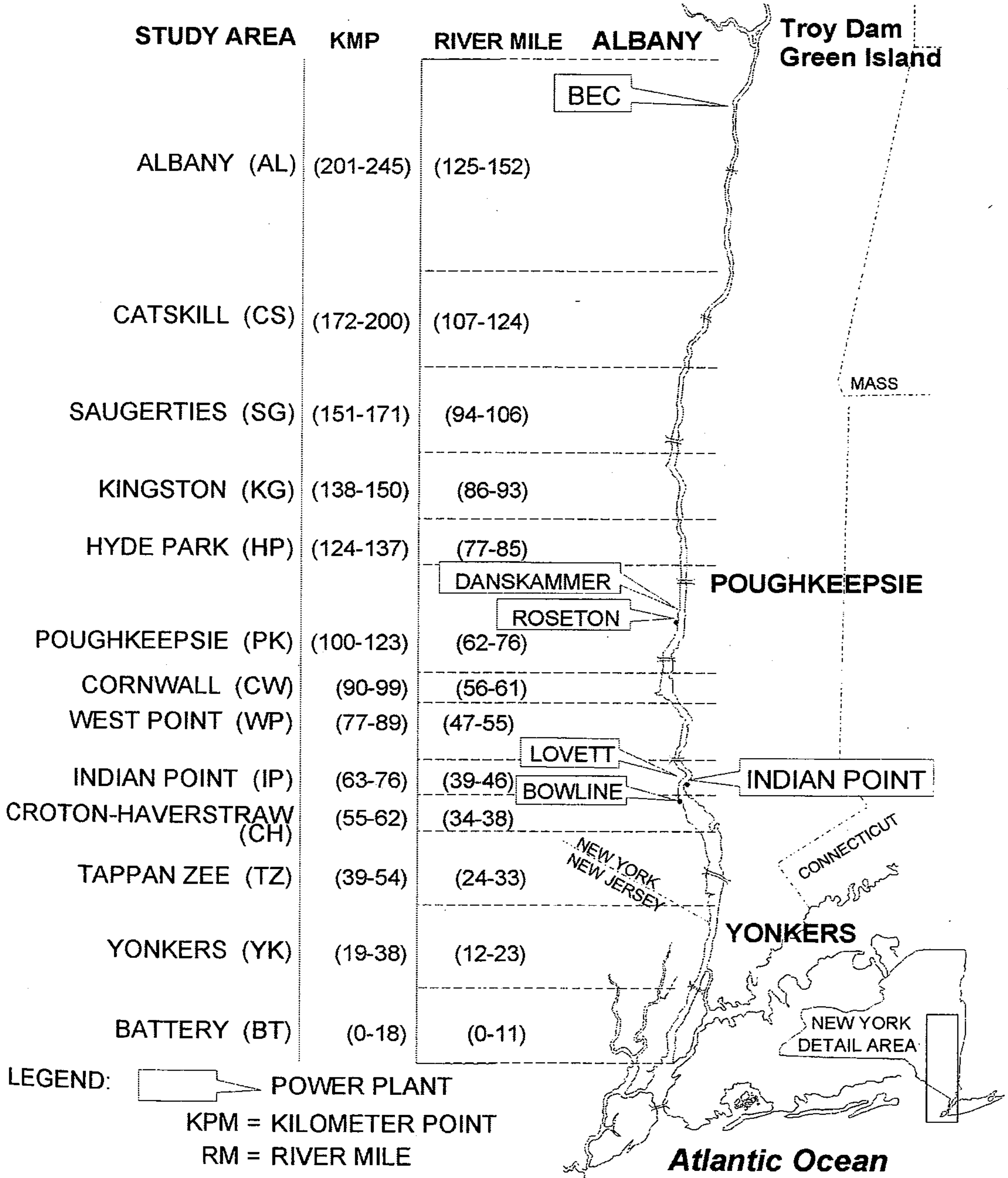
2.2.5.1 The Hudson River Estuary

<u>Watershed Description</u>

The Hudson River originates at Tear-of-the-Clouds in the Adirondack Mountains of northern New York State. From its source, the river flows south 315 mi (507 km) to its mouth at the Battery, at the south end of the island of Manhattan. The Hudson River basin extends 128 mi (206 km) from east to west and 238 mi (383 km) from north to south and drains an area of 13,336 square miles (sq mi) (34,540 sq km), with most of this area located in the eastern-central part of New York State and small portions in Vermont, Massachusetts, Connecticut, and New Jersey (Abood et al. 2006). The basin is bounded by the St. Lawrence and Lake Champlain drainage basins to the north; the Connecticut and Housatonic River basins to the east; the Delaware, Susquehanna, Oswego, and Black River basins to the west; and the basins of small tributaries and New York Harbor on the south. From the Troy Dam to the Battery, the lower Hudson River basin is about 154 mi (248 km) long and drains an area of about 5277 sq mi (13,670 sq km). The average slope of the lower Hudson River, defined in terms of the half-tide level, is about 0.6 m (2 ft) over 150 mi (240 km) (Abood et al. 2006). During the development of the multi-utility studies in the 1970s, the lower portion of the Hudson River from the Troy Dam to the Battery was divided into 13 study areas (river segments), depicted in Figure 2-10. The study area and river segment designations identified in the figure will be used to discuss monitoring results and data collection locations throughout this document.

<u>Lower Hudson River Basin Habitats</u>

The lower Hudson River estuary contains a variety of habitats, including tidal marshes, intertidal mudflats, and subtidal aquatic beds. These habitats exist throughout the length of the river and can be freshwater, brackish, or saline. The freshwater communities are generally located north of Newburgh (CHGEC 1999), with brackish communities found farther south. There are four locations within the estuary designated as National Estuarine Research Reserve System Sites by the National Oceanic and Atmospheric Administration (NOAA) and NYSDEC, including, from north to south, Stockport Flats, Tivoli Bay, Iona Island, and Piermont Marsh (NOAA 2008), as shown in Figure 2-11. The lower Hudson River basin also contains Haverstraw Bay, shown in Figure 2-11, a significant nursery area for a variety of fish, including striped bass, white perch, Atlantic tomcod, and Atlantic sturgeon, and a wintering area for the federally listed endangered shortnose sturgeon (FWS 2008a).



1 Source: Abood et al. 2006

2 **Figure 2-10. Hudson study area and river segments**

3

1 **Figure 2-11. Hudson river area and national estuarine research sites**

2

Community type and habitat characteristics are influenced by the extent of tidal excursions, which are controlled by tidal stage and river flow. During drought periods, the 100 milligrams per liter (mg/L) (0.1 parts per thousand (ppt)) salinity front can extend up to 130 km (81 mi) above the ocean entrance (Abood et al. 2006).

In general, narrow, shallow river reaches with high current flow have extensive bottom scour and low organic carbon levels. The coarse gravel substrate provides spawning habitat for some species. Similar characteristics can also be found where tributaries to the main river stem join the Hudson. High current speeds through deep basins can generate turbulent flow that keeps weakly swimming zoo- and icthyoplankton suspended in the water column and away from silty nearshore locations and potential predators. Shallow, shore-zone habitats often support submerged aquatic vegetation that provides habitat and protection for juvenile fish and other aquatic communities. Broad, shallow basins often create depositional environments where fine sediments, high levels of organic carbon, and nutrients are present. These environments are generally highly productive and may serve as nursery areas for juvenile fish species (CHGEC 1999).

Human activities, however, have significantly affected the lower Hudson River estuary. Increasing human populations along the estuary throughout recent history have contributed to increased habitat alteration. Section 2.2.5.2 examines human influences in greater detail.

The construction of railroad lines along the banks of the river disrupted the connection of the river to marshland and wetland habitats. Construction of causeways interfered with or completely blocked tributary inlets, disrupting sediment transport and other natural phenomena. Anthropogenic activities also resulted in the dredging of some habitats and the filling of others. The historical impacts to the lower Hudson River habitats are discussed later in this section.

To describe the predominant habitat features associated with the lower Hudson River estuary, Central Hudson Gas and Electric Corporation (CHGEC; 1999) divided the lower river from the Troy Dam to the Battery into five subsections of roughly comparable volume consisting of one or more of the regions and river segments identified in Figure 2-10. Beginning at the Troy Dam, the first subsection extends from RM 152 to 94 (RKM 245 to 151) and includes the Albany, Catskill, and Saugerties study areas. This subsection of the river is relatively narrow and has extensive shoals and numerous tributaries. Within this subsection and approximately 6.2 mi (10 km) south of the Troy Dam, the river is about 574 ft (175 m) wide—the narrowest part of the lower Hudson (Abood et al. 2006). The slope of the river is also greatest in this subsection and generates current velocities greater than in other areas.

The second subsection of the river defined by CHGEC (1999) extends from RM 93 to 56 (RKM 150 to 90) and includes the Kingston, Hyde Park, Poughkeepsie, and Cornwall study areas. This subsection contains a series of progressively deeper basins, and the volume of this area is approximately 1.5 times larger than that of the adjacent upriver areas. Shallow shoreline and shoal areas are common only in the southernmost end of this subsection.

The third subsection of the river defined by CHGEC (1999) extends from RM 55 to 39 (RKM 89 to 63), and includes the West Point and IP2 and IP3 study areas. At this location, the Hudson Highlands land mass forced glaciers through a narrow constriction, resulting in the deepest and most turbulent flow observed in the lower Hudson. Within this subsection, the river channel narrows abruptly, bends sharply to the east, and reaches a depth of over 150 ft (46 m). At the lower portions of this subsection, the river bottom consists of a series of progressively shallower gouges that result in a corrugated bottom that ends in shallow water behind the Hudson Highlands. The IP2 and IP3 and Bowline Point power stations (along with the no-longer-operating Lovett station) are located within this river subsection.

The fourth subsection of the river defined by CHGEC (1999) is located from RM 38 to 24 (RKM 62 to 39) and includes the Croton-Haverstraw and Tappan Zee study areas (Figure 2-10). This is the widest and shallowest portion of the lower Hudson River and has the most extensive shoal and shore zone areas. The presence of slow-moving currents and shoal areas results in the deposition of suspended sediment, organic carbon, and nutrients. The major source of suspended sediment to the Hudson is associated with watershed basin runoff and erosion, and basin-wide loads have been estimated at 800,000 tons per year (t/yr; 726,000 MT/yr) (Abood et al. 2006). The presence of slow-moving currents, shoal and shore-zone habitat, and high carbon and nutrient inputs makes this a highly productive portion of the lower Hudson River and provides important spawning and nursery areas for juvenile fish.

The fifth subsection of the river defined by CHGEC (1999) begins at RM 24 (RKM 38) and extends to the river's entrance into New York Harbor, encompassing the Yonkers and Battery study areas. In this subsection, the river again constricts and gradually deepens as it enters New York Harbor. In this location, the river is generally straight and contains few shoal areas or shore-zone habitats. The final 12 mi (19 km) of the lower Hudson have extensive armoring and contain little remaining natural shoreline (CHGEC 1999).

Sampling Strata Definitions

In order to effectively sample and study the lower Hudson, researchers have attempted to define specific zones, habitats, or locations within the river. These specific locations, often called strata, provide researchers with a quantitative way to sample the environment and integrate the resulting information. A variety of attempts have been made to define the channel morphology and thus the potential strata of the lower Hudson. Miller et al. (2006) describe three major habitat areas in the lower Hudson:

(1) Intertidal: Areas exposed at low tide and submerged at high tide that include mud flats, sand, broadleaf marsh, and emergent intertidal vegetation.

(2) Shallows: Areas of the river less than 6.6 ft (2.0 m) deep at mean low tide. This habitat supports submerged aquatic vegetation (SAV) in the river and is considered one of the most productive habitats in the estuary and of great ecological importance.

(3) Deepwater: Areas of the river greater than 6.6 ft (2.0 m) deep at mean low tide. This area represents the limit of light penetration and generally does not support SAV.

During the development of the Hudson River Utilities studies of the lower Hudson River in the 1970s, the study areas and river segments were divided into four primary strata to support fish and plankton investigations. These strata provide a geomorphological basis for partitioning the river and are still used to define sampling locations (ASA 2007):

(4) Shore: The portion of the Hudson River estuary extending from the shore to a depth of 10 ft (3.0 m). This area was primarily sampled by beach seine.

(5) Shoal: The portion of the Hudson River extending from the shore to a depth of 20 ft (6.1 m) at mean low tide.

(6) Bottom: The portion of Hudson River extending from the bottom to 10 ft (3.0 m) above the bottom where the river depth is greater than 20 ft (6.1 m) mean low tide.

(7) Channel: The portion of the Hudson River not considered bottom where river depth is greater than 20 ft (6.1 m) at mean low tide.

Hydrodynamics and Flow Characteristics

In the lower Hudson River, freshwater flow is one of the most important factors in determining and influencing the physical, chemical, and biological processes in the estuary and the resulting interactions within the food web. Hydrodynamics and flow characteristics are controlled by a complex series of interactions that include short- and long-term fluctuations in meteorological conditions, precipitation and runoff in the upstream portion of the watershed, the influence of tides and currents in downstream portions of the river, and the presence of a “salt wedge” that moves up- or downstream depending on river flow and tidal fluctuation (Blumberg and Hellweger 2006). Freshwater flow varies throughout the year, with maximum flow occurring during the months of March through May, with low-flow conditions beginning in June and continuing until November (Abood et al. 2006). Under normal conditions, approximately 75 percent of the total freshwater flow enters the lower Hudson River at Troy, with the remaining portion contributed by tributaries discharging into the upper reach of the estuary (CHGEC 1999; Abood et al. 2006). Because of tidal oscillation in the estuary, it is not possible to accurately measure freshwater flow in the lower estuary. Freshwater flow is, however, monitored by the U.S. Geological Survey (USGS) at Green Island, the farthest downstream USGS gauge above tidewater (CHGEC 1999; Abood et al. 2006). Data recorded from this gauge from 1948 to 2006 show that the mean annual flow was approximately 14,028 cfs (397.23 m^3/s). The lowest recorded annual flow was 6400 cfs (180 m^3/s) in 1965; the highest was 22,100 cfs (626 m^3/s) in 1976. Measured flows from Green Island from 1996 to 2006 ranged from 11,400 cfs (323 m^3/s) in 2002 to over 18,000 cfs (510 m^3/s) in 1996 (USGS 2008).

Salinity

CHGEC (1999) describes four salinity habitat zones in the Hudson River:

(8) polyhaline (high salinity): RM 1–19 (RKM 1–31)

(9) mesohaline (moderate salinity): RM 19–40 (RKM 31–64)

(10) oligohaline (low salinity): RM 40–68 (RKM 64–109)

(11) tidal freshwater: RM 68–152 (RKM 109–245)

The IP2 and IP3 and Bowline Point facilities are located in the oligohaline zone and generally experience salinities of 0.5 to 5 ppt. The actual salinity present at a given time and place can vary considerably in the lower regions of the river because of salinity intrusion, which occurs throughout the year. The typical tidal excursion in the lower Hudson River is generally 3 to 6 mi (5 to 10 km), but can extend up to 12 mi (19 km) upstream. During the spring, the salt front is located between Yonkers and Tappan Zee and moves upstream to just south of Poughkeepsie during the summer (Blumberg and Hellweger 2006). Abood et al. (2006) report that, during drought periods, the salt front (defined as water with a salinity of 100 mg/L (0.1 ppt)) can extend up to RM 81. Stratification also occurs within this salt-intruded reach. Studies by Abood et al. (2006) suggest that from 1997–2003, salinity in the Hudson River has increased approximately 15 percent for a given flow rate. The authors suggest that this conclusion be viewed with caution and that further analysis is required to confirm this finding. Real-time monitoring of the salt front position on the lower Hudson River is provided by USGS and can be accessed via its Web site (USGS 2008).

Temperature

Water temperatures in the Hudson River vary seasonally, with a maximum temperature of 25°C (77°F) occurring in August and a minimum temperature of 1°C (34°F) occurring in January–February. The magnitude and distribution of water temperatures in the estuary are influenced by a variety of factors and complex relationships. Abood et al. (2006) identified four categories of parameters that play a significant role in water temperature—(1) atmospheric conditions, including radiation, evaporation, and conduction, (2) hydrodynamic conditions, including channel geometry, flow, and dispersion, (3) boundary conditions associated with the temperature of the ocean and freshwater, and (4) anthropogenic inputs, including those associated with activities that use river water for cooling purposes. The four parameters are interrelated and collectively influence temperature ranges and distributions in the estuary. Anthropogenic influences are of particular concern because they generally represent a constant influence on the system that may be controlled or managed, unlike those influences associated with climate, river morphology/geometry, and natural interactions between the river and ocean. Abood et al. (2006) indicate that the greatest percentage of artificial (anthropogenic) heat input into the lower Hudson River estuary is associated with the use of river water for condenser cooling in support of electrical power generation. The authors indicate that there are currently six power plants operating in the lower Hudson River estuary, with a total electrical generation of approximately 6000 MW(e), that use the Hudson River as cooling water. These plants collectively use 4.6 million gpm (290 m^3/s) and produce approximately 8×10^{11} British thermal units per day (Btu/day) (2.3×10^{8} kilowatt-hours per day (kWh/day), or 9800 MW of thermal power output). Anthropogenic activities can also result in a net cooling effect on the river. An example given by Abood et al. (2006) suggests that a 1-million-gallon-per-day (mgd) (3800-m^3/day) sewage effluent facility discharging water at 18°C (64°F) during the summer would cool the river because river ambient temperatures are higher.

Attempts to determine long-term changes to the temperature of the lower Hudson River are often confounded by changes in measurement locations and procedures, especially in long-term studies.

An analysis of long-term temperature trends in the lower Hudson River was attempted by Ashizawa and Cole (1994), using data obtained from the Poughkeepsie Water Works (PWW), which processes drinking water. This facility is located in the Poughkeepsie study area approximately 30 mi (48 km) upstream from IP2 and IP3 (Figure 2-10). A nearly continuous data set is available from PWW, beginning in 1908 and continuing to the present day. The data set represents water withdrawn from the Hudson River approximately 14 ft (4.3 m) below low tide. The results of the study show that the overall mean annual water temperature at the intake location was 12.2°C (54°F), and that water temperatures were highly correlated with air temperature during the winter and spring months. Although the overall trends in temperature suggested a gradual warming, the authors concluded that the relationship was not monotonic (i.e., showing change in only one direction over time). Rather, there were periods of both increasing and decreasing temperatures, with episodes of statistically significant warming occurring approximately 22.7 percent of the time and episodes of significant cooling occurring 11.5 percent of the time. During the period from 1918 to 1990, the authors observed a significant increase in temperature, with a rate of warming of 0.12°C (0.22°F) per decade. The sharpest increase during that time occurred from 1971 to 1990 at 0.46°C (0.83°F) per decade; the sharpest cooling occurred from 1908 to 1923 at 0.79°C (1.42°F) per decade. The authors noted that there has been only one cooling event since 1923 (1968 to 1977), which occurred during a time of greater than average rainfall and record-setting freshwater flows, illustrating the complex relationships between weather, river flow, hydrodynamic connections, and anthropogenic effects discussed earlier.

Dissolved Oxygen

As discussed above, obtaining reliable data and trends associated with temperature and dissolved oxygen (DO) can be problematic in dynamic, open-ended systems. Measurements obtained during routine sampling within the river provide only a snapshot of actual conditions; measurements taken continuously from fixed, known locations provide long-term records, but only for the point or area of interest. Declines in DO can be caused by both natural and anthropogenic activities and may be transient or persist episodically or continually through time.

In some cases, observed declines in DO at specific times and locations in the Hudson River have been at least partially attributed to the appearance of invasive species, such as zebra mussels (Caraco et al. 2000). Even episodic events can have serious implications for fish and invertebrate communities and dramatically alter marine and estuarine food webs. To evaluate long-term DO trends in the lower Hudson River, Abood et al. (2006) examined two long-term data sets of DO observations collected by the New York City Department of Environmental Protection (NYCDEP) and covering the lower reaches of the river. Measurements of DO taken in August from 1975 to 2000 during the Long River Surveys indicate the lowest percent saturation (less than 75 percent) at West Point and the highest (greater than 90 percent) at the Kingston and Catskill reaches (Figure 2-10). Percent saturation at the river segment encompassing IP2 and IP3 was approximately 76 percent. Based on the NYCDEP data set, the authors concluded that there has been a substantial increase in DO since the early 1980s, probably resulting from the significant upgrades to the Yonkers and North River Sewage Treatment Plants in the lower reach of the Hudson.

Organic Matter

Organic matter can enter and influence a food web from two sources—autochthonous inputs, which are produced within the aquatic system, and allochthonous inputs, which are imported to the aquatic system from the surrounding terrestrial watershed (Caraco and Cole 2006). In the lower Hudson River, autochthonous sources of carbon originating within the river are associated with the primary production of phytoplankton and macrophyte communities. Studies by Caraco and Cole (2006) of the Hudson River from Albany to Newburgh during May–August 1999 and 2000 concluded that runoff from the upper Hudson and Mohawk River watershed was responsible for the majority of the allochthonous sources of carbon, represented as dissolved organic carbon (DOC) and particulate organic carbon (POC). Inputs from sewage, adjoining marshes, and tributaries accounted for less than 25 percent of the inputs. Total organic carbon (TOC) inputs were on average highest at the uppermost stretch of the Hudson and decreased down river by over twofold. Allochthonous loads were approximately fourfold lower in 1999 than in 2000 for all three river sections studied. The authors noted that the importance of allochthonous and autochothonous loads varied more than thirtyfold across space and time and that the variation was related to hydrologic inputs. During the summer of 1999 (the driest in

15 years), loadings of allochthonous inputs were low, but phytoplankton biomass and primary productivity were high. The resulting ratio of autochthonous/allochthonous inputs was tenfold greater than that measured during the summer of 2000 (the wettest in 15 years). These data suggest to the NRC staff that variations in sources and the importance of carbon inputs can be influenced by a variety of nonanthropogenic factors and result in changes to food web structure and function that directly impact higher trophic levels.

Nitrogen loading to rivers and estuaries comes primarily from forest and agricultural drainage, discharge from sewage treatment plants, and from nonpoint sources associated with urbanization. The most common forms of nitrogen in these systems are amino compounds originating from plant and animal proteins (CHGEC 1999). In the Hudson River, nitrate is the major contributor to the total nitrogen load, and in the lower Hudson River, approximately half of the total inorganic nitrogen loading is attributed to wastewater treatment systems and urban runoff (CHGEC 1999).

Total nitrogen and ammonia concentrations in the Hudson from Troy to Yonkers (obtained from EPA STORET) show differing trends from 1975 through 1992. Total nitrogen concentrations appear to vary without trend, while ammonia concentrations appear to be highest in river stretches near Yonkers and at locations upstream of Poughkeepsie (CHGEC 1999).

Phosphorus, in the form of phosphates, enters river systems as leachates from rock formations and soil. Additional inputs are associated with wastewater treatment plant discharges. Inorganic phosphates are used by plants and converted to organic forms that are used by animals (CHGEC 1999). Total phosphorus concentrations in the Hudson River during August 1974 suggest that the highest concentrations are associated with the lower 25 RM (40 RKM). Ortho-phosphorus concentrations from the EPA STORET database from 1975 through 1992 suggest that the highest concentrations are associated with the Yonkers-Piermont and Glenmont-Troy areas of the upper river.

The distribution and ratios of allochthonous and autochthonous nutrient inputs form the basis of complex food webs that can have large influences on upper trophic levels. Macronutrients such as carbon, nitrogen, phosphorus, and silicon are used by plants as raw materials to produce new biomass through photosynthesis. In some freshwater systems, the lack or excess of a specific macronutrient can limit growth or contribute to eutrophication and result in basinwide impacts to aquatic resources.

2.2.5.2 Significant Environmental Issues Associated with the Hudson River Estuary

Early Settlement

Anthropogenic impacts to the Hudson River ecosystem have existed for many centuries, with a possible origin approximately 11,000 years ago, after the retreat of the Wisconsin-stage ice sheet (CHGEC 1999). Swaney et al. (2006) categorized changes in watershed characteristics and effects based on four broad time scales—pre-European settlement, precolonial and colonial settlement, 19th century, and 20th century (Table 2-1). To put the scale of the anthropogenic impacts to the Hudson River watershed in context, the human population within the watershed has grown from approximately 230,000 at the time of the first census in 1790 to approximately 5 million today (not including parts of the boroughs of New York City outside the watershed, such as Queens). In 1609, the Hudson River watershed was almost entirely forested; by 1880, 68 percent of the watershed was farmland. Available records show that from the early 18th century to 1993, nearly 800 dams were constructed in the watershed, ranging in height from 2 to

700 ft (0.6 to 213 meters) (Swaney et al. 2006). A brief chronology of significant events that occurred from pre-European settlement to modern times is presented below.

Before settlement by European explorers, impacts associated with aboriginal populations were restricted to those from activities associated with hunting and gathering, and localized fires. During precolonial and colonial settlement, immigrants cleared large portions of forest cover to accommodate agriculture. These activities altered watershed dynamics and increased settlement loads and temperature in streams and rivers. Dramatic anthropogenic impacts occurred during the 19th century as populations along rivers, streams, and coastal areas increased, land clearing continued, and construction of roads, bridges, railroads, canals, and industrial centers occurred to support the emerging industrial revolution. The emergence of tanning and logging activities resulted in large-scale clearing of forests, construction of roads that were later expanded into highways and railroad lines, and the development of dams and canals to control floods and divert water for human needs. All of these activities resulted in profound changes to the dynamics of the Hudson River watershed. In some cases, the presence of railroad lines or highways effectively isolated nearby wetland communities from the main stem of the river; in other cases, wetland and marsh areas were filled and destroyed. Dredging and dam development significantly altered the flow characteristics of the Hudson River and influenced the migratory patterns of many species (Swaney et al. 2006).

During the latter part of the 19th century, the growing human population created increased pollution and nutrient loading, which remained unregulated until the mid-20th century. Anthropogenic impacts occurring during the 20th century include the expansion of human population centers, further development of infrastructure to support industrial development (highways, roads, rail lines, factories), and a gradual shift in agricultural practices from traditional methods to new technologies that used specialized fertilizers, pesticides, and other agrochemicals. Industrialization during the 19th and 20th centuries also provided pathways for invasive species and nuisance organisms to colonize new habitats via canals, ship ballast water, and accidental or deliberate agricultural introductions (Swaney et al. 2006).

During the latter part of the 20th century, environmental awareness of degraded conditions resulted in the creation of important environmental laws and monitoring programs and significant improvements to wastewater treatment facilities. The laws and activities resulted in significant improvements to some water-quality parameters and a new awareness of emerging threats (e.g., the presence of endocrine-disrupting pharmaceuticals, nanomaterials, and other contaminants or constituents). A brief description of some of the significant environmental issues and anthropogenic events is presented below (Swaney et al. 2006).

Dredging, Channelization, and Dam Construction

As described above, dredging, channelization, and dam construction within the Hudson River watershed has occurred for over 200 years. The U.S. Army Corps of Engineers (USACE) has maintained a shipping channel from the ocean to the Port of Albany since the late 18th century and dredges the channel on an as-needed basis (CHGEC 1999). Dredging in some river segments occurs every 5 years (Miller et al. 2006). In some cases, dredging has significantly changed the hydrodynamic characteristics of the river and resulted in significant losses of intertidal and shallow water nursery habitats for fish (Miller et al. 2006). As described above, from the early 18th century to 1993, nearly 800 dams were constructed in the watershed, ranging in height from 2 to 700 ft (0.6 to 213 m) (Swaney et al. 2006). A study of the inorganic and organic content of marshes within the watershed by Peteet et al. (2006) revealed a pattern of decreasing inorganic content with the arrival of the Europeans to the present day that was probably the result of the construction of tributary dams. The presence of dams, river channelization, and shoreline armoring to protect road and rail lines disconnects or interferes with normal river processes and often results in an overall decrease of sediment transport into and through the estuary. Because these structures are now an existing part of the landscape, in most cases, it is extremely difficult or impossible to restore historical river structure and function.

Industry and Water Use Impacts

As described above, anthropogenic impacts on the watershed from aboriginal cultures were generally small and restricted to effects associated with hunter-gatherer community activities and the presence of fires. Before the 1900s, the dominant industries were those of the primary sector (agriculture, forestry, fishing, and mining). During the 1900s, there was an increase in the use of the Hudson River to provide transportation, drinking water, and water for industrial activities. During the development of industrial activity, there was a progressive increase in secondary sector industries, including the manufacture of food products, textiles, pulp and paper products, chemical, machinery, and transportation-related goods (CHGEC 1999).

The Hudson River was and is used as a source of potable water, a location for permitted waste disposal, a mode of transportation, and a source of cooling water by industry and municipalities. As of 1999, at least five municipalities use the lower Hudson as a source of potable water, and Rohmann et al. (1987) identified 183 separate industrial and municipal discharges to the Hudson and Mohawk rivers. The chemical industry has the greatest number of industrial users, followed by oil, paper, and textile manufacturers; sand, gravel, and rock processors; power plants; and cement companies (CHGEC 1999).

Table 2-1. Historical Impacts on the Hudson River Watershed

Pre-European Settlement	
Aboriginal agriculture	Localized fires and associated changes in biomass, habitat, and nutrient dynamics
Precolonial and Colonial Settlement	
Land clearing	Removal of forest cover and changes in habitat and streamflow characteristics
19th Century	
Tanning	Preferential clearing of forests leading to increased sediment and organic loads to water bodies
Logging	Extensive clearing of forests that affects water quality and habitat
Agriculture	Clearing of forests, use of fertilizers and nitrogen-fixing crops
Canal and dam development	Increase of waterborne invasive species, wetland drainage, flow alterations, habitat fragmentation
Railroad development	Increased access to forests leading to risk of fire; terrestrial, wetland, and aquatic habitat loss
Road development	Increases in impervious surfaces and runoff
Urbanization and industrialization	Increased pollution from unregulated sewage and factory waste discharges
Dam development for water supply infrastructure needs	Changes in flow regime and sediment transport
Highway and road development	Increase in impervious surfaces and runoff, impacts to terrestrial communities
Agriculture decline	Changes in land use practices (reforestation or increased land development)
Changing agricultural practices	Increased inorganic nutrients (fertilizers) and changes in organic (manure) loads
Urban development and sprawl	Impervious surface impacts, increased runoff, construction impacts, stream channelization

Adapted from: Swaney et al. 2006

At present, there are 11 facilities along the lower Hudson River with water discharges of 50 mgd (189,000 m^3/day) or greater (Table 2-2). Of these, two are associated with wastewater discharge, and nine are associated with power generation. Between Poughkeepsie and Yonkers (RM 24–77 (RKM 39–124)), there are four steam power generating stations that use water from the Hudson River for condenser cooling (Danskammer Point, Roseton, IP2 and IP3, and Bowline Point). Of these, IP2 and IP3 have traditionally used the greatest quantity of water for cooling (2800 mgd, or 10.6 million m^3/day), and Danskammer Point the least. Presently, Roseton operates intermittently, based on energy needs and the current prices of oil and natural gas. Excluding the water use of Roseton, the IP2 and IP3 facility accounts for 60 percent of the water use from RM 24–77 (RKM 39–124). Impacts associated with industrial water use can include impingement or entrainment of fish, larval forms, and invertebrates from water intake; heat or cold shock associated with water discharges; and the cumulative effects of the discharge of low levels of permitted chemicals (CHGEC 1999).

<u>Municipal Wastewater Treatment Plants</u>

Wastewater collection and sewage treatment construction began in New York City in the late 17th century, and many of the sewer systems were connected in lower and central Manhattan Island between 1830 and 1870. The first wastewater treatment system was constructed in 1886 and included a screen system designed to protect bathers on Coney Island (Brosnan and O'Shea 1996.)

In 2004, the NYSDEC identified 610 municipal wastewater treatment plants in New York State (NYSDEC 2004a). These facilities produce a total discharge flow of approximately 3694 mgd (13.98 million m^3/day). In the lower Hudson River basin, there are 78 secondary treatment facilities with a total flow of 556 mgd (2.1 million m^3/day), 41 tertiary facilities with a total flow of 11 mgd (42,000 m^3/day), and 10 other/unknown facilities with a total flow of approximately 1 mgd (3800 m^3/day). The total flow associated with all 129 facilities is approximately 568 mgd (2.15 million m^3/day). There are 33 facilities that use what is described as less than primary, primary, or intermediate treatment. A total of 404 facilities employ secondary treatment, and 173 employ tertiary treatment (NYSDEC 2004a).

As discussed above, the increasing populations along the Hudson River and within the watershed resulted in an increased discharge of sewage into the Hudson and an overall degradation of water quality. Beginning in 1906 with the creation of the Metropolitan Sewerage Commission of New York, a series of studies was conducted to formulate plans to improve water quality within the region (Brosnan and O'Shea 1996). In the freshwater portion of the lower Hudson River, the most dramatic improvements in wastewater treatment were made between 1974 and 1985, resulting in a decrease in the discharge of suspended solids by 56 percent.

Improvements in the brackish portion of the river were even greater. In the New York City area, the construction and upgrading of water treatment plants reduced the discharge of untreated wastewater from 450 mgd (1.7 million m^3/day) in 1970 to less than 5 mgd (19,000 m^3/day) in 1988 (CHGEC 1999). The discharge of raw sewage was further reduced between 1989 and 1993 by the implementation of additional treatment programs (Brosnan and O'Shea 1996).

During the 1990s, three municipal treatment plants located in the lower Hudson River converted to full secondary treatment—North River (1991), North Bergen MUA-Woodcliff (1991), and North Hudson Sewerage Authority West New York (1992). In addition, the North Hudson

Sewerage Authority-Hoboken plant, located on the western bank of the Hudson River opposite Manhattan Island, went to full secondary treatment in 1994 (CHGEC 1999). Upgrades to the Yonkers Joint Treatment plant in 1988 and the Rockland County Sewer District #1 in 1989 also resulted in improvements in water quality in the brackish portion of the Hudson River. In the mid-1990s, the Rockland County Sewer District #1 and Orangetown Sewer District plants were also upgraded(CHGEC 1999).

Table 2-2. Facilities Discharging at Least 50 mgd (190,000 m^3/day) into the Lower Hudson River

Facility	Activity	Location			Discharge (mgd)
		Region	RM	RKM	
59th Street Station	Power generation	Battery (BT)	7	11	70
North River	Wastewater discharge	Battery (BT)	10	16	170
Yonkers	Wastewater discharge	Yonkers (YK)	17	27	92
Bowline Point	Power generation	Croton-Haverstraw (CH)	37	60	912
Lovett	Power generation	Indian Point	42	68	496
Indian Point	Power generation	Indian Point	43	69	2,800
Westchester Resource Recovery	Power generation	Indian Point	43	69	55
Danskammer Point	Power generation	Poughkeepsie (PK)	66	106	457
Roseton[a]	Power generation	Poughkeepsie (PK)	67	108	926
Bethlehem	Power generation	Albany (AL)	140	225	515
Empire State Plaza	Power generation	Albany (AL)	146	235	108

[a] Roseton currently operates intermittently based on availability and cost of oil and natural gas.

Adapted from: Entergy 2007a

A review of long-term trends in DO and total coliform bacteria concentrations by Brosnan and O'Shea (1996) has shown that improvements to water treatment facilities have improved water quality. The authors noted that, between the 1970s and 1990s, DO concentrations in the Hudson River generally increased. The increases coincided with the upgrading of the North River plant to secondary treatment in spring 1991. DO, expressed as the average percent saturation, exceeded 80 percent in surface waters and 60 percent in bottom waters during summers in the early 1990s. DO minimums also increased from less than 1.5 mg/L in the early 1979s to greater than 3.0 mg/L in the 1990s, and the duration of low DO (hypoxia) events was also reduced (Brosnan and O'Shea 1996). Similar trends showing improvements in DO were noted by Abood et al. (2006) from an examination of two long-term data sets collected by NYCDEP in the lower reaches of the river. Brosnan and O'Shea (1996) also noted a strong decline in total coliform bacteria concentrations that began in the 1970s and continued into the 1990s, coinciding with sewage treatment plant upgrades.

Chemical Contaminants

The lower Hudson River currently appears on the EPA 303-d list as an impaired waterway because of the presence of polychlorinated biphenyls (PCBs) and the need for fishing restrictions (EPA 2004). The following is a description of the chemical contaminants in the river.

Chemical contaminants in the Hudson River and surrounding watershed generally fall into three major categories—(1) pesticides and herbicides, including dichloro-diphenyl-trichloroethane (DDT) and its metabolites, aldrin, lindane, chlordane, endrin, heptachlor, and toxaphene, (2) heavy metals, including arsenic, cadmium, chromium, copper, inorganic and methylated mercury, lead, and zinc, and (3) other organic contaminants, including PCBs, and polycyclic aromatic hydrocarbons (PAHs) (CHGEC 1999). In addition, there is a growing concern that the discharge of pharmaceuticals and hormones via wastewater may pose a risk to aquatic biota and human communities (NOAA 2008b). There is also a concern that waste products or residuals associated with the emerging nanotechnology market could create a new source of environmental risk (EPA 2007b).

Pesticides and herbicides generally enter the Hudson River via runoff from agricultural activities in the upper watershed and have a high affinity to binding with organic carbon. In the Hudson and Raritan River basins, the use of DDT, once a common pesticide, peaked in 1957 and subsequently decreased until the compound was banned in the early 1970s (Phillips and Hanchar 1996). Sediment contaminant trends suggest that the concentration of DDT in sediment has generally decreased since the 1970s and is currently at or near the effects-range-median (ER-M), which is the median sediment concentration for a particular chemical or contaminant at which adverse biological effects have been observed (Steinberg et al. 2004). In the lower Hudson River, comparison of the EPA-sponsored regional environmental monitoring and assessment program (R-EMAP) results from 1993 to 1994 and 1998 show that the concentrations of the metals cadmium, nickel, lead, and silver have generally declined and are at or below ER-M. The concentrations of mercury, however, continue to be above ER-M at many locations in the lower river (Steinberg et al. 2004).

Contamination of the sediment, water, and biota of the Hudson River estuary resulted from the manufacture of capacitors and other electronic equipment in the towns of Fort Edward and Hudson Falls, New York, from the 1940s to the 1970s. Investigations conducted by EPA and others over the past 25 years have delineated the extent and magnitude of contamination, and numerous cleanup plans have been devised and implemented. Recently, EPA Region 2 released a “Fact Sheet” describing a remedial dredging program designed to remove over 1.5 million cubic yards (1.15 million m^3) of contaminated sediment covering 400 acres (160 ha) extending from the Fort Edwards Dam to the Federal Dam at Troy (EPA 2008a). Phase 1 of the project was completed in October 2009, and resulted in the removal of 293,000 cubic yards of PCB-contaminated sediment from the river. While this volume exceeded established goals for Phase 1, removal was completed for only 10 of 18 targeted areas due to the presence of contamination in some areas that was deeper than expected, and the presence of woody debris and PCB oil in the sediment that complicated the removal effort. Phase 2 of the project will begin with removal actions at areas that were not completed under Phase 1 (EPA 2009). Concentrations of PCBs in river sediments below the Troy Dam are much lower. Work summarized by Steinberg et al. (2004) suggests that the sediment-bound concentrations of PCBs and dioxins have generally declined in the lower Hudson River since the 1970s and are now at or below ER-M limits.

Chemical contaminants present in the tissues of fish in the Hudson River estuary have been extensively studied for many years and resulted in the posting of consumption advisories by the States of New York and New Jersey. Current information summarized in Steinberg et al. (2004) suggests that many recreationally and important fish and shellfish still contain levels of metals, pesticides, PCB, and dioxins above U.S. Food and Drug Association (FDA) guidance values for commercial sales. Tissue concentrations of mercury were of concern only for striped bass; other fish and shellfish, including flounder, perch, eels, blue crab, and lobster, contained concentrations of mercury in their tissues well below the FDA limit for commercial sale of 2 parts per million (ppm). Concentrations of chlordane in white perch, American eels, and the hepatopancreas (green gland) of blue crab were also above FDA guidelines. Concentrations of DDT in the tissues of most recreationally and commercially valuable fish and shellfish in the estuary were below the 2 ppm FDA limit with the exception of American eel. The concentrations of 2,3,7,8-TCDD (commonly referred to as dioxin) and total PCBs in fish and shellfish tissues were often above FDA guidance limits, suggesting that fish and shellfish obtained from some locations within the estuary should be eaten in moderation or not at all. A detailed list of fish consumption advisories for both New York and New Jersey may be found in the *Health of the Harbor* report published by the Hudson River Foundation in 2004 (Steinberg et al. 2004).

Steinberg et al (2004) found that although a wide variety of contaminants still exists in sediment, water, and biota in the lower Hudson River, the overall levels appear to be decreasing because of the imposition of strict discharge controls by Federal and State regulatory agencies and improvements in wastewater treatment. These trends appear to be confirmed by the results of a NOAA-sponsored toxicological evaluation of the estuary in 1991, as described in Wolfe et al. (1996). Employing a combination of bioassay tests using amphipods, bivalve larvae, and luminescent bacteria and measurements of contaminants in a variety of environmental media, the NOAA study showed that spatial patterns of toxicity generally corresponded to the distributions of toxic chemicals in the sediments. Areas that exhibited the greatest sediment toxicity were the upper East River, Arthur Kill, Newark Bay, and Sandy Hook Bay. The lower Hudson River adjacent to Manhattan Island, upper New York Harbor, lower New York Harbor off Staten Island, and parts of western Raritan Bay generally showed lower toxicity. The supporting sediment chemistry, including acid-volatile sulfide and simultaneously extracted metals, suggests that metals were generally not the cause of the observed toxicity, with the possible exception of mercury. Among all contaminants analyzed, toxicity was most strongly associated with PAHs, which were substantially more concentrated in toxic samples than in nontoxic samples, and which frequently exceeded sediment quality criteria (Wolfe et al. 1996).

There is continuing concern, however, that legacy PCB waste may still pose a threat to invertebrate, fish, and human populations. A study by Achman et al. (1996) suggests that PCB concentrations in sediment measured at several locations in the lower Hudson River from the mouth to Haverstraw Bay are above equilibrium with overlying water and may be available for transfer within the food web. The authors concluded in some locations within the lower Hudson River, the sediments could act as a source of PCBs and pose a long-term chronic threat, but that fate and transport modeling would be required to fully understand the implications of this potential contaminant source.

Nonpoint Pollution

Nonpoint pollution can include the intentional or unintentional discharges of chemicals and constituents into rivers, streams, and estuaries. This section briefly summarizes three types of nonpoint pollution that may affect fish and shellfish resources in the Hudson River estuary—coliform bacteria that affect shellfish resources or swimmers, floatable debris, and surface slicks. All information is derived from Steinberg et al. (2004).

Levels of coliform bacteria in the Hudson River estuary have generally decreased from 1974 to 1998, primarily in response to wastewater treatment improvements. At present, only stretches of the river near the southern end of the island of Manhattan have geometric mean coliform concentrations of 201–2000 coliform cells/100 mL. The incidence of shellfish-related illness in New York State has also decreased from a high of over 100 reported cases per year in 1982 to only a few in 1999. Steinberg et al. (2004) caution, however, that the incidence of shellfish-related illness is probably underreported and likely misdiagnosed when reported.

Common floatable debris found on New York beaches includes cigarette butts, food containers and wrappings, plastic and glass, and medical waste. The amount of debris removed from New York Harbor annually has generally exceeded 5000 t (4500 MT) since 1988, with no apparent downward trend. The presence of surface slicks in the harbor has appeared to decline since 1994.

Invasive or Exotic Species

The presence of invasive or exotic species in the Hudson River estuary has been documented for over 200 years and probably began occurring after the Wisconsin-stage ice sheet receded over 10,000 years ago. In a compilation of information concerning the distribution of exotic organisms in the freshwater portions of the Hudson River basin, Mills et al. (1996) determined that at least 113 nonindigenous species of vertebrates, plants, and invertebrates have established populations in the Hudson River Basin. The list would undoubtedly be larger if better information was available concerning the historical populations of small invertebrates and algae. Most invasive species arrive through unintentional releases (e.g., from ship ballast water or agricultural cultivation activities) or via vectors introduced by the construction of canals.

While the presence of new or exotic species can result in a benefit (e.g., the largemouth and smallmouth bass recreational fishery), many have had a negative impact on their new environment. A classic example of the latter is the appearance of the zebra mussel in the freshwater portion of the Hudson River in 1991. Beginning in early fall 1992, zebra mussels have been dominant in the freshwater tidal Hudson, constituting more than half of heterotrophic biomass and filtering a volume of water equal to all of the water in the estuary every 1–4 days during the summer (Strayer 2007). The impacts of this species on the freshwater portions of the Hudson River are presented in Section 2.2.5.6.

The impacts of other invasive aquatic species are discussed elsewhere in this chapter. The issue is of magnitude significant enough to result in Federal actions to control future introductions. In 1992, the U.S. Congress passed an amendment to Public Law 101-646, the “Nonindigenous Aquatic Nuisance Species Act,” extending some of the Great Lakes-oriented provisions of that Act and the regulations that followed from it to the Hudson River. In particular, as of late 1994, vessels entering the Hudson River with foreign ballast water must have exchanged that water in midocean and must arrive with a salinity of at least 30 ppt (Mills et al. 1996).

2.2.5.3 Regulatory Framework and Monitoring Programs

The regulatory framework, actions, and authorities governing environmental permitting and monitoring on the Hudson River are complex and have evolved significantly over time. The following is a chronological description of the major activities that have occurred over the past four decades.

Early Environmental Investigations

Early biological studies of the Hudson River began as a river survey program known as the Hudson River Fisheries Investigation (HRFI) which occurred from 1965 to 1968 under the direction of the Hudson River Policy Committee (HRPC) (Barnthouse and Van Winkle 1988). The investigations were intended to address the potential entrainment impacts of the proposed Cornwall pumped storage facility on striped bass. The objective of the HRFI program was to define the spatial and temporal distribution of striped bass eggs, larvae, and juveniles in relation to the intake to better understand the potential impacts of facility operation. The summary report produced by HRPC concluded that entrainment impacts associated with the operation of the Cornwall facility would be negligible, and this conclusion formed the basis of the decision by the Federal Power Commission (FPC) to license the facility in 1971. These conclusions were challenged on the grounds that an erroneous method had been used to estimate striped bass entrainment. This challenge ultimately resulted in a halt to the construction of the Cornwall facility in 1974 pending resolution of this issue (Barnthouse and Van Winkle 1988; Christensen and Englert. 1988).

During this period, IP1 was in operation, IP2 and IP3 were under construction, and a modest fish sampling program was being conducted in the area of Indian Point by New York University and Raytheon (Barnthouse and Van Winkle 1988). The enactment of the National Environmental Policy Act of 1969 (NEPA) on January 1, 1970, and the interpretation that it required the Atomic Energy Commission (AEC) to explicitly consider nonradiological impacts in its licensing decisions had immediate and dramatic impacts on IP2 and IP3. During the permitting process for IP2, the major point of contention again centered on whether facility operation would significantly affect striped bass eggs, larvae, and juveniles because of entrainment. The Consolidated Edison Company of New York, the owner of IP2 at the time, concluded in its ER that entrainment impacts would be insignificant. The environmental impact statement (EIS) prepared by the AEC staff in 1972 expressed concern about the impacts of thermal discharges, entrainment, and impingement associated with cooling system operation and concluded that “The operation of IP1 and IP2 with the present once-through cooling system has the potential for a long-term environmental impact on the aquatic biota inhabiting the Hudson River which [sic] would result in permanent damage to and severe reduction in the fish population, particularly striped bass, in the Hudson River, Long Island Sound, the adjacent New Jersey coast, and the New York Bight” (USAEC 1972). The final conclusion reached by AEC for IP2 was a recommendation that an operating license be issued with the following conditions to protect the environment—(1) once-through cooling was permitted only until January 1, 1978, and thereafter a closed-cycle system would be required, (2) the applicant would evaluate the economic and environmental impacts of an alternative closed-cycle system and submit this evaluation to AEC by July 1, 1973, (3) after approval by AEC, the required closed-cycle system would be designed, built, and placed in operation no later than January 1, 1978 (USAEC 1972).

The USAEC results published in 1972 were influenced to a great extent by the results of an entrainment model developed by C.P. Goodyear of the Oak Ridge National Laboratory (described in Hall 1977), and during subsequent years, the use of numerical simulation models to assess the impacts of entrainment from once-through facilities received a great deal of attention. As the models were developed, there was much debate concerning the assumptions used by the modelers, and the predictive ability of the models was the subject of numerous scientific symposia, peer-reviewed journal articles, and hearings. This information formed the basis of the decisions handed down by the Atomic Safety and Licensing Board in 1973 and the Atomic Safety and Licensing Appeals Board in 1974. These decisions stipulated that IP2 would be allowed to operate using once-through cooling but only until May 1, 1979. Unless the operator of the facility could demonstrate through new studies that the environmental impacts of once-through cooling were negligible, cooling towers would have to be installed (Barnthouse et al. 1984).

In late 1974, FPC held hearings to reconsider the Cornwall facility application. Recent data and numerical models that had been developed for IP2 were also evaluated. Because the information and assessment presented at the hearings provided conflicting conclusions concerning impacts, FPC was unable to determine the magnitude of potential environmental impacts, and the hearings were adjourned without resolution concerning plant licensing. In 1975, the NRC, the successor agency to AEC, published an EIS for IP3 that once again expressed concern associated with the impacts of the once-through cooling system, including impacts associated with entrainment, impingement, and thermal releases. Using a combination of entrainment modeling and an improved striped bass life-cycle model, the NRC concluded that impingement and entrainment impacts were "likely to result in a substantial decrease in the Hudson River spawned striped bass population" (NRC 1975). The NRC indicated that the applicant, who had used different parameters in its impingement and entrainment simulation modeling, did not share this conclusion. The NRC agreed to allow IP3 to operate as a once-through facility but required the applicant to comply with a variety of technical specifications including the collection of additional environmental data to evaluate the impact of entrainment, impingement, and thermal discharges. The applicant was also required to comply with the license conditions agreed to in 1974 that required a cessation of once-through cooling by 1979 unless new evidence demonstrated that environmental impacts were negligible (NRC 1975; Barnthouse et al. 1984).

<u>Pollutant Discharge Elimination System Permitting</u>

On October 28, 1975, EPA gave its approval to NYSDEC to issue SPDES permits in the State of New York. Before that time, national pollutant discharge elimination system (NPDES) (the federally administered analog to SPDES for States in which EPA has not granted authority to discharge to waters of the United States) permits were issued directly by EPA. Issues considered by EPA before the issuance of the 1975 permits included the thermal impacts of once-through cooling and fish mortalities associated with the cooling water intakes. During this time, scientists representing both the applicants and the regulatory agencies had embarked on ambitious programs to better understand the impacts of once-through cooling systems on sensitive fish species. This included a large-scale field program and the use and refinement of numerical simulation models to better understand entrainment impacts.

Depending on the model used and the assumptions employed, the impacts of once-through cooling ranged from negligible to catastrophic (Barnthouse et al. 1984). Further, although field collections were occurring, the amount of information available to be used as input data or to calibrate model output was limited. As a result, the EPA deemphasized the use of simulation modeling to estimate entrainment impacts and, in 1975, issued permits for IP2 and IP3, Bowline Units 1 and 2, and Roseton Unit 1 that required the construction of cooling towers. The utility companies contested the permits and requested adjudicatory hearings. In 1977, the owners of IP2 and IP3, Bowline, and Roseton facilities sought an administrative adjudicatory hearing against the EPA NPDES permits issued in 1975 to overturn the cooling water intake conditions and other requirements. The EPA hearings began in 1977 and ended in 1980 with the Hudson River Settlement Agreement (HRSA).

Hudson River Settlement Agreement

After a number of years of adjudicatory proceedings, the owners of IP2 and IP3, Roseton, and Bowline facilities signed the HRSA. The 10-year agreement was intended to resolve the disputes related to the issuance of the 1975 NPDES permits and provide the necessary funding to support a long-term investigation of the lower Hudson River estuary. Parties to the agreement, which was effective for the 10-year period from May 10, 1981, to May 10, 1991, included EPA, the New York State Attorney General, NYSDEC, the Scenic Hudson Preservation Conference (Scenic Hudson), the Hudson River Fishermen's Association (the predecessor to Riverkeeper), and the Natural Resources Defense Council (NYSDEC 2003a). HRSA provided for mitigative measures to reduce fish mortalities at each generation station from impingement and entrainment during once-through cooling operation, seasonal outages during sensitive aquatic life stages, and the installation of variable speed pumps at IP2 and IP3 within 3½ years of the effective date of the agreement to allow for more efficient use of cooling water. In addition, HRSA established a biological monitoring program of fish species at various life stages within the lower Hudson River to better understand spatial and temporal trends.

In 1982, NYSDEC, under authority from EPA, issued SPDES permits to each of the facilities covered by HRSA. The permits included limitations on thermal releases and incorporated the terms of HRSA in the permit language to ensure that the environmentally protective mitigative measures stipulated in the agreement were included as conditions. These permits expired in 1987, and NYSDEC issued SPDES permit renewals to each of the three HRSA facilities. Permits for IP2 and IP3, Bowline Point 1 and 2, and Roseton 1 and 2 became effective on October 1, 1987, and have been administratively continued by the NYSDEC since October 1,1992 (NYSDEC 2003a). HRSA conditions were incorporated into the permit language as before. Before the permits expired in 1992, NYSDEC received timely renewal applications, and the department and the applicants executed an agreement on May 15, 1991, to continue the mitigative measures described in HRSA until the SPDES renewal permits were issued. The agreement also stipulated that the parties would negotiate in good faith to resolve issues associated with impingement, entrainment, and thermal discharges, and to resolve issues associated with mitigation and alternatives (NYSDEC 2003a).

In response to a lawsuit filed in 1991 by Riverkeeper, Scenic Hudson, and the Natural Resources Defense Council, a consent order was signed by all parties on March 23, 1992, which stipulated that the operators of IP2 and IP3, Roseton, and Bowline would continue the HRSA mitigative measures, such as timed outages to reduce impacts to fish, and continue to fund the ongoing environmental studies of the lower Hudson River. The 1992 consent order was extended by the parties on four separate occasions, with the fourth extension expiring on February 1, 1998. At present, there has been no agreement on a fifth consent order because of the ongoing SPDES renewal process, but the operators of IP2 and IP3, Roseton, and Bowline have agreed to continue the mitigative measures included in their existing SPDES permit and to follow the provisions of the fourth consent order until new SPDES permits are issued (NYSDEC 2003b). The major monitoring and assessment programs conducted under HRSA that form the basis for the staff's assessment of impacts are discussed below.

<u>Environmental Studies in the Lower Hudson Estuary</u>

Numerous environmental studies were conducted in the Hudson River in support of HRSA and by other organizations to develop a baseline and to assess changes to key components of the ecosystem over time. A general description of the studies evaluated during the development of this SEIS is presented in Table 2-3. Other studies are cited throughout the description and historical assessment of impacts; however, only the data obtained from these studies were made available for further analysis.

Impingement losses associated with IP2 and IP3 were studied annually from 1975 to 1990. Data from 1975 to 1980 provided for analysis were weekly estimates of the total number impinged, organized by operating unit and taxon. From 1979 to 1980, estimates were further delineated by life stage (young of the year, yearling, yearling or older). Data from 1981 to 1990 included seasonal estimates of the total number impinged by operating unit, taxon, and life stage.

As a part of the HRSA, IP2 and IP3 were required to replace the existing debris screens in 12 of the intake bays with angled screens and fish bypass systems. A subsequent analysis, however, showed that the angled screen system did not significantly reduce impingement mortality, and so the HRSA settlement parties rejected this mitigation option (Fletcher 1990). Con Edison and the New York Power Authority elected to install and test a Ristroph screen system at IP2 and IP3. The trial machine, referred to as "screen version 1" by Fletcher (1990), was installed in a single intake bay of IP2 and IP3 and evaluated from January 16 to April 19, 1985. At the request of the Hudson River Fishermen's Association, Fletcher (1990) evaluated the design of the trial machine, conducted flume tests, and suggested improvements to the design that were incorporated into "screen version 2." This final design, also known as a modified Ristroph screen, was installed in all intake bays of IP2 and IP3. As it was not required by the NYSDEC, no further studies were conducted after the installation of the modified Ristroph system at IP2and IP3 to determine actual mortality of key species, and no additional impingement monitoring was conducted.

Ichthyoplankton entrainment losses associated with IP2 and IP3 were studied between May and August in 1981, 1983 through 1985, and in 1987, as well as between January and August 1986. Data provided for this analysis were the combined IP2 and IP3 weekly mean densities (number/1000 m^3) of each life stage (egg, yolk-sac larvae, post-yolk-sac larvae, and juvenile) by taxon.

Data from the three field surveys from the Hudson River Estuary Monitoring Program were also provided for this analysis (Long River Survey (LRS), Fall Juvenile Survey (FJS), and the Beach Seine Survey (BSS)). All three data sets include the annual total catch and volume sampled per taxon from 1974 through 2005, the annual abundance index per taxon and life stage from 1974 through 2005, and the weekly regional density of each life stage by taxon from 1979 through 2005.

Table 2-3. Hudson River Environmental Studies Table
(Information used in SEIS to assess impacts; data provided by Entergy)

Study	Study Dates	Information Available
Impingement Abundance[1]	1975–1990	Number of fish impinged at IP2 and IP3.
Entrainment Abundance Studies	1981 1983–1987	Entrainment density by species and life stage for IP2 and IP3 combined.
Longitudinal River Ichthyoplankton Surveys	1974–2004	Standing crop, temporal and geographic distributions, and growth rates for ichthyoplankton forms of fish species, with an emphasis on Atlantic tomcod, American shad, striped bass, white perch, and bay anchovy. Sampling generally occurred in spring, summer, and fall.
Fall Juvenile Surveys	1974–2005	Standing crop and temporal and geographic indices for young-of-the-year fish in shoal, bottom, and channel habitats in the estuary with an emphasis on Atlantic tomcod, American shad, striped bass, and white perch. Surveys generally conducted in midsummer and fall.
Beach Seine Surveys	1974–2005	Abundance and distribution of young-of-the-year fish in the shore-zone habitat in the estuary, with an emphasis on American shad, Atlantic tomcod, striped bass, and white perch. Surveys generally conducted in summer and fall.

2.2.5.4 Potentially Affected Fish and Shellfish Resources

The Hudson River estuary is home to a large and diverse assemblage of fish and shellfish. Species richness and abundance vary according to season and location and can be influenced by climatological changes that affect water temperature, salinity, and sediment load. Waldman et al. (2006) report that 212 species of fish have been recorded north of the southern tip of Manhattan Island, with the largest contributions associated with temperate marine strays (65), introduced species (28), and freshwater species surviving the Pleistocene glaciations in the Atlantic coast refugia (21). The authors also note that only 10 diadromous (traveling between fresh- and salt-water) species are known to occur in the Hudson River Estuary.

The NRC staff identified 18 aquatic representative important species (RIS) to use in assessing the impacts of IP2 and IP3 (Table 2-4). This list contains RIS identified in past analyses conducted by NYSDEC, the NRC, and the current and past owners of IP2 and IP3. The aquatic RIS identified in this section are meant to represent the overall aquatic resource and reflect the

[1] Entergy re-submitted this data to NRC on November 24, 2009, because the data Entergy initially provided to NRC staff contained errors that caused some impingement numbers to appear artificially high. The new data are publicly available through ADAMS at ML093420528. NRC staff relied on the new impingement data – along with the other data listed in Table 2-3 – for its analysis in this SEIS.

complexity of the Hudson River ecosystem by encompassing a broad range of attributes, such as biological importance, commercial or recreational value, trophic position, commonness or rarity, interaction with other species, vulnerability to cooling system operation, and fidelity or transience in the local community. Table 2-5 provides the locations in the Hudson River estuary where specific RIS and life stages represented at least 10 percent of the total number collected in reference surveys or studies.

What follows is a discussion of life histories, abundance data, and other information for each aquatic RIS. Unless otherwise noted, information on impingement or entrainment trends are from electronic data provided to NRC staff by Entergy or its contractors. The significance of impingement and entrainment, and the presence of other potential environmental stressors on aquatic RIS is discussed in Chapter 4 and Appendixes H and I.

Table 2-4. Aquatic Representative Important Species

Common Name	Scientific Name	Occurrence and Status	Predator/Prey Relationships
Alewife	*Alosa pseudoharengus*	Anadromous	Juveniles eat insect larvae and amphipods; adults eat zooplankton, small fish, and fish eggs. Species is prey of bluefish, weakfish, and striped bass.
Atlantic menhaden	*Brevoortia tyrannus*	Permanent or seasonal resident	Juveniles and adults eat phytoplankton, zooplankton, copepods, and detritus. Species is prey of bluefish and striped bass.
American shad	*Alosa sapidissima*	Anadromous	Juveniles and adults primarily eat zooplankton, small crustaceans, copepods, mysids, small fish, and fish eggs. Species is prey of oceanic species.
Atlantic sturgeon	*Acipenser oxyrinchus*	Candidate for Federal endangered status; Anadromous	Juveniles and adults are bottom feeders, subsisting on mussels, worms, shrimp, and small fish.
Atlantic tomcod	*Microgadus tomcod*	Anadromous permanent or seasonal resident	Diet includes crustaceans, polychaete worms, mollusks, and small fish. Juveniles are prey of striped bass when anchovies are scarce.
Bay anchovy	*Anchoa mitchilli*	Estuarine	Species primarily eats zooplankton and is prey of YOY bluefish and striped bass.
Blueback herring	*Alosa aestivalis*	Anadromous	Species' diet includes insect larvae and copepods It is prey of bluefish, weakfish, and striped bass.
Bluefish	*Pomatomus saltatrix*	Permanent or seasonal resident	Juveniles eat bay anchovy, Atlantic silverside, striped bass, blueback herring, Atlantic tomcod, and American shad. Species is prey of a variety of birds.

Gizzard shad	*Dorosoma cepadianum*	Freshwater	Juveniles eat daphnids, cladocerans, adult copepods, rotifers, algae, phytoplankton, and detritus; adults eat phyto- and zooplankton. Species is prey of striped bass, other bass species, and catfish.
Hogchoker	*Trinectes maculates*	Estuarine	Adults are generalists and eat annelids, arthropods, and tellinid siphons. Species is prey of striped bass.
Rainbow smelt	*Osmerus mordax*	Anadromous	Larval and juvenile smelt eat planktonic crustaceans; larger juveniles and adults feed on crustaceans, polychaetes, and fish. Adults eat anchovies and alewives. Species is prey of striped bass and bluefish.
Shortnose sturgeon	*Acipenser brevirostrum*	Federally endangered; permanent or seasonal resident	Juveniles feed on benthic insects and crustaceans.
Spottail shiner	*Notropis hudsonius*	Freshwater	Species eats aquatic insect larvae, zooplankton, benthic invertebrates, and the eggs and larvae of fish, including their own species. Species is prey of striped bass.
Striped bass	*Morone saxatilis*	Anadromous	Species eats menhaden. river herring, tomcod, and smelt. Larvae are prey of spottail shiner, white perch, striped bass, bluegill, and white catfish.
Weakfish	*Cynoscion regalis*	Permanent or seasonal resident	Small weakfish feed primarily on crustaceans, while larger weakfish feed primarily on anchovies, herrings, spot. Species is prey of bluefish, striped bass, and other weakfish.
White catfish	*Ameiurus catus*	Freshwater	Juveniles eat midge larvae. Adults are omnivores, feeding on anything from fish to insects to crustaceans.
White perch	*Morone americana*	Estuarine	Species eat eggs of other fish and larvae of walleye and striped bass. Prey of larger piscivorous fish and terrestrial aquatic vertebrates.
Blue Crab	*Callinectes sapidus*	Estuarine	Zoea eat phytoplankton, and dinoflagellates; adults opportunistic. Larval crabs are the prey of fish, shellfish, jellyfish; juvenile and adult blue crabs are prey of a wide variety of fish, birds, and mammals.

Table 2-5. Locations in the Hudson River Estuary (see Figure 2-10) Where the Presence of Aquatic RIS Life Stages Represented at Least 10 Percent of the Total Number Collected in Referenced Surveys or Studies **(adapted from ASA 2007; river segment abbreviations from Figure 2-10)**

<table>
<tr><th rowspan="2">Species</th><th rowspan="2">Lifestage</th><th colspan="13">River Segments</th></tr>
<tr><th>BT</th><th>YK</th><th>TZ</th><th>CH</th><th>IP</th><th>WP</th><th>CW</th><th>PK</th><th>HP</th><th>KG</th><th>SG</th><th>CS</th><th>AL</th></tr>
<tr><td rowspan="5">Alewife</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">LRS[c]</td></tr>
<tr><td>YSL[d]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">LRS</td></tr>
<tr><td>PYSL[e]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">LRS</td><td></td></tr>
<tr><td>YOY[f]</td><td></td><td></td><td colspan="2">BSS[a]</td><td></td><td></td><td>BSS</td><td></td><td></td><td></td><td colspan="2">BSS</td><td></td></tr>
<tr><td>Year +[g]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Atlantic menhaden[h]</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>YOY</td><td colspan="4">ASMFC 2006a</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Year +</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">American shad</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">LRS</td></tr>
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<tr><td>YOY</td><td></td><td></td><td></td><td></td><td></td><td></td><td>BSS</td><td colspan="3">LRS</td><td colspan="2">LRS/BSS</td><td>BSS</td></tr>
<tr><td>Year +</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Atlantic sturgeon</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>YSL</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Year +</td><td></td><td></td><td></td><td></td><td colspan="4">FJS[b]: Only 12 fish caught 2005</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Atlantic tomcod</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>PYSL</td><td></td><td colspan="2">LRS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>YOY</td><td></td><td colspan="2">LRS/FJS</td><td></td><td colspan="2">LRS/FJS</td><td>FJS</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Year +</td><td></td><td colspan="2">FJS</td><td></td><td colspan="2">FJS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Table 2-5 (continued)

<table>
<tr><th>Species</th><th>Lifestage</th><th>BT</th><th>YK</th><th>TZ</th><th>CH</th><th>IP</th><th>WP</th><th>CW</th><th>PK</th><th>HP</th><th>KG</th><th>SG</th><th>CS</th><th>AL</th></tr>
<tr><td rowspan="5">Bay anchovy</td><td>Eggs</td><td colspan="3">LRS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>YOY</td><td colspan="4">LRS/BSS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Year +</td><td></td><td colspan="2">BSS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Blueback herring</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">LRS</td></tr>
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<tr><td rowspan="5">Bluefish</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td rowspan="5">Gizzard shad</td><td>Eggs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Table 2-5 (continued)

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<tr><th>Species</th><th>Lifestage</th><th>BT</th><th>YK</th><th>TZ</th><th>CH</th><th>IP</th><th>WP</th><th>CW</th><th>PK</th><th>HP</th><th>KG</th><th>SG</th><th>CS</th><th>AL</th></tr>
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<tr><td>Year +</td><td colspan="13">FJS/LRS: Only 32 fish caught in 2005</td></tr>
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Table 2-5 (continued)

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2 [a] BSS: Beach Seine Survey (1974–2005)
3 [b] FJS: Fall Juvenile Survey (also known as Fall Shoals Survey) (1979–2004)
4 [c] LRS: Long River Survey (1974–2004)
5 [d] YSL: yolk-sac larvae
6 [e] PYSL: post-yolk-sac larvae
7 [f] YOY: young of year
8 [g] Year +: yearling and older
9 [h] Obtained from ASMFC 2006a distribution
10 [l] Obtained from ASMFC 2006a distribution
11 Source: NYSDEC 2004b

Alewife

The alewife (*Alosa pseudoharengus*, family Clupeidae) is a pelagic, anadromous species found in riverine and estuarine habitats along the Atlantic coast from Newfoundland to South Carolina; landlocked populations have also been introduced in the Great Lakes and Finger Lakes. The species is historically one of the most commercially important fish species in Massachusetts and continues to be harvested as a source of fish meal, fish oil, and protein for animal food industries (Fay et al. 1983). The commercial fishing industry does not differentiate between the alewife and the blueback herring (*Alosa aestivalis*) and refers to the two species collectively as river herring. Commercial landings of river herrings peaked in the 1950s at approximately 34,000 MT (37,500 t) and then declined to less than 4000 MT (4400 t) in the 1970s (Haas-Castro 2006a). Between 1996 and 2005, landings of river herring ranged from 300 to 900 MT (330 to 990 t) annually, with 90 percent of landings in Maine, North Carolina, and Virginia (Haas-Castro 2006a). The river herring fishery is one of the oldest fisheries in the United States; however, no commercial fisheries for river herring exist in the Hudson River today. River herring are often taken as bycatch in the offshore mackerel fishery; within New York and New Jersey, river herring accounted for 0.3 percent of annual landings on the Atlantic coast (CHGEC 1999).

Spawning adults enter the Hudson River from the Atlantic Ocean in early spring and spawn once per year between late May and mid-July in shallow, freshwater tributaries with low current at temperatures between 11°C (52°F) and 27°C (81°F) (Everly and Boreman 1999; Fay et al. 1983). Females first spawn at 3 to 4 years of age and produce 60,000 to 100,000 eggs. Alewives spawn 3 to 4 weeks before blueback herring in areas where the two species occur sympatrically, and the peak spawning of each species occurs 2 to 3 weeks apart from one another (Fay et al. 1983). Within the Hudson River estuary, peak abundance of river herring eggs generally occurs within the Catskill region of the upper estuary during mid-May (CHGEC 1999). Incubation time varies inversely with water temperature and ranges from 2 to 15 days, and eggs are semidemersal and are easily carried by currents (Fay et al. 1983; CHGEC 1999). The yolk sac larvae (YSL) stage lasts approximately 2 to 5 days, and the post-yolk-sac larvae (PYSL) stage lasts until transformation to the juvenile stage at approximately 20 millimeters (mm) (0.78 in.). Full development occurs at approximately 45 mm (1.8 in.) at the age of about 1 month (Fay et al. 1983; CHGEC 1999).

Young-of-the-year (YOY) have been found in both lower and upper regions of the river (Table 2-5). Juveniles migrate to the ocean between July and November of their first year. At sexual maturity, alewives weigh 153 to 164 grams (g) (0.34 to 0.36 pounds (lb)) and can weigh 325 to 356 g (0.72 to 0.78 lb) by their seventh year; the average length for males is 29 cm and for females is 31 cm (Fay et al. 1983). Alewives in the Hudson River estuary have a life span of up to 9 years (Haas-Castro 2006a). Juveniles in the lower Hudson River have been reported to feed on chironomid larvae and amphipods, and the diet of adult alewives consists primarily of zooplankton, amphipods, mysids, copepods, small fish, and fish eggs. After spawning, alewives feed heavily on shrimp (Fay et al. 1983; CHGEC 1999). The species fulfills an important link in the estuarine food web between zooplankton and top piscivores. Juvenile and adult alewife is prey for gulls, terns, and other coastal birds, as well as bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), and striped bass (*Morone saxatilis*) (CHGEC 1999).

The annual abundance in the Hudson River of YOY alewifes has been estimated to range from 110,000 to 690,000 individuals (CHGEC 1999). For each annual cohort, entrainment mortality for the combined abundance of alewife and blueback herring for all water withdrawal locations within the Hudson River varies widely, ranging from 8 to 41 percent for data taken between 1974 and 1997, while impingement mortality of the alewife is low, ranging from 1.1 to 1.9 percent for the same time period (CHGEC 1999). The Atlantic States Marine Fisheries Commission (ASMFC) implemented a Fisheries Management Plan for the American shad and river herring in 1985. Restoration efforts under the plan include habitat improvement, fish passage, stocking, and transfer programs; however, the abundance of river herring still remains well below historic estimates (Haas-Castro 2006a). River herring were present in both impingement and entrainment samples obtained from IP2 and IP3.

Atlantic Menhaden

The Atlantic menhaden (*Brevoortia tyrannus*, family Clupeidae) is a euryhaline species found in inland tidal waters along the Atlantic coast from Nova Scotia to Florida (MRC 2006). Menhaden is commercially harvested as a high-grade source of omega-3 fatty acid, which is used in pharmaceuticals and processed food production (ASMFC 2006a). Atlantic menhaden make up between 25 and 40 percent of the combined annual landings of menhaden species along the Atlantic coast and Gulf of Mexico (Rogers and Van Den Avyle 1989). The Atlantic menhaden was first commercially fished in the late 1600s and early 1700s for use in agricultural fertilizer, and the species was later harvested for oil beginning in the early 1800s (Rogers and Van Den Avyle 1989). Fish meal from menhaden also became a staple component in swine and ruminant feed beginning in the mid-1900s and began to be used in aquaculture feed in the 1990s (ASMFC 2006a).

Atlantic menhaden migrate seasonally and exhibit north-south and inshore-offshore movement in large schools composed of individuals of a similar size and age (Rogers and Van Den Avyle 1989). Migration patterns are linked to spawning habits, and the species spawns year-round throughout the majority of its range, with spawning peaks in the spring and fall in mid-Atlantic and northern Atlantic regions (MRC 2006). Menhaden reach sexual maturity at lengths of 18 to 23 cm (7.1 to 9.1 in.), and female fecundity ranges from 38,000 eggs for a small female to 362,000 eggs for a large female (ASMFC 2006a; MRC 2006). Eggs are pelagic and hatch offshore in 2.5 to 2.9 days at an average temperature of 15.5°C (59.9°F) (ASMFC 2006a; Rogers and Van Den Avyle 1989). Larvae absorb the yolk sac within approximately 4 days of hatching and begin to feed on zooplankters (Rogers and Van Den Avyle 1989).

The survival of larvae is a function of temperature and salinity, with the highest survival rates occurring in laboratory experiments at temperatures greater than 4°C (39°F) and salinities of 10 to 20 ppt (ASMFC 2006a). Larvae migrate shoreward into estuaries at 1 to 3 months of age at a size of 14 to 34 mm (0.55 to 1.3 in.) (ASMFC 2006a). Metamorphosis to the juvenile stage occurs at approximately 38 mm (1.5 in.), and menhaden begin to filter feed on phytoplankton, zooplankton, copepods, and detritus (MRC 2006). Juveniles move into shallow portions of estuaries and are generally more abundant in areas of lower salinity (less than 5 ppt) and waters above the brackish-freshwater boundary in rivers. Juveniles leave estuaries in dense schools between August and November at lengths of 55 to 140 mm (2.2 to 5.5 in.) and migrate southward along the North Carolina coast as far south as Florida in late fall and early winter (Rogers and Van Den Avyle 1989). During the following spring and summer, menhaden move northward, redistributing in schools consisting of similarly sized individuals (ASMFC 2006a).

Most menhaden reach maturity at 2 years of age, at which point approximately 90 percent of individuals are capable of spawning (Rogers and Van Den Avyle 1989). Menhaden lose their teeth as juveniles, and adults are strictly filter feeders, feeding on planktonic organisms (ASMFC 2006a). Atlantic menhaden can live 8 to 10 years; however, fish over 4 years of age are uncommon in commercial catches. Maximum adult length is 500 mm (19.7 in.) and maximum weight is 1500 g (3.3 lb) (Rogers and Van Den Avyle 1989). Menhaden are prey for a number of piscivorous fish, including bluefish (*P. saltatrix*), striped bass (*M. saxatilis*), bluefin tuna (*Thunnus thynnus*), as well as birds and marine mammals because of their abundance in nearshore and estuarine waters (ASMFC 2006a; Rogers and Van Den Avyle 1989).

Atlantic menhaden were not a focus of the Hudson River monitoring programs; therefore, historical records for the Hudson River population trends are unavailable. However, based on tagging studies, the Atlantic menhaden population appears to be composed of a single population that undergoes extensive seasonal migration (ASMFC 2006a). Menhaden are primarily harvested via reduction purse-seine fishing, and Virginia and North Carolina are the only States that currently permit this type of fishing for this species (ASMFC 2006a). Menhaden landings peaked during the late 1950s at an annual average of over 600,000 t (544,000 MT) and then declined during the 1960s from 576,000 t (523,000 MT) in 1961 to 162,000 t (147,000 MT) in 1969. Landings rose in the 1970s as the stock rebuilt, maintained moderate levels during the 1980s, and declined again in the 1990s. Landings have varied in the 2000s with average annual landings of 184,900 t (168,000 MT) from 2000 to 2004, and 146,900 t (133,000 MT) landed in 2005. Landings from the reduction purse-seine fishery accounted for 79 percent of total landings along the Atlantic coast in 2005 (ASMFC 2006a). Atlantic menhaden are also harvested for bait in many Atlantic coast States; however, no data are available for these landings as they are taken via cast net, pound net, gill net, and as bycatch. Atlantic menhaden were generally not present in entrainment samples from IP2 and IP3, but were present in impingement samples.

<u>American Shad</u>

The American shad (*Alosa sapidissima*, family Clupeidae) is the largest of the anadromous herring species found in the Hudson River estuary and ranges from Newfoundland to northern Florida. The species is most abundant between Connecticut and North Carolina. The stock was introduced along the Pacific coast in the Sacramento and Columbia Rivers in 1871, and the population is now established from Cook Inlet, Alaska, to southern California (Facey and Van Den Avyle 1986). American shad has been commercially harvested via gillnets for meat and roe since the late 17th century (Haas-Castro 2006b). Before World War II, American shad was the most valuable fish along the east coast (Facey and Van Den Avyle 1986).

American shad spend most of their life at sea and only return to their natal rivers at sexual maturity (at the age of about 5 years) to spawn. Adult American shad have an average length of 30 in. (76.2 cm), weigh up to 12 lb (5.4 kg), and have a life span in the Hudson River of about 11 years (CHGEC 1999). Shad eggs have a high mortality rate, and fecundity of females changes with latitude, decreasing from south to north. Females in southern rivers produce 300,000 to 400,000 eggs, and females in northern rivers produce an average of 125,000 eggs (Haas-Castro 2006b). Spawning occurs at night in shallow waters of moderate current in sand, gravel, or mud substrates (Facey and Van Den Avyle 1986). The species can repeat annual spawning up to five times within their lifetime in northeastern rivers; however, most shad from southeastern rivers die after spawning (Facey and Van Den Avyle 1986; CHGEC 1999). Egg abundance in the Hudson River peaks in May, and once hatched, YSL transform into PYSL within 4 days to 1 week in waters at a temperature of 17°C (63°F) (Everly and Boreman 1999; CHGEC 1999). Larvae inhabit riffle pools of moderate depth near spawning grounds and develop into juveniles 4 to 5 weeks after hatching when they are approximately 25 mm (1 in.) in length (Everly and Boreman 1999; Facey and Van Den Avyle 1986). American shad eggs, YSL, PYSL, and YOY are generally found between Kingston and Albany (Table 2-5), probably in response to food availability (Limburg 1996). Juveniles travel downriver in schools between June and July (Everly and Boreman 1999), utilize the middle estuary by September, and move to the lower estuary by late October (Limburg 1996). Adults spend the summer months in the northwestern Atlantic waters off the Gulf of Maine, the Bay of Fundy, and the coast of Nova Scotia. In the fall months, individuals migrate southward as far as North Carolina (CHGEC 1999).

Shad stop eating before running and spawning and resume feeding after spawning during their downriver migration back to the Atlantic Ocean (Everly and Boreman 1999). Larvae feed on *Bosmina* spp., cyclopoid copepodites, and chironomid larvae. Juveniles are opportunistic feeders and consume free-swimming organisms at the surface as well as insects (CHGEC 1999). The principal food source of the adult American shad is zooplankton, though the species also consumes small crustaceans, copepods, mysids, small fish, and fish eggs (Facey and Van Den Avyle 1986). The American eel (*Anguilla rostrata*) and catfish (*Ictalurus* spp.) prey upon American shad eggs, and bluefish (*Pomatomus saltatrix*) prey upon larvae (CHGEC 1999). Once juveniles migrate to the Atlantic Ocean, likely predators include sharks, tuna, and porpoises; adult shad are not thought to have many predators (Facey and Van Den Avyle 1986).

The estimated population of American shad in the Hudson River has declined from 2.3 million in 1980 to 404,000 in 1996 (ASMFC 1998). The decline of the species in the Hudson and Connecticut Rivers in the past century is attributed to overfishing, degradation of riverine habitat, and dam construction (Haas-Castro 2006b). ASMFC implemented a Fisheries Management Plan for the American shad and river herring in 1985. Restoration efforts under the plan include habitat improvement, fish passage, stocking, and transfer programs; however, abundance of American shad remains well below historic estimates (Haas-Castro 2006b). Low DO conditions can affect the migration patterns of American shad and limit spawning. Improvements in sewage treatment facilities along the Hudson River in the late 1960s have eliminated the low DO conditions that were problematic in waters south of Albany and have allowed adult shad to spawn farther upriver (CHGEC 1999). According to CHGEC (1999), entrainment mortality has caused a 23.8 percent annual decrease in abundance of juvenile American shad, and impingement may reduce the population by an additional 1 percent annually. The majority of entrainment mortality is believed to occur in the Albany region as a result of the Albany Steam Station and Empire State Plaza (CHGEC 1999). American shad were present in both impingement and entrainment samples obtained from IP2 and IP3.

<u>Atlantic Tomcod</u>

The demersal, anadromous Atlantic tomcod (*Microgadus tomcod*, family Gadidae) is found in northwest Atlantic estuarine habitats, with a range extending from southern Labrador and northern Newfoundland to Virginia (Stewart and Auster 1987). The species is nonmigratory and inhabits brackish waters, including estuarine habitats, salt marshes, mud flats, eel grass beds, and bays. The species is short-lived, with an estimated mortality rate ranging from 81 to

98 percent by the age of 2 years (McLaren et al. 1988). Mean lifespan within the Hudson River is 3 years, though populations north of the Hudson River tend to be longer lived (Stewart and Auster 1987). Most tomcod within the Hudson River are thought to remain within the estuary for life; however, a small number of individuals have been marked and recaptured in the lower New York Bay, the East River, and western Long Island Sound (Klauda et al. 1988). The tomcod has not been a commercially important species in the northeast within the past century, and no catch statistics have been recorded since the 1950s, as the species is generally a target for winter sport fishing only along the New England coast (Stewart and Auster 1987). Tomcod are particularly vulnerable to impingement and entrainment because of their high concentration near the lower portion of the Hudson River estuary (Barnthouse and Van Winkle 1988; Boreman and Goodyear 1988) (Table 2-5).

Spawning occurs under ice between December and January in shallow stream mouths (Stewart and Auster 1987). In the Hudson River, tomcod aged 11 to 13 months contribute approximately 85 to 97 percent of annual egg production, and the majority of tomcod in the Hudson River spawn only once in their lifetime (McLaren et al. 1988). Females produce an average of 20,000 eggs, and incubation time correlates inversely with salinity and ranges from 24 to 63 days (Dew and Hecht 1994; Stewart and Auster 1987). Once hatched, larvae float to the surface and are swept by currents into estuaries, where they develop into juveniles. YSL are found throughout the lower half of the estuary, and PYSL are concentrated in the Yonkers and Tappan Zee regions of the estuary (CHGEC 1999) (Table 2-5). Adults are found at all levels of salinity, but larvae and juvenile densities are highest within the 4.5 to 6.7 ppt salinity range (Stewart and Auster 1987). The Hudson River represents the southernmost major spawning area of the species, and the tomcod is the only major species within the freshwater region of the Hudson River to hatch between February and March (Dew and Hecht 1994). Because the species hatches earlier than herring species within the Hudson and larvae and juveniles are able to tolerate low temperatures, tomcod experience little interspecific competition for food until the fall of their first year (McLaren et al. 1988). Tomcod are found at temperatures as low as -1.2°C (30°F) and have not been observed to inhabit waters at temperatures higher than 26°C (79°F) (Stewart and Auster 1987). The species has also been observed at a wide range of depths varying from the surface to 69 m (226 ft) (Froese and Pauly 2007a). Tomcod have three visible stages of first year growth within the Hudson River population. Juveniles show rapid growth during the spring, little to no growth during the summer, and rapid growth again in the fall, which is highly correlated with prevailing water temperatures (McLaren et al. 1988). Growth has been found to slow at temperatures above 19°C (66°F), and growth essentially ceases at temperatures above 22°C (72°F) (CHGEC 1999).

The diet of tomcod consists primarily of small crustaceans but also may include polychaete worms, mollusks, and small fish. Because tomcod have a lipid-rich liver and prey on many benthic organisms, they are especially sensitive to contaminants in highly polluted waterways, including PCBs and other chlorinated hydrocarbons (Levinton and Waldman 2006). Recent work by Wirgin and Chambers (2006) has reported evidence of induction of hepatic expression of cytochrome P4501A1 and messenger ribonucleic acid (mRNA) in Hudson River tomcod, suggesting a potential for deoxyribonucleic acid (DNA) damage, somatic mutations, and initiation of carcinogenesis consistent with chemical exposure. Within the Hudson River estuary, juvenile tomcod serve as alternate prey in the summer months for yearling striped bass (*M. saxatilis*) during years when juvenile striped bass's main prey, the bay anchovy (*A. mitchilli*), is scarce (Dew and Hecht 1976 cited in Stewart and Auster 1987). Juvenile tomcod are also the prey of large juvenile bluefish (*P. saltatrix*) (Juanes et al. 1993).

The Hudson River tomcod population exhibits wide fluctuations in annual abundance because the species is relatively short lived, and a yearly population is generally composed of only one age class (Levinton and Waldman 2006). The population of tomcod aged 11 to 13 months has been estimated to vary year-to-year between 2 to 5 million individuals, and numbers of tomcod aged 23 to 25 months may vary from 100,000 to 900,000 individuals. A combined abundance index suggests that a population decline has occurred since 1989 (CHGEC 1999). Recent information provided by Entergy (2006c) estimated the population of Atlantic tomcod spawning in the Hudson River during the winter of 2003–2004 to be 1.7 million fish, with 95 percent confidence limits of 1.0 and 2.9 million fish. This estimate, derived by a Petersen mark-recapture technique, is based on the number of tomcod caught and marked between RM 25 and 76 (RKM 40 to 122) in box traps between December 15, 2003, and February 1, 2004, and recaptured in trawls in the Battery region from January 5 through April 11, 2004. The estimated 2003–2004 Atlantic tomcod spawning population in the Hudson River is the ninth lowest observed among 20 recent years of Petersen estimates (Entergy 2006c). Atlantic tomcod were present in both impingement and entrainment samples obtained from IP2 and IP3.

<u>Bay Anchovy</u>

The bay anchovy (*Anchoa mitchilli,* family Engraulidae) occurs along the Atlantic coastline from Maine to the Gulf of Mexico and the Yucatan Peninsula (Morton 1989) and is a common shallow-water fish in the Hudson River estuary. No commercial fishery for the bay anchovy exists on the Hudson River, but it is preyed upon by other fish, such as the striped bass (*M. saxatilis*), which is recreationally important on the Hudson River. Unless otherwise noted, the information below is from Morton (1989).

Considered a warm water migrant, the bay anchovy uses the Hudson River estuary for spawning and as a nursery ground. Adults are found in a variety of habitats, including shallow to moderately deep offshore waters, nearshore waters off sandy beaches, open bays, and river mouths. Studies conducted in the Hudson River from 1974–2005 suggest that eggs, YSL, PYSL, YOY, and older individuals occur in greatest abundance from the Battery to IP2 and IP3 (Table 2-5, Figure 2-10). There is also evidence from recent work by Dunning et al. (2006a) that the peak standing crops of bay anchovy eggs and larvae in New York Harbor, the East River, and Long Island Sound are approximately eight times larger than the population estimates for the lower Hudson River, probably because of the larger water volumes in those areas and the salinity preference of the species. Spawning generally occurs at water temperatures between 9 and 31°C (48 and 88°F). The spawning period for the species is long, typically ranging from May through October. Spawning generally occurs in the late evening or at night, and the eggs are pelagic. Schultz et al. (2006) has reported that anchovies that spawn in the Hudson River are mostly 2 years old, whereas yearlings predominate in other locations, such as Chesapeake Bay. Eggs are usually concentrated in salinities of 8 to 15 ppt and, at temperatures around 27°C (81°F), hatch in 24 hours. At hatching, the YSL are about 1.8 to 2.0 mm (0.07 to 0.08 in.) long. Within 24 hours of hatching, YSL consume the yolk sac and become PYSL. Fins begin to develop during the PYSL stage. Larvae are transparent and become darker as they develop into juveniles. PYSL eat copepod larvae and other small zooplankton.

Larvae metamorphose to juveniles at about a length of 16 mm (0.63 in.). Juveniles and adults travel and hunt in large schools. Juveniles acquire adult characteristics at about 60 mm (2.4 in.) in length and gain a silvery lateral band. Adults have a relatively high tolerance to fluctuations in both river temperature and salinity, and there is evidence in the Hudson River that early-stage anchovies migrate up-estuary at a rate or 0.6 km/day (0.4 mi/day) and are capable of periodic vertical migration (Schultz et al. 2006). Adult and juvenile bay anchovy feed primarily on mysid shrimp, copepods, other small crustaceans, small mollusks, other plankton, and larval fish (Hartman et al. 2004). Important predators include birds, bluefish (*P. saltatrix*), weakfish (*C. regalis*), summer flounder (*Paralichthys dentatus*), and striped bass (*M. saxitilis*) (CHGEC 1999). The population trend in the Hudson River appears to show a population decline, although exact population counts are not available (Tipton 2003). Tipton (2003) also speculates that the reduction in bay anchovy may be linked to increased predation and overall populations of striped bass, bluefish, or other important commercial fish. Fishery statistics are not available for this species from National Marine Fisheries Service (NMFS) because of the lack of commercial and recreational fishing. The Mid-Atlantic Fishery Management Council has not identified bay anchovy as a managed species. Bay anchovy were present in impingement samples, and represented a sizable portion in entrainment samples obtained from IP2 and IP3 during 1981, and 1983-1987.

<u>Blueback Herring</u>

The blueback herring (*Alosa aestivalis*, family Clupeidae) is an anadromous species found in riverine and estuarine waters along the Atlantic coast ranging from Nova Scotia to St. Johns River, Florida. As noted in the life history of the alewife (*A. pseudoharengus*), commercial fisheries do not differentiate between the blueback herring (*A. aestivalis*) and alewife, and the two species are collectively referred to as river herring. River herring are harvested for fish meal, fish oil, and protein for animal food industries (Fay et al. 1983). Commercial landings of river herrings peaked in the 1950s at approximately 34,000 MT (37,000 t) and then declined to less than 4000 MT (4400 t) in the 1970s. Between 1996 and 2005, landings of river herring ranged from 300 to 900 MT (330 to 990 t) annually, with the majority of the landings in Maine, North Carolina, and Virginia (Haas-Castro 2006a). The river herring fishery is one of the oldest fisheries in the United States; however, no commercial fisheries for river herring exist in the Hudson River today. River herring are often taken as bycatch in the offshore mackerel fishery. Within New York and New Jersey, river herring accounted for 0.3 percent of annual landings on the Atlantic coast (CHGEC 1999).

Blueback herring spawn once per year between late May and mid-July in the main channels of estuaries or relatively deep freshwater with swift currents on sand or gravel substrate at temperatures between 14°C (57°F) and 27°C (81°F) (Everly and Boreman 1999; Fay et al. 1983). Female egg production varies greatly, ranging from 46,000 to 350,000 eggs per female (Fay et al. 1983), and incubation time is approximately 6 days (Bigelow and Schroeder 1953). Blueback herring spawn 3 to 4 weeks after alewives in areas where the two species occur sympatrically, and the peak spawning of each species occurs 2 to 3 weeks apart from one another (Fay et al. 1983). In the Hudson, blueback herring spawn most commonly within the Mohawk River and upper Hudson River (CHGEC 1999). The YSL stage exists 2 to 3 days before yolk-sac absorption, and the PYSL stage lasts until larvae reach approximately 20 mm (0.79 in.), with full development occurring at 45 mm (1.8 in.) (Fay et al. 1983). Eggs, YSL, PYSL, and YOY are generally found between Poughkeepsie and Albany (Table 2-5). Juvenile blueback herring assume adult characteristics within a month of hatching, at which point growth slows. Peak abundance of juveniles occurs during late June within the upper estuary (CHGEC 1999) (Table 2-5). Migration downriver to the Atlantic Ocean occurs in October, which is generally later than peak migration for both the American shad and the alewife within the Hudson River estuary (Fay et al. 1983). Some blueback herring do not migrate and tend to stay within the lower reaches of the estuary during their first 1 to 2 years (CHGEC 1999). Average length for males is 23 cm (9.1 in.) and for females is 26 cm (10 in.) (Collette and Klein-MacPhee 2002).

Adult blueback herring feed mainly on copepods but also eat amphipods, shrimp, fish eggs, crustacean eggs, insects, and insect eggs. The diet of blueback herring in the lower Hudson River consists primarily of chironomid larvae and copepods. As described for the alewife, blueback herring is an important link in the estuarine food web between zooplankton and top piscivores. The blueback herring is prey for gulls, terns, and other coastal birds, as well as for bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), and striped bass (*Morone saxatilis*) (CHGEC 1999).

Annual abundance of blueback herring YOY in the Hudson River estuary has been estimated to range from 1.2 million to 50.1 million individuals from sampling conducted with a Tucker trawl since 1979 (CHGEC 1999). According to CHGEC (1999), entrainment mortality for the combined abundance of blueback herring and alewife for all water withdrawal locations within the Hudson River varies widely, ranging from 8 to 41 percent in data taken between 1974 and 1997, while impingement mortality of the two species was low, ranging from 0.2 to 0.7 percent for the same time period. Blueback herring were present in both impingement and entrainment samples obtained from IP2 and IP3.

<u>Bluefish</u>

The bluefish (*Pomatomus saltatrix*, family Pomatomidae) is a migratory, pelagic species that occurs in temperate and tropical waters worldwide on the continental shelf and in estuaries. Along the Atlantic coast, the bluefish ranges from Nova Scotia to the Gulf of Mexico (Pottern et al. 1989). Bluefish are a highly sought-after sport fish along the North Atlantic Coast, and State and Federal regulations on the commercial catch of the species began in the early 1970s (CHGEC 1999; Pottern et al. 1989). The majority of the Atlantic coast bluefish catch occurs between New York and Virginia, and recreational fishing has accounted for 80 to 90 percent of the total bluefish catch in the past, with a peak in 1981 and 1985 of over 43,000 MT (47,000 t). Landings have since decreased, reaching a low of 3300 MT (3600 t) in 1999; landings in 2005 totaled 3500 MT (3300 t) (Shepherd 2006a). The bluefish is also harvested commercially for human consumption, and during peak years in 1981 to 1983, average annual landings were 7.4 million kg (16.3 million lb), accounting for 0.5 percent of the total Atlantic coast commercial finfish and shellfish landings (Pottern et al. 1989).

North American bluefish populations range from New England to Cape Hatteras, North Carolina, in the summer, and migrate to Florida and the Gulf Stream during the winter. Fisheries data also indicate the existence of small nonmigratory populations in southern Florida waters and the Gulf of Mexico (Pottern et al. 1989). Bluefish are generally not found in waters colder than 14 to 16°C (57.2 to 60.8°F) and exhibit signs of stress at temperatures below 11.8°C (53.2°F) and above 30.4°C (86.7°F) (Collette and Klein-MacPhee 2002).

Generally, bluefish have two major spawnings per year. The first spawning occurs during the spring migration as bluefish move northward to the South Atlantic Bight between April and May; the second spawning occurs in the summer in offshore waters of the Middle Atlantic Bight between June and August. Two distinct cohorts of juvenile bluefish in the fall result from the two spawning events, which mix during the year creating a single genetic pool (Shepherd 2006a). Females can produce 600,000 to 1.4 million eggs (CHGEC 1999). Larvae hatch in 46 to 48 hours at temperatures of 18 to 22°C (64.4 to 71.6°F) (Collette and Klein-MacPhee 2002). Newly hatched larvae are pelagic and stay in offshore waters for the first 1 to 2 months of life before migrating shoreward to shallower waters (CHGEC 1999). Beach seine survey results indicate YOY bluefish are generally found between Yonkers and Croton-Haverstraw (Table 2-5). YSL typically consume the yolk sac by the time they reach 3 to 4 mm (0.12 to 0.16 in.) in length (Pottern et al. 1989). Bluefish larvae grow rapidly; spring-spawned juveniles reach lengths of 25 to 50 mm (0.99 to 2 in.) once they move to mid-Atlantic bays in the summer, grow to lengths of 175 to 200 mm (6.9 to 7.9 in.) by late September when migration begins, and reach lengths of about 260 mm (10.2 in.) by the following spring. Summer-spawned juveniles exhibit slower growth because they are unable to inhabit bays and estuaries until after their first migration, though summer-spawned juvenile growth rates exceed those of spring-spawned juveniles during the second year, at which point differences between the two stocks are less pronounced (Pottern et al. 1989). Adult bluefish can live up to 12 years and reach weights of 14 kg (31 lb) and lengths of 100 cm (39 in.) (Shepherd 2006a).

Bluefish are avid predators, and the Atlantic coast population is estimated to consume eight times its biomass in prey annually. Larvae feed on zooplankton and larvae of other pelagic-spawning fish (Pottern et al. 1989). In the Hudson River estuary, YOY feed on bay anchovy (*A. mitchilli*), Atlantic silverside (*M. menidia*), striped bass (*M. saxatilis*), blueback herring (*A. aestivalis*), Atlantic tomcod (*M. tomcod*), and American shad (*A. sapidissima*) (CHGEC 1999; Juanes et al. 1993). Adult bluefish diets are dominated by squids, clupeids, and butterfish. YOY bluefish are prey for birds including Atlantic puffin (*Fratercula arctica arctica*), Arctic tern (*Sterna paradioaea*), and roseate tern (*Sterna dougalli dougalli*) (Collette and Klein-MacPhee 2002). Sharks also prey on bluefish; species include the bigeye thresher (*Alopias superciliosus*), white shark (*Carcharodon carcharias*), shortfin mako (*Isurus oxyrinchus*), longfin mako (*I. paucus*), tiger shark (*Galeocerdo cuvier*), blue shark (*Prionace glauca*), sandbar shark (*Carcharhinus plumbeus*), smooth dogfish (*Mustelus canis*), spiny dogfish (*Squalus acanthias*), and angel shark (*Squatina* spp.) (Collette and Klein-MacPhee 2002).

The bluefish population data from the Hudson River estuary show a declining trend since the population peaked in 1981 and 1982 (CHGEC 1999). Bluefish populations along the east coast have historically fluctuated widely, though analysis by the National Marine Fisheries Service (NMFS) of data between 1974 and 1986 did not find evidence of a systematic decline of the species (CHGEC 1999). According to CHGEC (1999), bluefish have not been found in entrainment samples from power plants along the Hudson River, which include Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2 (CHGEC 1999). CHGEC (1999) also stated that juvenile bluefish may be impinged, but the numbers are estimated to be relatively small. Electronic data obtained from Entergy (Entergy 2007b) showed that bluefish eggs and larvae were infrequently observed in entrainment samples, but were common in impingement samples from IP2 and IP3 (NL-09-160).

Gizzard Shad

The gizzard shad (*Dorosoma cepedianum*, family Clupeidae) is a pelagic herring species that is found in the waters of the Atlantic and Gulf coastal plains streams as well as in freshwater lakes and reservoirs ranging from New York to Mexico (MDNR 2007a). Gizzard shad are found mainly in freshwater rivers, reservoirs, lakes, and swamps, and in slightly brackish waters of estuaries and bays (Froese and Pauly 2007b). The gizzard shad is a relatively recent immigrant to the Hudson River estuary, though it is now considered a permanent resident, and the species is continuing to expand its range throughout the northeastern United States (CHGEC 1999; Levinton and Waldman 2006). No commercial or sport fishery for gizzard shad exists on the Hudson River (CHGEC 1999). Larvae have been observed in the tidal waters of the Hudson River since 1989 (Levinton and Waldman 2006). A spawning population is believed to exist in the Mohawk River, but no spawning has been observed in the Hudson River (CHGEC 1999).

Adult gizzard shad grow to 23 to 36 cm (9 to 14 in.) in length with an average weight of 907 g (2 lb) and an average life span of 7 years in northern populations (CHGEC 1999; Morris 2001). Both males and females mature between 2 and 3 years of age, and females spawn between April and June in shallow waters between 10 and 21°C (50 and 70°F) (CHGEC 1999; MDNR 2007a). Fecundity is thought to be highly variable but does appear to increase with size of the female (CHGEC 1999). Females can produce between 50,000 and 379,000 eggs (MDNR 2007a). Eggs hatch in 1.5 to 7 days, depending on water temperature (CHGEC 1999). YSL transform into PYSL within 5 days of hatching and begin to feed on microzooplankton until they reach 2.5 cm (1 in.) in length. At this point, development of the digestive system supports a diet including plant material; juveniles eat a variety of daphnids, cladocerans, adult copepod, rotifers, algae, phytoplankton, and detritus (CHGEC 1999). Gizzard shad grow rapidly during the first 5 to 6 weeks of life, at which point growth slows; individuals reach a length of 10 to 25 cm (4 to 10 in.) by their first summer (CHGEC 1999). Adults are filter feeders, eating a variety of phytoplankton and zooplankton. Larvae are not an important prey species because of their size, but age 0 gizzard shad are consumed by a number of species including striped bass, largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculates*), white bass (*Morone chrysops*), and spotted bass (*Micropterus punctulatus*) (CHGEC 1999). Predators of adult gizzard shad include catfish (order Siluriformes) and striped bass (*M. saxatilis*) (Morris 2001).

Abundance data are not available for the gizzard shad from the Hudson River sampling programs because of the low capture rate of the species in these programs (CHGEC 1999). Beach seine surveys from 1974 to 2005 suggest YOY and older gizzard shad occur primarily from Cornwall north to Albany (Table 2-5). Impingement data are available at three power stations along the Hudson River (Danskammer, Roseton Units 1 and 2, and the now-shuttered Lovett Generating Station) and indicate year-to-year fluctuations with a general trend of increasing impingement and peak adult impingement during the winter months. According to CHGEC (1999), entrainment of early life stages is thought to be low, and small gizzard shad are rare in utility ichthyoplankton surveys. Gizzard shad eggs and larvae were not observed in entrainment samples from IP2 and IP3 during evaluations in 1981 and 1983-1987, but were commonly observed in impingement samples.

Hogchoker

The hogchoker (*Trinectes maculatus*, family Soleidae) is a right-eyed flatfish species found along the Atlantic coast in bays and estuaries from Maine to Panama (Dovel et al. 1969). The hogchoker is common in the Hudson River estuary and surrounding bays and coastal waters, and abundance indices from the annual Fall Juvenile Survey (also known as the Fall Shoals Survey) channel sampling in the Hudson River from 1974 to 1997 indicate that the hogchoker population has remained relatively stable with a nonsignificant 1 percent increase per year (CHGEC 1999). Because of its small size (adults range from 6 to 15 cm (2.4 to 5.9 in.) with a maximum size of 20 cm (7.9 in.)), the hogchoker is not commercially harvested in any area within its geographic range (Collette and Klein-MacPhee 2002). CHGEC (1999) indicates that hogchoker larvae are found mainly within deeper channel waters and are not often captured during the Longitudinal River Survey; low numbers of juveniles are captured during the Beach Seine and Fall Juvenile Surveys, and yearlings and adults are generally not exposed to Hudson River generating stations because they remain in the waters below RM 34 (CHGEC 1999). However, the Fall Juvenile Survey information reviewed by the NRC staff suggests that YOY and older hogchokers have been collected from Tappan Zee to Poughkeepsie—an area that includes IP2 and IP3 (Table 2-5).

The majority of hogchokers in the Hudson River reach sexual maturity at the age of 2 years, though some faster growing males have been observed to spawn at age 1 year (Koski 1978). Spawning occurs in estuaries between May and October in the Hudson River estuary, which is a 5-week longer spawning period than that of the Chesapeake Bay population (Collette and Klein-MacPhee 2002; Koski 1978). Spawning occurs in waters 20 to 25°C (68 to 77°F) and a salinity of 10 to 16 ppt (Collette and Klein-MacPhee 2002). Eggs are observed in greatest numbers from the last week in May through July in lower estuary waters. Egg production is positively correlated with size, and females can produce between 11,000 and 54,000 eggs. Within the Hudson River, eggs are most common between RM 12 and 24 (RKM 19 and 39). Eggs hatch in 24 to 36 hours at temperatures between 23.3 and 24.5°C (73.9 and 76.1°F). YSL absorb the yolk sac within 48 hours of hatching, and eye migration occurs within 34 days of hatching or at lengths of 0.2 to 0.4 in. (0.51 to 0.02 cm) (Collette and Klein-MacPhee 2002; CHGEC 1999). Larvae have been observed to congregate upstream in waters with lower salinity than their hatching ground (Dovel et al. 1969). Within the Hudson River, YSL are most abundant between RM 24 and 33 (RKM 39 and 53), and PYSL are most abundant from RM 24 through RM 55 (RKM 39 and 89). Juveniles are found above RM 39 (RKM 63), while yearling and older individuals are found below RM 34 (RKM 55) (CHGEC 1999). Adult individuals inhabit nonvegetated waters with sandy or silty bottoms (Whiteside and Bonner 2007).

Adult hogchokers feed mainly on annelids, arthropods, and tellinid siphons (Derrick and Kennedy 1997). The species is a generalist and may also prey on midges, ostracods, aquatic insects, annelids, crustaceans, and foraminiferans (Whiteside and Bonner 2007). Larger striped bass (*M. saxatilis*) prey on yearling and older hogchokers within the Hudson River estuary, which may affect the abundance of those age groups (CHGEC 1999). The Northeast Fisheries Science Center also found the smooth dogfish (*Mustelus canis*) to be a predator of hogchoker (Roundtree 1999 as cited in Collette and Klein-MacPhee 2002). Hogchokers were observed in both impingement and entrainment samples from IP2 and IP3.

Rainbow Smelt

Rainbow smelt (*Osmerus mordax*, family Osmeridae) is an anadromous species once found along the Atlantic coast from Labrador to the Delaware River, although the southern end of the range is now north of the Hudson River. NOAA (2007) lists rainbow smelt as a Species of Concern. Unless otherwise noted, information below comes from Buckley (1989).

Adult rainbow smelt along the east coast move into saltwater in summer, where they are found in waters less than 1 mi (1.6 km) from shore and usually no deeper than 6 m (20 ft). In spring, spawning adults typically move up the estuaries before ice breaks up to spawn above the head of tide in water temperatures of 4.0 to 9.0°C (39 to 48°F). They have been found to run up into coastal streams to spawn at night and then return to the estuary during the day. Females, depending on size, produce about 7,000 to 75,000 eggs (summarized in NOAA 2007a), which are from 1.0 to 1.2 mm (about 0.04 in.) in diameter. Eggs are typically deposited over gravel, and egg survival appears to be influenced by water flow, substrate type, and egg density. Exposure to salt or brackish water can cause egg mortality, as can sudden increases in temperature, diseases, parasites, contaminant exposure, and predation by other fish species. Incubation times can be 8 to 29 days and decrease with increasing water temperature. Common mummichog (*Fundulus heteroclitus*) and fourspine stickleback (*Apeltes quadracus*) are reported to be major predators of smelt eggs.

YSL are 5 to 6 mm (0.20 to 0.24 in.) long at hatching. The yolk sac is absorbed by the time the larvae reach 7 mm (0.28 in.) and enter the PYSL stage. The larvae initially concentrate near the surface and drift downstream. As they grow, they seek deeper water and congregate near the bottom. Vertical migration begins, and they move to the surface to feed during the day and deeper at night. The vertical migration patterns may maintain their position in two-layered estuarine systems. Larval and small juvenile smelt eat copepods and other small planktonic crustaceans as well as fish. In turn, larval and juvenile smelt are probably eaten by most estuarine piscivores.

Smelt grow fairly rapidly and begin to school when they reach a length of 19 mm (0.75 in.). As the smelt grow, they move down estuaries into higher salinity and, as adults, migrate to sea. They are mature and participate in spawning runs at age 1. Adults grow to average approximately 25.4 cm (10 in.) in length. Larger juveniles and adults feed on euphausiids, amphipods, polychaetes, and fish such as anchovies (family Engraulidae) and alewives (*A. pseudoharengus*). Adults also eat other fish species, including common mummichog, cunner (*Tautogolabrus adspersus*), and Atlantic silversides (*Menidia menidia*). Bluefish (*P. saltatrix*), striped bass (*M. saxatilis*), harbor seals (*Phoca vitulina*), and other large piscivores eat adult smelt.

Once a prevalent fish in the Hudson River, an abrupt smelt population decline in the Hudson River was observed from 1994 to , and the species may now have no viable population within the Hudson River. The last tributary run of rainbow smelt was recorded in 1988, and the Hudson River Utilities' Long River Ichthyoplankton Survey show that PYSL essentially disappeared from the river after 1995 (Daniels et al. 2005). When present, the largest abundances of eggs and YSL occurred from Poughkeepsie to the Catskills, and the largest abundances of PYSL, YOY, and older individuals were distributed from approximately Yonkers to Hyde Park (Table 2-5, Figure 2-6). Rainbow smelt runs in the coastal streams of western Connecticut declined at about the same time as in the Hudson River (Daniels et al. 2005).

Smelt landings in waters south of New England have dramatically decreased, although the reasons for this are unknown. Daniels et al. (2005) note slowly increasing water temperatures in the Hudson River and suggest that the disappearance of rainbow smelt from the Hudson River may be a result of global warming. Rainbow smelt were observed in both impingement and entrainment samples obtained from IP2 and IP3.

Spottail Shiner

The spottail shiner (*Notropis hudsonius*, family Cyprinidae) is a freshwater species which occurs across much of Canada, south to the Missouri River drainage, and in Atlantic States from New Hampshire to Georgia, with habitat ranging from small streams to large rivers and lakes, including Lake Erie (Smith 1985a). One of the most abundant fishes in the Hudson River, spottail shiners are commonly 3.9 in. (100 mm) in length, which is large for shiner species (Smith 1985a). The maximum length is approximately 5.8 in. (147 mm) (Schmidt and Lake 2006; Smith 1985a; Marcy et al. 2005a).

Spottail shiners spawn from May to June or July (typically later for the northern populations) over sandy bottoms and stream mouths (Smith 1985a; Marcy et al. 2005a); water chestnut (*Trapa natans*) beds provide important spawning habitat (CHGEC 1999). Individuals older than 3 years are seldom found, but there is evidence of individuals living up to 4 or 5 years (Marcy et al. 2005a). Fecundity is a factor of age: the ovaries of younger females contain 1400 eggs, and ovaries of older females contain from 1300 to 2600 eggs; a correlation between fecundity and size does not appear to exist (Marcy et al. 2005a). In the Hudson River Estuary, beach seine survey data from 1974 to 2005 showed the largest abundances of YOY and Year 1+ individuals occurred from Poughkeepsie north to Albany (Table 2-5).

Spottail shiners are opportunistic feeders, typically eating insects, bivalve mollusks, and microcrustaceans throughout the water column (Marcy et al. 2005a). Aggregations of spottail shiners have been observed preying on eggs of alewives (*Alosa psedoharengus*) and mayflies (Marcy et al. 2005a). Striped bass (*M. saxatilis*) larvae are also prey for spottail shiners (McGovern and Olney 1988), as are spottail eggs and larvae (Smith 1985a). Spottail shiners are frequently used as bait (Smith 1985a), and they are an important prey species for some fish, including walleye (*Sander vitreus*), channel catfish (*I. punctatus*), northern pike (*Esox lucius*), and smallmouth bass (*Micropterus dolomieu*) (IDFG 1985). The Hudson River population of spottail shiners is known to be susceptible to impingement and entrainment at water intakes, and this could be affecting the survivorship of most life stages (CHGEC 1999). Eggs and larval forms of spottail shiner were infrequently observed in entrainment samples from IP2 and IP3, but were commonly impinged.

Striped Bass

The striped bass (*Morone saxatilis*, family Moronidae) is an anadromous species, with a range extending from St. Johns River, Florida, to St. Lawrence River, Canada (ASMFC 2006b). Individual stocks of striped bass spawn in rivers and estuaries from Maine to North Carolina. When adults leave the estuaries to go to the Atlantic, the stocks mix; striped bass return to their natal rivers and estuaries to spawn. The Atlantic coast striped bass fishery has been one of the most important commercial fisheries on the east coast for centuries and has been regulated since European settlement in North America (ASMFC 2006b). In 1982, overfishing depleted the striped bass population to fewer than 5 million fish. Since that time, the Atlantic coast population has been restored to 65 million in 2005 (ASMFC 2006b). Striped bass have been important in both commercial and recreational fisheries, and while the majority of the stock spawns in the Chesapeake Bay, the Hudson River contributes to the stock as well. Fabrizio (1987) reported that of the age 2–5 individuals sampled from the Rhode Island commercial trap-net fishery in November 1982, 54 percent were from the Chesapeake Bay stock and 46 percent were from the Hudson River stock. Wirgin et al. (1993) estimated that the Chesapeake Bay and Hudson River stocks combined contributed up to 87 percent of the mixed fishery stock on the Atlantic coast.

The striped bass is a long-lived species, reaching 30 years of age, and spends the majority of its life in coastal estuaries and the ocean. Females reach maturity between 6 and 9 years, and then produce between 0.5 million and 3 million eggs per year, which are released into riverine spawning areas (ASMFC 2006b). The males, reaching maturity between 2 and 3 years, fertilize the eggs as they drift downstream (ASMFC 2006b). The eggs hatch into larvae, which absorb their yolk and then feed on microscopic organisms. PYSL mature into juveniles in the nursery areas, such as river deltas and inland portions of coastal sounds and estuaries, where they remain for 2 to 4 years, before joining the coastal migratory population in the Atlantic (ASMFC 2006b). Recent field investigations by Dunning et al. (2006b) have suggested that dispersal of age 2+ striped bass out of the Hudson River may be influenced by cohort abundance. In the spring or summer, adults migrate northward from the mouth of their spawning rivers up the Atlantic coast, and in the fall or winter they return south, in time to spawn in their natal rivers (Berggren and Lieberman 1978; ASMFC 2006b). Work by Wingate and Secor (2007), using remote biotelemetry on a total of 12 fish, suggested that specific homing patterns are possible for this species, and these patterns may influence their susceptibility to localized natural and anthropogenic stressors. Based on long-term monitoring data, various life-stages associated with this species are found in the Hudson River from Tappan Zee to Albany (Table 2-5).

Several factors play a role in spawning, including water temperature, salinity, total dissolved solids concentration, and water velocity and flow. Peak spawning occurs in water temperatures of 15 to 20°C (59 to 68°F) but can occur between 10 and 23°C (50 and 73°F) (Shepherd 2006b). Striped bass reach 150 cm (59 in.) in length and 25 to 35 kg (55 to 77 lb) in weight (Shepherd 2006b). Adult striped bass are omnivores and prey on invertebrates and fish, especially clupeids, including menhaden (*B. tyrannus*) and river herring (*Alosa* spp.) (Shepherd 2006b). Diets vary by season and location, typically including whatever species are available (Bigelow and Schroeder 1953). YOY striped bass diet is made up of fish and mysid shrimp (Walter et al. 2003).

Compared to other anadromous species, striped bass appear to spend extended periods in the Hudson River, contributing to their PCB body burdens. In 1976, the Hudson River commercial fishery was closed because of PCB contamination, although shad fishermen continue to catch striped bass in their nets (CHGEC 1999). Commercial restrictions on harvesting the Atlantic coastal fishery, in part supported by the Atlantic Striped Bass Conservation Act of 1984 (16 U.S.C. 5151–5158), which allows coastal States to cooperatively regulate and manage the stock, have led to the declaration of full recovery of the population in 1995 (ASMFC 2006b). Abundance levels have continued to increase in the Atlantic population. Restrictions on both commercial and recreational fisheries have been relaxed because of the recovery of the population (ASMFC 2006b), but the fisheries continue to be limited to State waters (within 3 nautical miles of land), and New York State's commercial fishery remains completely closed. While commercial landings have remained lower than the levels seen in the early 1970s, recreational landings have increased, and in 2004 made up 72 percent of the total weight harvested from the Atlantic stock (Shepherd 2006b). Recreational fishing in the Hudson River during the spring generally occurs north of the Bear Mountain Bridge (RKM 75 (RM 46)) (Euston et al. 2006). Striped bass were commonly found in entrainment and impingement samples obtained from IP2 and IP3.

Weakfish

The weakfish (*Cynocsion regalis*, family Sciaenidae) is a demersal species found along the Atlantic coast ranging from Massachusetts Bay to southern Florida and is occasionally found as far north as Nova Scotia and as far south as the eastern Gulf of Mexico (Mercer 1989). The weakfish is one of the most abundant fish species along the Atlantic coast and is fished recreationally as well as commercially via gill-net, pound-net, haulseine, and trawl (Mercer 1989). ASMFC considers weakfish to be composed of one stock based on genetic analysis; however, more recent tagging studies have indicated that weakfish may return to their natal estuary to spawn (ASMFC 2006c). The stock as a whole is thought to be declining as evidenced by decreased landings in recent years. Landings peaked in 1981 and 1982 at 12,500 MT (13,800 t), declined from 1989 through 1993, peaked again in 1998 at over 5000 MT (5500 t), and then declined from 1999 through 2004, at which point a record low of less than 1000 MT (1100 t) was reported (ASMFC 2006c). Entrainment of eggs and larvae at power plants within the Hudson River is not common because weakfish spawn in waters with higher salinity, though movement of juveniles into the Hudson River estuary during late winter and early spring results in some entrainment of young juveniles and impingement of larger juveniles (CHGEC 1999).

Weakfish are found at a depth range of 10 to 26 m (33 to 85 ft) and temperatures between 17 and 27°C (63 and 81°F) (Froese and Pauly 2007c). Adults favor shallow coastal waters with sandy substrate and a salinity of 10 ppt or higher, though they are found in a variety of estuarine environments (CHGEC 1999). Adult weakfish vary greatly in size, ranging from 6 to 31 in. (15 to 79 cm) in length, with a maximum weight of 20 lb (9.1 kg), and can live up to 11 years (CHGEC 1999). Most weakfish mature at the age of 2 during the late summer months, and almost all weakfish are mature by the end of their third summer (CHGEC 1999). Size at maturity varies with latitude: in northern populations, females have been observed to mature at 256 mm (10.1 in.) and males at 251 mm (9.9 in.), while in North Carolina populations, females have been observed to spawn at 230 mm (9.1 in.) and males at 180 mm (7.1 in.) (Mercer 1989). Weakfish migrate southward in the fall to the coastal waters of North Carolina and Virginia and then move northward in the spring to spawn (ASMFC 2006c).

Spawning takes place along the northeastern coast of the Atlantic between the Chesapeake Bay and Montauk, Long Island, New York, in nearshore coastal and estuarine waters during the spring and summer (CHGEC 1999). Within the New York Bight, two spawning peaks occur in mid-May, consisting of larger individuals that migrate northward earlier, and in June, consisting of smaller individuals (Mercer 1989). Fecundity estimates vary widely, though fecundity can be generally correlated with size and geographic area (from 4593 eggs for a 203-mm (8-in.) female to 4,969,940 eggs for a 569-mm (22.4-in.) female and from 306,159 eggs for a northern female to 2,051,080 eggs for a similarly sized female in North Carolina) (Collette and Klein-MacPhee 2002). Eggs can tolerate a temperature range of 12 to 31.5°C (53.6 to 88.7°F) and a salinity range of 10 to 33 ppt (Collette and Klein-MacPhee 2002). Larvae hatch within 36 to 40 hours at temperatures of 20 to 21°C (68 to 69.8°F) (Mercer 1989). Larvae move into bays and estuaries after hatching; in the Hudson River estuary, larvae are rarely observed north of the George Washington Bridge because of the lower salinity of these waters (CHGEC 1999). Larvae feed primarily on cyclopoid copepods, as well as calanoid copepods, tintinnids, and polychaete larvae (Collette and Klein-MacPhee 2002). Weakfish juveniles grow rapidly during their first year and reach lengths of 7.6 to 15.2 cm (3 to 6 in.) by the end of the summer (CHGEC 1999). Juveniles are typically distributed from Long Island to North Carolina in late summer and fall in waters of slightly higher salinity, sand or sand-grass substrates, and depths of 9 to 26 m (30 to 85 ft) (Mercer 1989). Juveniles are considered adults at approximately 30 mm (1.2 in.) (Collette and Klein-MacPhee 2002).

Adult weakfish feed on a variety of organisms, and their diet varies with locality and availability of food sources. Smaller weakfish (less than 20 cm (7.9 in.)) feed primarily on crustaceans, while larger weakfish feed primarily on anchovies, herrings, spot, and other fish (CHGEC 1999; Mercer 1989). Adult weakfish of all sizes also prey on decapod shrimps, squids, mollusks, and annelid worms (CHGEC 1999; Mercer 1989). Bluefish (*P. saltatrix*), striped bass (*M. saxatilis*), and older weakfish prey on younger weakfish, while weakfish of larger size are preyed on by dusky sharks (*Carcharhinus obscurus*), spiny dogfish (*Squalus acanthias*), smooth dogfish (*Mustelus canis*), clearnose skate (*Raja eglanteria*), angel sharks (*Squatina* spp.), goosefish (family Lophiidae), and summer flounder (*Paralichthys dentatus*) (Collette and Klein-MacPhee 2002).

YOY and older weakfish are generally found from Yonkers to West Point (Table 2-5). Weakfish abundance fluctuated from 1979 to 1990, and abundance was relatively low between 1990 and 1997; overall, abundance declined 6 percent between 1979 and 1997 (CHGEC 1999). The weakfish stock as a whole declined suddenly in 1999 and approached even lower levels by 2003, which ASMFC determined to be the result of higher natural mortality rates rather than the result of fishing mortality (ASMFC 2007b). A leading hypothesis suggests that insufficient prey species and increased predation by striped bass may contribute significantly to rising natural mortality rates in the weakfish population (ASMFC 2007b). Weakfish were commonly found in both impingement and entrainment samples obtained from IP2 and IP3.

<u>White Catfish</u>

The white catfish (*Ictalurus catus*, family Ictaluridae) is a demersal species found in estuarine and freshwater habitats along the Atlantic coast from the lower Hudson River to Florida, though it has been introduced in other areas, including Ohio and California (Smith 1985b). The natural distribution of the species is thought to be in coastal streams from the Chesapeake Bay to Texas; limited recreational fishing for this species occurs in the Hudson River (CHGEC 1999). White catfish are the least common species of catfish in New York waters (NYSDEC 2008a). The New York State Department of Health has issued a fish advisory for the species because of the potential for elevated levels of PCBs (NYSDOH 2007). Additionally, the New Jersey Department of Environmental Protection (NJDEP) has issued a health advisory for the white catfish downstream of the New York-New Jersey border, which includes portions of the Hudson River and Upper New York Bay (NJDEP and NJDHSS 2006).

The white catfish is of intermediate size compared with other species in the family; adults grow to lengths of 8.3 to 24 in. (21 to 62 cm) and reach weights of 0.6 to 2.2 lb (0.25 to 1.0 kg) (Marcy et al. 2005b). The species has been reported to live 11 or more years as evidenced by individuals observed in South Carolina (Marcy et al. 2005b). White catfish prefer fresh or brackish water and, in the upper Hudson River, are most commonly found in channel borders, shoals, and vegetated backwaters (Marcy et al. 2005b). Though the white catfish is more salt tolerant than most catfish species, it is not typically found in waters with salinities above 8 ppt (CHGEC 1999; NJDEP 2005). Fall Juvenile Survey data from 1979 to 2004 suggests that YOY and older individuals were generally found from the Saugerties to Albany segments of the Hudson River (Figure 2-10, Table 2-5).

White catfish are sexually mature between 3 to 4 years of age at the size of 7 to 8 in. (18 to 20 cm). Adults move upstream for spawning between late June and early July when Hudson River water temperatures reach approximately 70°F (21°C) (CHGEC 1999). Before spawning, both males and females construct nests on sand or gravel bars, and males protect the nest once females lay eggs. Females that are 11 to 12 in. (28 to 30 cm) can lay 3200 to 3500 eggs. Eggs hatch in 6 to 7 days at temperatures between 75 to 85°F (24 to 29°C) (CHGEC 1999; Smith 1985b). Males continue to protect young until the juveniles form large schools and disperse from the nest (MDNR 2007b). YOY migrate downstream to deeper waters in September and October, and generally, yearling and older white catfish move out of the upper Hudson River estuary once the water temperatures drop below 59°F (15°C) to overwinter in the lower estuary. (Smith 1985b, CHGEC 1999).

White catfish have an especially varied diet. Adults collected from the North Newport River in Georgia were found to consume over 50 different species of prey (Marcy et al. 2005b). Juveniles and smaller adults feed primarily on midge larvae and macroinvertebrates, while larger adults have a more diverse diet, which may consist of midge larvae, crustaceans, algae, fish eggs, and a number of fish species, including herring (*Clupea* spp.), menhaden (*Brevoortia* spp.), gizzard shad (*Dorosoma cepedianum*), and bluegills (*Lepomis macrochirus*) (CHGEC 1999; Smith 1985b). Amphipods are widely consumed by adult catfish and make up a large percentage (up to 80 percent) of the volume of food eaten (CHGEC 1999).

The white catfish population is considered stable throughout the majority of its range, though the Hudson River population appears to have been in decline since 1975 (CHGEC 1999). The decline may partially be a result of food-limited growth and survival of larvae and YOY as a result of resource depletion by PYSL and YOY striped bass (*Morone saxatilis*) (CHGEC 1999). According to CHGEC (1999), early life stages of this species are generally not at risk of entrainment because spawning and early development occurs upstream near nests, which adult white catfish guard. CHGEC (1999) also states that juvenile and adult white catfish are infrequently impinged; the species has been recorded to consist of 0.42 percent of total fish impinged at IP2 and IP3. White catfish were not commonly observed in entrainment samples but were common in impingement samples obtained from IP2 and IP3.

<u>White Perch</u>

White perch (*Morone americana*) is endemic to the North American eastern coastal areas and range from Nova Scotia to South Carolina. It is not actually a perch, but a member of the temperate bass family Percichthyidae, along with striped bass (*M. saxatilis*). White perch are year-round residents in the Hudson River between New York City and the Troy Dam near Albany. They have never been a recreationally or commercially important resource for the Hudson River, and commercial fishing was closed in 1976 because of PCB contamination, but they are well represented in impingement collections of Hudson River power plants. In other parts of its range, white perch is intensively fished (Klauda et al. 1988).

Spawning habitats vary and can be clear or turbid, fast or slow, in water less than 7 m (23 ft) deep (Stanley and Danie 1983). In the Hudson River, most spawning occurs in the upper reaches (RKM 138 to 198 (RM 86 to 123)) in shallow embayments and tidal creeks, and adults move offshore and downriver after spawning (Klauda et al. 1988). Spawning in the Hudson River begins in late April when water temperatures reach 10 to 12°C (50 to 54°F) and can continue until late May or early June when temperatures reach 16 to 20°C (61 to 68°F) (Klauda et al. 1988). Fecundity depends on age and size of the females and ranges from about 5,000 to over 300,000 eggs (Stanley and Danie 1983). The eggs are adhesive and sink and may stick to the substrate or each other.

Hatching takes place between 1 and 6 days following fertilization, and the incubation period is inversely related to water temperature but relatively unaffected by salinity and silt levels (Collette and Klein-MacPhee 2002; Stanley and Danie 1983). Newly hatched YSL are about 2 mm (0.08 in.) long, and after 5 to 6 days, the yolk sac is absorbed (Collette and Klein-MacPhee 2002). The YSL generally remain in the same area where they hatched for 4 to 13 days (Stanley and Danie 1983). PYSL eat zooplankton and grow rapidly. Juveniles eat larger zooplankton. In the spring as water temperature rises, adults, which can reach maximum lengths of 495 mm (19.5 in.), begin their spawning migration and start to move upstream into shallower, fresher waters and into tidal streams.

Juveniles tend to stay in inshore areas of the estuary and in creeks until they are about a year old and 20 to 30 cm (8 to 12 in.) in length and then tend to move downstream to brackish areas (Stanley and Danie 1983). Although they may move offshore during the day, they tend to return to shoal areas at night. Most males and females mature at 2 years. After spawning, they return to deeper waters. In summer, large schools of white perch tend to move slowly without direction, and they tend not to travel very far. (Stanley and Danie 1983)

White perch are opportunistic feeders and have a broad range of prey. Young adults in freshwater environments feed on aquatic insects, crustaceans, and other smaller fishes (Stanley and Danie 1983). In brackish and estuarine environments, the white perch feed on fish eggs, the larvae of walleye (*Sander vitreus*) and striped bass, and other smaller adult fish (Chesapeake Bay Program 2006). Young adult white perch also consume amphipods, snails, crayfish, crabs, shrimp, and squid where available. White perch larger than 22 cm (9 in.) feed almost exclusively on other fish. White perch are consumed by many larger predatory fish species. White perch were commonly observed in both entrainment and impingement samples obtained from IP2 and IP3.

Blue Crab

Blue crab (*Callinectes sapidus*, family Portunidae) is an important commercial and recreational resource throughout much of its range, which in the western Atlantic is from Nova Scotia through the Gulf of Mexico to northern Argentina. The life history of blue crab in the Hudson River estuary is largely based on the Delaware and Chesapeake Bays, where the most relevant information in the United States has been gathered. Unless otherwise noted, information below is from Perry and McIlwain (1986).

Spawning and mating in blue crabs occur at different times. Mating takes place when female crabs are in the soft condition after their terminal, or last, molt. Males then carry the soft-shelled females until their shell hardens. Females store the sperm, which is used to fertilize the eggs for repeated spawnings. After the shell hardens, the females move downstream to the mouths of estuaries to spawn. Females extrude fertilized eggs and attach them on the underside of their bodies as a bright orange "sponge" consisting of up to 2 million eggs. The eggs become darker as they mature, and the sponge is almost black at the time of hatching. The eggs hatch and release the first zoea stage after about 2 weeks.

Larval crabs go through seven zoeal stages (and sometimes eight) in 31 to 49 days, depending on temperature and salinity. The zoeae are planktonic and live in the ocean near shore. Zoeae eat small zooplankton, such as rotifers. The last zoeal stage metamorphoses with its molt to a megalops larva, which persists from 6 to 20 days. Megalops larvae have more crab-like features than zoeae and are initially planktonic but gradually become more benthic. Megalops larvae inhabit the lower estuary and nearshore areas (ASMFC 2004) and have been found as far as 40 mi (64 km) offshore. Winds, tides, and storms transport the larvae back in towards shore (Kenny 2002). Among others, jellyfish are predators on crab larvae.

The megalops larvae molt and metamorphose into the first crab stage, which has all the features of a blue crab, and, like all crustaceans, grows by molting. The early crab stages, which are 10 to 20 mm (0.4 to 0.8 in.) carapace width in size, migrate to fresher water. Although benthic, blue crabs are good swimmers. They feed less and cease molting as winter nears and bury themselves in the mud in winter. Because the Hudson River is at the northern end of the blue crab's range, severe winters may affect over-winter survival (Kenney 2002).

In the Chesapeake Bay, blue crabs mature in 18 to 20 molts, at which time females undergo a final, or terminal, molt, and males continue to grow and molt (Kenney 2002). In the Hudson River, most females make the terminal molt before they reach a carapace width of about 125 mm (4.92 in.) (Kenney 2002). Adult males prefer the low salinity areas of upper estuaries, while females, after mating, move to and remain in the higher salinity areas of the lower estuary. Blue crabs can live about 3 or 4 years, although most probably do not live past the age of 2. Adult blue crabs are benthic predators that will lie in wait to catch small fish. They also eat other crabs and crustaceans, mollusks, dead organisms, zebra mussels, aquatic plants, and organic debris. They will also eat other blue crabs. Young and adult blue crabs are prey for many predators, including a variety of birds, including herons and diving ducks; humans; raccoons; and fish, including various members of the sciaenid (drum) family, American eel, and striped bass. Cannibalism is thought to be a major source of mortality. Environmental factors thought to affect juvenile and adult blue crab populations include drought, winter mortality, hypoxia, hurricanes, and the effects of human development (ASMFC 2004).

New York has a relatively small blue crab fishery, which reported a large decrease in landings in 1997; since then, the harvest has been about a million pounds a year (ASMFC 2004). Blue crab fishing in the Hudson River Estuary occurs mostly in the summer and fall (Kenney 2002). Egg-bearing females are returned to the river to help protect spawning stock (Kenney 2002). Blue crab have been impinged on the screens of IP2 and IP3.

2.2.5.5 Special Status Species and Habitats

Atlantic Sturgeon

The Atlantic sturgeon (*Acipenser oxyrhynchus*, family Acipenseridae) is an anadromous species, with a range extending from St. Johns River, Florida, to Labrador, Canada. Considered the "cash crop" of Jamestown before tobacco, the Atlantic sturgeon has been harvested for its flesh and caviar, as well as its skin and swim bladder. A long-lived, slowly maturing species, the Atlantic sturgeon can reach 60 years of age (ASMFC 2007c; Gilbert

1989). Maturity is reached at 7 to 30 years for females, and 5 to 24 for males, with fish in the southern range maturing earlier than those inhabiting the northern range (ASMFC 2007c). Fecundity is correlated with age and size, ranging from 400,000 to 8 million eggs per female (NMFS 2007). Individuals reach lengths of about 79 in. (200 cm), while the largest recorded sturgeon was 15 ft (4.5 m) and 811 lb (368 kg) (ASMFC 2007c).

In the spring, adult Atlantic sturgeons migrate to freshwater to spawn, with males arriving a few weeks before the females. In the Hudson River, the males' migration occurs when water temperatures reach 5.6 to 6.1°C (42 to 43°F); the females appear when water temperatures warm to 12.2 to 12.8°C (54 to 55°F). Spawning occurs a few weeks later (Gilbert 1989). Eggs are deposited on hard surfaces on the river bottom, and hatch after 4 to 6 days (Shepherd 2006c). Individuals do not spawn annually—spawning intervals range from 1 to 5 years for males and 2 to 5 years for females (NMFS 2007). Females typically leave the estuary 4 to 6 weeks after spawning, but the males can remain in the estuary until the fall. Larvae feed from their yolk sac for 9 to 10 days, and then the PYSL begin feeding on the river bottom (Gilbert 1989). In the fall, the juveniles move downstream from freshwater to the estuaries, where they remain for 3 to 5 years, and then migrate to the ocean as adults (Shepherd 2006c). Individuals return to their natal river for spawning, and so the species is divided into five distinct population segments (ASSRT 2007). Juveniles and adults are bottom feeders, subsisting on mussels, worms, shrimp, and small fish (Gilbert 1989; ASMFC 2007c).

Before 1900, landings of Atlantic sturgeon reached 3500 MT (3860 t) per year. This number dropped in the 20th century, and from 1950 to 1990, landings ranged from 45 to 115 MT (50 to 127 t) per year (Shepherd 2006c). ASMFC placed a moratorium on harvesting wild Atlantic sturgeon for the entire coast in 1997, in an attempt to allow the population to recover. In 1999, the Federal Government banned the possession and harvest of sturgeon in the Exclusive Economic Zone (Shepherd 2006c; ASMFC 2007c). Using a Petersen mark–recapture population estimator, Peterson et al. (2000) estimated that the Hudson River population of age 1 Atlantic sturgeon had declined about 80 percent between 1977 and 1985. The authors suggested that the then-current recruitment could be too low to sustain the population. As of October 2006, NMFS has listed Atlantic sturgeon as a candidate species for listing under the Endangered Species Act (71 *Federal Register* (FR) 61022). Threats such as bycatch, water quality, and dredging continue to affect Atlantic sturgeon (ASMFC 2007c). In the Hudson River, the Federal Dam (the southernmost obstruction in the river) is upstream of the northern extent of the Atlantic sturgeon spawning habitat and therefore is not a limiting factor (ASSRT 2007).

Average levels of PCBs in Hudson River sturgeon tissue exceeded FDA guidelines for human consumption in the 1970s and 1980s; since then, levels of PCBs have dropped below FDA guidelines (ASSRT 2007). Although the State placed a moratorium on harvesting Atlantic sturgeon in 1996 when it became apparent that the Hudson River stock was overfished, the American shad gill net fishery continues to take subadult sturgeon as bycatch. The Review Team for Atlantic Sturgeon concluded in 2007 (ASSRT 2007) that the Hudson River subpopulation has a moderate risk (less than 50 percent) of becoming endangered in the next 20 years as a result of the threat of commercial bycatch. Despite this, the Hudson River supports the largest subpopulation of spawning adults and juveniles, and some long-term surveys indicate that the abundance has been stable since 1995 or is even increasing (ASSRT 2007). Recent work by Sweka et al. (2007) has suggested that a substantial population of juvenile Atlantic sturgeon are present in Haverstraw Bay and that future population monitoring should focus on this area to obtain the greatest statistical power for assessing population trends. Eggs and larval forms of Atlantic sturgeon were not observed in entrainment samples collected from IP2 and IP3 in 1981 and 1983-1987, but sturgeon were present in impingement samples.

Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*, family Acipenseridae) is amphidromous, with a range extending from St. Johns River, Florida, to St. John River, Canada. Unlike anadromous species, shortnose sturgeons spend the majority of their lives in freshwater, moving to saltwater periodically, without relation to spawning (Collette and Klein-MacPhee 2002). From colonial times, shortnose sturgeons have rarely been the target of commercial fisheries but have frequently been taken as incidental bycatch in Atlantic sturgeon and shad gillnet fisheries (Shepherd 2006c; Dadswell et al. 1984). The shortnose sturgeon was listed on March 11, 1967, as endangered under the Endangered Species Act of 1973, as amended. In 1998, a recovery plan for the shortnose sturgeon was finalized by NMFS (NMFS 1998). The threats to the species include dams, water pollution, and destruction or degradation of habitat (Shepherd 2006c).

Shortnose sturgeon can grow up to 143 cm (56 in.) in total length, and can weigh up to 23 kg (51 lb). Females are known to live up to 67 years, while males typically do not live beyond 30 years (Dadswell et al. 1984). As young adults, the sex ratio is 1:1; however, among fish larger than 90 cm (35 in.), measured from nose to the fork of the tail, the ratio of females to males increases to 4:1. Throughout the range of the shortnose sturgeon, males and females mature at 45 to 55 cm (18 to 22 in.) fork length, but the age at which this length is achieved varies by geography. At the southern extent of the sturgeon's range, males reach maturity at age 2, and females reach maturity at 6 years or younger; in Canada, males can reach maturity as late as age 11, and females at age 13 (Dadswell et al. 1984; OPR undated). One to two years after reaching maturity, males begin to spawn at 2-year intervals, while females may not spawn for the first time until 5 years after maturing, and thereafter spawn at 3- to 5-year intervals (Dadswell et al. 1984; OPR undated). Shortnose sturgeon migrate into freshwater to spawn during late winter or early summer. Eggs adhere to the hard surfaces on the river bottom before hatching after 4 to 6 days. Larvae consume their yolk sac and begin feeding in 8 to 12 days, as they migrate downstream away from the spawning site (Kynard 1997; Collette and Klein-MacPhee 2002). The juveniles, who feed on benthic insects and crustaceans, do not migrate to the estuaries until the following winter, where they remain for 3 to 5 years. As adults, they migrate to the nearshore marine environment, where their diet consists of mollusks and large crustaceans (Shepherd 2006c; OPR undated).

In the Hudson River, shortnose sturgeon use the lower Hudson and are dispersed throughout the river estuary from late spring to early fall and then congregate to winter near Sturgeon Point (RKM 139 (RM 86)). They then spawn in the spring, just downstream of the Federal Dam at Troy. The population of shortnose sturgeons in the Hudson River has increased 400 percent since the 1970s, according to Cornell University researchers (Bain et al. 2007). Recent work by Woodland and Secor (2007) estimates a fourfold increase in sturgeon abundance over the past three decades, but reports that the population growth slowed in the late 1990s, as evidenced by the nearly constant recruitment pattern at depressed levels relative to the 1986–1992 year classes. Although the Hudson River appears to support the largest population of shortnose sturgeons, Bain et al. (2007) report that other populations along the Atlantic coast are also increasing, and some appear to be nearing safe levels, suggesting that the overall population could recover if full protection and management continues. NMFS (2009) recently suggested to NRC Staff that the shortnose sturgeon population estimates for the Hudson River of 60,000 fish presented in Bain et al. (2007) are likely overestimates, and that 30,000 is a more appropriate estimate. Eggs and larval forms of shortnose sturgeon were not observed in entrainment samples from IP2 and IP3 in 1981 and 1983-1987, but sturgeon were present in impingement samples.

2.2.5.6 Other Potentially Affected Aquatic Resources

Phytoplankton and Zooplankton

Phytoplankton and zooplankton communities often form the basis of the food web in rivers and estuaries. The phytoplankton in the Hudson River generally fall into three major categories—diatoms, green algae, and blue-green algae. Diatoms are abundant through most of the year, but reach peak densities when water temperatures are low and watershed runoff and river flows are high. Green algae are present in highest abundances during the summer, when river flows are low and water temperatures are relatively high. Blue-green algae are generally present in late summer and early fall (CHGEC 1999).

Zooplankton populations in the Hudson River are divided into two major categories—holoplankton, which spend their entire live cycle as plankton, and meroplankton, which include the eggs and larvae of fish and shellfish that spend only a part of their life cycle in the planktonic community. Holoplankton in the brackish areas of the Hudson River from approximately IP2 and IP3 downstream (RM 40 (RKM 64)) are generally dominated by marine species; holoplankton from Poughkeepsie north (RM 68 (RKM 109)) are generally dominated by freshwater forms (Figure 2-10). Zooplankton sampling from Haverstraw Bay to Albany from April to December 1987–1989 identified five numerically dominant taxa—the cyclopoid copepod, *Diacyclops bicuspidatus thomasi*; the cladoceran, *Bosmina longirostris*; and the rotifers *Keratella* spp., *Polyarthra* spp., and *Trichocera* spp. (CHGEC 1999). Work by Lonsdale et al. (1996) suggests that larger (greater than 64 microns (0.0025 in.)) zooplankton species that include both mesozooplankton and micrometazoa have a minimal role in controlling total phytoplankton biomass in the lower Hudson River estuary. Grazing pressure sufficient to contribute to the decline of the phytoplankton standing crop occurred only during the month of October.

Phytoplankton communities in the freshwater portion of the Hudson River are susceptible to predation by the zebra mussel, *Dreissena polymorpha*. Work by Roditi et al. (1996) suggests that the mussels are able to remove Hudson River phytoplankton effectively in the presence of sediment and can do so at rapid rates. The authors indicate that, based on their measurements and unpublished estimates of the size of the zebra mussel population, the mussels present in the upper stretches of the river can filter a volume equivalent to the entire freshwater portion of the Hudson River every 2 days. Strayer suggests that they filter a volume of water equal to all of the water in the estuarine Hudson every 1–4 days during the summer (2007). Significant declines in zooplankton biomass were also reported after the introduction of the mussel (Pace et al. 1998). Work by Strayer et al. (2004) suggests that the long-term impacts of zebra mussel removal of phytoplankton and zooplankton have profoundly affected the food web in the Hudson River, resulting in a shift of open-water species to downriver locations away from the mussels and a shift of littoral species upriver. The resulting changes affected a variety of commercially and recreationally important species, including American shad and black bass, illustrating the importance of zooplankton and phytoplankton in food webs associated with the freshwater portion of the Hudson River (Strayer et al. 2004).

Aquatic Macrophyte Communities

Aquatic macrophyte communities provide food and shelter to a variety of fish and invertebrate communities and are an important component of the Hudson River ecososystem. Macrophyte communities are generally divided into three broad groups that include emergent macrophytes, floating-leaved macrophytes, and submerged macrophytes (also known as SAV). Emergent macrophytes in the Hudson River generally occur near the shoreline to a water depth of about 5 ft (1.5 m) and have leaves that rise out of the water. Floating leaved macrophytes are attached to the bottom and have floating leaves and long, flexible stems. Submerged macrophytes are found beneath the water surface at a depth related to the clarity of the water (CHGEC 1999). The composition and distribution of aquatic macrophyte communities vary along the river and are controlled by physical characteristics and season. Work by Findlay et al. (2006) shows that the densities of macroinvertebrates in SAV beds were more than three times as high as densities on unvegetated sediments, suggesting that SAV beds may be the richest feeding grounds in the Hudson River estuary for fish. Further, the authors also noted that many species of macroinvertebrates that are common in aquatic macrophyte beds are rare or absent from unvegetated sites.

SAV beds in the Hudson are represented by two predominant species—the native submerged eel grass, *Vallisneria americana* and the introduced water chestnut, *Trapa natans* (Findlay et al. 2006). CHGEC (1999) identified 18 species of submergent aquatic vegetation between Kingston and Nyack, including nine species of *Potamogeton* (pondweed), and *Elodea* sp. (common pondweeds used in aquaria), and a variety of other species. Historical and recent work has shown that SAV occupies major portions of some reaches of the Hudson River, when present, and can cover as much as 25 percent of the river bottom (Findlay et al. 2006). New York State has been studying the SAV in the Hudson River estuary from the Troy Dam south to Yonkers since 1995. Using true color aerial photography, researchers from Cornell University and the New York Sea Grant Extension inventoried the spatial extent of the SAV and water chestnut beds from 1995 to 1997 and in 2002. They determined that vegetated area constitutes roughly 8 percent of total river surface area with eel grass three times as abundant as water chestnut. Plant coverage over the entire study area from the Troy Dam to Yonkers was about 6 percent of the river bottom area for eel grass and 2 percent for water chestnut, although the distribution of both plants varies greatly among reaches of the tidal freshwater Hudson River (Nieder et al. 2004). According to NYSDEC (2007a), there has been a 9-percent decline in all SAV and a 7-percent gain in water chestnut.

Coastal Marshes, Wetlands, and Riparian Zones

Coastal marshes, tidal wetlands, and associated riparian zones are found along the lower Hudson River. Vegetation in these areas includes emergent grasses, sedges, and other plants adapted to nearshore conditions that often experience changes in runoff, salinity, and temperature. FWS has identified the area extending from the Battery north to Stony Point at the northern end of Haverstraw Bay as Lower Hudson River Estuary Complex #21 (FWS 2008a). Within this complex there are many significant wetland habitats, including a regionally significant nursery and wintering habitat for a variety of anadromous, estuarine, and marine fish, as well as a migratory area for birds and fish that feed on abundant prey items.

Recognizing the importance of coastal wetlands, tidal marshes, and riparian zones, NOAA, partnering with NYSDEC, identified four locations along the lower Hudson River estuary for inclusion in the National Estuarine Research Reserve System in 1982 (NOAA 2008a). The areas, from north to south, are Stockport Flats, Tivoli Bay, Iona Island, and Piermont Marsh; they collectively represent over 4800 acres (1900 ha) of protected habitat.

Stockport Flats is the northernmost site in the Hudson River Reserve and is located on the east shore of the river in Columbia County near the city of Hudson. This site is a narrow, 5-mi-long landform that includes Nutten Hook, Gay's Point, Stockport Middle Ground Island, the Hudson River Islands State Park, a portion of the upland bluff south of Stockport Creek, and dredge spoils and tidal wetlands between Stockport Creek and Priming Hook. The dominant features of Stockport Flats include freshwater tidal wetlands that contain subtidal shallows, intertidal mudflats, intertidal shores, tidal marshes, and floodplain swamps (NOAA 2008a).

Tivoli Bay extends for 2 mi along the east shore of the Hudson River between the villages of Tivoli and Barrytown, in the Dutchess County town of Red Hook. The site includes two large coves on the east shore—Tivoli North Bay, a large intertidal marsh, and Tivoli South Bay, a large, shallow cove with mudflats. The site also includes an extensive upland buffer area bordering North Tivoli Bay. Habitats at this site include freshwater intertidal marshes, open waters, riparian areas, shallow subtidal areas, mudflats, tidal swamps, and mixed forest uplands (NOAA 2008a).

Iona Island is located near the Town of Stony Point in Rockland County, 6 mi south of West Point. This bedrock island is located in the vicinity of the Hudson Highlands and is bordered to the west and the southwest by Salisbury and Ring Meadows. In the early 20th century, filling activities connected Round Island to the south end of Iona Island. There is approximately 1 mi of marsh and shallow water habitat between Iona Island and the west shore of the Hudson River, and the area includes brackish intertidal mudflats, brackish tidal marsh, freshwater tidal marsh, and deciduous forested uplands.

Piermont Marsh lies at the southern edge of the village of Piermont, 4 mi south of Nyack. The marsh is located on the west shore of the Tappan Zee region near the town of Orangetown in Rockland County. The site includes 2 mi of shoreline south of the mile-long Erie Pier and the mouth of Sparkill Creek. Habitats at this location include brackish tidal marshes, shallows, and intertidal mud flats.

2.2.5.7 Nuisance Species

<u>Zebra Mussel</u>

In the early 1990s, the nonnative zebra mussel, *Dreissena polymorpha,* made its first appearance in the freshwater portions of the Hudson River estuary. Beginning in early fall 1992, zebra mussels have been dominant in the freshwater tidal Hudson, constituting more than half of heterotrophic biomass, and filtering a volume of water equal to all of the water in the estuary every 1-4 days during the summer (Strayer 2007). The mussel's range extends from Poughkeepsie to the Troy Dam, with the highest densities occurring between Saugerites and Albany (CHGEC 1999; Strayer et al. 2004; Caraco et al. 1997). The presence of the mussels resulted in a decrease in phytoplankton biomass of 80 percent (Caraco et al. 1997) and a decrease of zooplankton abundance of 70 percent (Pace et al. 1998). Water chemistry was also altered, as phosphate and nitrate concentrations increased and DO concentrations decreased after the mussels were established (CHGEC 1999; Caraco et al. 2000). Caraco et al. (2000) indicated that these effects fundamentally changed food web relationships in the river and may have had a significant impact on many fish species.

Work by Strayer et al. (2004) found that open-water species such as *Alosa* spp. (shad and herring) exhibited a decreased abundance in response to Zebra mussel introduction, while the abundance of littoral species such as centrarchids (sunfish) increased. The median decrease in abundance of open-water species was 28 percent, and the median increase in abundance of littoral species was 97 percent. The authors also noted that populations of open-water species shifted downriver, away from the zebra mussel population, while littoral species shifted upriver.

Growth rates of open-water and littoral species were also affected by the mussels. Strayer and Smith (1996) found impacts to unionid bivalve mussels (*Elliptio complanata, Anodonta implicata, Leptodea ochracea*) such as decreasing densities and incidences of infestations. After the arrival of the zebra mussel, the authors reported that densities of these three unionid clam species fell by 56 percent, recruitment of YOY unionids fell by 90 percent, and the biological condition of unionids fell by 20–50 percent, with *E. complanata* less severely affected than the other two. Strayer and Smith (1996) suggest that the impacts to these species may be associated with both competition for food and biofouling by zebra mussels.

The work of Strayer, Caraco, Pace, and others has raised important questions and issues concerning the nature of impacts to fish communities from exotic or introduced species, the management of fish populations affected by these species, and the need to carefully consider all potential environmental stressors present when assessing the reasons for fish or invertebrate population declines. Changes in abundance and distribution in the freshwater portion of the Hudson River estuary involved many recreationally and commercially important species, including striped bass (*M. saxatilis)*, American shad (*A. sapidissima*), redbreast sunfish, and black bass (*Micropterus* spp.*)*. The changes Strayer et al. (2004) documented since 1992 include overall decreases in abundance, redistribution of species up- or downriver in relation to the mussels and fundamental changes to food webs because of the physical presence of the mussels and their filtration activity.

Recent work by Strayer and Malcom (2006) suggests that there are still significant gaps in understanding about the biology and life cycle of the zebra mussel in the Hudson River. The researchers used a combination of long-term data and simulation modeling. The authors evaluated mussel population size, adult growth, and body condition and found considerable interannual variation in these factors that was not strongly correlated with phytoplankton population. The data suggested a 2- to 4-year population cycle that was driven by large interannual variations in recruitment. Strayer and Malcolm's (2006) work indicates that a complete understanding of the potential effects of this species on aquatic food webs, and thus recreationally, commercially, or ecologically important fish and invertebrate species and communities requires a better understanding of the factors affecting the zebra mussel life cycle in the Hudson River than currently exists.

<u>Water Chestnut</u>

The water chestnut was first observed in North America in 1859 near Concord, Massachusetts (FWS 2004). Currently, the plant is found in Maryland, Massachusetts, New York, and

Pennsylvania. The most problematic populations are found in the Connecticut River Valley, Lake Champlain region, and the Hudson, Potomac and Delaware Rivers (FWS 2004). Water chestnut impacts to water bodies can include increasing sedimentation and reducing Dissolved Oxygen (DO), as well as developing dense mats that cause competition for nutrients and space with other species (IPCNYS 2008).

According to CHGEC (1999), the water chestnut was introduced into the upper Hudson River in the late 1880s and was established by the 1930s. An eradication program was begun by the NYSDEC using the herbicide 2,4-D, but the program was discontinued in 1976. Since 1976, the water chestnut beds have expanded into dense stands in available habitat in the fresh and low-salinity brackish areas of the estuary, and as of 1999, the exotic water chestnut was the dominant form of rooted vegetation in shallow areas of the estuary upstream of Constitution Island (RM 53 (RKM 85)). CHGEC (1999) indicates that water chestnut beds in some parts of the Hudson River are now so dense that they have adversely affected water circulation, lowered DO concentrations, and altered fish communities.

Ctenophores

Members of the phylum Ctenophora, variously known as comb jellies, sea gooseberries, sea walnuts, or Venus's girdles, are genatinous marine carnivores that are present in marine and estuarine waters from the sea surface to depths of several thousand meters. Ctenophores are characterized by eight rows of cilia that are used for locomotion. Cilia rows are organized into stacks of "combs" or "ctenes"; hence the name comb jellies. Ctenophore morphology can range from simple sac-like shapes without tentacles, to large, multilobed individuals equipped with adhesive cells called colloblasts. Worldwide, there are probably 100 to 150 species, but most are poorly known and are challenging to collect and study because of their fragility (Haddock 2007).

As members of the zooplankton community, ctenophores influence marine and estuarine food webs by preying on a variety of eggs and larvae. Predator-prey relationships between the ctenophore *Mnemiopsis leidyi* and eggs of the bay anchovy (*A. mitchelli)* have been described by Purcell et al. (1994) in the Chesapeake Bay, and Deason (1982) described a similar relationship between *M. leidyi* and *Acartia tonsa*, a copepod prey species. Similarly, the NRC staff finds it possible that during certain times of the year, ctenophore predation may influence zooplankton abundance in the higher salinity portions of the Hudson River. Laboratory studies evaluating the feeding and functional morphology of *M. mccradyi* by Larson (1988) provided new information concerning how prey are captured by ctenophores, but there is little field information available on predator-prey dynamics in natural systems, primarily because of the difficulties associated with field collections. At present, the impact of ctenophores on zooplankton, eggs, and larvae in the lower portions of the Hudson River is unknown.

2.2.6 Terrestrial Resources

This section describes the terrestrial resources of the IP2 and IP3 site and its immediate vicinity, including plants and animals of the upland areas, an onsite freshwater pond, and riparian areas along the river shoreline.

2.2.6.1 Description of Site Terrestrial Environment

As mentioned at the beginning of this chapter, the IP2 and IP3 site includes 239 acres (96.7 ha) on the east bank of the Hudson River. The property is bordered by the river on the west and the north (Lents Cove), a public road (Broadway) on the east, and privately owned industrial property on the south. The site is hilly, with elevations rising to about 150 ft (46 m) above the level of the river at the highest point. The site is enclosed by a security fence that follows the property line. Developed areas covered by facilities and pavement occupy over half of the site (134 acres (54.2 ha)), predominantly in the central and southern portions. Outside the central portion of the site where the reactors and associated generator buildings are located, small tracts of forest totaling approximately 25 acres (10 ha) are interspersed among the paved areas and facilities. Maintained areas of grass cover about 7 acres (2.8 ha) of the site. The northern portion of the site is covered by approximately 70 acres (28 ha) of forest (Entergy 2007a). Within this forested area is a 2.4-acre (0.97-ha) freshwater pond (Entergy 2007a; NRC 1975). The New York State Freshwater Wetlands Map for Westchester County indicates that there are no streams or wetlands on the site (NYSDEC 2004c).

The site is within the northeastern coastal zone of the eastern temperate forest ecoregion (EPA 2007a). The forest vegetation of the site and adjacent areas was characterized by a survey performed in the early 1970s, before the completion of construction of IP3 (NRC 1975). At that time, the canopy of this forest included a mixture of hardwoods such as red oak (*Quercus rubra*), white oak (*Q. alba*), black oak (*Q. velutina*), chestnut oak (*Q. prinus*), shagbark hickory (*Carya ovata*), black cherry (*Prunus serotina*), tulip tree (*Liriodendron tulipifera*), river birch (*Betula nigra*), and maple (*Acer* spp.), as well as conifers such as eastern hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*). The subcanopy included sassafras (*Sassafras albidum*) and sumac (*Rhus* spp.). The shrub layer included swamp juneberry (*Amelanchier intermedia*), summer grape (*Vitis aestivalis*), poison ivy (*Toxicodendron radicans*), and Virginia creeper (*Parthenocissus quinquefolia*); and the herbaceous layer included forbs such as wildflowers and ferns (NRC 1975). This forest community covers the riverfront north of the reactor facilities, surrounds the pond in the northeast corner of the site, and exists in fragmented stands in the eastern and southern areas of the site. The vegetation in the developed areas of the site consists mainly of turf grasses and planted shrubs and trees around buildings, parking areas, and roads.

The animal community of the site has not been surveyed but likely consists of fauna typical of mixed hardwood forest habitats in the region. Birds that have been observed breeding in the area of northwestern Westchester County and that utilize habitats such as the forest, pond, and riverfront habitats present on and adjacent to the site include the great blue heron (*Ardea herodias*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), wild turkey (*Meleagris gallopavo*), Cooper's hawk (*Accipiter cooperii*), pileated woodpecker (*Dryocopus pileatus*), blue jay (*Cyanocitta cristata*), American robin (*Turdus migratorius*), and scarlet tanager (*Piranga olivacea*) (NYSDEC 2005, Dunn and Alderfer 2006). Numerous waterfowl utilize the lower Hudson River in winter. In the region of southeastern New York that includes Westchester County, waterfowl counts in January 2007 identified at least 22 species of ducks and geese, as well as loons, grebes, and cormorants (NYSOA 2007). In addition to the waterfowl that use the Hudson River, raptors also forage and nest along the river. For example, the bald eagle (*Haliaeetus leucocephalus*), which preys on fish and waterfowl, congregates along the lower Hudson River in winter (NYSDEC 2008b, 2008c), and the peregrine falcon (*Falco peregrinus*), which preys on waterfowl and other birds, nests on bridges over the lower Hudson (NYSDEC 2008d, 2008e).

Mammals likely to occur in the forest habitats on and adjacent to the site include the gray fox (*Urocyon cinereoargenteus*), mink (*Mustela vison*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis viginiana*), white-tailed deer (*Odocoileus virginianus*), red squirrel (*Tamiasciurus hudsonicus*), white-footed mouse (*Peromyscus leucopus*), and northern short-tailed shrew (*Blarina brevicauda*). Aquatic mammals that may occur along and within the river include the river otter (*Lutra canadensis*) and muskrat (*Ondatra zibethicus*) (NYSDEC 2007b; Whitaker 1980).

Reptiles and amphibians likely to occur on and in the vicinity of the site include species that typically inhabit upland forest habitats of the region, including the black rat snake (*Elaphe obsoleta*), eastern box turtle (*Terrapene carolina*), and American toad (*Bufo americanus*). Species likely to inhabit aquatic habitats such as the 2.4-acre (0.97-ha) pond and river shoreline include the northern water snake (*Nerodia sipedon*) and bullfrog (*Rana catesbeiana*) (NYSDEC 2007b, Conant and Collins 1998). The pond historically was used for fishing and is likely to contain minnows (family Cyprinidae) and sunfishes (family Centrarchidae).

There are no State or Federal parks, wildlife refuges, wildlife management areas, or other State or Federal lands adjacent to the site. The closest such lands to the site are two State parks, Bear Mountain State Park and Harriman State Park, which are located across the Hudson River approximately 1 mi and 2 mi, respectively, northwest of the site at their closest points (Entergy 2007a). In addition, a Significant Coastal Fish and Wildlife Habitat, referred to as "Hudson RM 44–56," begins approximately 1 mi north of the site and extends upriver. Significant Coastal Fish and Wildlife Habitats are designated by the New York Department of State, Division of Coastal Resources. Hudson RM 44–56 provides important habitat for wintering bald eagles as well as waterfowl (NYSDOS 2004).

Of the total 4000 ft (1220 m) of transmission line, approximately 3500 ft (1070 m) traverses buildings, roads, parking lots, and other developed areas. As a result, the total length of the ROWs that is vegetated is only about 500 ft (150 m). The ROWs are approximately 150 ft (46 m) wide, and the vegetation within the ROWs is mainly grasses and forbs. The transmission lines included in this SEIS are those that were originally constructed for the purpose of connecting IP2 and IP3 to the existing transmission system. These two lines are described in more detail in Section 2.1.7. Each line is approximately 2000 ft (610 m) in length, all of which is within the site except for a terminal, 100-ft (30-m) segment of each that crosses the facility boundary and Broadway to connect to the Buchanan substation (Entergy 2005b; NRC 1975).

2.2.6.2 Threatened and Endangered Terrestrial Species

Two species that are federally listed as threatened or endangered, and one candidate species, have been identified by FWS as known or likely to occur in Westchester County. These are the endangered Indiana bat (*Myotis sodalis*), the threatened bog turtle (*Clemmys muhlenbergii*), and the candidate New England cottontail (*Sylvilagus transitionalis*) (FWS 2008b). In addition, 194 species that are listed by the State of New York as endangered, threatened, species of special concern (animals), or rare (plants) have a potential to occur in Westchester County based on recorded observations or their geographic ranges. The identities, listing status, and preferred habitats of these federally and State-listed species are provided in Table 2-6.

Federally Listed Species

The three federally listed and candidate species are discussed below. In addition to these species that currently have a Federal listing status, a recently delisted species, the bald eagle, also occurs in Westchester County. On July 9, 2007, FWS issued a rule in the *Federal Register* (72 FR 37346) removing the bald eagle from the Federal List of Endangered and Threatened Wildlife, effective August 8, 2007. As discussed in Section 2.2.6.1, bald eagles winter in substantial numbers in the vicinity of the site, particularly in a Significant Coastal Fish and Wildlife Habitat area upstream of the site from RM 44 to 56 (RKM 70 to 90) (NYSDOS 2004). Bald eagles also have nested in recent years at locations along the Hudson River in the vicinity of the site. In New York, the breeding season generally extends from March to July, and in the southeastern part of the state, wintering eagles begin to arrive in November and congregate in greatest numbers in February. Adult bald eagles are dark brown with a white head and tail and a yellow bill. Juveniles are completely brown with a gray bill until they are mature at about 5 years of age. The bald eagle feeds primarily on fish but also preys on waterfowl, shorebirds, small mammals, and carrion (NYSDEC 2008b).

Indiana Bat

The Indiana bat (*Myotis sodalis*) currently is listed as endangered under the Endangered Species Act of 1973 as amended (16 U.S.C. 1531 *et seq.*). Critical habitat for the Indiana bat was designated in 1976 (41 FR 41914) at eleven caves and two mines in six States (Missouri, Illinois, Indiana, Kentucky, Tennessee, and West Virginia). There is no designated critical habitat in New York.

The Indiana bat is a medium-sized bat with a head and body length slightly under 2 in. (5.1 cm), a wing span of 9 to 11 in. (23 to 28 cm), a weight of approximately 0.3 ounces (8.5 g), and a life span of about 10 years (FWS 2002, FWS 2007a). It feeds on flying insects captured in flight at night as it forages in forested areas, forest edges, fields, riparian areas, and over water. Indiana bats are migratory and hibernate in large colonies in caves or mines (hibernacula). Hibernacula may support from fewer than 50 to more than 10,000 Indiana bats (FWS 2007a). In New York, hibernation may last from September to May. After emerging in spring, the bats may migrate hundreds of miles to summer habitats, where they typically roost during the day under bark separating from the trunks of dead trees or in other tree crevices (FWS 2007a). Reproductive females congregate in maternity colonies of up to 100 or more bats, where they give birth and care for their single young until it can fly, usually at 1 to 2 months of age (FWS 2007a). Males and nonreproductive females generally roost individually or in small colonies and may remain near their hibernaculum rather than migrating (FWS 2007a).

The Indiana bat may occur in 20 States in the eastern United States from New England to the Midwest, mainly within the central areas of this region from Vermont to southern Wisconsin, eastern Oklahoma, and Alabama. In summer, Indiana bat maternity colonies and individuals may occur throughout this range. In winter, populations are distributed among approximately 280 hibernacula in 19 States (FWS 2007a). New York has a total of 10 known hibernacula in caves and mines in Albany, Essex, Jefferson, Onondaga, Ulster, and Warren Counties (NYNHP 2008a). The nearest of these counties to the site is Ulster County, which is about 20 mi (32 km) to the north of the site at its closest point. The two largest hibernating colonies in New England (estimated populations in 2005 of over 11,300 and 15,400) are in two abandoned mines located in Ulster County approximately 45 mi (72 km) north of the site near the Town of Rosendale

(FWS 2007a; Sanders and Chenger 2001). The larger of these is among the 10 largest Indiana bat hibernacula in the country (NYNHP 2008a). There are 13 general areas in the State where maternity and bachelor colonies are known to occur in summer. Hibernacula, maternity colonies, and bachelor colonies are not known to be present in Westchester County or the vicinity of the site, although Westchester County is within the potential range of the Indiana bat in New York (NYNHP 2008a). Given the presence of large hibernacula within migration distance of the site and the presence of suitable foraging habitat and possible roosting trees in the forest at the north end of the site, the NRC staff finds it possible that Indiana bats may use this area as summer habitat.

Bog Turtle

The northern population of the bog turtle (*Clemmys muhlenbergii*), which occurs in Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, and Pennsylvania, was federally listed as threatened in 1997 under the ESA (16 U.S.C. 1531 *et seq.*). The southern population was listed as threatened because of its similarity of appearance to the northern population. The two populations are discontinuous. The southern population occurs mainly in the Appalachian Mountains from southern Virginia through the Carolinas to northern Georgia and eastern Tennessee (FWS 2001). In New York, the bog turtle occurs in the central and southeastern parts of the State, primarily in the Hudson Valley region (NYSDEC 2008f, 2008g).

The bog turtle is one of the smallest turtles in North America. Its upper shell is 3 to 4 in. (7.6 to 10 cm) long and light brown to black in color, and each side of its black head has a distinctive patch of color that is bright orange to yellow. Its life span may be 40 years or longer. The bog turtle is diurnal and semiaquatic; it forages on land and in water for its varied diet of insects and other invertebrates, frogs, plants, and carrion (FWS 2001; NYNHP 2008b). In southeastern New York, the bog turtle usually is active from the first half of April to the middle of September, and hibernates the remainder of the year underwater in soft mud and crevices (FWS 2001). Northern bog turtles primarily inhabit wetlands fed by groundwater or associated with the headwaters of streams and dominated by emergent vegetation. These habitats typically have shallow, cool water that flows slowly and vegetation that is early successional, with open canopies and wet meadows of sedges (*Carex* spp.). Other herbs commonly present include spike rushes (*Eleocharis* spp.) and bulrushes (*Juncus* spp. and *Scirpus* spp.) (FWS 2001). Bog turtle habitats in the Hudson River Valley also frequently include sphagnum moss (*Sphagnum* spp.) and horsetail (*Equisetum* spp.) (NYNHP 2008b). Commonly associated woody plants include alders (*Alnus* spp.) and willows (*Salix* spp.) (FWS 2001; NYNHP 2008b).

Of the 74 historic bog turtle locations recorded in New York, over half still may provide suitable habitat. However, populations are known to exist currently at only one-fourth of these locations, principally in southeastern New York (NYSDEC 2008f). The New York Natural Heritage Program (NYNHP) database contains locations in northwestern Westchester County where the bog turtle has been recorded as occurring historically. Although there were a few records during the 1990s of bog turtles in Westchester County, the NYNHP states that “it is not known if any extant populations remain in this county” (NYNHP 2008b). According to the data collected for the New York State Reptile and Amphibian Atlas for the period 1990 to 2007, the only reported occurrence of the bog turtle in Westchester County was near the eastern border of the State (NYSDEC 2008g). The New York State Freshwater Wetlands Map for Westchester County (NYSDEC 2004c) indicates that there are no wetlands on the IP2 and IP3 site. The nearest offsite wetland, which is adjacent to the north end of the site, is located on the east side of Broadway and drains under the roadway to Lent's Cove. Its potential to provide bog turtle habitat was not evaluated. The 2.4-acre (0.97-ha) pond in the northern portion of the site is surrounded by mature forest with a closed canopy and does not provide the highly specialized wetland habitat (early successional wet meadows) required by the bog turtle.

While acknowledging that the wetland nearest to the site has not been evaluated for the presence of the bog turtle, the NRC staff notes that there is no suitable habitat on the site and there are no recently recorded occurrences of the bog turtle in portions of Westchester County near the plant site. Thus, the NRC staff finds that the bog turtle is unlikely to occur on the site or in the immediate vicinity of the site.

New England Cottontail Rabbit

The New England cottontail rabbit (*Sylvilagus transitionalis*) is a Federal candidate for listing as an endangered or threatened species (72 FR 69034) and is State-listed as a species of special concern in New York (NYSDEC 2008h). It is similar in appearance to the more common and widespread eastern cottontail (*S. floridanus*). The New England cottontail can often be distinguished from the eastern cottontail by its slightly smaller size, shorter ears, darker fur, black spot between the ears, and black line at the front edge of the ears (NYNHP 2008c). Cottontails have short life spans and reproduce at an early age. Breeding season for the New England cottontail typically is from March to September (NYNHP 2008c). There may be two to three litters per year, with a usual litter size of five young and a range from three to eight (FWS 2007b). The diet of the species consists mainly of grasses and other herbaceous plants in spring and summer and the bark, twigs, and seedlings of shrubs and other woody plants in autumn and winter (NYNHP 2008c).

The New England cottontail is native only to the northeastern United States. Populations historically were found throughout New England. The range of this species has become fragmented and currently is approximately 14 percent of its historical extent (72 FR 69034). In New York, the New England cottontail currently is thought to occur only in separate populations east of the Hudson River within Columbia, Dutchess, Putnam, and Westchester Counties (NYNHP 2008c). The dramatic decreases in population and range are primarily the result of loss of suitable habitat. The New England cottontail requires a specialized habitat of early successional vegetative growth such as thickets, open wooded areas with a dense understory, and margins of agricultural fields (NYNHP 2008c). Land development associated with the growth of urban and suburban areas and the maturation of early successional forests have been the primary causes of the loss of these types of habitat (69 FR 39395).

The known locations of the New England cottontail in Westchester County are in the central and northeastern areas of the county (NYNHP 2008c), not in the northwestern area where the IP2 and IP3 site is located. The forests on the site consist mainly of mature hardwoods and do not contain early successional habitats, such as thickets, that are required by the New England cottontail. Therefore, the New England cottontail is considered unlikely to occur on or in the immediate vicinity of the site.

State-Protected Species

The only State-listed terrestrial species identified by NYNHP as currently occurring in the vicinity of the IP2 and IP3 site is the bald eagle (NYSDEC 2007c). The only other documented occurrences in the NYNHP database for the site vicinity were historical records for four plant species that have not been documented in the site vicinity since 1979 or earlier (NYSDEC

2007c). None of the State-listed species potentially occurring in Westchester County (Table 2-6) are on the site or have been found there.

Table 2-6. Federally and State-Listed Terrestrial Species Potentially Occurring in Westchester County

Scientific Name	Common Name	Federal Status [(a)]	New York State Status [(b)]	Habitat [(c)]
Amphibians				
Ambystoma jeffersonianum	Jefferson salamander	-	SSC	Deciduous woodlands with a closed canopy and riparian habitats [(1)]
Ambystoma laterale	blue-spotted salamander	-	SSC	Marshes, swamps, and adjacent upland areas with loose soils [(1)]
Ambystoma opacum	marbled salamander	-	SSC	Near swamps and shallow pools, rocky hillsides and summits, and wooded sandy areas [(1)]
Rana sphenocephala utricularus	southern leopard frog	-	SSC	Wet, open areas such as grasslands, marshes, and swales with slow-flowing water [(2)]
Reptiles				
Carphophis amoenus	eastern worm snake	-	SSC	Mesic, wooded or partially wooded areas, often near wetlands or farm fields [(1)]
Clemmys guttata	spotted turtle	-	SSC	Small ponds surrounded by undisturbed vegetation, marshes, swamps, and other small bodies of water [(1)]
Clemmys insculpta	wood turtle	-	SSC	Hardwood forests, fields, wet pastures, woodland marshes, and other areas adjacent to streams [(1)]
Clemmys muhlenbergii	bog turtle	FT	SE	Wet meadows with an open canopy or open boggy areas [(2)]
Crotalus horridus	timber rattlesnake	-	ST	Mountainous or hilly areas with rocky outcrops and steep ledges in deciduous or deciduous-coniferous forests [(2)]
Heterodon platyrhinos	eastern hognose snake	-	SSC	Open woods and margins, grasslands, agricultural fields, and other habitats with loose soils [(1)]
Sceloporus undulatus	northern fence lizard	-	ST	Open, rocky areas on steep slopes surrounded by oak-dominated forests [(2)]

1 **Table 2-6** (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Terrapene carolina	eastern box turtle	-	SSC	Forests, grasslands, and wet meadows [1]
Birds				
Accipiter cooperii	Cooper's hawk	-	SSC	Mixed hardwood-coniferous forests, commonly near water [1]
Accipiter gentilis	northern goshawk	-	SSC	Mature mixed hardwood-coniferous forests [1]
Accipiter striatus	sharp-shinned hawk	-	SSC	Forests, open woods, and old fields [1]
Ammodramus maritimus	seaside sparrow	-	SSC	Coastal tidal marshes with emergent vegetation [2]
Ammodramus savannarum	grasshopper sparrow	-	SSC	Grasslands and abandoned fields [1]
Buteo lineatus	red-shouldered hawk	-	SSC	Open, moist forests and swamp margins [3]
Caprimulgus vociferous	whip-poor-will	-	SSC	Dry to moist open forests [1]
Chordeiles minor	common nighthawk	-	SSC	Open coniferous woods, grasslands, and near populated areas [1]
Circus cyaneus	northern harrier	-	ST	Salt and freshwater marshes, shrubland, and open grassy areas [2]
Cistothorus platensis	sedge wren	-	ST	Moist meadows with small bushes, boggy areas, and coastal brackish marshes [2]
Dendroica cerulea	cerulean warbler	-	SSC	Wet, mature hardwood forests with a dense canopy [1]
Falco peregrinus	peregrine falcon	-	SE	Holes or ledges in the rock on cliff faces, and on top of bridges or tall buildings in urban areas [2]
Haliaeetus leucocephalus	bald eagle	-	ST	Shorelines of large water bodies, such as lakes, rivers, and bays [2]

2

1 **Table 2-6.** (continued)

Scientific Name	Common Name	Federal Status [(a)]	New York State Status [(b)]	Habitat [(c)]
Icteria virens	yellow-breasted chat	-	SSC	Thickets, overgrown pastures, woodland understory, margins of ponds and swamps, and near populated areas [(1)]
Ixobrychus exilis	least bittern	-	ST	Large marshes with stands of emergent vegetation [(2)]
Melanerpes erythrocephalus	red-headed woodpecker	-	SSC	Open forests and developed areas with trees, such as parks and gardens [(1)]
Pandion haliaetus	Osprey	-	SSC	Large bodies of water such as lakes, rivers, and seacoasts [(1)]
Podilymbus podiceps	pied-billed grebe	-	ST	Marshes and shorelines of ponds, shallow lakes or slow-moving streams in areas with emergent vegetation and open water [(2)]
Rallus elegans	king rail	-	ST	Shallow fresh to salt marshes with substantial emergent vegetation [(2)]
Vermivora chrysoptera	golden-winged warbler	-	SSC	Recently abandoned agricultural fields surrounded by trees, open areas of dense herbaceous vegetation [(1)]
Mammals				
Myotis sodalis	Indiana bat	FE	SE	Wooded areas with living, dying, and dead trees during the summer; caves and mines in the winter [(2)]
Sylvilagus transitionalis	New England cottontail rabbit	FC	SSC	Disturbed areas, open woods, areas with shrubs and thickets, marshes [(2)]
Insects				
Callophrys henrici	Henry's elfin	-	SSC	Borders and clearings of pine-oak woods [(4)]
Erynnis persius	Persius duskywing	-	SE	Stream banks, marshes, bogs, mountain prairies, and sand plains [(4)]

2

1 Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [(a)]	New York State Status [(b)]	Habitat [(c)]
Pontia protodice	checkered white	-	SSC	Dry, open habitats such as fields, roads, railroad tracks, weedy vacant lots, and sandy areas [(4)]
Speyeria idalia	regal fritillary	-	SE	Wet fields and meadows, marshes [(4)]
Tachopteryx thoreyi	gray petaltail	-	SSC	Rocky gorges in forests with small streams fed by seepage areas or fens [(2)]
Plants				
Acalypha virginica	Virginia three-seeded mercury	-	SE	Dry upland forests, thickets, and prairies [(5)]
Agastache nepetoides	yellow giant hyssop	-	ST	Open wooded areas, roadsides, railroads, thickets, and fencerows [(2)]
Ageratina aromatica var. *aromatica*	small white snakeroot	-	SE	Upland forests, roadsides, fencerows, and old fields [(6)]
Agrimonia rostellata	woodland agrimony	-	ST	Slopes, streambanks, and thickets in rich, mesic forests and wooded pastures [(2)]
Amaranthus pumilus	seabeach amaranth	-	SE	Sparsely vegetated areas of barrier island beaches and inlets [(1)]
Aplectrum hyemale	Puttyroot	-	SE	Upland to swampy forests [(2)]
Arethusa bulbosa	dragon's mouth orchid	-	ST	Sphagnum swamps and wet meadows [(2)]
Aristolochia serpentaria	Virginia snakeroot	-	SE	Well-drained, rocky slopes of rich wooded areas [(2)]
Asclepias variegata	white milkweed	-	SE	Open wooded areas and thickets [(7)]
Asclepias viridiflora	green milkweed	-	ST	Dry, rocky hillsides, grasslands, and open areas [(2)]
Bidens beckii	water marigold	-	ST	Slow-moving or still waters [(6)]

2

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Bidens bidentoides	Delmarva beggar-ticks	-	SR	Borders of freshwater tidal marshes and mudflats [2]
Bidens laevis	smooth bur-marigold	-	ST	Freshwater to brackish tidal marshes and mudflats [2]
Blephilia ciliata	downy wood mint	-	SE	Shallow soils of disturbed areas such as fields and powerline ROWs [2]
Bolboschoenus maritimus paludosus	seaside bulrush	-	SE	Alkaline or saline marshes, pond edges, and transient wet areas [8]
Bolboschoenus novae-angliae	saltmarsh bulrush	-	SE	Brackish tidal marshes [2]
Botrychium oneidense	blunt-lobe grape fern	-	SE	Rich, moist soils of deciduous forests [2]
Bouteloua curtipendula var. *curtipendula*	side-oats grama	-	SE	Dry, open areas and disturbed lands such as powerline ROWs, pastures, and bluffs along rivers [2]
Callitriche terrestris	terrestrial starwort	-	ST	Exposed, muddy ground in pastures, forests, and on the banks of ponds [2]
Cardamine longii	Long's bittercress	-	ST	Shady tidal creeks, swamps, and mudflats [2]
Carex abscondita	thicket sedge	-	ST	Swamps, wooded streambanks, mesic forests, and shrublands [2]
Carex arcta	northern clustered sedge	-	SE	Edges of reservoirs and rivers, wooded swamps, swales, and wet meadows [2]
Carex bicknellii	Bicknell's sedge	-	ST	Open woods, dry to mesic prairies, rocky areas with sparse vegetation [6]
Carex conjuncta	soft fox sedge	-	SE	Edges of streams, thickets, swales, and wet meadows [2]
Carex cumulata	clustered sedge	-	ST	Open rocky areas with shallow soils, such as powerline ROWs, recently burned areas, or other successional habitats [2]

1 **Table 2-6** (continued)

Scientific Name	Common Name	Federal Status [(a)]	New York State Status [(b)]	Habitat [(c)]
Carex davisii	Davis' sedge	-	ST	Near rivers, on open gravel bars of large rivers, in wet meadows, and disturbed areas [(2)]
Carex hormathodes	marsh straw sedge	-	ST	Coastal salt and brackish tidal marshes, swales on beaches, edges of swamps, and wet forests near the coast [(2)]
Carex lupuliformis	false hop sedge	-	SR	Swamps, marshes, and floodplain forests [(2)]
Carex mesochorea	midland sedge	-	SE	Dry prairies, oak forests, and roadsides [(2)]
Carex mitchelliana	Mitchell's sedge	-	ST	Edges of streams and ponds, swamps, and wet meadows [(2)]
Carex molesta	troublesome sedge	-	ST	Open wooded areas and fields [(2)]
Carex nigromarginata	black edge sedge	-	SE	Dry to mesic rocky areas in deciduous forests [(2)]
Carex retroflexa	reflexed sedge	-	SE	Rocky ledges, openings and edges of dry to mesic deciduous forests, and along paths and railroads [(2)]
Carex seorsa	weak stellate sedge	-	ST	Hardwood or conifer swamps and thickets [(6)]
Carex straminea	straw sedge	-	SE	Edges of swamps and marshes [(2)]
Carex styloflexa	bent sedge	-	SE	Wet areas of streambanks, thickets, and pine barrens; swampy woods [(2)]
Carex typhina	cattail sedge	-	ST	Wetlands, floodplain forests, sedge meadows, and flats along rivers [(2)]
Carya laciniosa	big shellbark hickory	-	ST	Rich soils in floodplains and along the banks of rivers and marshes [(2)]
Castilleja coccinea	scarlet Indian paintbrush	-	SE	Open areas, including on limestone bedrock in prairies, and fields with moist, sandy soils [(2)]
Ceratophyllum echinatum	prickly hornwort	-	ST	Quiet lakes, ponds, streams, and swamps [(1)]

2

1 **Table 2-6** (continued)

Scientific Name	Common Name	Federal Status [(a)]	New York State Status [(b)]	Habitat [(c)]
Chamaelirium luteum	fairy wand	-	ST	Moist woodlands, thickets, meadows, and swamps [(2)]
Cheilanthes lanosa	woolly lip fern	-	SE	Dry areas on rock outcrops and ledges [(2)]
Chenopodium berlandieri var. *macrocalycium*	large calyx goosefoot	-	SE	Coastal sands and beaches [(6)]
Chenopodium rubrum	red pigweed	-	ST	Brackish marshes and developed lands [(5)]
Crassula aquatica	water pigmyweed	-	SE	Rocky shores of rivers, marshes, and tidal mudflats [(2)]
Crotalaria sagittalis	Rattlebox	-	SE	Sandy soils in pastures and pine plantations [(2)]
Cyperus echinatus	globose flatsedge	-	SE	Inland disturbed areas such as roadsides and pastures [(6)]
Cyperus flavescens	yellow flatsedge	-	SE	Wet, sandy soils of roadsides, coastal pond margins, and salt marshes [(2)]
Cyperus retrorsus var. *retrorsus*	retrorse flatsedge	-	SE	Moist to dry sandy soils in open woods and thickets [(6)]
Cypripedium parviflorum var. *parviflorum*	small yellow ladyslipper	-	SE	Rich humus and decaying leaves on wooded slopes and river bluffs, moist swales, and creek margins [(1)]
Desmodium ciliare	little leaf tick-trefoil	-	ST	Dry upland forests and glades [(5)]
Desmodium humifusum	spreadi ng tick-trefoil	-	SE	Dry, sandy soils in open pine and oak forests [(9)]
Desmodium laevigatum	smooth tick-trefoil	-	SE	Dry, upland forests [(5)]
Desmodium nuttallii	Nuttall's tick-trefoil	-	SE	Dry, upland forests; acidic gravel seeps; and dry to mesic grasslands [(5)]

2

1 **Table 2-6** (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Desmodium obtusum	stiff tick-trefoil	-	SE	Open woods, old fields, and grasslands [2]
Desmodium pauciflorum	small-flowered tick-trefoil	-	SE	Upland forests [5]
Dichanthelium oligosanthes var. *oligosanthes*	few-flowered panic grass	-	SE	Upland forests, prairies, lake margins, and glades [5]
Digitaria filiformis	slender crabgrass	-	ST	Sandy soils in dry forests and prairies, sandstone glades, and agricultural fields [5]
Diospyros virginiana	Persimmon	-	ST	Rocky slopes, dry woodlands, open pastures, and swamp margins [8]
Draba reptans	Carolina whitlow grass	-	ST	Open areas with limestone outcrops, dry sandy soils, and cedar glades [2]
Eclipta prostrata	false daisy	-	SE	Lake margins, mesic to wet prairies, and fields and other developed lands [5]
Eleocharis equisetoides	knotted spikerush	-	ST	Shallow ponds in coastal areas [2]
Eleocharis ovata	blunt spikerush	-	SE	Marshy areas near rivers, shallow ponds [2]
Eleocharis quadrangulata	angled spikerush	-	SE	Lake margins and shallow ponds [2]
Eleocharis tricostata	three-ribbed spikerush	-	SE	Wet depressions, edges of ponds, pine barrens, and grasslands [6]
Eleocharis tuberculosa	long-tubercled spikerush	-	ST	Lake margins, ponds, streams, marshes, grasslands, and disturbed lands [6]
Equisetum palustre	marsh horsetail	-	ST	Wet areas such as marshes, stream margins, meadows, and wooded areas [2]
Equisetum pratense	meadow horsetail	-	ST	Rocky soils, riverbanks, roadsides, and railroad ditches [2]

2

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Euonymus americanus	American strawberry bush	-	SE	Wooded areas, stream banks, and thickets in sandy soils [8]
Fimbristylis castanea	marsh fimbry	-	ST	Brackish and salt marshes [6]
Fuirena pumila	dwarf umbrella sedge	-	SR	Pond margins, seeps, and wet grasslands and swales [6]
Gamochaeta purpurea	purple everlasting	-	SE	Open, disturbed areas such as fields, roadsides, and edges of forests [6]
Geranium carolinianum var. *sphaerospermum*	Carolina cranesbill	-	ST	Dry upland forests and prairies, limestone glades, agricultural fields, and pastures [5]
Geum vernum	spring avens	-	SE	Organic soils of forested hillsides, thickets, and floodplains [1]
Geum virginianum	rough avens	-	SE	Hardwood forests, roadsides, wooded swamps, and riverbanks [2]
Hottonia inflata	Featherfoil	-	ST	Ponds and swales in coastal areas [2]
Houstonia purpurea var. *purpurea*	purple bluets	-	SE	Well-drained hillsides in mesic forests [10]
Hylotelephium telephioides	live forever	-	SE	Rocky cliffs and outcrops [7]
Hypericum prolificum	shrubby St. John’s wort	-	ST	Disturbed areas such as roadsides and powerline ROWs, fields, thickets, and margins of swamps [2]
Iris prismatica	slender blue flag	-	ST	Rich, mucky soils [6]
Jeffersonia diphylla	twin leaf	-	ST	Calcareous soils in mesic forests, semishaded rocky hillsides, and exposed limestone [2]
Lechea pulchella var. *moniliformis*	bead pinweed	-	SE	Dry to mesic upland forests [5]
Lechea racemulosa	Illinois pinweed	-	SR	Infertile or sandy soils [11]

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Lechea tenuifolia	slender pinweed	-	ST	Dry, open, grassy areas, wooded areas with pines or oaks, rocky hillsides, and disturbed areas [2]
Lemna perpusilla	minute duckweed	-	SE	Still waters in ponds and lakes [6]
Lespedeza angustifolia	narrow-leaved bush clover	-	SR	Dry sandy soil [12]
Lespedeza repens	trailing bush clover	-	SR	Dry upland forests and dry to mesic grasslands [5]
Lespedeza stuevei	velvety bush clover	-	ST	Dry, rocky areas in woodlands and clearings, old fields, and roadsides [1]
Lespedeza violacea	violet bush clover	-	SR	Dry to mesic grasslands, thickets, and upland forests [5]
Liatris scariosa var. *novae-angliae*	northern blazing star	-	ST	Dry, sandy grasslands, rocky hilltops, and sandy roadsides [2]
Lilaeopsis chinensis	eastern grasswort	-	ST	Margins of peaty or rocky intertidal and brackish marshes [2]
Limosella australis	Mudwort	-	SR	Edges of freshwater pools and intertidal fresh to brackish water bodies [1]
Linum striatum	stiff yellow flax	-	SR	Sandy soils in mesic to wet forests, swamps, seeps, and lake margins [5]
Liparis liliifolia	large twayblade	-	SE	Peaty soils in hardwood swamps, dry wooded slopes, and railroad ditches [2]
Lipocarpha micrantha	dwarf bulrush	-	SE	Sandy soils along pond margins and riverbanks [2]
Listera convallarioides	broad-lipped twayblade	-	SE	Wet sandy soils in white cedar swamps [2]
Ludwigia sphaerocarpa	globe-fruited ludwigia	-	ST	Margins of shallow ponds and wetland channels in pine barrens, clearings in shrub swamps [2]
Lycopus rubellus	gypsy wort	-	SE	Marshes and inundated swamps [2]

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Lysimachia hybrida	lance-leaved loosestrife	-	SE	Wet upland and floodplain forests, wet prairies, lake margins, swamps, and seeps [5]
Magnolia virginiana	sweetbay magnolia	-	SE	Along bays; in swamps; in wet, forested lowlands; and in grasslands [6]
Melanthium virginicum	Virginia bunchflower	-	SE	Railroad ditches, grasslands, marshes, and wet wooded areas [6]
Mimulus alatus	winged monkey-flower	-	SR	Muddy shores of lakes, swamps, and wet forests [5]
Monarda clinopodia	basil balm	-	SE	Ravines in mesic forests, thickets, and lakeshores [5]
Oldenlandia uniflora	clustered bluets	-	SE	Sandy soils in swamps, bogs, and margins of streams and reservoirs [13]
Oligoneuron rigidum var. *rigidum*	stiff leaf goldenrod	-	ST	Dry open areas such as rocky slopes, thickets, edges of forests, and grasslands [2]
Onosmodium virginianum	Virginia false gromwell	-	SE	Open coastal uplands, inland rocky wooded areas in dry soils [2]
Orontium aquaticum	golden club	-	ST	Freshwater swamps and tidal marshes, and sphagnum swamps, fens, and coastal ponds [2]
Oxalis violacea	violet wood sorrel	-	ST	Rich, rocky soils on steep hillsides and open summits [2]
Panicum rigidulum var. *elongatum*	tall flat panic grass	-	SE	Mesic flatwoods and forested lowlands, prairies, and edges of lakes [5]
Paspalum laeve	field beadgrass	-	SE	Sandy soils in open woodlands and prairies [1]
Pinus virginiana	Virginia pine	-	SE	Areas of poor soils such as maritime oak forests, pine/oak barrens, and rocky summits [2]

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [(a)]	New York State Status [(b)]	Habitat [(c)]
Platanthera ciliaris	orange fringed orchid	-	SE	Wide range of habitats from wet, rich soils to dry, rocky mountainous areas [(1)]
Platanthera hookeri	Hooker's orchid	-	SE	Pine or poplar forests with open understories in dry to moist soils [(2)]
Podostemum ceratophyllum	Riverweed	-	ST	In fast-flowing streams and rivers with rocky bottoms [(2)]
Polygala lutea	orange milkwort	-	SE	Wet, sandy soils and marshes in pine barrens [(14)]
Polygonum douglasii douglasii	Douglas' knotweed	-	ST	Disturbed, dry areas such as rocky outcrops with sandy soils [(6)]
Polygonum erectum	erect knotweed	-	SE	Developed areas such as roadsides, sidewalks, and lawns and floodplain forests [(5)]
Polygonum glaucum	seabeach knotweed	-	SR	Coastal beaches [(6)]
Polygonum tenue	slender knotweed	-	SR	Dry, acidic soils in open areas such as rocky summits, scrubby wooded sites, and abandoned agricultural fields [(5)]
Potamogeton diversifolius	water thread pondweed	-	SE	Marshes and pond margins [(2)]
Potamogeton pulcher	spotted pondweed	-	ST	Ponds, marshes, and slow-moving streams and rivers [(2)]
Pterospora andromedea	giant pine drops	-	SE	Thick humus of coniferous forests [(14)]
Pycnanthemum clinopodioides	basil mountain mint	-	SE	Rocky soils in dry forests and grasslands [(2)]
Pycnanthemum muticum	blunt mountain mint	-	ST	Wet sandy soils in coastal swales, pond margins, swamps, and roadside thickets [(2)]
Pycnanthemum torrei	Torrey's mountain mint	-	SE	Dry, open areas of rocky hilltops, roadside ditches, and red cedar barrens [(2)]

1 **Table 2-6** (continued)

Scientific Name	Common Name	Federal Status [(a)]	New York State Status [(b)]	Habitat [(c)]
Ranunculus micranthus	small-flowered crowfoot	-	ST	Partially shaded summits in forests [(2)]
Rhynchospora scirpoides	long-beaked beakrush	-	SR	Wet, sandy soils of pond margins in coastal pine barrens [(2)]
Sabatia angularis	rose pink	-	SE	Rocky soils in open woods, sandy soils, and pond margins [(5)]
Sagittaria montevidensis var. *spongiosa*	spongy arrowhead	-	ST	Mudflats in freshwater to brackish tidal marshes [(2)]
Salvia lyrata	lyre leaf sage	-	SE	Rich, rocky soils in open forests; pastures with sandy soils [(14)]
Scirpus georgianus	Georgia bulrush	-	SE	Moist grasslands and borders of wet forests and marshes [(2)]
Scleria pauciflora var. *caroliniana*	few-flowered nutrush	-	SE	Mesic to wet woods, grasslands, and bogs [(6)]
Scutellaria integrifolia	hyssop skullcap	-	SE	Fields and clearings in upland forests, roadside ditches, swamps, and pond margins [(2)]
Sericocarpus linifolius	flax leaf whitetop	-	ST	Open woods, roadside ditches, and fields [(6)]
Sisyrinchium mucronatum	Michaux's blue-eyed grass	-	SE	Fields, roadside ditches, edges of forests, and coastal grasslands [(2)]
Smilax pulverulenta	Jacob's ladder	-	SE	Rich, limestone soils in woods and thickets [(6)]
Solidago latissimifolia	coastal goldenrod	-	SE	Coastal freshwater to brackish swamps and thickets [(6)]
Solidago sempervirens var. *mexicana*	seaside goldenrod	-	SE	Sand dunes and brackish marsh margins [(6)]
Sporobolus clandestinus	rough rush grass	-	SE	Sandy soils in open forests, prairies, and limestone bluffs [(5)]
Suaeda linearis	narrow leaf sea blite	-	SE	Beaches and salt marshes [(6)]

2

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Symphyotrichum boreale	northern bog aster	-	ST	Fens, clearings within coniferous swamps, meadows, shores of ponds and lakes [2]
Symphyotrichum subulatum var. *subulatum*	saltmarsh aster	-	ST	Saltwater marshes, margins of tidal creeks and salt ponds, and brackish swales among sand dunes [2]
Trichomanes intricatum	Appalachian bristle fern	-	SE	Protected cracks and crevices in rock [1]
Trichostema setaceum	tiny blue curls	-	SE	Dry forests, old fields, rocky outcrops, and coastal sandy soils [13]
Tripsacum dactyloides	northern gamma grass	-	ST	Mesic grasslands and margins of streams and salt marshes [8]
Trollius laxus	spreading globeflower	-	SR	Limestone soils in meadows and open swamps [6]
Utricularia minor	lesser bladderwort	-	ST	Wet meadows and still waters of shallow ponds [5]
Utricularia radiata	small floating bladderwort	-	ST	Ponds and slow-moving waters [2]
Veronicastrum virginicum	Culver's root	-	ST	Moist prairies and woods, meadows, and banks of streams [1]
Viburnum dentatum var. *venosum*	southern arrowwood	-	ST	Moist soils in open woods and edges of streams [8]
Viburnum nudum var. *nudum*	possum haw	-	SE	Hardwood swamps [13]
Viola brittoniana	coast violet	-	SE	Wet soils in borders of woodlands, meadows, and near coastal streams and rivers [1]
Viola hirsutula	southern wood violet	-	SE	Shallow, rocky soils in rich woods [15]
Viola primulifolia	primrose leaf violet	-	ST	Sandy soils in marsh edges, meadows [5]

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status [a]	New York State Status [b]	Habitat [c]
Vitis vulpine	winter grape	-	SE	Mesic to wet forests, lakeshores, agricultural fields [5]

[a]Federal listing status definitions: FC = Federal Candidate Species, FE = Federally Endangered, FT = Federally Threatened (FWS 2008b)
[b]State listing status definitions: SE = State Endangered, SC = Species of Special Concern in New York, SR = State Rare, ST = State Threatened (NYSDEC 2008h; NYNHP 2007)
[c] Habitat information sources:
1 NatureServe 2007
2 NYNHP 2008d
3 NYSDEC 2008i
4 Opler et al. 2006
5 Iverson et al. 1999
6 FNA Editorial Committee 1993+
7 Niering and Olmstead 1979
8 NRCS 2008
9 CPC 2008
10 NCSU 2008
11 Nearctica 2008
12 Britton and Brown 1913
13 KSNPC 2008
14 Lady Bird Johnson Wildflower Center Native Plant Information Network (NPIN) 2008
15 Pullen Herbarium 2008

2.2.7 Radiological Impacts

The following discussion focuses on the radiological environmental impacts and the dose impacts to the public from normal plant operations at the IP2 and IP3 site. Radiological releases, doses to members of the public, and the resultant environmental impacts, are summarized in two IP2 and IP3 reports—the Annual Radioactive Effluent Release Report and the Annual Radiological Environmental Operating Report. Limits for all radiological releases are specified in the IP2 and IP3 ODCM and are used by Entergy to meet Federal radiation protection limits and standards.

Radiological Environmental Impacts

Entergy conducts a radiological environmental monitoring program (REMP) in which radiological impacts to the environment and the public around the IP2 and IP3 site are monitored, documented, and compared to NRC standards. Entergy summarizes the results of its REMP in an Annual Radiological Environmental Operating Report (Entergy 2007d; all items in this section are from Entergy 2007d). The objectives of the IP2 and IP3 REMPs are the following:

- to enable the identification and quantification of changes in the radioactivity of the area
- to measure radionuclide concentrations in the environment attributable to operations of the IP2 and IP3 site

Environmental monitoring and surveillance have been conducted at IP2 and IP3 since 1958, 4 years before the startup of IP1. The preoperational program was designed and implemented to determine the background radioactivity and to measure the variations in activity levels from natural and other sources in the vicinity, as well as fallout from nuclear weapons tests. The preoperational radiological data include both natural and manmade sources of environmental radioactivity. These background environmental data permit the detection and assessment of current levels of environmental activity attributable to plant operations.

The REMP at IP2 and IP3 directs Entergy to sample environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The REMP designates sampling locations for the collection of environmental media for analysis. These sampling locations are divided into indicator and control locations. Indicator locations are established near the site, where the presence of radioactivity of plant origin is most likely to be detected. Control locations are established farther away (and upwind/upstream, where applicable) from the site, where the level would not generally be affected by plant discharges or effluents. The use of indicator and control locations enables the identification of potential sources of detected radioactivity as either background or from plant operations. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents. A total of 1342 analyses was performed in 2006. This amount is higher than required because of the inclusion of additional sample locations and media.

The REMP is used to measure the direct radiation and the airborne and waterborne pathway activity in the vicinity of the IP2 and IP3 site. Direct radiation pathways include radiation from buildings and plant structures, airborne material that may be released from the plant, or from cosmic radiation, fallout, and the naturally occurring radioactive materials in soil, air, and water. Analysis of thermoluminescent dosimeters (TLDs), which measure direct radiation, indicated that there were no increased radiation levels attributable to plant operations.

The airborne pathway includes measurements of air, precipitation, drinking water, and broadleaf vegetation samples. The airborne pathway measurements indicated that there was no increased radioactivity attributable to 2006 IP2 and IP3 station operation.

The waterborne pathway consists of Hudson River water, fish and invertebrates, aquatic vegetation, bottom sediment, and shoreline sediment Measurements of the media comprising the waterborne pathway indicated that, while some very low levels of plant discharged radioactivity were detected, there was no adverse radiological impact to the surrounding environment attributed to IP2 and IP3 operations (Entergy 2007d).

<u>2006 REMP Results</u>

The following is a detailed discussion of the radionuclides detected by the 2006 REMP that may be attributable to current plant operations (all information summarized from Entergy 2007d).

During 2006, cesium-137, strontium-90, and tritium were the only potentially plant-related radionuclides detected in some environmental samples. Tritium may be present in the local environment because of either natural occurrence, other manmade sources, or plant operations. Small amounts of tritium were detected in one of four quarterly composite samples from the discharge mixing zone (386 picocuries per liter (pCi/L) (14.28 becquerel per liter (Bq/L)). This composite sample was detected at a value much lower than the required lower limit of detection (LLD) of 3000 pCi/L (111 Bq/L).

In 2006, the detected radionuclide(s) attributable to past atmospheric weapons testing consisted of cesium-137 and strontium-90 in some media. The levels detected for cesium-137 were consistent with the historical levels of radionuclides resulting from weapons tests as measured in previous years. Before 2006, strontium-90 analysis had not been conducted since 1984, so comparison to recent historical levels is not possible. However, the low levels detected in the environment are consistent with decayed quantities of activity from historic atmospheric weapons testing. Strontium-90 was detected in four fish and invertebrate samples, three in the control samples and one in the indicator samples. Since the levels detected were comparable in the indicator and control location samples, atmospheric weapons testing is the likely cause. Of 18 special water samples, 5 indicated strontium-90 at levels close to the level of detection, at an average of 0.78 pCi/L (0.028 Bq/L). All of these detections are considered to be residual levels from atmospheric weapons tests.

Iodine-131 is also produced in fission reactors but can result from nonplant-related manmade sources (e.g., medical administrations). Iodine-131 was not detected in 2006. Cobalt-58 and cobalt-60 are activation/corrosion products also related to plant operations. They are produced by neutron activation in the reactor core. As cobalt-58 has a much shorter half-life, its absence "dates" the presence of cobalt-60 as residual. When significant concentrations of cobalt-60 are detected but no cobalt-58, there is an increased likelihood that the cobalt-60 results from residual cobalt-60 from past operations. There was no cobalt-58 or cobalt-60 detected in the 2006 REMP, though cobalt-58 and cobalt-60 have been observed in previous years.

Data resulting from analysis of the special water samples for gamma emitters, tritium analysis, and strontium-90 show that 18 samples were analyzed for strontium-90, and 5 of them showed detectable amounts of strontium-90. All of the results were very low (with a range of 0.49–1.26 pCi/L (0.018–0.046 Bq/L)) and within the range considered to be residual levels from atmospheric weapons tests. Other than the above, only naturally occurring radionuclides were detected in the special water samples.

The results of the gamma spectroscopy analyses of the monthly drinking water samples and results of tritium analysis of quarterly composites showed that, other than naturally occurring radionuclides, no radionuclides from plant operation were detected in drinking water samples. The data indicate that operation of IP2 and IP3 had no detectable radiological effect on drinking water.

The results of the analysis of bottom sediment samples for cesium-137 showed that it was detected at 7 of 10 indicator station samples, and at 1 of 3 control station samples. Cesium-134 was not detected in any bottom sediment samples. The lack of cesium-134 suggests that the primary source of the cesium-137 in bottom sediment is from historical plant releases at least several years old and from residual weapons test fallout.

While not required by the ODCM, strontium-90 analysis was conducted at three indicator locations and one control location in August 2006. Strontium-90 was not identified in any of the samples. The detection of cesium-137 in bottom sediment has been generally decreasing over the last 10 years, and cesium-134 has not been detected in bottom sediment since 2002. The data for 2006 are consistent with but slightly lower than historical levels.

In summary, IP2- and IP3-related radionuclides were detected in 2006; however, residual radioactivity from atmospheric weapons tests and naturally occurring radioactivity were the predominant sources of radioactivity in the samples collected. The 2006 levels of radionuclides in the environment surrounding IP2 and IP3 are well below the NRC's reporting levels as a result of IP2 and IP3 operations. The radioactivity levels in the environment were within the historical ranges (i.e., previous levels resulting from natural and manmade sources for the detected radionuclides). Further, IP2 and IP3 operations did not result in an adverse impact to the public greater than environmental background levels. (Entergy 2007d)

2009 REMP Results

Because of the time period between the Staff's original review of the REMP data and the issuance of the final SEIS, the Staff extended the scope of its review to include the most current available data from the 2009 REMP report (all data from Entergy 2010b).

The following is a summary of the results of 2009 radiological environmental monitoring program contained in the applicant's annual REMP report.

Direct Radiation

The 2009 and previous years' data show that there is no measurable direct radiation in the environment due to the operation of the Indian Point site.

Airborne Particulates and Radioiodine

No airborne radioactivity attributable to the operation of Indian Point was detected in 2009.

Hudson River Water

No radionuclides other than those that are naturally occurring were detected in the Hudson River Water samples.

Drinking Water

The data indicates that operation of the Indian Point units had no detectable radiological impact on drinking water.

Hudson River Shoreline Soil

Cs-137 has been and continues to be present in this media, both at indicator and control locations, at a consistent level over the past ten years.

Broad Leaf Vegetation

The detection of low levels of Cs-137 has occurred sporadically at both indicator and control locations at relatively low concentrations for the past ten years and not at all in the last five years; however, Cs-137 was not detected in 2009.

Fish and Invertebrates

The fish and invertebrate sample analysis results showed there were no plant related gamma emitting radionuclides detected in 2009. However, the results for Sr-90 in fish and invertebrate samples were reported as not reliable and under review. When the results are available and certified, Entergy will submit them as an addendum to the REMP report. The NRC staff reviewed the 2008 results for Sr-90 in fish and invertebrates, in place of the 2009 results. As in 2009, no plant related gamma emitting radionuclides were detected in the samples. Sr-90 was found in two or six indicator samples (8.8 pCi/kg average) in the vicinity of the plant. Sr-90 was also found in two of six control samples (16.3 pCi/kg average) located approximately 20 miles upriver from the plant. The lower limit of detection (i.e., sensitivity of the analysis) was approximately 5 pCi/kg. The NRC's reporting level (i.e., the concentration value in an environmental sample, if exceeded, which must be reported to the NRC) for Sr-90 in fish samples is 40 pCi/kg.

Aquatic Vegetation

Positive results for Cs-137 (17.3 +/- 4.1 pCi/kg) were reported for the sampling location at Lents Cove. However, the amount was at a level below the lower limit of detection of the measuring instrument. At his level even activity-free samples would, about 5% of the time, show a positive result due to normal background statistical fluctuations. In the historical record, a 17 pCi/kg result was reported for a 2005 aquatic vegetation sample. There are about five samples per year, varying from 3 to 10, going back to 2005. No I-131 was detected.

Hudson River Bottom Sediment

Cs-137 was detected at six of six indicator station samples and at one of two control station samples. This frequency of detection is not unusual. Cs-134 was not detected in any bottom sediment samples. The lack of Cs-134 suggests that the primary source of the Cs-137 in bottom sediment is from historical plant releases over the years and from residual weapons test fallout. Notably, the discharge canal bottom sediments were 232 pCi/kg and 1810 pCi.kg on samples taken three months apart. There is nothing in effluent release data and in monitoring well data that corresponds to this difference, yet the larger result is significantly different from other indicator and control locations from 2009 and the historical record. The average in 2009 is 493 pCi/kg. This is consistent with historical annual average concentration for indicator locations. Samples taken in 2010 will be examined for their corroborative value. The detection of Cs-137 in bottom sediment generally decreased from an average of 1200 pCi/kg in the early 1990s to 500 pCi/kg in the mid-1990s to a recent value of 250 pCi/kg over the last three years. Cs-134 has not been detected in bottom sediment since 2002.

Precipitation

Other than naturally occurring radionuclides, no radionuclides were detected in precipitation samples. A review of historical data over the last 10 years indicates tritium had been detected in both indicator and control precipitation samples in 1999; however, there have been no instances of positive values since that time.

Soil

Other than naturally occurring radionuclides, no plant-related activity was detected in any of the soil samples.

Groundwater

Tritium was detected at very low concentrations in seven of the 40 groundwater samples analyzed. The amount detected ranged from 193 to 329 pCi/L and averaged 244 pCi/L - which are well below the required LLD of 3000 pCi/L. Other than tritium, there were no potentially plant-related radionuclides detected in the groundwater samples.

Land Use Census

A census was performed in the vicinity of Indian Point in 2009. This census consisted of a milch animal and a residence census. The results of the 2009 census were generally same as the 2007 census results. The New York Agricultural Statistic Service showed there were no animals producing milk for human consumption found 4-8 within 5 miles (8 km) of the plant. Field observations also yielded no milching animal locations within five miles. The 2009 land use census indicated there were no new residences that were closer in proximity to IPEC.

Conclusion

The applicant concludes that the 2009 REMP results demonstrate the relative contributions of different radionuclide sources, both natural and anthropogenic, to the environmental concentrations. The results indicate that the fallout from previous atmospheric weapons testing continues to contribute to detection of Cs-137 in some environmental samples. There are infrequent detections of plant related radionuclides in the environs; however, the radiological effects are very low and are significantly less than those from natural background and other anthropogenic sources (Entergy 2010b).

The NRC staff reviewed the IP2 and IP3 annual radiological environmental operating reports for 2002 through 2006 and 2009 and looked for any significant impacts to the environment or any unusual trends in the data. A multi-year period provides a representative data set that covers a broad range of activities that occur at IP2 and IP3 such as, refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities

Based on the NRC Staff's review of the applicant's historical and 2009 REMP data, no unusual trends were observed, and the data showed that there was no significant radiological impact to the environment from operations at the IP2 and IP3 site. Small amounts of radioactive material (i.e., tritium, cesium-137, iodine-131, and strontium-90) were detected that are below NRC's reporting values for radionuclides in environmental samples. Overall, the results were comparable to historical REMP results.

<u>New York State Department of Health Monitoring</u>

The New York State Department of Health (NYSDOH) also performs sampling and analysis of selected independent environmental media around IP2 and IP3. The NYSDOH environmental radiation monitoring program collects various types of samples to measure the concentrations of selected radionuclides in the environment. Samples of air, water, milk, sediment, vegetation, animals, and fish are typically obtained. In addition, TLDs are used to measure environmental gamma radiation levels in the immediate proximity of IP2 and IP3. The NRC staff reviewed the published data for the years 1993 and 1994, the most current publicly available reports. The data indicated that the radiation levels observed in the environment around IP2 and IP3 were low, or consistent with background radiation, and some samples were below the detection sensitivity for the analysis. No samples exceeded any of the New York State guidelines.

The following information was reported in the 1993 report (NYSDOH 1994):

- Radioactivity in air samples showed low levels of gross beta activity and levels of iodine-131 were usually below detection levels.
- No milk sample was collected, as the remaining nearby dairy farm had closed.
- Radioactivity in water samples showed low levels of gross beta activity.
- Tritium levels were at typical background levels.
- The levels for other radioisotopes were low with most samples below minimum detectable levels.

Plant and the Environment

- Direct environmental radiation shows that the TLD data are typical of the normal background level in this area.

The following information was reported in the 1994 report (NYSDOH 1995):

- Radioactivity in air samples showed low levels of gross beta activity, and levels of iodine-131 were below detection levels.
- No milk samples were collected in 1994, as the last dairy farm closed in 1992.
- Radioactivity in water samples showed low levels of gross beta activity.
- Tritium levels were at typical background levels.
- The levels for other radioisotopes were low with most samples below minimum detectable levels.
- Radioactivity in fish samples showed that naturally occurring potassium-40 is responsible for most of the activity. All other isotopes are below detectable levels.
- Direct environmental radiation values for the TLD data are typical of the normal background level in this area.

Groundwater Contamination and Monitoring

In August of 2005, Entergy discovered tritium contamination in groundwater outside the IP2 spent fuel pool (SFP). As a result, Entergy began an on-site and off-site groundwater monitoring program (in September of 2005) in addition to the routine REMP. Entergy used this monitoring program to characterize the on-site contamination, to quantify and determine its on-site and off-site radiological impact to the workers, public and surrounding environment, and to aid in identification and repair of any leaking systems, structures or components (Entergy 2006d).

In Section 5.1 of its ER, Entergy identified the release of radionuclides to groundwater as a potentially new issue based on NRC staff analysis in a previous license renewal proceeding. In its discussion of the issue, Entergy concluded that the radionuclide release does not affect the onsite workforce, and that Entergy anticipated the leakage would not affect other environmental resources, such as water use, land use, terrestrial or aquatic ecology, air quality, or socioeconomics. In addition, Entergy asserted that no NRC dose limits have been exceeded, and EPA drinking water limits are not applicable since no drinking water exposure pathway exists (Entergy 2007a).

Entergy has taken measures to control releases from the IP1 and IP2 SFPs using waste management equipment and processes. Additional monitoring actions have also been developed as part of the site's groundwater monitoring program, which supplements the existing REMP to monitor potential impacts of site operations throughout the license renewal term and to monitor potential impacts of site operations and waste and effluent management programs (Entergy 2007a).

In addition to Entergy's assertions in the IP2 and IP3 ER, Entergy provided the NRC additional information, by report dated January 11, 2008, that included the conclusions of a 2-year investigation of onsite leaks to groundwater that it had initiated following the 2005 discovery of

SFP leakage. Entergy stated that it had characterized and modeled the affected groundwater regime, and that it had identified sources of leakage and determined the radiological impacts resulting from this leakage. In the same letter, Entergy reported that it had begun a long-term groundwater monitoring program and initiated a remediation program to address the site groundwater conditions. Entergy also stated that it had performed radiological dose impact assessments and that it will continue to perform them, and report results to the NRC in each annual Radiological Effluent Release Report. Radiological Effluent Release Reports are publically available through the NRC. Entergy's investigation indicates that the only noteworthy dose pathway resulting from contaminated groundwater migration to the Hudson River is through the consumption of fish and invertebrates from the river. According to Entergy, the resultant calculated dose to a member if the public is below 1/100 of the federal limits (Entergy 2008c).

As part of the NRC's ongoing regulatory oversight program, the NRC staff performed an extensive inspection of Entergy's actions to respond to the abnormal leakage as well Entergy's groundwater monitoring program. This inspection focused on assessing Entergy's groundwater investigation to evaluate the extent of contamination, as well as the effectiveness of actions taken or planned to effect mitigation and remediation of the condition. The NRC staff adopts the findings and content of the inspection report, released by letter dated May 13, 2008, in this SEIS (NRC 2008). The inspection findings include the following key points (NRC 2008):

(12) Currently, there is no drinking water exposure pathway to humans that is affected by the contaminated groundwater conditions at the IP2 and IP3 site. Potable water sources in the area of concern are not presently derived from groundwater sources or the Hudson River, a fact confirmed by the New York State Department of Health. The principal exposure pathway to humans is from the assumed consumption of aquatic foods (i.e., fish or invertebrates) taken from the Hudson River in the vicinity of Indian Point that has the potential to be affected by radiological effluent releases. However, no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations.

(13) The annual calculated exposure to the maximum exposed hypothetical individual, based on application of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Release of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I," relative to the liquid effluent aquatic food exposure pathway is currently, and expected to remain, less than 0.1 % of the NRC's "As Low As is Reasonably Achievable (ALARA)" guidelines of Appendix I of Part 50 (3 mrem/yr (0.03 mSv/yr) total body and 10 mrem/yr (0.1 mSv/yr) maximum organ), which is considered to be negligible with respect to public health and safety, and the environment.

Finally, by letter dated May 15, 2008, Entergy reaffirmed its January 11th letter and provided the NRC a list of commitments for further actions to address groundwater contamination (Entergy 2008d). Entergy indicated that it would remove spent fuel from the IP1 SFP, process remaining water and "bottoms" from the IP1 SFP, and incorporate aspects of the long-term groundwater monitoring program in the site's ODCM and associated procedures. To date, NRC staff has observed that Entergy has removed all spent fuel from the IP1 SFP and drained the pool, as well as incorporated aspects of the monitoring program into the ODCM and associated procedures. As of October, 2009, Entergy had drained and cleaned the IP1 SFP (NRC 2009).

Also, NRC findings since the 2008 inspection reports have been consistent with the 2008 inspection report.

New York State Groundwater Investigations

New York State performed its own groundwater investigation of the tritium leakage at Indian Point and reported its findings in a Community Fact Sheet (NYSDEC 2007d) as follows:

> The New York State Department of Environmental Conservation (DEC) and the New York State Department of Health (DOH) have been participating in the ongoing groundwater investigation of radionuclide contamination in groundwater under the plant, and the release of that water to the Hudson River. The purpose of our involvement is to protect the interests of the citizens and the environment of the State of New York by helping to ensure that Entergy performs a timely, comprehensive characterization of site groundwater contamination, takes appropriate actions to identify and stop the sources of the leak, and undertakes any necessary remedial actions.

The key findings reported by New York State are listed below:

- There are no residential or municipal drinking water wells or surface reservoirs near the plant.
- There are no known impacts to any drinking water source.
- No contaminated groundwater is moving toward surrounding properties.
- Contaminated groundwater is moving into the Hudson River.
- Public exposure can occur from the groundwater entering the Hudson River through consumption of fish.
- NYSDOH has confirmed Entergy's calculated dose to humans from fish.
- Strontium-90 levels in fish near the site (18.8 pCi/kg (0.69 Bq/kg)) are no higher than in those fish collected from background locations across the State.
- Recent strontium-90 data in fish are limited. (The State plans to conduct additional sampling.)

Dose Impacts to the Public

The results of the IP2 and IP3 radiological releases into the environment are summarized in the IP2 and IP3 Annual Radioactive Effluent Release Reports. Limits for all radiological releases are specified in the IP2 and IP3 ODCMs and used to meet Federal radiation protection standards. In the draft SEIS, the NRC staff performed a review of historical radiological release data during the period 2002 through 2006 and the resultant dose calculations revealed that the calculated doses to maximally exposed individuals in the vicinity of IP2 and IP3 were a small fraction of the limits specified in the IP2 and IP3 ODCM to meet the dose design objectives in Appendix I to 10 CFR Part 50, as well as the dose limits in 10 CFR Part 20 and EPA's 40 CFR Part 190, as indicated in the following summary list. The NRC staff has reviewed data from 2009 and confirmed that calculated doses to maximally exposed individuals in the vicinity of IP2 and IP3 remained a small fraction of these same limits. The current results are described in "Indian Point Units 1, 2, and 3—2009 Annual Radioactive Effluent Release Report" (Entergy 2010a). A breakdown of the calculated maximum dose to an individual located at the IP2 and IP3 site boundary from liquid and gaseous effluents and direct radiation shine from IP1 and the two operating reactor units during 2009 is summarized below:

- The calculated maximum whole-body dose to an offsite member of the general public from liquid effluents was $9.00x10^{-4}$ mrem ($9.00x10^{-6}$ mSv) for IP1 and IP2 and $2.49x10^{-4}$ mrem ($2.49x10^{-6}$ mSv) for IP3, well below the 3 mrem (0.03 mSv) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum organ dose to an off-site member of the general public from liquid effluents was $1.71x10^{-3}$ mrem ($1.71x10^{-5}$ mSv) for IP1 and IP2 (child bone) and $4.59x10^{-4}$ mrem ($4.59x10^{-6}$ mSv) for IP3 (adult GI tract), well below the 10 mrem (0.10 mSv) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum gamma air dose at the site boundary from noble gas discharges was $1.14x10^{-4}$ millirad (mrad) ($1.14x10^{-6}$ milligray (mGy)) for IP1 and IP2 and $6.82x10^{-5}$ mrad ($6.82x10^{-7}$ mGy) for IP3, well below the 10 mrad (0.10 mGy) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum beta air dose at the site boundary from noble gas discharges was $1.77x10^{-4}$ mrad ($1.77x10^{-6}$ mGy) for IP1 and IP2 and $1.77x10^{-4}$ mrad ($1.77x10^{-6}$mGy) for IP3, well below the 20 mrad (0.20 mGy) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum organ dose to an offsite member of the general public from gaseous iodine, tritium, and particulate effluents was $2.10x10^{-3}$ mrem ($2.10x10^{-5}$ mSv) to the child liver for IP1 and IP2 and $3.18x10^{-3}$ mrem ($3.18x10^{-5}$ mSv) to the child liver for IP3, well below the 15 mrem (0.15 mSv) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum total whole-body dose to an offsite member of the general public from the site's combined groundwater and storm drain pathways is $2.56x10^{-4}$ mrem ($2.56x10^{-6}$ mSv).
- The calculated maximum organ (adult bone) dose to an offsite member of the general public from the site's combined groundwater and storm drain pathways is $1.03x10^{-3}$ mrem ($1.03x10^{-5}$ mSv).
- The calculated maximum total body dose to an offsite member of the public from all radioactive emissions (radioactive gaseous and liquid effluents, direct radiation shine, and new liquid effluent release pathway) from the IP2 and IP3 site was 5.11 mrem ($5.11 x10^{-2}$ mSv), well below EPA's 25 mrem (0.25 mSv) limit in 40 CFR Part 190.

The NRC staff reviewed the 2006 and 2009 Radioactive Effluent Release Report and found that the 2006 and 2009 radiological data are consistent, with reasonable variation as the result of operating conditions and outages, with the 5-year historical radiological effluent releases and resultant doses. These results, including those from the new issue concerning a new liquid effluent release pathway, confirm that IP2 and IP3 is operating in compliance with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190. As noted in Section 2.1.4 of this SEIS, the applicant does not anticipate any significant changes to the radioactive effluent releases or exposure pathways from IP2 and IP3 operations during the license renewal term, and, therefore, the NRC staff expects that impacts to the environment are not likely to change.

Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms during the period of extended operation. Such an action is not expected to change the applicant's ability to maintain radiological doses to members of the public well within regulatory limits. This is based on the absence of any projected significant increases in the amount of radioactive liquid, gaseous, or solid waste as a result of the replacements, as discussed in Section 2.1.4 of this SEIS. Thus, the staff concludes that similar small doses to members of the public and small impacts to the environment are expected during the period of extended operations.

2.2.8 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in IP2 and IP3 operations. IP2 and IP3 and the communities that support them can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required by IP2 and IP3 operations. IP2 and IP3 operations, in turn, create the demand and pay for the people, goods, and services in the form of wages, salaries, and benefits for jobs and dollar expenditures for goods and services. The measure of the communities' ability to support the demands of IP2 and IP3 depends on their ability to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomics region of influence (ROI) is defined by the areas where IP2 and IP3 employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The IP2 and IP3 ROI consists of a four-county area (Dutchess, Orange, Putnam, and Westchester Counties) where approximately 84 percent of IP2 and IP3 employees reside. The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding IP2 and IP3.

Entergy employs a permanent workforce of approximately 1255 employees (Entergy 2007a). Approximately 90 percent live in Dutchess, Orange, Putnam, Rockland, Ulster, and Westchester Counties, New York, and Bergen County, New Jersey (Table 2-7). The remaining 10 percent of the workforce is divided among 36 counties in Connecticut, Pennsylvania, New Jersey, New York, and elsewhere with numbers ranging from 1 to 15 employees per county. Given the residential locations of IP2 and IP3 employees, the most significant impacts of plant operations are likely to occur in Dutchess, Orange, Putnam, and Westchester Counties. The focus of the socioeconomic impact analysis in this SEIS is therefore on the impacts of IP2 and IP3 on these four counties.

Refueling outages at IP2 and IP3 occur at 24-month intervals for each unit, which results in an outage each year for one or the other units. During refueling outages, site employment increases by 950 workers for approximately 30 days (Entergy 2007a). During outages, most of these workers are likely to reside in the four-county ROI.

Table 2-7. IP2 and IP3 Employee Residence by County in 2006

County	Number of IP Energy Center Personnel	Percentage of Total
Bergen, NJ	17	1.4
Dutchess, NY	528	42.1
Orange, NY	243	19.4
Putnam, NY	78	6.2
Rockland, NY	28	2.2
Ulster, NY	31	2.5
Westchester, NY	206	16.4
Other	124	9.9
Total	1255	100.1

Source: Entergy 2007a

2.2.8.1 Housing

Table 2-8 lists the total number of occupied housing units, vacancy rates, and median value in the ROI in 2006. According to the 2000 Census, there were over 613,000 housing units in the ROI, of which approximately 584,000 were occupied. The median value of owner-occupied units ranged from $141,500 in Orange County to $285,800 in Westchester County. The vacancy rate was the lowest in Westchester County (3.5 percent) and highest in Putnam County (6.6 percent).

In 2006, the estimated total number of housing units in Westchester County grew by more than 6,000 units to 355,581, and the total number of occupied units declined by 4000 units to 333,114. As a result, the number of available vacant housing units increased by more than 10,200 units to 22,467, or 6.3 percent of the available units. In addition, the estimated number of available housing units also increased in Dutchess, Orange, and Putnam Counties (USCB 2008a).

Table 2-8. Housing in Dutchess, Orange, Putnam and Westchester Counties, New York

	Dutchess	Orange	Putnam	Westchester	ROI
			2000		
Total	106,103	122,754	35,030	349,445	613,332
Occupied housing units	99,536	114,788	32,703	337,142	584,169
Vacant units	6,567	7,966	2,327	12,303	29,163
Vacancy rate (percent)	6.2	6.5	6.6	3.5	4.8
Median value (dollars)	150,800	141,500	205,500	285,800	195,900
			2006*		
Total	111,507	132,983	36,471	355,581	636,542
Occupied housing units	104,289	121,887	33,544	333,114	592,834
Vacant units	7,218	11,096	2,927	22,467	43,708
Vacancy rate (percent)	6.5	8.3	8.0	6.3	6.9
Median value (dollars)	334,200	319,300	407,800	581,600	410,725

* Estimated
Source: USCB 2008a; 2006 American Community Survey

2.2.8.2 Public Services

This section presents a discussion of public services including water supply, education, and transportation.

Water Supply

IP2 and IP3 do not utilize a public water system for plant circulating and service water purposes, but instead rely on surface water from the Hudson River. Potable water and process water are supplied to the site by the Village of Buchanan water supply system. Based on water bills, IP2 and IP3 utilize approximately 2.3 million cubic feet (ft^3) or 17.4 million gal per month (65,000 m^3 or 8.7 million L per month) of potable water (VBNY 2006). There are no restrictions on the supply of potable water from the Village of Buchanan. The Village of Buchanan obtains its water from two sources, the City of Peekskill Public Water System and the Montrose Improvement District. While the demand on the City of Peekskill Public Water System currently appears to be near the system design capacity, the contract with the Montrose Improvement District (now consolidated with the Northern Westchester Joint Water Works) appears to NRC staff to be capable of providing an adequate supply of potable water based on treatment capacity upgrades.

Public water supply systems in the vicinity of IP2 and IP3 include community and noncommunity (including nontransient noncommunity and transient noncommunity) systems. Community water systems within a 10 mi (16 km) radius of IP2 and IP3 include Westchester, Putnam, Orange, and Rockland County systems. Each of these county systems uses both groundwater and surface water sources (EPA 2006b). Although outside the 10 mi (16 km) radius, public water supply systems in Dutchess County were included because Dutchess County provides residence to the largest percentage of the site's permanent full-time employees (42 percent). Approximately 57 percent of the Dutchess County community water systems, including the

Poughkeepsie water supply system, obtain water from surface water sources that include the Hudson River (EPA 2006b).

The Village of Buchanan purchases water from the City of Peekskill Public Water System and the Montrose Improvement District. The City of Peekskill has two sources of water, both of which are surface waters. The City of Peekskill's year-round major water source originates in the Town of Putnam Valley (Putnam County). The City of Peekskill's second source of water is an emergency source from a neighboring community, via the Catskill Aqueduct. Water is pumped to the Camp Field Reservoir in the City of Peekskill, where it is then filtered and treated (PWD 2005).

The Town of Cortlandt purchases 80 percent of its water supply from the Montrose Improvement District, which treats raw water purchased from the New York City Catskill Aqueduct. The town purchases 10 percent from the City of Peekskill, which filters and treats raw water pumped from the Peekskill Hollow Brook to the city's Camp Field Reservoir, and 10 percent from the Town of Yorktown, which purchases water filtered and treated by the Westchester County-owned Amawalk treatment plant (CCWD no date).

The Cortlandt Consolidated Water District (CCWD) has joined with the Yorktown and Montrose Improvement District in a new corporation known as the Northern Westchester Joint Water Works (NWJWW). The NWJWW has assumed ownership of the Amawalk treatment plant, which has been upgraded to 7 mgd (26,000 m^3/day) capacity. A new NWJWW 7 mgd (26,000 m^3/day) plant (Catskill water treatment plant) has been in operation since 2000 (CCWD no date).

Westchester Joint Water Works (WJWW) serves the municipalities of the Village/Town of Mamaroneck, Town/Village of Harrison, portions of the City of New Rochelle, and the City of Rye. WJWW, which has a capacity of 14.2 mgd (53,800 m^3/day) and an average daily demand of 13.1 mgd (49,600 m^3/d), obtains its water from the Catskill and Delaware watersheds of the New York City water system, which includes the Delaware Aqueduct, Rye Lake (Delaware watershed), and the Kensico reservoir (WJWW 2006).

A majority of Rockland County uses groundwater to supply numerous small public water systems, most of which are supplied by a single well (RWS 2006). The large public water systems of Rockland County include United Water New York (UWNY), Nyack Village Public Water System, and Suffern Village Public Water System (RWS 2006). UWNY provides water to approximately 267,000 residents from 53 groundwater wells drilled throughout the county, Lake DeForest, and the Letchworth reservoirs (UWNY 2006). The UWNY peak demand in 2006 was estimated at 47.5 mgd (180,000 m^3/day) and its peak supply at approximately 48.5 mgd (184,000 m^3/day) (RCDH 2006).

The Poughkeepsie Water Treatment Facility, which is owned and operated by the City and Town of Poughkeepsie, provides drinking water in Dutchess County to the City of Poughkeepsie, Town of Poughkeepsie, and Village of Wappingers Falls. The plant is located along and draws water from the Hudson River. The plant was built in 1962 and is currently rated at a maximum capacity of 16 mgd (61,000 m^3/day). Average demand is reported to be approximately 8 mgd (31,000 m^3/day) (PTWD 2005).

The Village of Ossining Water System in Westchester County is supplied from two surface water sources, the Indian Brook Reservoir, located near Fowler Avenue and Reservoir Road, and the Croton Reservoir, which is part of the New York City Water System. The average blend of water is approximately 63 percent from the Croton Reservoir and 37 percent from the Indian Brook Reservoir. The system obtains its water from the Croton watershed in Putnam and Westchester counties and serves approximately 30,000 people. The Village of Ossining Water System services an average daily demand of approximately 3.7 mgd (14,000 m^3/day) (VOWS 2005).

Many public water supply systems supply only small segments of the population. For example, Orange County has approximately 150 public water systems, but no major public water systems in the county were identified within 10 mi of IP2 and IP3. Groundwater is the primary source of both community and noncommunity water supply systems and serves 60 to 85 percent of the population in the area (NWWW 2006; OCWA 2006; PCWD 2006; RCDH 2006). Large areas of Westchester, Putnam, Orange, Rockland, and Dutchess Counties are not served by community water supplies. Private water supplies in these areas draw primarily from groundwater sources. The groundwater quality in New York is generally good, but contamination can and does occur locally.

The Village of Croton-on-Hudson public water system is supplied by a groundwater well system located downstream from the New Croton Dam and spillway. Groundwater is pumped from the well system directly into the distribution system. The system has a total storage capacity of 2.3 mgd (8700 m^3/day) and supplies approximately 7600 people an average of 1.1 mgd (4200 m^3/day) (VCOH 2005).

Table 2-9 lists the major public water supply systems within the vicinity of IP2 and IP3.

Table 2-9. Major Public Water Supply Systems in 2005 (mgd)

Water Supplier [a]	Water Source [a]	Average Daily Production [b]	Design Capacity [b]	Population Served [a]
Northern Westchester Joint Water Works [c]	SW	6.9	14.0	0
Peekskill, NY	SW	3.9	4.0	22,400
Croton-on-Hudson, NY	GW	1.1	2.3	7,100
Westchester Joint Water Works	SW	13.1	14.2	55,200
Ossining, NY	SW	3.7	6.0	30,000
Poughkeepsie, NY	SW	8.9	16.0	28,000
United Water New York	GW & SW	47.5	48.5	270,000
Village of Suffern	GW	2.0	4.0	12,000
Village of Nyack	SW	1.8	3.0	14,700

GW = Groundwater; SW = surface water; N/A = Not Applicable or No Information Available
[a] EPA 2008b
[b] Average daily production and design capacity. Information from 2005 Annual Drinking Water Quality Report for each public water system.
[c] Includes the CCWD, Yorktown Improvement District, and the Montrose Improvement District (CCWD 2006).

An estimated 85,000 residents north of Kensico Dam in Westchester County use groundwater as their primary water source. Exceptions are residents using surface water or aqueduct sources in Mt. Kisco, parts of the Town of Yorktown, much of the Town of Cortlandt, and most municipalities directly adjoining the Hudson River (WCDP 2003). Approximately 15 percent of the residents of the Town of Cortlandt are estimated to use groundwater supplies (WCDP 2003, Table 2).

Education

IP2 and IP3 are located in the Hendrick Hudson Central School District, Westchester County, which had an enrollment of approximately 2800 students in 2003. Including the Hendrick Hudson Central School District, Westchester County has 40 school districts with a total enrollment of approximately 147,000 students. In contrast, Dutchess, Orange, and Putnam Counties have 16, 17, and 6 school districts with a total enrollment of approximately 46,000, 66,000, and 17,000 students, respectively (WCDP 2005).

Transportation

Several major highway routes serve as transportation corridors along either side of the Hudson River Valley. Westchester County and Putnam County are located on the eastern side of the Hudson River. The primary highways in Westchester County include Interstate 684, US 9, US 6, and US 202, as well as the Taconic State and Saw Mill River Parkways (see Figures 2–1 and 2-2). US 9 runs north and south along the Hudson River Valley through both Westchester and Putnam Counties. Further east, the Taconic State Parkway also runs north and south through both counties. The Taconic State Parkway and the Saw Mill River Parkway connect near Hawthorne, New York, southeast of the site. Interstate 684 runs north and south along the eastern side of Westchester County and connects to Interstate 84 in Putnam County. US 6 runs east and west through the southern end of Putnam County and the northern portion of Westchester County. US 202 runs east and west across northern Westchester County. The Saw Mill River Parkway extends northeast and southwest between US 9 at Riverdale, New York, and Interstate 684. Additional highways within the two counties include State Routes 117, 120, 129, 100, 139, and 301.

The nearest highway serving the site area is US 9. Using local roads from US 9, the site can be accessed from Broadway. A summary of data from 2005 of the New York State Department of Transportation estimates for average annual daily traffic counts on US 9 north and south of the site is presented in Table 2-10.

The Palisades Interstate Parkway is the largest highway system in Rockland County, running north and south through the county, and connecting with US 6 and US 9W in southeastern Orange County (see Figure 2–2). US 9W runs north and south along the Hudson River and connects with Interstate 87 to the south at the Village of Nyack, New York. Interstate 87 allows travel north and south through Orange County but then loops toward the east across Rockland County, crosses the Hudson, and intersects US 9, the Saw Mill River Parkway, and the Taconic State Parkway in Westchester County. US 202 runs northeast and southwest through Rockland County till it meets US 9W and then crosses the Hudson River and runs easterly and intersects the Taconic State Parkway. Route 17 (future Interstate 86) runs northwest and southeast across Orange County to where it intersects Interstate 87, and turns south until it intersects Route 3 near New York City. Interstate 84 runs east and west through Orange County, crosses the Hudson River, and travels down Dutchess County and into Putnam County were it meets Interstate 684.

Dutchess County is located approximately 13 mi (21 km) north of the site, on the east side of the Hudson River. The major roads in this county are Interstate 84, US 44, US 9, Route 199 (Taconic State Parkway), and Route 22. Interstate 84 and US 44 run east and west in the southern and central portions of the county, respectively. Route 199 (Taconic State Parkway), Route 22, and US 9 run north and south in the central, eastern, and western portions of the county, respectively.

Table 2-10. Average Annual Daily Traffic Counts on US 9 Near IP2 and IP3, 2004[a]

Roadway and Location	Annual Average Daily Traffic
US 9—from Montrose crossing to Route 9A overlap [b]	50,500
US 9—from Peekskill city line to Montrose crossing	11,800[c]
US 9—from Montrose crossing to Old Post Road crossing	5,950[c]

Source: NYSDOT 2005

[a] Traffic volume during the average 24-hour day during 2004.

[b] Readings taken at a continuous count station (accounts for seasonal and daily variation).

[c] NYSDOT projection from the latest year for which data were available.

2.2.8.3 Offsite Land Use

This section describes land use conditions in Dutchess, Orange, Putnam, and Westchester Counties in New York, because the majority of the IP2 and IP3 workforce lives in these counties. In addition to payment-in-lieu-of-taxes (PILOT) and property tax payments to Westchester County, the surrounding counties receive property tax payments from the 1255 people employed by the site.

Dutchess County

Dutchess County is distinctly different from its neighboring counties in that it contains a combination of urban and rural settings rather than metropolitan areas. Currently, Dutchess County is conserving open spaces such as farms while increasing the number of housing units available in order to create a mix of urban areas and farmland (Dutchess County Department of Planning and Development 2006).

Dutchess County occupies roughly 802 sq mi (2080 sq km) or approximately 513,000 acres (208,000 ha) (USCB 2008b). The largest category of land use in Dutchess County is agriculture. Evenly distributed throughout the county, land used for agriculture makes up 21.3 percent (112,339 acres (45,462 ha)) of the county's area (USDA 2002a). Major agricultural land uses consist of cropland (52.75 percent), woodland (23.32 percent), pasture (11.12 percent), and other uses (12.81 percent) (USDA 2002a). Residential land areas cover approximately 7.1 percent of Dutchess County, with approximately 1.4 percent being devoted to commercial, industrial, and transportation uses (Entergy 2007a).

Dutchess County is planning to create developments in central locations by developing mass transit systems and waterways. Retail areas are planned to be centralized and within convenient walking distance from these transient terminals. Developments outside the primary growth areas are designed to blend into the natural landscape. In this way, Dutchess County hopes to maintain its open spaces and farming culture (PDCTC 2006; Dutchess County Department of Planning and Development 2006).

Orange County

Three interstates intersect within Orange County. A byproduct of the county's interstate road access is a clustering of industry and commercial development along these highway corridors. Recently, most new development has occurred in the southeastern corner of the county as a result of the access to major transportation corridors. The largest land development in the southeastern part of the county is the U.S. Military Academy at West Point (see Figure 2-2) (Orange County Department of Planning 2003).

Orange County occupies roughly 816 sq mi (2110 sq km) or approximately 522,000 acres (211,000 ha) (USCB 2008b). Approximately 107,977 acres (43,697 ha) are used for agricultural purposes, with major agricultural land uses consisting of cropland (65.53 percent), woodland (16.50 percent), pasture (8.99 percent), and other uses (8.98 percent) (USDA 2002b). Residential land areas cover approximately 7.5 percent of Orange County, with approximately 1.7 percent devoted to commercial, industrial, and transportation uses (Entergy 2007a).

Orange County's Comprehensive Development Plan continues to reflect the importance of transportation interchanges, crossroads, and corridors (Orange County Department of Planning 2003). The dynamic real estate market and the loss of open spaces has been a challenge for Orange County. The county, along with civic organizations, has been inventorying current open spaces as part of defining and recommending future open space needs. Orange County also plans to initiate a redevelopment program to assist with historical improvements to the cities and villages within Orange County. With the increasing growth of Orange County, nontraditional zoning strategies are expected to help maintain historical and open spaces throughout the county (Orange County Department of Planning 2003).

Putnam County

Putnam County occupies roughly 231 sq mi (598 sq km) or approximately 148,000 acres (59,900 ha) (USCB 2008b) and is one of the fastest growing counties in New York (Putnam County Division of Planning and Development 2003). Approximately 6720 acres (2720 ha) (4.3 percent) are in agricultural use, with major agricultural land uses consisting of woodland (59.87 percent), cropland (26.49 percent), and other uses (13.65 percent) (USDA 2002c). Hilly topography has prevented or slowed development in the more rugged parts of the county. Additionally, there are many wetlands throughout the county. The most significant wetland in the county is the Great Swamp, which is a 4200-acre (1700-ha) wetland. Agricultural land use, undeveloped land, and forest land within the county have been decreasing. Residential land use occurs on large lot subdivisions or in rural areas. Industrial and commercial development can be found around the villages and along the major transportation corridors (Putnam County Division of Planning and Development 2003). Residential land use accounts for approximately 6.9 percent of the county's land, while only 1.1 percent is used for commercial, industrial, or transportation purposes (Entergy 2007a).

Putnam County attempts to integrate development into the natural environment, which includes enhancing, when possible, views of the Hudson River (Putnam County Division of Planning and Development 2003). The county and municipalities are working together by changing the zoning ordinances and subdivision regulations to preserve strategic historic structures and protect open spaces, while providing affordable housing and development throughout the county (Putnam County Division of Planning and Development 2003).

Westchester County

Westchester County occupies roughly 433 sq mi (1121 sq km) or approximately 277,000 acres (112,000 ha) (USCB 2008b). According to the 2002 U.S. Department of Agriculture (USDA) Census of Agriculture, 129 farms were located in Westchester County, which is a 10 percent increase since 1997 (USDA 2002e). Land acreage associated with farms increased 14 percent during this period with total acreage increasing from 8681 acres (3513 ha) to over 9917 acres (4013 ha). The average size of farms also increased 4 percent, from 74 to 77 acres (30 to 31 ha) from 1997 to 2002. Of the approximately 9917 acres (4013 ha) in agricultural land use in 2002, the major agricultural land uses consisted of woodland (48.84 percent), cropland (24.83 percent), pasture (12.81 percent), and other uses (13.53 percent) (USDA 2002d).

Residential land areas cover approximately 30.1 percent of Westchester County, with approximately 3.1 percent devoted to commercial, industrial, and transportation uses (Entergy 2007a). The long-range plan for the physical development of Westchester County concentrates on three distinct physical characteristics—centers, corridors, and open space (Westchester County Department of Planning 2000).

IP2 and IP3 are located in Westchester County in the Village of Buchanan, within the Town of Cortlandt. IP2 and IP3 provide tax revenues and other payments to both the Town of Cortlandt and the Village of Buchanan. The Town of Cortlandt encompasses 34.5 sq mi (89.4 sq km) or 22,080 acres (8935 ha) (TOCNY 2006). Land use is predominately residential zoning with ½-acre to 2-acre plots further protecting environmentally sensitive areas and open spaces (TOCNY 2004). The town's growth was intentionally slowed over the past several decades, allowing the town's leaders to plan its development. Significant commercial development has taken place along major transportation corridors, as well as at new community facilities within the area. From 1992 to 2004, the Town of Cortlandt has increased open space by 65 percent from 2729 acres (1104 ha) to 4502 acres (1822 ha) (TOCNY 2004). The town also has made an effort to increase public access to the Hudson River waterfront and encourage historic preservation (TOCNY 2004).

The Village of Buchanan, located within the Town of Cortlandt, encompasses 1.4 sq mi (3.6 sq km) or 896 acres (363 ha) (VBNY 1998). Land use in the village has changed very little over the last 20 to 30 years. The Village of Buchanan recently began restoring older buildings to beautify the village square. The Village of Buchanan has zoning ordinances, subdivision ordinances, and a development review board (Miller 2006).

2.2.8.4 Visual Aesthetics and Noise

IP2 and IP3 can be seen from the Hudson River but are shielded from the land side by surrounding high ground and vegetation. With the exception of Broadway, the site is also shielded from view from the Village of Buchanan. The superheater stack for IP1 (334 ft (102 m) tall), the IP2 and IP3 turbine buildings (each 134 ft (41.8 m) tall), and reactor containment structures (each 250 ft (76 m) tall) dominate the local landscape and can be seen from the Hudson River.

Noise from IP2 and IP3 is detectable offsite, and the Village of Buchanan has a sound ordinance (Chapter 211-23 of the Village Zoning Code) that limits allowable sound levels at the property line of the sound generating facility. The combined frequencies of the sound standard equate to an overall level of 48 decibels (dB(A)). An ambient noise level monitoring program was conducted in the vicinity of IP2 and IP3 between September 2001 and January 2002, which showed that IP2 and IP3 meet the Village of Buchanan's sound ordinance (Enercon Services 2003).

2.2.8.5 Demography

According to the 2000 census, approximately 1,113,089 people lived within 20 mi (32 km) of IP2 and IP3, which equates to a population density of 886 persons per sq mi (332 persons per sq km) (Entergy 2007a). This density translates to the least sparse Category 4 (greater than or equal to 120 persons per square mile within 20 mi). Approximately 16,791,654 people live within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a). This equates to a population density of 2138 persons per sq mi (825 persons per sq km). Applying the proximity measures from NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants" (GEIS), IP2 and IP3 are classified as proximity Category 4 (greater than or equal to 190 persons per square mile within 50 mi (80 km)). Therefore, according to the sparseness and proximity matrix presented in the GEIS, the IP2 and IP3 ranks of sparseness Category 4 and proximity Category 4 indicate that IP2 and IP3 are located in a high-population area.

Table 2-11 shows population projections and growth rates from 1970 to 2050 in Dutchess, Orange, Putnam, and Westchester Counties. The population growth rate in Westchester County for the period of 1990 to 2000 was the lowest of the four counties at 5.6 percent. County populations are expected to continue to grow in all four counties in the next decades although Westchester County's population is expected to increase at a lower rate. Dutchess, Orange, and Putnam County populations are projected to continue to grow at a rapid rate through 2050.

The 2000 and 2006 (estimate) demographic profiles of the four-county ROI population are presented in Table 2-12 and Table 2-13. Minority individuals (both race and ethnicity) constitute 28.8 percent of the total four-county population. The minority population was composed largely of Hispanic or Latino and Black or African-American residents.

According to the U.S. Census Bureau's 2006 American Community Survey, minority populations in the four-county region were estimated to have increased by nearly 90,000 persons and made up 32.7 percent of the total four-county population in 2006 (see Table 2-13). The largest increases in minority populations were estimated to occur in Hispanic or Latino and Asian populations. The Black or African-American population increased by approximately 5 percent from 2000 to 2006 but remained unchanged as a percentage of the total four-county population.

Table 2-11. Population and Percent Growth in Dutchess, Orange, Putnam, and Westchester Counties, New York, from 1970 to 2000 and Projected for 2010 and 2050

	Dutchess		Orange		Putnam		Westchester	
Year	Population	Percent Growth[a]	Population	Percent Growth[a]	Population	Percent Growth[a]	Population	Percent Growth[a]
1970	222,295	—	221,657	—	56,696	—	894,104	—
1980	245,055	10.2	259,603	17.1	77,193	36.2	866,599	-3.1
1990	259,462	5.9	307,647	18.5	83,941	8.7	874,866	1.0
2000	280,150	8.0	341,367	11.0	95,745	14.1	923,459	5.6
2006	***295,146***	***5.4***	***376,392***	***10.3***	***100,603***	***5.1***	***949,355***	***2.8***
2010	328,000	17.1	408,900	19.8	110,000	14.9	974,200	5.5
2020	362,900	10.6	467,000	14.2	120,300	9.4	985,800	1.2
2030	431,500	18.9	532,400	14.0	134,300	11.6	1,011,900	2.6
2040	460,450	6.7	584,005	9.7	146,439	9.0	1,054,968	4.3
2050	503,133	9.3	641,518	9.8	158,966	8.6	1,088,609	3.2

— = No data available.

(a) Percent growth rate is calculated over the previous decade.

Sources: Population data for 1970 through 2000 (USCB 2008c); population data for 2006 (estimated) 2006 American Community Survey; population projections for 2010–2030 by New York Metropolitan Transportation Council, September 2004; population projections for 2040 and 2050 (calculated)

Table 2-12. Demographic Profile of the Population in the IP2 and IP3 Four-County ROI in 2000

	Dutchess	Orange	Putnam	Westchester	Region of Influence
Total Population	280,150	341,367	95,745	923,459	1,640,721
Race (percent of total population, not Hispanic or Latino)					
White	80.3	77.6	89.8	64.1	71.2
Black or African-American	8.9	7.5	1.5	13.6	10.8
American Indian and Alaska Native	0.2	0.2	0.1	0.1	0.1
Asian	2.5	1.5	1.2	4.4	3.3
Native Hawaiian and Other Pacific Islander	0.0	0.0	0.0	0.0	0.0
Some other race	0.2	0.1	0.1	0.3	0.3
Two or more races	1.5	1.4	1.0	1.8	1.6
Ethnicity					
Hispanic or Latino	18,060	39,738	5,976	144,124	207,898
Percent of total population	6.4	11.6	6.2	15.6	12.7
Minority Population (including Hispanic or Latino ethnicity)					
Total minority population	55,237	76,607	9,772	331,683	473,299
Percent minority	19.7	22.4	10.2	35.9	28.8

Source: USCB 2008c

Table 2-13. Demographic Profile of the Population in the IP2 and IP3 Four-County ROI in 2006 (Estimate)

	Dutchess	Orange	Putnam	Westchester	Region of Influence
Total Population	295,146	376,392	100,603	949,355	1,721,496
Race (percent of total population, not Hispanic or Latino)					
White	77.2	71.1	85.0	60.8	67.3
Black or African-American	7.8	8.7	2.0	13.5	10.8
American Indian and Alaska Native	0.1	0.3	0.0	0.1	0.1
Asian	3.4	2.5	2.2	5.5	4.3
Native Hawaiian and Other Pacific Islander	0.1	0.0	0.0	0.0	0.0
Some other race	0.2	0.3	0.1	0.5	0.4
Two or more races	2.6	1.7	1.0	1.0	1.5
Ethnicity					
Hispanic or Latino	24,879	57,980	9,692	175,990	268,541
Percent of total population	8.4	15.4	9.6	18.5	15.6
Minority Population (including Hispanic or Latino ethnicity)					
Total minority population	67,160	108,604	15,068	372,414	563,246
Percent minority	22.8	28.9	15.0	39.2	32.7

Source: USCB 2008c

Transient Population

Within 50 mi (80 km) of IP2 and IP3, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services. In 2007, there were approximately 655,000 students attending colleges and universities within 50 mi (80 km) of IP2 and IP3 (IES 2008).

In 2000 in Westchester County, 0.8 percent of all housing units were considered temporary housing for seasonal, recreational, or occasional use. By comparison, seasonal housing accounted for 2.3 percent, 1.8 percent, 4.0 percent, and 3.1 percent of total housing units in Dutchess, Orange, and Putnam Counties, and New York as a whole, respectively (USCB 2008c). Table 2-14 provides information on seasonal housing located within 50 mi (80 km) of IP2 and IP3.

1 **Table 2-14. Seasonal Housing within 50 mi (80 km) of the IP2 and IP3**

County [a]	Housing units	Vacant housing units: For seasonal, recreational, or occasional use	Percent	
New York	**7,679,307**	**235,043**	**3.1**	
Bronx	490,659	962	0.2	
Dutchess	106,103	2,410	2.3	
Kings	930,866	2,616	0.3	
Nassau	458,151	3,086	0.7	
New York	798,144	19,481	2.4	
Orange	122,754	2,215	1.8	
Putnam	35,030	1,417	4.0	
Queens	817,250	4,574	0.6	
Richmond	163,993	524	0.3	
Rockland	94,973	380	0.4	
Suffolk	522,323	38,350	7.3	
Sullivan	44,730	13,309	29.8	
Ulster	77,656	5,238	6.7	
Westchester	349,445	2,711	0.8	
County Subtotal	5,012,077	97,273	4.1	(avg)
Connecticut	**1,385,975**	**23,379**	**1.7**	
Fairfield	339,466	3795	1.1	
Litchfield	79,267	4579	5.8	
New Haven	340,732	3,245	1.0	
County Subtotal	759,465	11619	2.6	(avg)
New Jersey	**3,310,275**	**109,075**	**3.3**	
Bergen	339,820	1266	0.4	
Essex	301,011	660	0.2	
Hudson	240,618	674	0.3	
Middlesex	273,637	905	0.3	
Morris	174,379	1237	0.7	
Passaic	170,048	849	0.5	
Somerset	112,023	456	0.4	
Sussex	56,528	3575	6.3	
Union	192,945	475	0.2	
Warren	41,157	361	0.9	
County Subtotal	1,902,166	10,458	1.0	(avg)
Pennsylvania	**5,249,750**	**148,230**	**2.8**	
Pike	34,681	15350	44.3	
County Subtotal	34,681	15,350	44.3	(avg)
County Total	**7,708,389**	**134,700**	**4.3**	(avg)

Source: USCB 2008c
[a] Counties within 50 mi of IP2 and IP3 with at least one block group located within the 50-mi radius
avg = percent average for counties within the IP2 and IP3 50-mi radius and excludes state percentage

Migrant Farm Workers

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers may follow the harvesting of crops, particularly fruit, throughout the northeastern U.S. rural areas. Others may be permanent residents near IP2 and IP3 who travel from farm to farm harvesting crops.

Migrant workers may be members of minority or low-income populations. Because they travel and can spend significant time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncounted, these workers would be underrepresented in U.S. Census Bureau (USCB) minority and low-income population counts.

Information on migrant farm and temporary labor was collected in the 2002 Census of Agriculture. Table 2-15 provides information on migrant farm workers and temporary farm labor (fewer than 150 days) within 50 mi (80 km) of IP2 and IP3. According to the 2002 Census of Agriculture, approximately 9100 farm workers were hired to work for fewer than 150 days and were employed on 1800 farms within 50 mi (80 km) of the IP2 and IP3. The county with the largest number of temporary farm workers (1951 workers on 193 farms) was Suffolk County in New York.

In the 2002 Census of Agriculture, farm operators were asked for the first time whether any hired migrant workers, defined as a farm worker whose employment required travel that prevented the migrant worker from returning to his or her permanent place of residence the same day. A total of 360 farms in the 50-mi (80-km) radius of IP2 and IP3 reported hiring migrant workers. Suffolk County in New York reported the most farms (110) with hired migrant workers, followed by Orange and Ulster Counties in New York with 69 and 55 farms, respectively. Dutchess, Putnam, and Westchester Counties host relatively small numbers of migrant workers compared to those counties.

According to 2002 Census of Agriculture estimates, 275 temporary farm laborers (those working fewer than 150 days per year) were employed on 34 farms in Westchester County, and 435, 1583, and 127 temporary farm workers were employed on 132, 244, and 22 farms, respectively, in Dutchess, Orange, and Putnam Counties (USDA 2002e).

Table 2-15. Migrant Farm Worker and Temporary Farm Labor within 50 mi (80 km) of IP2 and IP3

County [a]	Number of farm workers working fewer than 150 days	Number of farms hiring workers for fewer than 150 days	Number of farms reporting migrant farm labor	Number of farms with hired farm labor
New York				
Bronx	0	0	0	0
Dutchess	435	132	18	194
Kings	0	0	0	0
Nassau	91	24	4	31
New York	0	0	0	4
Orange	1583	244	69	349
Putnam	127	22	0	27
Queens	–	1	0	1
Richmond	–	1	0	3
Rockland	69	19	0	21
Suffolk	1951	193	110	313
Sullivan	595	100	1	124
Ulster	550	102	55	163
Westchester	275	34	3	68
Subtotal	**5676**	**872**	**260**	**1298**
Connecticut				
Fairfield	377	108	1	114
Litchfield	459	174	9	198
New Haven	713	88	25	102
Subtotal	**1549**	**370**	**35**	**414**
New Jersey				
Bergen	103	32	3	40
Essex	–	3	1	4
Hudson	0	0	0	0
Middlesex	334	71	15	92
Morris	432	69	12	83
Passaic	66	15	4	17
Somerset	160	100	8	114
Sussex	200	158	4	217
Union	–	7	1	8
Warren	549	131	17	178
Subtotal	**1844**	**586**	**65**	**753**

Table 2-15 (continued)

County [a]	Number of farm workers working fewer than 150 days	Number of farms hiring workers for fewer than 150 days	Number of farms reporting migrant farm labor	Number of farms with hired farm labor
Pennsylvania				
Pike	–	8	0	10
Subtotal	–	**8**	**0**	**10**
Total	**9069**	**1836**	**360**	**2475**

Source: USDA 2002e, "Census of Agriculture," County Data, Table 7. Hired Farm Labor—Workers and Payroll: 2002

[a] Counties within 50 mi of IP2 and IP3 with at least one block group located within the 50-mi radius

2.2.8.6 Economy

This section contains a discussion of the economy, including employment and income, unemployment, and taxes.

Employment and Income

Between 2000 and 2006, the civilian labor force in Westchester County increased 3.8 percent from 452,417 to 469,558. The civilian labor force in Dutchess, Orange, and Putnam Counties also grew by 11.9, 16.4, and 9.4 percent, respectively (USCB 2008c).

In 2002, health care and social assistance represented the largest sector of employment in the four-county region followed closely by retail, manufacturing, and the accommodation and food service industry. The health care and social assistance sector employed the most people in Westchester County followed by retail trade and professional, scientific, and technical services sectors. A list of some of the major employers in Westchester County in 2006 is provided in Table 2-16. As shown in the table, the largest employer in Westchester County in 2006 was IBM Corporation with 7475 employees.

Income information for the IP2 and IP3 ROI is presented in Table 2-17. In 1999, the date of the last economic census, the four counties each had median household incomes far above the New York State average. Per capita income, with the exception of Orange County, was also above the New York State average. In 1999, only 8.8 percent of the population in Westchester County was living below the official poverty level, while in Dutchess, Orange, and Putnam Counties, 7.5, 10.5, and 4.4 percent of the respective populations were living below the poverty level. The percentage of families living below the poverty level was about the same for Dutchess, Orange, and Westchester Counties. Putnam County had the smallest percentage of families living below the poverty level (USCB 2008c).

1 **Table 2-16. Major Employers in Westchester County in 2006**

Firm	Number of Employees
IBM Corporation	7475
County of Westchester	5881
Yonkers Public Schools	4049
Westchester Medical Center	3367
United States Postal Service District Office	3007
Verizon Communications	2733
Sound Shore Health System of Westchester	2515
City of Yonkers	2418
Riverside Health Care (St. John's Riverside Hospital)	2418
PepsiCo Incorporated	2372
White Plains Hospital Center	1923
New York State Department of Correctional Services	1735
Pace University	1620
MTA Metro-North Railroad	1617
Entergy Nuclear Northeast	1500
Morgan Stanley	1475
The Bank of New York Company	1450
Mount Vernon City School District	1450
Con Edison	1400
City School District of New Rochelle	1352
Phelps Memorial Hospital Center	1347
White Plains Public Schools	1285

Source: The Journal News 2006

2 **Table 2-17. Income Information for the IP2 and IP3 ROI**

	Dutchess	Orange	Putnam	Westchester	New York
Median household income 1999 (dollars)	53,086	52,058	72,279	63,582	43,393
Per capita income 1999 (dollars)	23,940	21,597	30,127	36,726	23,389
Percent of families living below the poverty level (2000)	5.0	7.6	2.7	6.4	11.5
Percent of individuals living below the poverty level (2000)	7.5	10.5	4.4	8.8	14.6

Source: USCB 2008c

Unemployment

In 2006, the annual unemployment averages in Westchester and Dutchess, Orange, and Putnam Counties were 5.3, 5.5, 6.2, and 4.8 percent, respectively, which were lower than the annual unemployment average of 6.5 percent for the State of New York (USCB 2008c).

Taxes

IP2 and IP3 are assessed annual property taxes by the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District. PILOT payments, property taxes, and other taxes from the site are paid directly to the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District (see Table 2-18). The payments to the Town of Cortlandt are distributed to the Town of Cortlandt, Westchester County, the Verplanck Fire District, the Hendrick Hudson Central School District, and Lakeland Central Schools.

PILOT payments, property taxes, and other taxes paid by Entergy account for a significant portion of revenues for these government agencies. The remainder is divided between the Village of Buchanan, Westchester County, the Town of Cortlandt, and the Verplanck Fire District.

The Village of Buchanan is the principal local jurisdiction that receives direct revenue from the site. In fiscal year 2006, PILOT payments, property taxes, and other taxes from the site contributed about 39 percent of the Village of Buchanan's total revenue of $5.07 million, which is used for police, fire, health, transportation, recreation, and other community services for over 2100 residents (NYSOSC 2007). Additionally in fiscal year 2006, PILOT payments, property taxes, and other taxes from the site contributed over 27 percent of the total revenue collected for the Hendrick Hudson Central School District.

Entergy also pays approximately $1 million dollars per year to New York State Energy Research and Development Authority (NYSERDA) for lease of the discharge canal structure and underlying land (NYSERDA 2007).

From 2003 through 2006, the Town of Cortlandt had between $31.6 and $34.5 million annually in total revenues (NYSOSC 2008). Between 2003 and 2006, IP2 and IP3 PILOT and property tax payments represented 11 to 16 percent of the Town's total revenues (see Table 2-18).

From 2003 through 2006, the Hendrick Hudson Central School District had between $51 and $57 million annually in total revenues (NYSOSC 2008). Between 2003 and 2006, IP2 and IP3 PILOT payments represented 27 to 38 percent of the school district's total revenues (see Table 2-18).

From 2003 to 2006, the Village of Buchanan had between $5 and $5.7 million annually in total revenues (NYSOSC 2008). Between 2003 and 2006, IP2 and IP3 PILOT and property tax payments represented between 39 and 44 percent of the Village's total revenues (see Table 2-18).

Table 2-18. IP2 and IP3 PILOT and Property Tax Paid and Percentage of the Total Revenue of the Town of Cortlandt, Hendrick Hudson Central School District, and Village of Buchanan, 2003 to 2006

Entity	Year	Total Revenue (millions of dollars)	PILOT and Property Tax Paid (millions of dollars)	Percent of Total Revenue
Town of Cortlandt	2003	31.6	5.0	16
	2004	31.9	4.7	15
	2005	34.5	3.8	11
	2006	33.8	3.7	11
Hendrick Hudson Central School District	2003	51.1	19.6	38
	2004	52.8	18.9	36
	2005	56.9	16.9	30
	2006	55.9	15.3	27
Village of Buchanan	2003	5.7	2.3	40
	2004	5.0	2.2	44
	2005	5.1	2.0	39
	2006	5.1	2.0	39

Source: NYSOSC 2008; ENN 2007c

2.2.9 Historic and Archeological Resources

This section presents a brief summary of the region's cultural background and a description of known historic and archaeological resources at the IP2 and IP3 site and its immediate vicinity. The information presented was collected from the New York State Historic Preservation Office (NYSHPO), and the applicant's environmental report (Entergy 2007a).

2.2.9.1 Cultural Background

Prehistory

The basic prehistoric cultural sequence and chronology for New York State is presented in Table 2-19 below and the text that follows. This cultural sequence was generated primarily for western and southern New York, and its applicability to the unusual estuarine environments of the lower Hudson and southeastern New York is uncertain. Given the lack of excavated data specific to the lower Hudson River Valley, the NRC staff used this generalized sequence (Ritchie 1980).

Table 2-19. Cultural Sequence and Chronology

Cultural Period	Time Period
Paleo-Indian Period	10000–7000 B.C.
Archaic Period	7000–1000 B.C.
Woodland Period	1000 B.C.–A.D. 1524
European Contact	A.D. 1524–1608

Paleo-Indian Period

Archeological evidence suggests that Paleo-Indian people were hunter-gatherers who primarily hunted large mammals using projectiles tipped with distinctively flaked "fluted" stone points. These small, widely dispersed bands ranged over large geographic areas supplementing food taken from large mammal hunts by collecting edible wild plant foods, fishing, and hunting smaller game (Ritchie 1980).

Humans entered upstate New York and the Hudson River Valley for the first time around 10,000–9,000 B.C. Ritchie (1980) reports isolated finds of fluted points characteristic of the Clovis tradition in the Albany area. Data on Paleo-Indian fluted points indicate only one example each in Westchester, Rockland, and Orange Counties. Levine's more extensive publication (1989) regarding Paleo-Indian fluted points from surface collections in the Upper Hudson River Valley is similarly vague regarding the nature of findspots and their environmental settings. Most appear to have been collected from agricultural plow zones and indicate a temporary occupation, such as a hunting camp.

Excavated sites are consistently small and indicative of extremely short-term utilization. Of particular interest to the lower Hudson is the Port Mobil site, located above the Arthur Kill on Staten Island. Though badly disturbed, the location of the site indicates a strong estuarine orientation, and the lithic materials recovered at the site derive from both eastern New York and eastern Pennsylvanian sources (Ritchie 1994).

Archaic Period

Generalized hunter-gatherers exploiting large game and a wide variety of fauna, including small mammals and birds, and fish, characterize the Archaic period. The Early and Middle Archaic Periods had long been interpreted as representing a low point in human occupation in the Northeast, but as with the Paleo-Indian period, surface collections have begun to fill in the gap (Levine 1989). Part of the explanation for the increasing density of human occupation of upper New York State may involve the gradual transition from relatively resource-poor coniferous forests to hardwood forests during the course of the period (Salwen 1975). Gradually rising sea levels would have shortened the descent to the Hudson River banks and flooded any number of Early Archaic sites.

A study by Brennan noted that Archaic hunting and foraging was centered on two pools or bays, the Tappan Zee, stretching from just north of Yonkers to the Croton River, and Haverstraw Bay, from the Croton River to Bear Mountain. He disagreed, however, with the notion that any of the sites represented long-term, much less permanent, settlements and specialized subsistence. Instead, he suggested that Archaic exploitation of the lower Hudson was only seasonal, as part of a generalized subsistence strategy (Brennan 1977).

Woodland Period

The Woodland Period in New York State saw the establishment of horticulture and the development of larger social units, including matriarchal and matrilocal clans, sedentary villages, and tribes. Pottery is gradually introduced, and a much wider variety of material culture comes into use. While minor climate fluctuations took place during this period, the overall environment was very similar to that of today.

Early Woodland sites are similar to those of the Late Archaic Period. They are typically small sites, with projectile points, scrapers, and bone tools providing evidence of hunting, fishing, and limited cultivation (Funk 1976). Pottery is found on an increasing number of sites, typically stamped and impressed cooking pots tempered with crushed shell. The wide variety of pottery types found at individual sites, however, points to low levels of interaction between groups. Other new features of the early Woodland Period are burials with elaborate grave goods, including flints and bone tools, shell and copper beads, and stone pendants (Ritchie 1980).

By the Middle and Late Woodland Periods, the size and complexity of sites increased tremendously. The key to later developments was the introduction of horticulture and the cultivation of maize (*Zea mays*), beans (*Phaseolus vulgaris*), and squash (*Cucurbita pepo*). Processing of these crops was facilitated by the use of cooking pots and storage pits. Villages were occupied year-round by the end of the period and often comprised multiple longhouses positioned on defensible hills and fortified with walls or palisades.

European Contact, 1524–1608

The Contact Period in the lower Hudson Valley began in 1524, when the Spanish explorer Giovanni de Verrazzano reached New York Harbor in his ship, the *Dauphin*. After anchoring near Staten Island, he attempted to go ashore in a small boat but was forced to return to his ship because of a sudden storm. Verrazzano then departed quickly and continued up the East Coast. The Spanish continued to exploit the area between the Chesapeake and the Gulf of Maine, primarily as slavers, while French fishermen appear to have frequented the Grand Banks in the 16th century.

Historic Period

The Colonial Period, 1608–1776

The English explorer Henry Hudson undertook two unsuccessful Arctic explorations in search of the Northwest Passage to the Orient in 1608. With the support of the Dutch East Indies Company, Hudson's famous voyage in the *Half Moon* took place in 1609, whereupon he discovered instead the river that now bears his name. Almost immediately thereafter, Dutch traders in great numbers began flooding into the area, primarily in search of furs. In 1614, the New Netherlands Company was formed and given a charter by the Dutch to exploit the areas between the Connecticut, Mohawk, and Hudson Rivers. In 1614, the Dutch established Fort Nassau on the west bank of the Hudson River at what is now Albany.

The island known as Manhattan was, famously, purchased from the Manhattes in 1626, and other areas such as Staten Island, Hoboken, and Nyack were purchased in the succeeding decades (Francis 1997; Kraft 1991). Dutch, Walloon, Huguenot, and even small numbers of Jews began to arrive as refugees and settlers in New Amsterdam, but by 1630, the population was still only around 300. In 1664 an English fleet sailed into the harbor at New Amsterdam, and after some negotiation, the Dutch capitulated. The English seized the entire colony of New Amsterdam and renamed the area New York and New Jersey.

The Revolutionary War, 1776–1783

New York and, more specifically, Westchester County were the site of many significant events during the American Revolution. The social and economic structure of the State was still dominated by large landowners, and discontent had already emerged among tenant farmers during the 1750s and 1760s. British troops landed on Staten Island in July 1776 and advanced northward, pressing colonial forces under the command of George Washington to make a strategic retreat north into Westchester County (Griffin 1946). With a large British force advancing, the bulk of American forces in Westchester retreated across the Hudson to New Jersey (Griffin 1946; Countryman 2001). Westchester remained on the front lines until the end of the war. The American defense line stretched from Mamaroneck to Peekskill, with British forces arrayed across southern Westchester County, creating a “neutral ground” in between, across which violence raged. The British gradually captured the bulk of Westchester County by 1779 but were unable to press their advantage further (Griffin 1946; Countryman 2001).

The Americans slowly pushed the British back from the Hudson Highlands and then Westchester County. In July 1779, General Anthony Wayne and his Corps of Light Infantry conducted a successful assault against a British encampment at Stony Point (now a National Historic Landmark). The modern Stony Point Battlefield in Rockland County is across the Hudson River and south of the IP2 and IP3 site.

19th Century Development

The economy of Westchester County remained overwhelmingly agricultural during the first half of the 19th century, driving a number of infrastructure improvements. The Croton Turnpike, for example, was organized in 1807 to carry the enormous cattle traffic en route to New York City from Westchester County. Though shipbuilding was a major industry on both the Hudson and Long Island Sound sides of Westchester, regular sloop traffic to Manhattan did not begin until the later 18th century. After 1807, the steamboat revolution, engineered by Robert Livingston and Robert Fulton, opened a new era on the Hudson River.

The landscape of New York State and Westchester County was profoundly transformed by land speculation, which opened virtually the entirety of the State for farming, and more gradually by the spread of industry. Copper was mined near Sing-Sing and iron near Port Chester and Irvington, and iron working was established in Peekskill. During the latter part of the 19th century, the area just north of the IP2 and IP3 site was surface-mined, and a small lime kiln and blast furnace were operated within or adjacent to the footprint of the current facility (Enercon, 2006). By the end of the 19th century, industrialization was widespread in Westchester County.

20th Century Development

Land remained the dominant theme for the 20th century in Westchester County, but in a far different sense than during the 19th. The preceding century had seen the landscape transformed through the end of the manorial system and the spread of freehold farming, then by industrialization and transportation networks, and finally by deliberate preservation as New York City’s water source. Though the surrounding counties had always been secondary to New York

City in terms of population, productivity, and wealth, the 20th century gradually saw decisive political and economic subordination.

2.2.9.2 Historic and Archeological Resources at the IP2 & IP3 Site

Previously Recorded Resources

A Phase 1A Survey (literature review and sensitivity assessment) was conducted in 2006 by Entergy (Enercon, 2006). This survey was primarily a literature review and included only an informal walkover of a portion of the plant site. Areas of potential aboriginal and historical interest were noted; however, no sites were recorded as part of this effort.

More recently, Entergy conducted a Phase 1b investigation of potential cooling tower locations onsite as part of ongoing proceedings before the State of New York related to the facility's SPDES permit. This investigation was intended to indicate how potential installation of cooling towers may affect onsite archaeological resources. The potential impacts of cooling tower installation are discussed in Chapter 8 of this SEIS.

NYSHPO houses the State's archeological site files and information on historic resources such as buildings and houses, including available information concerning the National or State Register eligibility status of these resources. The NRC cultural resources team visited NYSHPO and conducted a records search for archeological sites located within or near the IP2 and IP3 property. The results of this search are detailed below.

There are no previously recorded archeological sites within the IP2 and IP3 property. A search for sites within a 1 mi (1.6 km) radius of the plant also revealed no previously recorded sites. The nearest recorded site (A-119-02-0003) is located southwest of the plant, at Verplanck's Point. Site A-119-02-003 is the site of the Revolutionary War era Fort Lafayette. The New York State Historic Trust site inventory form indicates that there is no longer any visible, above ground evidence of the fort; however, the inventory form documents artifacts from the fort site (including cannonballs and uniform buttons) found in the collections of local residents in the mid-1970s. The nearest previously recorded prehistoric archaeological site is the "Peekskill Shell Heap" (NYSM 6910). This site is a shell and artifact midden deposit located northeast of the IP2 and IP3 site in the City of Peekskill.

A review of the NYSHPO files was conducted to identify aboveground historic resources within 5 mi (8 km) of the plant. In Westchester County, 29 resources are listed on the National Register of Historic Places (NRHP) within the 5 mi (8 km) radius. Additionally, there are 16 NRHP-listed resources in Rockland County, 19 in Orange County, and 22 in Putnam County within 5 mi (8 km) of the site. The nearest NRHP-listed historic resource to the IP2 and IP3 facilities is the Standard House in the City of Peekskill, approximately 2 mi (3.2 km) to the northeast. The Standard House is a three-story Italianate structure built in 1855 and originally used as a boarding house and tavern. As mentioned in Section 2.2.9.1, the Stony Point Battlefield, a National Historic Landmark, is located across the Hudson River and south of IP2 and IP3.

IP1 began operation in August 1962 and was shut down in October 1974 and placed in SAFSTOR with intent for decommissioning at a later date. The plant was one of three "demonstration plants" that began operation in the early 1960s and is representative of the earliest era of commercial reactors to operate in the United States. To date, no formal significance or eligibility evaluation has been conducted for IP1.

Results of Walkover Survey

The NRC staff performed an informal walkover survey of the IP2 and IP3 property during the environmental site audit, including portions of the power block area and portions of the former Lent's Cove Park (wooded area north of the power block area). During this walkover, it was observed that the power block area has been extensively disturbed and graded. The NRC staff walked a meandering path through the wooded area north of the plant and along a portion of the shoreline of Lent's Cove.

The NRC cultural resources team observed evidence of prehistoric use of this area in two locations along the walkover route. The NRC staff observed two pieces of chert debitage near a stream in the western portion of the wooded area, and a Woodland Period, Meadowood Phase, projectile point was observed near the shoreline along Lent's Cove. Historic Period use of this area was also observed in the form of an apparent stone house foundation and scattered historic era trash piles.

Evidence of mining (Enercon 2006) was confirmed in the western portion of the wooded area. Manmade holes of varying size and piles of spoil material were observed by the NRC staff along the route of the walkover in this portion of the property.

The NRC staff observed a concrete stairway and retaining wall (remnants of an early 20th century park) south of the main power block area. These appear to be the only remaining features of the former Indian Point Park, a popular recreation area from 1923 to 1956 (Enercon 2006).

Potential Archeological Resources

As the result of disturbances associated with site preparation and construction, the main generating station areas at IP2 and IP3 have little or no potential for archeological resources. There is potential for archeological resources to be present in the wooded area north of the main generating station areas, and the historic period mining features in this area represent a potentially significant resource. The portion of the property south and east of the power block area, which contains a variety of ancillary plant facilities, has been disturbed by construction activities over the course of the plant's history. It is possible, however, that portions of that area not disturbed by construction activities may contain intact subsurface archeological deposits.

The 2009 Phase 1b investigation for potential cooling tower installation identified numerous historic resources south of IP3, in and around the potential location of the southernmost of two proposed cooling towers. The survey also identified some prehistoric resources at two south tower survey locations. Prehistoric artifacts included stone flakes and shatter, as well as quartz shatter. Historic resources include indications of a smelter that once operated onsite as well as concrete pads or caps, a fence, and other expected indications of historic site usage. Some resources, including the concrete stairway and retaining wall from the former Indian Point Park would require evaluation, should any construction activity be planned for that area of the facility.

2.2.10 Related Federal Project Activities and Consultations

During the preparation of the IP2 and IP3 ER, Entergy did not identify any known or reasonably foreseeable Federal projects or other activities that could contribute to the cumulative environmental impacts of license renewal at the site (Entergy 2006a).

The NRC staff reviewed the possibility that activities of other Federal agencies might affect the renewal of the operating licenses for IP2 and IP3. The presence of any such activity could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency in the preparation of the SEIS.

The NRC staff identified several current Federal projects occurring near IP2 and IP3. The NRC staff has determined that none of these Federal projects would result in impacts to the IP2 and IP3 license renewal review that would make it desirable for another Federal agency to become a cooperating agency in the preparation of this SEIS.

The NRC is required under Section 102(c) of 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. Federal agency comment correspondence is included in Appendix E.

New York/New Jersey/Philadelphia Airspace Redesign

The Federal Aviation Administration (FAA) is proposing to redesign the airspace in the New York/New Jersey/Philadelphia (NY/NJ/PHL) Metropolitan Area. This redesign was conceived as a system for more efficiently directing Instrument Flight Rule aircraft to and from five major airports in the NY/NJ/PHL Metropolitan Area, including John F. Kennedy International Airport and LaGuardia Airport in New York, Newark Liberty International Airport and Teterboro Airport in New Jersey, and Philadelphia International Airport in Pennsylvania. All of these airports are south of the IP2 and IP3 facility with the closest being the Teterboro Airport which is about 30 mi away. The redesign project also included 16 satellite airports in the study area. Of these satellite airports, the White Plains/Westchester County Airport, located about 24 mi south-southeast of the IP2 and IP3 facility, and Stewart International Airport, located about 25 mi north, are the closest to the facility.

FAA, in cooperation with DOT, prepared an EIS to evaluate the environmental effects of the NY/NJ/PHL Metropolitan Area Airspace Redesign in accordance with NEPA (DOT/FAA 2007). The proposed action for this EIS is to redesign the airspace in the NY/NJ/PHL metropolitan area. This involves developing new routes and procedures to take advantage of improved aircraft performance and emerging air traffic control technologies. The final EIS identified that potential significant impacts exist in the categories Noise/Compatible Land Use and Socioeconomic Impacts/Environmental Justice (DOT/FAA 2007). The greatest potential impact of the proposed action and preferred alternative is changes in the noise levels in the airspace redesign area.

The EIS provides detailed descriptions of the proposed noise mitigation procedures identified for the preferred alternative mitigation package. The EIS studied regions of the Appalachian Trail which lie north of the IP2 and IP3 facility. The trail crosses the Hudson River about 4 mi north of the facility near Bear Mountain. In this area, the EIS mitigated preferred alternative for 2011 would result in an average of 512.4 daily air jet operations in the region (DOT/FAA 2007). The no action alternative for 2011 air traffic would result in an average of 268.1 daily air jet operations (DOT/FAA 2007). The mitigated preferred alternative would, therefore, result in a more than 90-percent increase in air traffic in the region immediately north and northwest of the facility. The formal Record of Decision (ROD) for the airspace redesign study which supports the FAA’s mitigated preferred alternative was issued in September 2007 (FAA 2007).

Hudson River PCBs Site

The EPA Hudson River Polychlorinated Biphenyls (PCBs) Site encompasses a nearly 200 mi stretch of the Hudson River in eastern New York State from Hudson Falls, New York, to the Battery in New York City and includes communities in 14 New York counties and 2 counties in New Jersey (EPA 2008c). The EPA ROD for the Hudson River PCBs Superfund Site addresses the risks to people and ecological receptors associated with PCBs in the in-place sediments of the Upper Hudson River. The February 2002 ROD calls for targeted environmental dredging and removal of approximately 2.65 million cubic yards of PCB-contaminated sediment from a 40-mi stretch of the Upper Hudson. In the ROD, EPA selected a plan that addresses the risks to people and the environment associated with PCBs in the sediments of the Upper Hudson River. The actions in the Upper Hudson will lower the risks to people, fish, and wildlife in the Lower Hudson (EPA 2008c).

On January 25, 2008, EPA completed the final step in the approval process for the design of Phase 1 of the Hudson River PCBs Site dredging program (EPA 2008c). Phase 1 encompasses the construction of facilities necessary to process and transport sediments to be dredged from the river, as well as the first year of the dredging program and the habitat replacement and reconstruction program for those areas dredged during Phase 1. Phase 2 will consist of dredging the first three sections of the Upper Hudson River (north of the Federal Dam at Troy, New York) (EPA 2008d).

Phase 1 of the project was completed in October 2009, and resulted in the removal of 293,000 cubic yards of PCB-contaminated sediment from the river. While this volume exceeded established goals for Phase 1, removal was completed for only 10 of 18 targeted areas due to the presence of contamination in some areas that was deeper than expected, and the presence of woody debris and PCB oil in the sediment that complicated the removal effort. Phase 2 of the project will begin with removal actions at areas that were not completed under Phase 1 (EPA 2009).

U.S. Army Corps of Engineers Hudson River Federal Navigation Project

The U.S. Army Corps of Engineers (USACE), New York District, prepared an EIS addressing the effects of the Hudson River Federal Navigation Project in 1983. Environmental assessments updating the EIS were prepared by the USACE New York District for various maintenance dredging projects since the mid-1980s. USACE determined that the maintenance dredging for the Hudson River Federal Navigation Project, with placement of dredged material on the federally owned upland placement site on Houghtaling Island, has no significant adverse environmental impacts on water quality, marine resources, fish, wildlife, recreation, aesthetics, and flood protection (USACE 2006).

Coastal Zone Management Act

In the United States, coastal areas are managed through the Coastal Zone Management Act of 1972 (CZMA). The Act, administered by the NOAA Office of Ocean and Coastal Resource Management, provides for management of the nation's coastal resources, including the Great Lakes, and balances economic development with environmental conservation. The Federal Consistency Regulations implemented by NOAA are contained in 15 CFR Part 930.

This law authorizes individual states to develop plans that incorporate the strategies and policies they will employ to manage development and use of coastal land and water areas. Each plan must be approved by NOAA. One of the components of an approved plan is “enforceable polices,” by which a state exerts control over coastal uses and resources.

The New York Coastal Management Program was approved by NOAA in 1982. The lead agency is the Division of Coastal Resources within the Department of State. The lead agency implements and supervises all the various Coastal Zone Management programs in the state. New York's coastal zone includes coastal counties on Long Island as well as Westchester County, the boroughs of New York City, counties along the Hudson River up the Federal Dam at Troy, and counties along the Great Lakes (NOAA 2007). Federal Consistency requires “federal actions, occurring inside a state’s coastal zone, that have a reasonable potential to affect the coastal resources or uses of that state’s coastal zone, to be consistent with that state’s enforceable coastal policies, to the maximum extent practicable.”

IP2 and IP3 are located in Westchester County, within the State’s Coastal Zone, specifically in the Peekskill South region of the Hudson River (NYSDOS undated). The IP2 and IP3 site is adjacent to a Significant Coastal Fish and Wildlife Habitat (Haverstraw Bay), and south of the Hudson Highlands Scenic Area of Statewide Significance (NYSDOS undated). Based on IP2 and IP3’s location within the State’s Coastal Zone, license renewal of IP2 and IP3 will require a State coastal consistency certification.

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 100. Code of Federal Regulations, Title 10, Energy, Part 100, “Reactor Site Criteria.”

40 CFR Part 190. Code of Federal Regulations, Title 40, Protection of Environment, Part 190, “Environmental Radiation Protection Requirements for Normal Operations of Activities in the Uranium Fuel Cycle.”

40 CFR Part 261. Code of Federal Regulations, Title 40, Protection of Environment, Part 261, “Identification and Listing of Hazardous Waste.”

40 CFR Part 264. Code of Federal Regulations, Title 40, Protection of Environment, Part 264, “Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.”

40 CFR Part 273. Code of Federal Regulations, Title 40, Protection of Environment, Part 273, “Standards for Universal Waste Management.”

32 FR 4001. U.S. Department of the Interior. “Native Fish and Wildlife: Endangered Species.” March 11, 1967.

41 FR 41914. U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants: Determination of Critical Habitat for American Crocodile, California Condor, Indiana Bat, and Florida Manatee." September 24, 1976.

69 FR 39395. U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition to List the New England Cottontail as Threatened or Endangered." June 30, 2004.

71 FR 61022. National Marine Fisheries Services. "Endangered and Threatened Species; Revision of Species of Concern List, Candidate Species Definition, and Candidate Species List." October 17, 2006.

72 FR 37346. U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants: Removing the Bald Eagle in the Lower 48 States from the List of Endangered and Threatened Wildlife." Final rule. July 9, 2007.

72 FR 69033. U.S. Fish and Wildlife Service. "Review of Native Species That Are Candidates or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Resubmitted Petitions; Annual Description of Progress on Listing Actions." Proposed Rule. December 12, 2007.

6 New York Codes, Rules, and Regulations (NYCRR) Subpart B. Title 6 of the Official Compilation of New York Codes, Rules and Regulations, Subpart B, "Solid Waste."

16 U.S.C. Section 668aa(c). "Endangered Species Preservation Act." October 15.

16 U.S.C. Section 1531 to 1544. "Endangered Species Act of 1973" (16 U.S.C. 1531–1544, 87 Stat. 884), as amended. Public Law 93-205, approved December 28, 1973.

16 U.S.C. Section 5151 to 5158. "Atlantic Striped Bass Conservation Act" (16 U.S.C. 5151–1544, 98 Stat. 3187). Public Law 98-613, approved 1984.

Abood, K.A., T.L. Englert, S.G. Metzger, C.V. Beckers, Jr., T.J. Groninger, and S. Mallavaram. 2006. "Current and Evolving Physical and Chemical Conditions in the Hudson River Estuary." American Fisheries Society Symposium 51, pp. 39–61.

Achman, D.R., B.J. Brownawell, and L. Zhang. 1996. "Exchange of Polychlorinated Biphenyls Between Sediment and Water in the Hudson River Estuary." Estuaries 19:4, pp. 950–965.

ASA (ASA Analysis and Communication). 2007. 2005 Year Class Report for the Hudson River Estuary Monitoring Program. Prepared on behalf of Dynergy Roseton LLC, Entergy Nuclear Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, and Mirant Bowline LLC. January 2007. ADAMS No. ML073331067.

Ashizawa, D., and J.J. Cole. 1994. "Long-Term Temperature Trends of the Hudson River: A Study of the Historical Data." Estuaries 17:18, pp. 166–171.

ASSRT (Atlantic Sturgeon Status Review Team). 2007. "Status Review of Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus)." Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp. Accessed at http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/atlanticsturgeon2007.pdf on December 7, 2007.

Atlantic States Marine Fisheries Commission (ASMFC). 1998. "American Shad Stock Assessment: Peer Review Report." March 1998. Washington, DC. Accessed at http://www.asmfc.org/speciesDocuments/shad/stockassmtreports/shadstockassmtreport.PDF on January 21, 2008.

Atlantic States Marine Fisheries Commission (ASMFC). 2004. "Status of the Blue Crab (Callinectes sapidus) on the Atlantic Coast." Special Report No. 80.

Atlantic States Marine Fisheries Commission (ASMFC). 2006a. "2006 Stock Assessment Report for Atlantic Menhaden." Atlantic Menhaden Technical Committee. September 26, 2006. Accessed at http://www.asmfc.org/speciesDocuments/menhaden/reports/stockAssessments/2006StockAssessmentReport.pdf?bcsi_scan_513F405096A035F7=0&bcsi_scan_filename=2006StockAssessmentReport.pdf on February 5, 2008.

Atlantic States Marine Fisheries Commission (ASMFC). 2006b. "Species profile: Atlantic striped bass, the challenges of managing a restored stock." Accessed at http://www.asmfc.org/speciesDocuments/stripedBass/speciesprofile.pdf on December 10, 2007. ADAMS No. ML083360698.

Atlantic States Marine Fisheries Commission (ASMFC). "2006c Weakfish Stock Assessment Report." December 2006. Accessed at http://www.asmfc.org/speciesDocuments/weakfish/stockassessmentreports/2006WeakfishStockAssessment.pdf?bcsi_scan_B666A1DE717DB577=0&bcsi_scan_filename=2006WeakfishStockAssessment.pdf on February 13, 2008.

Atlantic States Marine Fisheries Commission (ASMFC). 2007a. "American Shad Stock Assessment Report for Peer Review." Stock Assessment Report No. 07-01 (Supplement) of the Atlantic States Marine Fisheries Commission. August 16, 2007. Accessed at http://www.asmfc.org/speciesDocuments/shad/stockassmtreports/2007ShadStockAssmtReportVolumeI.pdf on January 21, 2008.

Atlantic States Marine Fisheries Commission (ASMFC). 2007b. "Species Profile: Weakfish—The Challenge of Managing a Stock Decline When Fishing is Not the Cause." ASMFC Fisheries Focus, Vol. 16, Issue 4: May/June 2007. Accessed at http://www.asmfc.org/speciesDocuments/weakfish/weakfishProfile.pdf on February 17, 2008.

Atlantic States Marine Fisheries Commission (ASMFC). 2007c. "Species Profile: Atlantic Sturgeon, Ancient Species' Slow Road to Recovery." Accessed at http://www.asmfc.org/speciesDocuments/sturgeon/sturgeonProfile.pdf on December 6, 2007.

Bain, M.B., N. Haley, D.L. Peterson, K.K. Arend, K.E. Mills, and P.J. Sullivan. 2007. "Recovery of a U.S. Endangered Fish." PLoS ONE 2(1): e168. Department of Natural Resources, Cornell University, Ithaca, New York. Accessed at http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0000168#s3 on December 11, 2007.

Barnthouse, L.W., and W. Van Winkle. 1988. "Analysis of Impingement Impacts on Hudson River Fish Populations." American Fisheries Society Monograph 4, pp. 182–190.

Berggren, T.J., and J.T. Lieberman. 1978. "Relative Contribution of Hudson, Chesapeake, and Roanoke Striped Bass, Morone saxatilis, Stocks to the Atlantic Coast Fishery." U.S. National Marine Fisheries Service Fishery Bulletin 76, pp. 335–345.

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin 74, Fishery Bulletin of the Fish and Wildlife Service, Volume 53, Contribution No. 592, Woods Hole Oceanographic Institution. U.S. Government Printing Office. Accessed at http://www.gma.org/fogm on January 21, 2008.

Blumberg, A.F., and F.L. Hellweger. 2006. "Hydrodynamics of the Hudson River Estuary." American Fisheries Society Symposium 51, pp. 9–28.

Boreman, J., and C.P. Goodyear. 1988. "Estimates of Entrainment Mortality for Striped Bass and Other Fish Species Inhabiting the Hudson River Estuary." American Fisheries Society Monograph 4, pp. 152–160.

Brennan, L.A. 1977. "The Lower Hudson: The Archaic." In Amerinds and their Paleoenvironments in Northeastern North America. pp. 411–430. Edited by Walter S. Newman and Bert Salwen. New York Academy of Sciences, NY.

Britton, N.L., and A. Brown. 1913. An Illustrated Flora of the Northern United States, Canada and the British Possessions. Volume II. Second edition, revised and enlarged. Charles Scribner's Sons, New York.

Brosnan, T.M., and M.L. O'Shea. 1996. "Long-term Improvements in Water Quality Due to Sewage Abatement in the Lower Hudson River." Estuaries 19:4, pp. 890–900.

Buckley, J.L. 1989. "Species Profiles: Life Histories and Environment; Requirements of Coastal Fishes and Invertebrates (North Atlantic)—Rainbow Smelt." U.S. Fish and Wildlife Service Biological Report 82(11.106), U.S. Army Corps of Engineers, TR EL-82-4. 11 pp. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-106.pdf on March 13, 2008.

Caraco, N.F., J.J. Cole, P.A. Raymond, D.L. Strayer, M.L. Pace, S.E.G. Findlay, and D.T. Fisher. 1997. "Zebra Mussel Invasion in a Large, Turbid River: Phytoplankton Response to Increased Grazing." Ecology 78, pp. 588–602.

Caraco, N.F., J.J. Cole. S.E.G. Findlay, D.T. Fischer, G.G. Lampman, M.L. Pace, and D.L. Strayer. 2000. "Dissolved Oxygen Declines in the Hudson River Associated with the Invasion of the Zebra Mussel (Dreissena polymorpha)." Environmental Science and Technology 34, pp. 1204–1210.

Caraco, N.F., and J.J. Cole. 2006. "Hydrologic Control of External Carbon Loads and Primary Production in the Tidal Freshwater Hudson." American Fisheries Society Symposium 51, pp. 63–74.

Center for Plant Conservation (CPC). 2008. "National Collection of Endangered Plants—Plant Profiles." Accessed at http://www.centerforplantconservation.org/ASP/CPC_NCList_Alpha.asp on March 12, 2008. ADAMS No. ML083390228.

Chesapeake Bay Program. 2006. "White Perch." Accessed at http://www.chesapeakebay.net/white_perch.htm on January 11, 2008. ADAMS No. ML083390252.

CHGEC (Central Hudson Gas and Electric Corporation). 1999. "Draft Environmental Impact Statement for State Pollutant Discharge Elimination System Permits for Bowline Point, Indian Point 2 and 3, and Roseton Steam Electric Generating Stations." Consolidated Edison Company New York, Inc. New York Power Authority and Southern Energy New York. December 1999. ADAMS Accession No. ML083400128.

Christensen, S.W., and T.L. Englert. 1988. "Historical Development of Entrainment Models for Hudson River Striped Bass." American Fisheries Society Monograph 4, 133–142.

Collette, B.B., and G. Klein-MacPhee (eds.). 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine (3rd Ed.). 748 pp. Smithsonian Institute Press, Herndon, VA.

Conant, R., and J.T. Collins. 1998. A Field Guide to Reptiles and Amphibians, Eastern and Central North America. Third edition, expanded. Houghton Mifflin Co., Boston.

Cortlandt Consolidated Water District (CCWD). 2006. "Annual Water Supply Statement," p. 1. Accessed at www.townofcortlandt.com on July 15, 2006. ADAMS No. ML083390256.

Countryman, E. 2001. "From Revolution to Statehood (1776–1825)." In The Empire State: A History of New York, p. 237. Edited by Milton M. Klein. Cornell University Press, Ithaca, NY.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. "Synopsis of Biological Data on Shortnose Sturgeon, Acipenser brevirostrum LeSueur 1818". NOAA Technical Report NMFS-14, FAO Fisheries Synopsis No. 140, 45 pp. Accessed at http://www.nmfs.noaa.gov/pr/pdfs/species/shortnosesturgeon_biological_data.pdf on December 11, 2007.

Daniels, R.A., K.E. Limburg, R.E. Schmidt, D.L. Strayer, and R.C. Chambers. 2005. "Changes in Fish Assemblages in the Tidal Hudson River, New York." American Fisheries Society Symposium 45: pp. 471–503. Accessed at http://www.ecostudies.org/reprints/daniels_et_al_2005.pdf on March 13, 2008.

Deason, E.E. 1982. "Mnemiopsis leidyi (Ctenophora) in Narragansett Bay, 1975–1979: Abundance, Size, Composition, and Estimation of Grazing." Estuarine, Coastal and Shelf Science 15(2), pp. 121–134.

Department of Transportation (DOT)/Federal Aviation Administration (FAA). 2007. Final Environmental Impact Statement, New York/New Jersey/Philadelphia Metropolitan Area Airspace Redesign. July 2007.

Derrick, P.A., and V.S. Kennedy. 1997. "Prey Selection by the Hogchoker, Trinectes maculates (Pisces: Soleidae), Along Summer Salinity Gradients in Chesapeake Bay, USA." Marine Biology 129(4), pp. 699–711.

Dew, C.B., and J.H. Hecht. 1994. "Hatching, Estuarine Transport, and Distribution of Larval and Early Juvenile Atlantic Tomcod, Microgadus tomcod, in the Hudson River." Estuaries, Vol. 17, No. 2, pp. 472–488. Accessed at http://estuariesandcoasts.org/cdrom/ESTU1994_17_2_472_488.pdf on December 11, 2007. (Agencywide Documents Access and Management System (ADAMS) Accession No. ML073460164)

Dovel, W.L., J.A. Mihursky, and A.J. McErlean. 1969. "Life History Aspects of the Hogchoker, Trinectes maculatus, in the Patuxent River Estuary, Maryland." Chesapeake Science 10(2), pp.

104–119. Accessed at http://estuariesandcoasts.org/cdrom/CPSC1969_10_2_104_119.pdf on February 18, 2008.

Dunn, J.L., and J. Alderfer (eds.). 2006. National Geographic Field Guide to the Birds of North America. Fifth Edition. National Geographic, Washington, DC.

Dunning, D.J., Q.E. Ross, M.T. Mattson, and D.G. Heimbuch. 2006a. “Distribution and Abundance of Bay Anchovy Eggs and Larvae in the Hudson River and Nearby Waterways.” American Fisheries Society Symposium 51, pp. 215–226.

Dunning, D.J., J.R. Waldman, Q.E. Ross, and M.T. Mattson. 2006b. “Dispersal of Age-2+ Striped Bass Out of the Hudson River.” American Fisheries Society Symposium 51, pp. 287–294.

Dutchess County Department of Planning and Development—Greenway Connections Report. 2006. Dutchess County New York. Accessed at http://www.co.dutchess.ny.us/EnvironmentLandPres/ELPgreenwayguide.htm on June 30, 2006.

Enercon Services, Inc. (Enercon). 2003. “Economic and Environmental Impacts Associated with Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration.”

Enercon Services, Inc. (Enercon). 2006. “Phase 1A Literature Review and Archaeological Sensitivity Assessment of the Indian Point Site, Westchester County, New York.” Tulsa, OK.

Entergy Nuclear Northeast (ENN). 2007a. “Indian Point 2, Offsite Dose Calculation Manual (ODCM), Part II—Calculation Methodology.” Revision 11, Table 2-9.

Entergy Nuclear Northeast (ENN). 2007b. “Indian Point Site Audit Information Needs” (Letter from Fred R. Dacimo, Indian Point Energy Center to the U.S. Nuclear Regulatory Commission). Buchanan, NY. November 14, 2007. (ADAMS Accession No. ML073330590)

Entergy Nuclear Northeast (ENN). 2007c. “Supplement to License Renewal Application (LRA) Environmental Report References.” November 14, 2007. (ADAMS Accession No. ML073330590)

Entergy Nuclear Operations Inc. (Entergy). 2003a. “Indian Point Units 1 and 2—Annual Effluent and Waste Disposal Report.” Docket Numbers 50-3 and 50-247, Buchanan, NY. (ADAMS Accession No. ML031220099)

Entergy Nuclear Operations Inc. (Entergy). 2003b. “Indian Point Unit 3—Annual Radioactive Effluent Release Report.” Docket Number 50-286, Buchanan, NY. (ADAMS Accession No. ML031220024)

Entergy Nuclear Operations Inc. (Entergy). 2004. “Indian Point Units 1, 2, and 3—2003 Annual Effluent and Waste Disposal Report.” Docket Numbers 50-3, 50-247, and 50-286, Buchanan, NY. (ADAMS Accession No. ML041250522)

Entergy Nuclear Operations Inc. (Entergy). 2005a. “Indian Point Units 1, 2, and 3—2004 Radioactive Effluent Release Report.” Docket Numbers 50-3, 50-247, and 50-286, Buchanan, NY. (ADAMS Accession No. ML051180211)

Entergy Nuclear Operations, Inc. (Entergy). 2005b. “Indian Point Energy Center, Indian Point 3, Updated Final Safety Analysis Report,” Revision 01.

Plant and the Environment

Entergy Nuclear Operations, Inc. (Entergy). 2006a. “Indian Point 2 UFSAR,” Revision 20.

Entergy Nuclear Operations Inc. (Entergy). 2006b. “Indian Point Units 1, 2, and 3—2005 Annual Radioactive Effluent Release Report.” Docket Numbers 50-3, 50-247, and 50-286, Buchanan, NY. (ADAMS Accession No. ML061240373)

Entergy Nuclear Operations, Inc. (Entergy). 2006c. “Abundance and Stock Characteristics of the Atlantic Tomcod Spawning Population in the Hudson River, Winter 2003–2004.” Prepared by Normandeau Associates, Inc., Document R-19900.000. December 2006. ADAMS No. ML073511572.

Entergy Nuclear Operations Inc. (Entergy). 2006d. “Indian Point, Units 1, 2 and 3—Annual Radiological Environmental Operating Report for 2005.” Docket Numbers 50-3, 50-247, and 50 286, Buchanan, NY. (ADAMS Accession No. ML061290085)

Entergy Nuclear Operations, Inc. (Entergy). 2007a. “Applicant’s Environmental Report, Operating License Renewal Stage.” (Appendix E of “Indian Point, Units 2 & 3, License Renewal Application.”) April 23, 2007. (ADAMS Accession No. ML071210530)

Entergy Nuclear Operations, Inc. (Entergy). 2007b. “Indian Point, Units 2 & 3, License Renewal Application.” April 23, 2007. (ADAMS Accession No. ML071210512)

Entergy Nuclear Operations Inc. (Entergy). 2007c. “Indian Point Units 1, 2, and 3—2006 Annual Radioactive Effluent Release Report.” Docket Numbers 50-3, 50-247, and 50-286, Buchanan, NY. (ADAMS Accession No. ML071230305)

Entergy Nuclear Operations Inc. (Entergy). 2007d. “Indian Point, Units 1, 2, and 3—Annual Radiological Environmental Operating Report for 2006.” Docket Numbers 50-3, 50-247, and 50 286, Buchanan, NY. (ADAMS Accession No. ML071420088)

Entergy Nuclear Operations Inc. (Entergy). 2008. “Dry Cask Storage Information Sheet” (http://www.entergy-nuclear.com/content/Resource_Library/dry_cask/ Dry_Cask_Storage_info_sheet.pdf). Accessed at http://www.entergy-nuclear.com/resource_library/IPEC.aspx on June 26, 2008. ADAMS No. ML083390262.

Entergy Nuclear Operations Inc. (Entergy). 2010a. “2009 Annual Radioactive Effluent Release Report.” Indian Point Units 1, 2 & 3; Docket Nos. 50-003, 50-247, and 50-286; License Nos. DPR-5, DPR-26, DPR-64. Buchanan, NY. (ADAMS Accession No. ML101240989)

Entergy Nuclear Operations Inc. (Entergy). 2010b. “Indian Point Nuclear Power Plants Units 1, 2, and 3—Annual Radiological Environmental Operating Report for 2009.” Indian Point Units 1, 2 and 3; Docket Nos. 50-003, 50-247, and 50-286; License Nos. DPR-5, DPR-26, DPR-64; Buchanan, NY. (ADAMS Accession No. ML101390564)

Environmental Protection Agency (EPA). 2004. “Total Maximum Daily Loads, Listed Water Information, Cycle: 2004. Hudson River, Lower Hudson River.” Accessed at http://oaspub.epa.gov/tmdl/enviro.control?p_list_id=NY-1301-0002&p_cycle=2004 on February 23, 2008.

Environmental Protection Agency (EPA). 2006a. “Green Book.” Accessed at http://www.epa.gov/air/oaqps/greenbk/ancl.html on August 10, 2007. ADAMS No.ML083390099

Environmental Protection Agency (EPA). 2006b. “Safe Drinking Water Information System (SDWIS) Database.” Accessed at http://oaspub.epa.gov on January 24, 2006. ADAMS No. ML083390264.

Environmental Protection Agency (EPA). 2007a. “Level III Ecoregions of the Conterminous United States.” Western Ecology Division. Accessed at http://www.epa.gov/wed/pages/ecoregions/level_iii.htm on March 11, 2008. ADAMS No. ML083390482

Environmental Protection Agency (EPA). 2007b. “Nanotechnology White Paper.” EPA 100/B-07/001, February 2007. Science Policy Council, Washington, D.C. Accessed at http://www.epa.gov/osa/pdfs/nanotech/epa-nanotechnology-whitepaper-0207.pdf?bcsi_scan_A3171404B2C9D30E=0&bcsi_scan_filename=epa-nanotechnology-whitepaper-0207.pdf on December 2, 2008.

Environmental Protection Agency (EPA). 2008a. “Hudson River PCB Superfund Site, Dredge Area 2 Delineation Fact Sheet, 2008.” Accessed at http://www.epa.gov/hudson/factsheet_2nd_phaselow.pdf on February 4, 2008. ADAMS No. ML083360712.

Environmental Protection Agency (EPA). 2008b. “Local Drinking Water Information, Pennsylvania Drinking Water, Envirofacts Data on Pennsylvania, County Search—Allegheny and Beaver Counties—January 18, 2008.” Accessed at http://oaspub.epa.gov/enviro/sdw_form_v2.create_page?state_abbr=PA in April 2008. ADAMS No. ML083390266.

Environmental Protection Agency (EPA). 2008c. “Hudson River PCBs” Web page. Accessed at http://www.epa.gov/hudson on March 5, 2008. ADAMS No. ML083390040.

Environmental Protection Agency (EPA). 2009. “First Phase of Hudson River Dredging Project Complete.” Accessed at http:ww.epa.gov/Hudson/ on December 14, 2009.

Euston, E.T., S.A. Haney, K.A. Hattala, and A.W. Kahnle. 2006. “Overview of the Hudson River Recreational Fisheries, with an Emphasis on Striped Bass.” American Fisheries Society Symposium 51, pp. 295–315.

Everly, A.W., and J. Boreman. 1999. “Habitat Use and Requirements of Important Fish Species Inhabiting the Hudson River Estuary.” National Oceanic and Atmospheric Administration, Technical Memorandum NMFS-NE-121. Accessed at http://www.nefsc.noaa.gov/nefsc/publications/tm/tm121/ on November 29, 2007. (ADAMS Accession No. ML073460167)

Fabrizio, M.C. 1987. “Contribution of Chesapeake Bay and Hudson River Stocks of Striped Bass to Rhode Island Coastal Waters as Estimated by Isoelectric Focusing of Eye Lens Proteins.” Transactions of the American Fisheries Society 116, pp. 588–593.

Facey, D.E., and M.J. Van Den Avyle. 1986. “Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)—American Shad.” U.S. Fish and Wildlife Service Biol. Rep. 82 (11.76). U.S. Army Corps of Engineers, TR EL-82-4. Accessed at http://conserveonline.org/workspaces/atlantic.diadromous.migratory.fish/alosa.sapidissima/Shad%20profile.pdf on December 18, 2007.

Fay, C.W., R.J. Neves, and G.B. Pardue. 1983. "Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Alewife/Blueback Herring." U.S. Fish and Wildlife Service Biol. Rep. 82 (11.45). U.S. Army Corps of Engineers, TR EL-82-4. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-009.pdf on November 29, 2007. (ADAMS Accession No. ML073460154)

Federal Aviation Administration (FAA). 2007. Press Release: "FAA Issues Final Decision on Airspace Redesign." September 5, 2007. Accessed at http://news.thomasnet.com/companystory/535311 on March 5, 2008. ADAMS No. ML083390269.

Findlay, S., D. Strayer, M. Bain, and W.C. Nieder. 2006. "Ecology of Hudson River Submerged Aquatic Vegetation." Final Report to the New York State Department of Environmental Conservation. Accessed at http://www.nysl.nysed.gov/scandoclinks/ocm82162378.htm on February 21, 2008.

Fish and Wildlife Service (FWS). 2001. "Bog Turtle (Clemmys muhlenbergii), Northern Population, Recovery Plan." Hadley, Massachusetts. 103 pp. Accessed at http://ecos.fws.gov/docs/recovery_plan/010515.pdf on March 4, 2008.

Fish and Wildlife Service (FWS). 2002. "Threatened and Endangered Species: Indiana Bat (Myotis sodalis)." Accessed at http://www.fws.gov/midwest/Endangered/ on March 4, 2008. ADAMS No. ML083390273.

Fish and Wildlife Service (FWS). 2004. "Plant Invaders of Mid-Atlantic Natural Areas: Aquatic Plants." U.S. Fish and Wildlife Service Bayscapes Conservation Landscaping Program. October 7, 2004. Accessed at http://www.nps.gov/plants/alien/pubs/midatlantic/trna.htm on February 23, 2008. ADAMS No. ML083390277.

Fish and Wildlife Service (FWS). 2007a. "Indiana Bat (Myotis sodalis) Draft Recovery Plan: First Revision." Fort Snelling, Minnesota. 258 pp. Accessed at http://www.fws.gov/midwest/Endangered/mammals/documents/inba_fnldrftrecpln_apr07.pdf on March 4, 2008.

Fish and Wildlife Service (FWS). 2007b. "Species Assessment and Listing Priority Assignment Form, Scientific Name: Sylvilagus transitionalis, Common Name: New England Cottontail." April 16, 2007. Accessed at http://ecos.fws.gov/docs/candforms_pdf/r5/A09B_V01.pdf on March 10, 2008.

Fish and Wildlife Service (FWS). 2008a. Significant Habitats and Habitat Complexes of the New York Bight Watershed. Lower Hudson River Complex #21. Accessed at http://training.fws.gov/library/pubs5/web_link/text/low_hud.htm on February 23, 2008. ADAMS No. ML083390034.

Fish and Wildlife Service (FWS). 2008b. "Westchester County Federally Listed Endangered and Threatened Species and Candidate Species." Accessed at http://www.fws.gov/northeast/nyfo/es/CountyLists/WestchesterDec2006.htm on February 26, 2008. ADAMS No. ML083390032.

Flora of North America (FNA) Editorial Committee (eds.). 1993+. Flora of North America North of Mexico. 12+ vols. New York and Oxford. Accessed at http://www.efloras.org/flora_page.aspx?flora_id=1 on March 11, 2008.

Francis, P., Jr. 1997. "The Beads that Did Not Buy Manhattan Island." New York History 78: 411–428.

Froese, R., and D. Pauly (eds.). 2007a. "Microgadus Tomcod Atlantic Tomcod" on FishBase: World Wide Web Electronic Database. Version (10/2007). Accessed at http://www.fishbase.org/summary/Speciessummary.php?id=316 on November 30, 2007. (ADAMS Accession No. ML073460169)

Froese, R., and D. Pauly (eds.) 2007b. "Dorosoma cepedianum American Gizzard Shad" on FishBase: World Wide Web Electronic Database. Version (10/2007). Accessed at http://www.fishbase.org/Summary/SpeciesSummary.php?id=1604 on February 6, 2008. ADAMS No. ML083390031.

Froese, R., and D. Pauly (eds.) 2007c. "Cynoscion regalis Gray Weakfish" on FishBase: World Wide Web Electronic Database. Version (10/2007). Accessed at http://www.fishbase.org/Summary/SpeciesSummary.php?id=406 on February 14, 2008. ADAMS No. ML083390030.

Funk, R.E. 1976. Recent Contributions to Hudson Valley Prehistory. ed. Vol. pp. 272–275. State University of New York, State Education Department, Albany, NY.

Gilbert, C.R. 1989. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic Bight)—Atlantic and Shortnose Sturgeons." U.S. Fish and Wildlife Service Biological Report 82 (11.122). U.S. Army Corps of Engineers TR 82 4. 28 pp.

Griffin, E.F. 1946. Westchester County and Its People, A Record. pp. 281–294. Lewis Historical Publishing Company, New York.

Haas-Castro, R. 2006a. "Status of Fishery Resources off the Northeastern U.S.: River Herring." Northeast Fisheries Science Center Resource Evaluation and Assessment Division, National Oceanic and Atmospheric Administration. Accessed at http://www.nefsc.noaa.gov/sos/spsyn/af/herring/archives/38_RiverHerring_2006.pdf on December 17, 2007. ADAMS No. ML083390029.

Haas-Castro, R. 2006b. "Status of Fishery Resources off the Northeastern U.S.: American Shad." Northeast Fisheries Science Center Resource Evaluation and Assessment Division, National Oceanic and Atmospheric Administration. Accessed at http://www.nefsc.noaa.gov/sos/spsyn/af/shad/archives/39_AmericanShad_2006.pdf on December 18, 2007. ADAMS Accession No. ML083390028.

Haddock, S.H.D. 2007. "Comparative Feeding Behavior of Planktonic Ctenophores." Integrative and Comparative Biology 47(6), pp. 847–853.

Hall, C.A.S. 1977. "Model and the Decision Making Process: The Hudson River Power Plant Case." Ecosystem Modeling in Theory and Practice, pp. 345–364. C.A.S Hall and J.W. Day, Editors. Wiley, New York.

Hartman, K.J., J. Howell, and J.A. Sweka. 2004. "Diet and Daily Ration of Bay Anchovy in the Hudson River, New York." Transactions of the American Fisheries Society 133, pp. 762–771.

Hirschberg, D.J., P. Chen, H. Feng, and J.K. Cochran. 1996. "Dynamics of Sediment and Contaminant Transport in the Hudson River Estuary: Evidence from Sediment Distributions of Naturally Occurring Radionnuclides." Estuaries 19:4, pp. 931–949.

Howard, R.W. 2001. "The English Province (1664–1776)." In The Empire State: A History of New York, pp. 112–228. Edited by Milton M. Klein. Cornell University Press, Ithaca.

Idaho Department of Fish and Game, Bureau of Fisheries (IDFG). 1985. "Proposal for the Introduction of Spottail Shiner (Notropis hudsonius) into Ondeida Narrows Reservoir." November 1985. Accessed at https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Volume%20087_Article%2007.pdf on March 12, 2008.

Indian Point Energy Center. 2004. Meteorological Tower Data, 2000–2004. ADAMS No. ML083390408

Indian Point Energy Center. 2005. "Indian Point 3, Updated Final Safety Analysis Report," Revision 1, Section 2.6.5.

Institute of Educational Science (IES). 2008. U.S. Department of Education. National Center for Educational Statistics. "College Opportunities Online Locator." Accessed at http://nces.ed.gov/ipeds/cool/RefineSearch.aspx in April 2008.

Invasive Plant Council of New York State (IPCNYS). 2008. "Water Chestnut—Overview." Accessed at http://www.ipcnys.org/sections/target/water_chestnut_overview.htm on February 23, 2008.

Iverson, L.R., D. Ketzner, and J. Karnes. 1999. Illinois Plant Information Network. Illinois Natural History Survey and USDA Forest Service. Accessed at http://www.fs.fed.us/ne/delaware/ilpin/ilpin.html on March 11, 2008. ADAMS Accession No. ML083390027.

Juanes, F., R.E. Marks, K.A. McKown, and D.O. Conover. 1993. "Predation by Age-0 Bluefish on Age-0 Anadromous Fishes in the Hudson River Estuary." Transactions of the American Fisheries Society 122, pp. 348–356.

Kenney, G. 2002. "Annual Report on the Commercial Monitoring of the Hudson River Blue Crab Fishery." New England Interstate Water Pollution Control Commission and New York State Department of Environmental Conservation. New Paltz, NY.

Kentucky State Nature Preserves Commission (KSNPC). 2008. Kentucky Rare Plant Database. Accessed at http://eppcapps.ky.gov/nprareplants/ on March 14, 2008. ADAMS Accession No. ML083390026.

Klauda, R.J., J.B. McLaren, R.E. Schmidt, and W.P. Dey. 1988. "Life History of White Perch in the Hudson River Estuary." American Fisheries Society Monograph 4, 69–88.

Koski, R.T. 1978. "Age, Growth, and Maturity of the Hogchoker, Trinectes maculates, in the Hudson River, New York." Transactions of the American Fisheries Society 107(3), pp. 449–453.

Kraft, H.C. 1991. "The Indians of the Lower Hudson Valley at the Time of European Contact." In The Archaeology and Ethnohistory of the Lower Hudson Valley and Neighboring Regions: Essays in Honor of Louis A. Brennan. Edited by Herbert C. Kraft. Archaeological Services, Bethlehem, CT.

Kynard, B. 1997. "Life History, Latitudinal Patterns, and Status of the Shortnose Sturgeon Acipenser brevirostrum." Environmental Biology of Fishes 48, pp. 319–334.

Lady Bird Johnson Wildflower Center Native Plant Information Network (NPIN). 2008. Native Plant Database. Accessed at http://www.wildflower.org/plants/ on March 14, 2008. ADAMS Accession No. ML083390025.

Larson, R.J. 1988. "Feeding and Functional Morphology of the Lobate Ctenophore Mnemiopsis mccradyi." Estuarine, Coastal and Shelf Science 27(5), pp. 495–502.

Levine, M.A. 1989. "New Evidence for Postglacial Occupations in the Upper Hudson Valley." Bulletin, Journal of the New York State Archaeological Association 98: 5–12.

Levinton, J.S., and J.R. Waldman (eds.). 2006. The Hudson River Estuary. Cambridge University Press, New York.

Limburg, K.E. 1996. "Modeling the Ecological Constraints on Growth and Movement of Juvenile American Shad (Alosa sapidissima) in the Hudson River Estuary." Estuaries 19:4, pp. 794–813.

Lonsdale, D.J., E.M. Cosper, and M. Doall. 1996. "Effects of Zooplankton Grazing on Phytoplankton Size-Structure and Biomass in the Lower Hudson River Estuary." Estuaries 19:4, pp. 874–889.

Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005a. "Spottail Shiner." In: Fishes of the Middle Savannah River Basin. Athens, GA: University of Georgia Press, pp. 153–156.

Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005b. "White Catfish." In: Fishes of the Middle Savannah River Basin, pp. 212–214. University of Georgia Press, Athens, GA.

Maryland Department of Natural Resources (MDNR). 2007a. "Maryland Fish Facts: American Gizzard Shad." Accessed at http://www.dnr.state.md.us/fisheries/fishfacts/americangizzardshad.asp on February 6, 2008. ADAMS Accession No. ML083390023.

Maryland Department of Natural Resources (MDNR). 2007b. "White Catfish—Ameiurus catus." Accessed at http://www.dnr.state.md.us/fisheries/fishfacts/whitecatfish.asp on March 13, 2008. ADAMS Accession No. ML080730512.

McGovern, J.C., and J.E. Olney. 1988. "Potential Predation by Fish and Invertebrates on Early Life History Stages of Striped Bass in the Pamunkey River, Virginia." Transactions of the American Fisheries Society 117, pp. 152–161.

McLaren, J.B., T.H. Peck, W.P. Dey, and M. Gardinier. 1988. "Biology of Atlantic Tomcod in the Hudson River Estuary." American Fisheries Society Monograph 4, pp. 102–112.

Menhaden Resource Council (MRC). 2006. "Atlantic Menhaden Biology." Accessed at http://www.menhaden.org/biology.htm on February 4, 2008.

Mercer, L.P. 1989. "Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Weakfish." U.S. Fish and Wildlife Service Biological Report 82 (11.109). U.S. Army Corps of Engineers, TR EL-82-4. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-109.pdf on February 8, 2008.

Miller, B. (Building Inspector). Village of Buchanan. 2006. Phone conversation concerning land development in the Village of Buchanan on January 24, 2006.

Miller, D., J. Ladd, and W. Nieder. 2006. "Channel Morphology in the Hudson River Estuary: Historical Changes and Opportunities for Restoration." American Fisheries Society Symposium 51, pp. 29–37.

Mills, E.L., D.L. Strayer, M.D. Scheuerell, and J.T. Carlton. 1996. "Exotic Species in the Hudson River Basin: A History of Invasions and Introductions." Estuaries 19:4, pp. 814–823.

Morris, C. 2001. "Dorosoma cepedianum." Animal Diversity Web. Accessed at http://animaldiversity.ummz.umich.edu/site/accounts/information/Dorosoma_cepedianum.html on February 6, 2008.

Morton, T. 1989. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Bay Anchovy." U.S. Fish and Wildlife Service Biological Report 82 (11.97). U.S. Army Corps of Engineers TR EL-82-4 13 pp. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-097.pdf on March 13, 2008.

National Marine Fisheries Service (NMFS). 2009. Letter from Mary A. Colligan to David J. Wrona on February 24, 2009.

National Marine Fisheries Service (NMFS). 1998. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pages. Accessed at http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_shortnose.pdf on November 17, 2010.

National Oceanic and Atmospheric Administration (NOAA). 2004. Local Climatological Data–Annual Summary with Comparative Data—Binghamton, Albany, and New York City, New York. ISSN 0198-2419, Asheville, NC.

National Oceanic and Atmospheric Administration (NOAA). 2007. "Species of Concern: Rainbow Smelt, Osmerus mordax." Updated May 17, 2007. Accessed at http://nmfs.noaa.gov/pr/pdfs/species/rainbowsmelt_detailed.pdf on March 12, 2008.

National Oceanic and Atmospheric Administration (NOAA). 2008a. "Hudson River Reserve, New York." National Estuarine Research Reserve System. Accessed at http://www.nerrs.noaa.gov/HudsonRiver/ on February 23, 2008.

National Oceanic and Atmospheric Administration (NOAA). 2008b. "Pharmaceuticals in the Environment, Information for Assessing Risk." National Centers for Coastal Ocean Science (NCCOS), National Ocean Service. Accessed at http://www.chbr.noaa.gov/peiar on December 2, 2008.

National Park Service (NPS). 2006a. “Class I Mandatory Areas.” Accessed at http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm on December 4, 2008. ADAMS No. ML083390507

National Park Service (NPS). 2006b. “Explore Air. Class I Receptors.” Accessed at http://www2.nature.nps.gov/air/Maps/images/ClassIAreas.jpg on December 3, 2008. ADAMS No. ML083390114

National Severe Storm Laboratory (NSSL). 2006. “Tornadoes…Nature’s Most Violent Storms.”

Natural Resources Conservation Service (NRCS). 2008. Plants Database. U.S. Department of Agriculture. Accessed at http://plants.usda.gov/java/factSheet on March 10, 2008.

NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life (Web application). Version 6.2. NatureServe, Arlington, VA. Accessed at http://www.natureserve.org/explorer/ in March 2008.

Nearctica.com, Inc. (Nearctica). 2008. “Wildflowers of the Eastern United States.” Accessed at http://www.nearctica.com/flowers/index.htm on March 12, 2008.

New Jersey Department of Environmental Protection (NJDEP). 2005. “White Catfish.” Accessed at http://www.nj.gov/dep/fgw/fish_wht_cat.htm on March 13, 2008. (ADAMS Accession No. ML080730514)

New Jersey Department of Environmental Protection (NJDEP) and New Jersey Department of Health and Senior Services (NJDHSS). 2006. “Fish Smart, Eat Smart: A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters.” Accessed at http://www.state.nj.us/dep/dsr/2006fishadvisorybrochure.pdf on March 13, 2008. (ADAMS Accession No. ML080730515)

New York Natural Heritage Program (NYNHP). 2007. “New York Rare Plant Status Lists.” Albany, New York. 115 pp. June 2007. Accessed at http://www.dec.ny.gov/docs/wildlife_pdf/Rare_Plant_Status_Lists_2007.pdf on March 11, 2008.

New York Natural Heritage Program (NYNHP). 2008a. “Online Conservation Guide for Myotis sodalis.” Accessed at http://www.acris.nynhp.org/guide.php?id=7405 on March 21, 2008. ADAMS Accession No. ML083390018.

New York Natural Heritage Program (NYNHP). 2008b. “Online Conservation Guide for Glyptemys muhlenbergii.” Accessed at http://www.acris.nynhp.org/guide.php?id=7507 on March 21, 2008. ADAMS Accession No. ML083390017.

New York Natural Heritage Program (NYNHP). 2008c. “Online Conservation Guide for Sylvilagus transitionalis.” Accessed at http://www.acris.nynhp.org/guide.php?id=7415 on March 21, 2008. ADAMS Accession No. ML083390015.

New York Natural Heritage Program (NYNHP). 2008d. “Animal and Plant Guides.” Accessed at http://www.acris.nynhp.org/ in March 2008. ADAMS Accession No. ML083390012.

New York Metropolitan Transportation Council. 2004. Accessed at http://www.nymtc.org/Project/conformity/Appendix/Appendix%206B%20Population.pdf on April 2008.

New York State Department of Environmental Conservation (NYSDEC). 2003a. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1&2 Bowline 1&2 and Indian Point 2&3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties." Hudson River Power Plants FEIS. June 25, 2003. ADAMS Accession No. ML083360752.

New York State Department of Environmental Conservation (NYSDEC). 2003b. "Fact Sheet. New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal with Modification, Indian Point Electric Generating Station, Buchanan, NY." November 2003. Accessed at http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf on July 12, 2007. ADAMS Accession No. ML083360743.

New York State Department of Environmental Conservation (NYSDEC). 2004a. "Descriptive Data of Municipal Wastewater Treatment Plants in New York State." New York Department of Environmental Conservation, Division of Water, Bureau of Water Compliance. January 2004. Accessed at http://www.dec.ny.gov/docs/water_pdf/descdata2004.pdf on January 15, 2008.

New York State Department of Environmental Conservation (NYSDEC). 2004b. "Abundance and Distribution of Blue Crab (Callinectes sapidus) Overwintering in the Hudson River Estuary." Prepared by Normandeu Associates Inc. for New York State Department of Environmental Conservation, Hudson River Fisheries Unit. R-19934.000, March 2004. Accessed at http://www.nysl.nysed.gov/scandoclinks/ocm60127660.htm on March 15, 2008.

New York State Department of Environmental Conservation (NYSDEC). 2004c. New York State Freshwater Wetlands Map, Westchester County, Map 1 of 14. Promulgated October 7, 1987. Revised July 28, 2004.

New York State Department of Environmental Conservation (NYSDEC). 2005. "New York State Breeding Bird Atlas, 2000–2005." Release 1.0. Albany, NY. Updated June 2007. Accessed at http://www.dec.ny.gov/animals/7312.html on March 5, 2008. ADAMS Accession No. ML083380509.

New York State Department of Environmental Conservation (NYSDEC). 2007a. "Hudson River Estuary Program Annual Report for the Period April 1, 2006–March 30, 2007." The Hudson River Estuary Program, New York State Department of Environmental Conservation.

Accessed at http://www.dec.ny.gov/docs/remediation_hudson_pdf/annrep07.pdf on February 21, 2008. ADAMS Accession No. ML083380517.

New York State Department of Environmental Conservation (NYSDEC). 2007b. "Checklist of Amphibians, Reptiles, Birds and Mammals of New York State—Including Their Legal Status." Division of Fish, Wildlife and Marine Resources, Wildlife Diversity Group. Eighth revision. Accessed at www.dec.ny.gov/docs/wildlife_pdf/vertchecklist0907.pdf on March 3, 2008. ADAMS Accession No. ML083380524.

New York State Department of Environmental Conservation (NYSDEC). 2007c. Letter from Tara Seoane, Information Services, New York Natural Heritage Program, to Rani Franovitch, NRC. Response to November 27, 2007, request from the NRC for information on State-listed, proposed, and candidate species and critical habitat that may be in the vicinity of Indian Point. December 28, 2007. ADAMS Accession No. ML080070085.

New York State Department of Environmental Conservation (NYSDEC). 2008a. "Some Catfishes of New York." Accessed at http://www.dec.ny.gov/animals/7046.html on March 13, 2008. (ADAMS Accession No. ML080730517)

New York State Department of Environmental Conservation (NYSDEC). 2008b. "Bald Eagle Fact Sheet." Accessed at http://www.dec.ny.gov/animals/9383.html?showprintstyles on March 13, 2008. ADAMS Accession No. ML083380531.

New York State Department of Environmental Conservation (NYSDEC). 2008c. "Bald Eagles of the Hudson River." Accessed at http://www.dec.ny.gov/animals/9382.html?showprintstyles on March 13, 2008. ADAMS Accession No. ML083380535.

New York State Department of Environmental Conservation (NYSDEC). 2008d. "Peregrine Falcon Fact Sheet." Accessed at http://www.dec.ny.gov/animals/7294.html?showprintstyles on March 5, 2008. ADAMS Accession No. ML083380540.

New York State Department of Environmental Conservation (NYSDEC). 2008e. "Peregrine Falcon." Accessed at http://www.dec.ny.gov/animals/7059.html?showprintstyles on March 13, 2008. ADAMS Accession No. ML083380542.

New York State Department of Environmental Conservation (NYSDEC). 2008f. "Bog Turtle Fact Sheet." Accessed at http://www.dec.ny.gov/animals/7164.html?showprintstyles on March 13, 2008. ADAMS Accession No. ML083380545.

New York State Department of Environmental Conservation (NYSDEC). 2008g. "New York State Amphibian and Reptile Atlas Project." Accessed at http://www.dec.ny.gov/animals/7479.html?showprintstyles on March 13, 2008. ADAMS Accession No. ML083380553.

New York State Department of Environmental Conservation (NYSDEC). 2008h. "List of Endangered, Threatened and Special Concern Fish & Wildlife Species of New York State." Accessed at http://www.dec.ny.gov/animals/7082.html on March 17, 2008.

New York State Department of Environmental Conservation (NYSDEC). 2008i. "Red-shouldered Hawk Fact Sheet." Accessed at http://www.dec.ny.gov/animals/7082.html on March 17, 2008. ADAMS Accession No. ML083380558.

New York State Department of Health (NYSDOH). 1994. "Environmental Radiation in New York State." 1993 Annual Report. Albany, NY. ADAMS Accession No. ML070380534.

New York State Department of Health (NYSDOH). 1995. "Environmental Radiation in New York State." 1994 Annual Report. Albany, NY. ADAMS Accession No. ML070380532.

New York State Department of Health (NYSDOH). 2007. "Chemicals in Sportfish and Game: 2007–2008 Health Advisories." Division of Environmental Health Assessment. Accessed at http://www.health.state.ny.us/environmental/outdoors/fish/docs/fish.pdf on March 13, 2008. ADAMS Accession No. ML083380561.

New York State Department of State (NYSDOS). 2004. "Coastal Resources Online: Significant Coastal Fish and Wildlife Habitats—Hudson River Mile 44–56 link." Division of Coastal Resources. Accessed at http://www.nyswaterfronts.com/waterfront_natural_narratives.asp on March 17, 2008. ADAMS Accession No. ML083380563.

New York State Department of Transportation (NYSDOT). 2005. "2004 Traffic Data Report for New York State."

New York State Office of the State Comptroller (NYSOSC). 2008. "Local Government Services and Economic Development." Accessed at http://www.osc.state.ny.us on May 30, 2008. ADAMS Accession No. ML083380565.

New York State Ornithological Association (NYSOA). 2007. "Historical Waterfowl Count Data, 1973–2007." Accessed at http://www.nybirds.org/ProjWaterfowl.htm on March 5, 2008. ADAMS Accession No. ML083380567.

Nieder, W.C., E. Barnaba, S.E.G. Findlay, S. Hoskins, N. Holochuck, and E.A. Blair. (2004). "Distribution and Abundance of Submerged Aquatic Vegetation and Trapa natans in the Hudson River Estuary." Journal of Coastal Research 45: 150–161.

Niering, W.A. and N.C. Olmstead. 1979. The Audubon Society Field Guide to North American Wildflowers, Eastern Region. 863 pp. Alfred A. Knopf, Inc., NY.

North Carolina State University (NCSU). 2008. "Plant Fact Sheets." Accessed at http://www.ces.ncsu.edu/depts/hort/consumer/factsheets/index.html on March 12, 2008. ADAMS Accession No. ML083380570.

Northeast Regional Climate Center (NRCC). 2006. New York Climate Office. "The Climate of New York." Accessed at http://nysc.eas.cornell.edu/climate_of_ny.html on December 3, 2008. ADAMS No. ML083380625

Northern Westchester Water Works (NWWW). 2006. Telephone correspondence from R. Schoenewe (Enercon) to B. Leibowitz (Northern Westchester Water Works) regarding the Westchester County, NY, Public Water Supply. January 27, 2006.

Nuclear Regulatory Commission (NRC). 1975. "Final Environmental Statement Related to the Operation of Indian Point Nuclear Generating Plant Unit No. 3," Volume 1. Office of Nuclear Reactor Regulation. NUREG-75/002. February 1975.

Nuclear Regulatory Commission (NRC). 2006. "Indian Point Nuclear Generating Unit 2—NRC Special Inspection Report No. 05000247/2005011." Docket Number 50-247. Washington, DC. (ADAMS Accession No. ML060750842)

Nuclear Regulatory Commission (NRC). 2007. "Indian Point Nuclear Generating Unit 2—Routine Integrated Inspection Report No. 05000247/07003." Docket Number 50-247. Washington, DC. (ADAMS Accession No. ML072150161)

Nuclear Regulatory Commission (NRC). 2008. "Indian Point Nuclear Generating Unit Nos. 1 & 2 – NRC Inspection Report Nos. 05000003/2007010 and 05000247/2007010." Washington, DC. (ADAMS Accession No. ML081340425).

Nuclear Regulatory Commission (NRC). 2009. "NRC Inspection Report No. 05000003/2009006, Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit 1, Buchanan, NY." Docket Number 50-003. Washington, DC. (ADAMS Accession No. ML091470168).

Office of Protected Resources (OPR). Undated. "Shortnose Sturgeon (Acipenser brevirostrum)." National Marine Fisheries Service. Accessed at http://www.nmfs.noaa.gov/pr/species/fish/shortnosesturgeon.htm on December 11, 2007. ADAMS Accession No. ML083380572.

Opler, P.A., H. Pavulaan, R.E. Stanford, and M. Pogue, coordinators. 2006. "Butterflies and Moths of North America." Bozeman, MT: NBII Mountain Prairie Information Node. Accessed at http://www.butterfliesandmoths.org/ on March 18, 2008. ADAMS Accession No. ML083380575.

Orange County Department of Planning. 2003. Orange County Comprehensive Plan: Strategies for Quality Communities. Accessed at http://www.orangecountygov.com/documentView.asp?docID=138 on May 30, 2006. ADAMS Accession No. ML083380576.

Orange County Water Authority (OCWA). 2006. Telephone correspondence from R. Schoenewe (Enercon) to J. Beaumont (Orange County Water Works) regarding the Orange County, NY, Public Water Supply. January 27, 2006.

Pace, M.L., S.E.G. Findlay, and D. Fischer. 1998. "Effects of an Invasive Bivalve on the Zooplankton Community of the Hudson River." Freshwater Biology 39, pp. 103–116.

Peekskill Water Department, City of (PWD). 2005. "Annual Drinking Water Quality Report for 2005, City of Peekskill—Water Department." Accessed at http://www.ci.peekskill.ny.us on June 30, 2006. ADAMS Accession No. ML083380578.

Perry, H.M., and T.D. McIlwain. 1986. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico)—Blue Crab." U.S. Fish and Wildlife Service Biological Report 82 (11.55). U.S. Army Corps of Engineers, TR EL-82-4.

Peteet, D.M., D.C. Pederson, D. Kurdyla, and T. Guilderson. 2006. "Hudson River Paleoecology from Marshes: Environmental Change and its Implications for Fisheries." American Fisheries Society Monograph 51, pp. 113–128.

Phillips, P.J., and D.W. Hanchar. 1996. "Water-Quality Assessment of the Hudson River Basin in New York and Adjacent States—Analysis of Available Nutrient, Pesticide, Volatile Organic Compound, and Suspended-Sediment Data, 1970–1990." U.S. Geological Survey, Water-Resources Investigations Report 96-4065.

Pottern, G.B., M.T. Huish, and J.H. Kerby. 1989. "Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Bluefish." U.S. Fish and Wildlife Service Biological Report 82 (11.94). U.S. Army Corps of Engineers, TR EL-82-4. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-094.pdf on February 7, 2008. ADAMS Accession No. ML083380583.

Poughkeepsie Townwide Water District (PTWD). 2005. "Annual Water Quality Report for Calendar Year 2005." Accessed at http://www.townofpoughkeepsie.com/PoughkeepsieTWWD2005.pdf on July 10, 2006.

Poughkeepsie-Dutchess County Transportation Council (PDCTC) Planning and Development. 2006. Divisions: Poughkeepsie-Dutchess County Transportation Council. Accessed at http://www.co.dutchess.ny.us/CountyGov/Departments/Planning/PLpdctcIndex.htm on June 30, 2006. ADAMS Accession No. ML083380587.

Pullen Herbarium. 2008. Pullen Herbarium Specimen Database (MISS), University of Mississippi Department of Biology. Accessed at http://herbarium.olemiss.edu on March 14, 2008. ADAMS Accession No. ML083380589.

Purcell, J.E., D.A. Namazie, S.E. Dorsey, E.D. Houde, and J.C. Gamble. 1994. "Predation Mortality of Bay Anchovy Anchoa mitchelli Eggs and Larvae Due to Scyphomedusae and Ctenophores in Chesapeake Bay." Marine Ecology Progress Series 114, pp. 47–58.

Putnam County Division of Planning and Development. 2003. "Report on the Task Force on Vision 2010: Guiding Putnam into the Next Decade." Accessed at http://www.putnamcountyny.com/vision2010.html on May 30, 2006.

Putnam County Water Department (PCWD). 2006. Telephone correspondence from R. Schoenewe (Enercon) to E. Bartus (Putnam County Water Works) regarding the Putnam County, NY, Public Water Supply System. January 27, 2006.

Ritchie, W.A. 1980. The Archaeology of New York State. pp. 196–200. Harbor Hill Books, Harrison, NY.

Ritchie, W.A. 1994 (orig. 1980). The Archaeology of New York State. pp. xvii–xviii. Purple Mountain Press, Fleischmanns, NY.

Rockland County Department of Health (RCDH). 2006. "Assessment of United Water New York Supply." Accessed for New Projects, 2006. Accessed at http://www.co.rockland.ny.us/health/pdf/SupplyDemandTracking_1.pdf on August 28, 2006. ADAMS Accession No. ML083380591.

Rockland's Water Supply (RWS). 2006. Clearwater. Poughkeepsie, NY. Accessed at www.clearwater.org/sustainablewatershed/pdfs/miller.pdf on February 20, 2007.

Roditi, H.A., N.F. Caraco, J.J. Cole, and D.L. Strayer. 1996. "Filtration of Hudson Water by the Zebra Mussel (Dreissena polymorpha)." Estuaries 19:4, pp. 824–832.

Rogers, S.G., and M.J. Van Den Avyle. 1989. "Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Atlantic Menhaden." U.S. Fish and Wildlife Service Biological Report 82 (11.108). U.S. Army Corps of Engineers, TR EL-82-4. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-108.pdf on February 5, 2008. ADAMS Accession No. ML083380608.

Rohmann, S.O., N. Lilienthal, R.L. Miller, R.M. Szwed, and W.R. Muir. 1987. "Tracing a River's Toxic Pollution: A Case Study of the Hudson. Phase 2. 209 pp. Inform, Inc., NY.

Roundtree, R.A. 1999. "Nov. Diets of NW Atlantic Fishes and Squid." Accessed at http://www.fishecology.org/diets/diets.htm on February 20, 2008. ADAMS Accession No. ML083380610.

Salwen, Bert. 1975. "Post-glacial Environments and Cultural Change in the Hudson River Basin." Man in the Northeast 10: 43–70.

Sanders, C., and J. Chenger. 2001. "Williams Lake Telemetry Study: New York Indiana Bat Spring Migration Tracking." Bat Conservation and Management, Mechanicsburg, PA. Accessed at http://www.batmanagement.com/Projects/kings/WilliamsScreen.pdf on March 19, 2008. ADAMS Accession No. ML083380612.

Schmidt, R.E., and T.R. Lake. 2006. "Tributaries and Hudson River Fishes." In: The Hudson River Estuary. J.S. Levinton and J.R. Waldman, eds. 209 pp Cambridge University Press, Cambridge.

Schultz, E.T., K.M.M. Lwiza, J.R. Young, K.J. Hartman, and R.C. Tipton. 2006. "The Dynamics of Bay Anchovy in the Hudson River Estuary: Process-oriented Studies and Long-term Changes." American Fisheries Society Symposium 51, pp. 197–213.

Shepherd, G. 2006a. "Status of Fishery Resources off the Northeastern U.S.: Bluefish." Northeast Fisheries Science Center Resource Evaluation and Assessment Division, National Oceanic and Atmospheric Administration. Accessed at http://www.nefsc.noaa.gov/sos/spsyn/op/bluefish/archives/25_Bluefish_2006.pdf on February 7, 2008. ADAMS Accession No. ML083360690.

Shepherd G. 2006b. "Atlantic Striped Bass." Accessed at http://www.nefsc.noaa.gov/sos/spsyn/af/sbass/archives/40_StripedBass_2006.pdf on December 10, 2007. ADAMS Accession No. ML083360766.

Shepard, G. 2006c. "Status of Fishery Resources off the Northeastern US, NEFSC—Resource Evaluation and Assessment Division, Atlantic and Shortnose Sturgeons." Accessed at http://www.nefsc.noaa.gov/sos/spsyn/af/sturgeon/ on December 10, 2007. ADAMS Accession No. ML083380619.

Smith, C.L. 1985a. "Spottail Shiner." In: The Inland Fishes of New York State, pp. 194–195. New York State Department of Environmental Conservation, Albany, NY.

Smith, C.L. 1985b. "White Catfish." In: The Inland Fishes of New York State," pp. 78–79. New York State Department of Environmental Conservation, Albany, NY.

Snow, D.R. 1995. Mohawk Valley Archaeology: the Sites. Matson Museum of Anthropology, Pennsylvania State University, University Park, PA.

Stanley, J.G., and D.S. Danie. 1983. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic)—White Perch." U.S. Fish and Wildlife Service, Division of Biological Services, FWS/OBS-82/11.7. U.S. Army Corps of Engineers, TR EL-82-4. 12pp. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-007.pdf on March 14, 2008. ADAMS Accession No. ML083380621.

Steinberg, N., D.J. Suszkowski, L. Clark, and J. Way. 2004. Health of the Harbor: The First Comprehensive Look at the State of the NY, NY Harbor Estuary. A Report to the New York/New Jersey Harbor Estuary Program. Hudson River Foundation, New York. ADAMS Accession No. ML083380622.

Stewart, L.L., and P.J. Auster. 1987. "Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Atlantic Tomcod." U.S. Fish and Wildlife Service Biological Report 82 (11.76). U.S. Army Corps of Engineers, TR EL-82-4. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-076.pdf on November 29, 2007. ADAMS Accession No. ML073460171.

Strayer, D.L., and L.C. Smith. 1996. "Relationships Between Zebra Mussels (Dreissena polymorpha) and Unionid Clams During the Early Stages of the Zebra Mussel Invasion of the Hudson River." Freshwater Biology 36, pp. 771–779.

Strayer, D.L., K.A. Hattala, and A.W. Kahnle. 2004. “Effects of an Invasive Bivalve (Dreissena polymorpha) on Fish in the Hudson River Estuary.” Canadian Journal of Fisheries and Aquatic Sciences 61, pp. 924–941.

Strayer, D.L., and H.M. Malcom. 2006. “Long-term Demography of a Zebra Mussel (Dreissena polymorpha) Population. Freshwater Biology 51, pp. 117–130.

Strayer, D.L. 2007. “Zebra Mussels and the Hudson River.” Cary Institute of Ecosystem Studies. Accessed at http://www.ecostudies.org/people_sci_strayer_zebra_mussels.html on January 8, 2008. ADAMS Accession No. ML083380623.

Steinberg, N., D.J. Suszkowski, L. Clark, and J. Way. 2004. Health of the Harbor: The First Comprehensive Look at the State of NY.NY Harbor Estuary. A Report to the New York/New Jersey Harbor Estuary Program. Hudson River Foundation. New York, New York. ADAMS Accession No. ML083360721.

Swaney, D.P., K.E. Limburg, and K. Staingrook. 2006. “Some Historical Changes in the Pattern of Population and Land Use in the Hudson River Watershed.” American Fisheries Society Symposium 51, pp. 75–112.

Sweka, J.A., J. Mohler, M.J. Millard, T. Kehler, A. Kahnle, K. Hattala, G. Kenney, and A. Higgs. 2007. “Juvenile Atlantic Sturgeon Habitat Use in Newburgh and Haverstraw Bays of the Hudson River: Implications for Population Monitoring.” North American Journal of Fisheries Management 27, pp. 1058–1067.

The Journal News, New York’s Lower Hudson Valley. 2006 “Westchester County’s major employers.” From Staff Reports dated March 19, 2006. Accessed at http://www.lohud.com/apps/pbcs.dll/article?AID=/20060319/BUSINESS/603190302/1066/BUSINESS01 in April 2008. ADAMS Accession No. ML083380624.

Tipton, R.C. 2003. “Distributional Ecology of Bay Anchovy (Anchoa mitchilli) in the Hudson River Estuary, USA.” A dissertation submitted to West Virginia University. Forest Resources Sciences Wildlife and Fisheries Program. Accessed at http://kitkat.wvu.edu:8080/files/2930/Tipton_Ronald_Dissertation.pdf on March 13, 2008. ADAMS Accession No. ML083380626.

Town of Cortlandt, New York (TOCNY). 2004. Comprehensive Master Plan, Town of Cortlandt, July 2004. Accessed at http://www.townofcortlandt.com/ on May 30, 2006. ADAMS Accession No. ML083380627.

Town of Cortlandt, New York (TOCNY). 2006. Town Profile. Accessed at http://www.townofcortlandt.com/Cit-e-Access/webpage.cfm?TID=20&TPID=2564 on July 15, 2006. ADAMS Accession No. ML083380629.

U.S. Army Corps of Engineers (USACE). 2006. Public Notice No. HR-AFO-06. “Hudson River, New York (Coeymans and Kingstong Reaches) Federal Navigation Projects Maintenance Dredging.” April 7. Accessed at http://www.nan.usace.army.mil/.../buslinks/navig/cntldpth/kingston.pdf on March 5, 2008.

U.S. Atomic Energy Commission (USAEC). 1972. “Final Environmental Statement Related to the Operation of Indian Point Nuclear Generating Plant Unit No. 2.” Directorate of Licensing. Docket No. 50-247. September 1972.

U.S. Census Bureau (USCB). 2000. State and County Quick Facts. Accessed at http://www.census.gov on March 4, 2008. ADAMS Accession No. ML083380631.

U.S. Census Bureau (USCB). 2006. American Fact Finder, New York City, NY. Accessed at http://factfinder.census.gov/home/saff/main.html?_lang=en on March 4, 2008.

U.S. Census Bureau (USCB). 2008a. American FactFinder, American Community Survey of Dutchess, Orange, Putnam, and Westchester Counties, Data Profile Highlights. Housing Characteristics for 2000 and 2006. Accessed at http://factfinder.census.gov in April 2008.

U.S. Census Bureau (USCB). 2008b. "New York Quickfacts: Dutchess, Orange, Putnam, and Westchester Counties." Accessed at http://quickfacts.census.gov/ on March 11, 2008. ADAMS Accession No. ML083380632.

U.S. Census Bureau (USCB). 2008c. Decennial Census 2000 Data and American FactFinder, American Community Survey of Dutchess, Orange, Putnam, and Westchester Counties, Data Profile Highlights. ACS Demographic Estimates for 2006. Accessed at http://factfinder.census.gov in April 2008.

U.S. Department of Agriculture (USDA). 2002a. "Dutchess County: 2002 Census of Agriculture County Profile." Accessed at http://www.nass.usda.gov/census/census02/profiles/ny/ on May 15, 2005.

U.S. Department of Agriculture (USDA). 2002b. "Orange County: 2002 Census of Agriculture County Profile." Accessed at http://www.nass.usda.gov/census/census02/profiles/ny/ on May 15, 2005.

U.S. Department of Agriculture (USDA). 2002c. "Putnam County: 2002 Census of Agriculture County Profile." Accessed at http://www.nass.usda.gov/census/census02/profiles/ny/cp36079.PDF on May 15, 2005.

U.S. Department of Agriculture (USDA). 2002d. "Westchester County: Farm Statistics." Accessed at http://www.nass.usda.gov/census/census02/profiles/ny/cp36119.PDF on May 15, 2006.

U.S. Department of Agriculture (USDA). 2002e. "Census of Agriculture." Accessed at http://www.nass.usda.gov/census/census02/volume1/pa/index2.htm in April 2008. ADAMS Accession No. ML083380633.

U.S. Department of Commerce (USDOC). 2006a. National Climatic Data Center, NOAA Satellite and Information Service, Tornado Climatology. Accessed at http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html on August 28, 2006. ADAMS Accession No. ML083380644.

U.S. Department of Commerce (USDOC). 2006b. National Climatic Data Center (NCDC), 2006 Westchester County Tornado Query Results. Accessed at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll/wwevent~storms on July 6, 2006.

U.S. Geological Survey (USGS). 2008. "Hudson River Salt Front Data." Accessed at http://ny.water.usgs.gov/projects/dialer_plots/saltfront.html on January 31, 2008.

United Water New York (UWNY). 2006. "Annual Water Quality Report 2005." Accessed at http://www.unitedwater.com/uwny/pdfs/dNY.pdf on August 28, 2006. ADAMS Accession No. ML083380655.

Village of Buchanan, New York (VBNY). 1998. "About Our Village." Accessed at http://www.villageofbuchanan.com/ on July 7, 2006.

Village of Buchanan, New York (VBNY). 2006. Buchanan Water Department, Entergy Nuclear Operations, March, April, and May 2006 Account Statements.

Village of Croton-on-Hudson (VCOH). 2005. "Annual Water Quality Report 2005." Accessed at http://Village.croton onhudson.ny.us/Public_Documents/CrotonHudsonNY_WebDocs/Water/CCReport2005.pdf on July 14, 2006.

Village of Ossining Water System (VOWS). 2005. "Annual Drinking Water Report for 2005." Accessed at http://www.Village.ossining.ny.us/documents/wqr_2005.pdf on July 14, 2006.

Waldman, J.R., K.E. Limburg, and D.L. Strayer. 2006. "The Hudson River Environment and Its Dynamic Fish Community." American Fisheries Society Symposium 51, pp. 1–7.

Walter, J.F., A.S. Overton, K.H. Ferry, and M.E. Mather. 2003. "Atlantic Coast Feeding Habits of Striped Bass: A Synthesis Supporting a Coast-wide Understanding of Trophic Biology." Fisheries Management and Ecology 10 (5), pp. 349–360.

Westchester County Department of Planning (WCDP). 2003. "Northern Westchester County, Groundwater Conditions Summary, Data Gaps, and Program Recommendations Contract C PL-02-71." Prepared by The Chazen Companies, April 2003.

Westchester County Department of Planning (WCDP). 2005. "Databook Westchester County, Education, School Districts 2003." November 30, 2005.

Westchester County Department of Planning. 2000. Westchester County Databook: History, Geography and Land Use. Accessed at http://www.westchestergov.com/planning/research/main.htm on May 31, 2006. ADAMS Accession No. ML083380659.

Westchester Joint Water Works (WJWW). 2006. "Annual Drinking Water Quality Report for 2005." Accessed at http://www.wjww.com on June 30, 2006. ADAMS Accession No. ML083380661.

Whitaker, J.O., Jr. 1980. The Audubon Society Field Guide to North American Mammals. 745 pp. Alfred A. Knopf, Inc., New York.

Whiteside, B.G., and T.H. Bonner. 2007. "Trinectes maculates fasciatus: Hogchoker." Department of Biology, Texas State University, San Marcos. Accessed at http://www.bio.txstate.edu/~tbonner/txfishes/trinectes%20maculatus%20fasciatus.htm on February 19, 2008. ADAMS Accession No. ML083380667.

Wingate, R.L. and D.H. Secor. 2007. "Intercept Telemetry of the Hudson River Striped Bass Resident Contingent: Migration and Homing Patterns." Transactions of the American Fisheries Society 136, pp. 95–104.

Wirgin, I., L. Maceda, J.R. Waldman, and R.N Crittenden. 1993. "Use of Mitochondrial DNA Polymorphisms to Estimate the Relative Contributions of the Hudson River and Chesapeake Bay Striped Bass Stocks to the Mixed Fishery on the Atlantic Coast." Transactions of the American Fisheries Society 122, pp. 669–684.

Wirgin, I., and R.C. Chambers. 2006. "Atlantic Tomcod Microgadus tomcod: A Model Species for the Responses of Hudson River Fish to Toxicants." American Fisheries Society Symposium 51, pp. 331–365.

Wolfe, D.A., E.R. Long, and G.B. Thursby. 1996. "Sediment Toxicity in the Hudson-Raritan Estuary: Distribution and Correlations with Chemical Contamination." Estuaries 19:4, pp. 901–912.

Woodland, R.J., and D.H. Secor. 2007. "Year-Class Strength and Recovery of Endangered Shortnose Sturgeon in the Hudson River, New York." Transactions of the American Fisheries Society 136, pp. 72–81.

World Book Encyclopedia. 2006. "New York Climate." Chicago York Climate." Chicago, IL.

3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

Environmental issues associated with refurbishment activities are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[1] 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 include associated refurbishment actions that provide for safe and economic operation during the period of extended operation. These actions may have impacts on the environment that require evaluation, depending on the type of action and the plant-specific design.

3.1 Potential Refurbishment Activities

Entergy, in its environmental report (ER), stated that its evaluation of structures and components required by Title 10, Section 54.21, "Contents of Application—Technical Information," of the *Code of Federal Regulations* (10 CFR 54.21), did not identify the need for refurbishment of structures or components for purposes of license renewal and that Entergy planned no such refurbishment activities (Entergy 2007). Entergy indicated that routine operational and maintenance activities would be performed during the license renewal period but refurbishment activities as described in the GEIS were not planned.

During the license renewal environmental scoping process, the staff of the U.S. Nuclear Regulatory Commission (NRC) received comments (Kaplowitz 2007; Shapiro 2007) indicating that Entergy had taken steps toward procuring replacement reactor vessel heads and control rod drive mechanisms (CRDMs) for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and

[1] 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.

IP3). The scoping comments indicated that an overseas firm plans to deliver replacement reactor vessel heads and CRDMs for IP2 and IP3 in October 2011 and October 2012, respectively. Based on this information, the staff requested, by letter to Entergy dated December 5, 2007, additional information regarding these potential refurbishment activities (NRC 2007).

Entergy's response, dated January 4, 2008, indicated that "no reactor vessel head replacements are required for purposes of aging management during the period of extended operation. Accordingly, no evaluation of the environmental impacts of reactor vessel head replacement as a refurbishment activity is required or presented in the Environmental Report." The response also stated that "the decision to proceed with procurement of long lead items [replacement vessel heads] is strictly economic" and therefore need not be addressed in Entergy's environmental report (Entergy 2008a).

During a telephone conference call on March 18, 2008 (NRC 2008a), the staff acknowledged that while there may be no requirement to replace the reactor vessel heads at IP2 and IP3 for license renewal, Section 2.6.1 of the GEIS discusses initiating actions for environmental impacts associated with license renewal. These actions include (1) refurbishment, repair, or replacement activities that "may be performed to ensure that this objective [aging management and maintaining functionality of certain SSCs] is achieved" and (2) activities that licensees may choose to undertake, including "various refurbishment and upgrade activities at their nuclear facilities to better maintain or improve reliability, performance, and economics of power plant operation during the extended period of operation." Since the GEIS considers refurbishment activities beyond those that are related to aging management during the period of extended operation, the NRC staff indicated that Entergy's response to the staff's request for additional information (RAI) did not effectively address the staff's need for information about the potential refurbishment activities.

During the conference call, Entergy staff indicated that if license renewal were not being pursued for IP2 and IP3, Entergy would not have ordered the vessel head forgings. Entergy also indicated that the vessel head forgings that were procured for IP2 and IP3 may never be needed at IP2 and IP3.

Given that Entergy has taken steps toward obtaining the replacement reactor vessel heads and CRDMs, and given that these replacement activities, should they occur, would be associated with license renewal (i.e., they would not be undertaken in the absence of license renewal), the NRC staff issued an additional RAI on April 14, 2008 (NRC 2008b), in which the staff requested information from Entergy regarding the process Entergy would use in deciding whether to replace the vessel heads and CRDMs, as well as indicating the potential environmental impacts of these replacement activities. Entergy submitted its response to NRC on May 14, 2008 (Entergy 2008b).

In its RAI response, Entergy reasserted that it did not believe vessel head and CRDM replacement constituted a refurbishment activity (Entergy 2008b). In addition, the response indicated that the current vessel heads are in good condition, though Entergy may eventually decide to replace them pending the results of future inspections.

Entergy's response also provided a likely hypothetical scenario for the replacement activities, should they occur. The scenario includes the following characteristics (Entergy 2008b):

- Approximately 250 additional workers would be required for the replacement of each reactor vessel head and CRDM. The replacement would take place during a 60-day refueling outage for each unit, when approximately 950 refueling outage workers are at the Indian Point site. An additional 50 workers would be required to construct the vessel head storage structure, though their work would be largely completed before the beginning of the refueling outage.
- The reactor vessel heads would be manufactured overseas, transported to a U.S. port, and shipped up the Hudson River via barge, with the CRDMs installed, to the existing Indian Point barge slip.
- Once delivered to the IP2 and IP3 site, storage and preinstallation preparation would take place at onsite temporary structures. If possible, existing warehouses would also be used. The only permanent building constructed would be used to store the old reactor vessel heads and CRDMs; this building would likely be constructed near the onsite structure storing the old IP2 and IP3 steam generators and occupy less than 446 square meters (4800 square feet). All structures would be constructed on previously disturbed areas.
- Staff or contractors would cut a temporary opening in containment approximately 7.6 meters by 7.9 meters (25 feet by 26 feet) to allow for removal of the old heads and CRDMs and installation of the new ones. Containment concrete would be removed by hydro-demolition, while rebar and a portion of steel liner would be removed by other means.
- Before removing the old reactor vessel head from containment, Entergy would remove any loose contamination or affix it with a coating. The old head would then be transported to the onsite storage facility (for possible offsite permanent disposition). Meanwhile, the new head (with CRDMs) would be installed.
- Upon project completion, each unit's containment would be returned to its original configuration.

The NRC staff considered the GEIS guidance on refurbishment activities, the need to disclose potential impacts of the proposed action, and Entergy's analysis of possible impacts of vessel head and CRDM replacements. The NRC staff also acknowledged that vessel head and CRDM replacements may not occur. Nevertheless, to ensure that, should these refurbishment activities occur, their environmental impacts will have been characterized and disclosed in accordance with the National Environmental Policy Act and NRC implementing regulations, the NRC staff determined that it would be appropriate to evaluate the potential impacts of these possible replacement activities using the GEIS framework for refurbishment.

Since the NRC staff published the draft SEIS, Entergy indicated (at the 2009 Annual Assessment meeting in Tarrytown, NY), that it planned to replace the Unit 2 vessel head in 2014, and the Unit 3 vessel head in 2016. Entergy did not directly address timing for CRDM replacement at this meeting, but NRC staff finds it likely that Entergy would replace vessel heads and CRDMs at the same time. NRC staff addresses the potential environmental impacts of vessel head and CRDM replacements below.

3.2 Refurbishment Impacts

The IP2 and IP3 site was one of seven case study reactor locations the NRC staff used in determining potential environmental impacts from refurbishment activities while developing the GEIS. After reviewing construction-stage impacts at these seven plant sites and then scaling them down to better approximate the duration and intensity of impacts expected during plant refurbishment activities, the NRC staff determined that nine refurbishment-related issues would be Category 1 issues. The GEIS approach to refurbishment assumed longer duration outages, more workers, and a wider array of activities on site than would occur during the reactor vessel head and CRDM replacement project discussed here. The GEIS also noted, in Appendix B, that outages would grow shorter as licensees gained experience with major replacement activities. Additionally, the GEIS noted that some licensees may choose to perform only a few activities.

Even given larger workforces, more activities, and longer outages, the NRC staff determined in the GEIS that the impacts for these nine issues are SMALL.

Table 3-1 contains a list of Category 1 issues associated with refurbishment.

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
Ground Water Use and Quality	
Impacts of refurbishment on ground water use and quality	3.4.2
Land Use	
Onsite land use	3.2
Human Health	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	3.7.4, 3.7.4.3, 3.7.4.4, 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Provided below are the results of the NRC staff reviews and a brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," for each of the Category 1 refurbishment issues listed in Table 3-1. For each Category 1 issue, the NRC staff has not identified any new and significant information during its review of the Entergy ER (Entergy 2007), its site audit, the SEIS scoping process, public comments on the draft SEIS, and its evaluation of other available information, including Entergy's May 14, 2008, RAI response (Entergy 2008b).

- Impacts of refurbishment on surface water quality. Based on information in the GEIS, the Commission found the following:

  Impacts are expected to be negligible during refurbishment because best management practices are expected to be employed to control soil erosion and spills.

- Impacts of refurbishment on surface water use. Based on information in the GEIS, the Commission found the following:

  Water use during refurbishment will not increase appreciably or will be reduced during plant outage.

- Impacts of refurbishment on aquatic ecology. Based on information in the GEIS, the Commission found the following:

  During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.

- Impacts of refurbishment on ground water use and quality. Based on information in the GEIS, the Commission found the following:

  Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.

- Impacts of refurbishment on onsite land use. Based on information in the GEIS, the Commission found the following:

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

- Radiation exposures to the public during refurbishment. Based on information in the GEIS, the Commission found the following:

  During refurbishment, the gaseous effluents would result in doses that are similar to those from current operation. Applicable regulatory dose limits to the public are not expected to be exceeded.

- Occupational radiation exposures during refurbishment. Based on information in the GEIS, the Commission found the following:

  Occupational radiation doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risks from all causes including radiation is in the mid-range for industrial settings.

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

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

- Aesthetic impacts (refurbishment). Based on information in the GEIS, the Commission found the following:

  No significant impacts are expected during refurbishment.

The NRC staff identified no new and significant information related to these issues during its review of the Entergy ER, during the SEIS scoping process, in correspondence identified in Section 3.1 of this chapter, in Entergy's May 14, 2008, RAI response (Entergy 2008b) or from public comments on the draft SEIS. Therefore, the NRC staff expects that there would be no impacts related to these issues during the renewal term beyond those discussed in the GEIS.

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.

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 archeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed[a]	Not addressed[a]

[a] Environmental justice is not addressed in the GEIS because Executive Order 12898 issued on February 11, 1994, and implementation guidance were not available prior to completion of the GEIS. Table B-1 of Appendix B, Part A of 10 CFR Part 51 indicates that this issue will be addressed in site specific reviews. The NRC staff groups Environmental Justice with Category 2 issues because the NRC staff addresses it in site specific reviews along with Category 2 issues.

The results of the review for each Category 2 refurbishment issue are provided in the following sections.

3.2.1 Terrestrial Ecology—Refurbishment Impacts

Refurbishment impacts on terrestrial ecology are a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 notes that “Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application.

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment.

Entergy indicated, however, that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3. Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units. Because Entergy plans to conduct all of these activities on previously disturbed land within a relatively short period of finite duration, the level of impact on terrestrial natural resources is expected to be SMALL.

Mitigation measures would include routine land and vegetation management practices, as well as using the most disturbed areas possible for new buildings and staging areas. The NRC staff did not identify any cost-benefit studies associated with these measures.

3.2.2 Threatened or Endangered Species—Refurbishment Impacts

Refurbishment impacts on threatened or endangered species are a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Generally, plant refurbishment and continued operation are not expected to adversely affect threatened and endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected.

The NRC staff identified three federally listed terrestrial species—bog turtle, *Clemmys muhlenbergii*; New England cottontail, *Sylvilagus transitionalis*; and Indiana bat, *Myotis sodalist*—and one aquatic species—shortnose sturgeon, *Acipenser brevirostrum—as* potentially affected by the relicensing of Indian Point. As explained above under Section 3.2.1, Entergy plans to conduct all terrestrial refurbishment activities on previously disturbed land within a relatively short period of finite duration. Entergy does not plan to conduct these activities on undisturbed land, and no designated critical habitat occurs on the site (Entergy 2008b). As a result, the NRC staff finds that refurbishment activities are not likely to adversely affect the continued existence of listed terrestrial species or adversely modify designated critical habitats.

Based on analyses presented in Section 4.6.1, shortnose sturgeon eggs and larvae probably do not occur, or occur only rarely, in the vicinity of Indian Point. Juvenile and adult shortnose sturgeon do occur in the vicinity of Indian Point. For refurbishment, the replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). Entergy does not have plans to dredge to accommodate the barge at its dock and is not planning any other activities that would adversely affect aquatic species or habitats. Also, any onsite activities will have to follow existing regulations to control runoff from construction or industrial sites. Because no activities are planned that would adversely affect the aquatic environment, refurbishment activities are not likely to adversely affect the continued existence of endangered shortnose sturgeon.

Essential fish habitat, as defined under the 1996 amendments to the Magnuson-Stevens

Fishery Conservation and Management Act, occurs in the vicinity of IP2 and IP3 for red hake (*Urophycis chuss*) larvae, winter flounder (*Pleuronectes americanus*) larvae, windowpane (*Scophthalmus aquosus*) juveniles and adults, and Atlantic butterfish (*Peprilus triacanthus*) juveniles and adults. Because Entergy plans no refurbishment activities that would adversely affect the aquatic environment, there should be no adverse individual or cumulative effects on essential fish habitat in the project area.

3.2.3 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)

Air quality during refurbishment (nonattainment and maintenance areas) is a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage.

The May 14, 2008, RAI response from Entergy (Entergy 2008b) indicates that the replacement of reactor vessel heads and CRDMs for IP2 and IP3 will result in minor impacts to air quality. Citing the GEIS, Entergy states that the only potential sources of impacts to air quality would be (1) fugitive dust from site excavation and grading for construction of any new waste storage facilities and (2) emissions from motorized equipment and workers' vehicles.

Entergy indicates that the bulk of air quality impacts during the postulated refurbishment activity would result from exhaust emissions released by onsite motorized equipment and workers' vehicles (Entergy 2008b). These effects include temporary increases in atmospheric concentrations of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOCs), ammonia, and particulate matter (PM).

A table summarizing the attainment status of the counties within the immediate area of IP2 and IP3 shows nonattainment of the National Ambient Air Quality Standards (NAAQS) for 8-hour ozone in Dutchess, Orange, Putnam, Rockland, and Westchester Counties. There is nonattainment of the NAAQS for particulate matter, 2.5 microns or less in diameter ($PM_{2.5}$) in Orange, Rockland, and Westchester Counties. Westchester County is designated as a maintenance county for CO.

Based on a conservative assumption that 400 additional vehicles would travel to and from the site each day during a 65-day outage period (conservative because Entergy projects that only 300 additional workers over 60 days could accomplish the replacement activities), Entergy estimated that air emissions of VOCs, CO, and NO_x would increase by 0.95 tons (0.86 metric tons (MT)), 16.1 tons (14.6 MT), and 1.02 tons (0.926 MT), respectively (Entergy 2008b). The regulatory conformity thresholds for VOCs, CO, and NO_x are 50 tons (45 MT), 100 tons (90.7 MT), and 50 tons (45 MT), respectively, as indicated in 40 CFR 51.853(b). A comparison of Entergy's conservative estimates for vehicle emissions versus the associated regulatory conformity levels indicates that none of the thresholds would be exceeded. Based on this analysis, the NRC staff finds that air quality impacts during the postulated reactor vessel head and CRDM replacement would be SMALL.

The NRC staff identified a variety of measures that could mitigate potential air quality impacts resulting from the vessel head and CRDM replacements at IP2 and IP3. These include the use of multiperson vans and carpooling policies to reduce the number of vehicles used to transport workers to the site. The NRC staff did not identify any cost-benefit studies applicable to these mitigation measures.

3.2.4 Housing Impacts—Refurbishment

Housing impacts during refurbishment are a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

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

Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers at the Indian Point site for up to 60 days during two separate refueling outages, one for each unit, 12 months apart. Approximately 250 workers would be needed for each replacement in addition to the normal number of refueling outage workers. An additional 50 workers would construct a storage structure for the old reactor vessel heads and CRDMs. This work would be completed before the beginning of the refueling outage (Entergy 2008b).

The number of additional workers would cause a short-term increase in the demand for temporary (rental) housing units in the region beyond what is normally experienced during a refueling outage at the Indian Point site. Since IP2 and IP3 are located in a high-population area (see Section 2.2.8.5) and the number of available housing units has either kept pace with or exceeded changes in county populations (see Section 2.2.8.1), any changes in employment would have no noticeable effect on the availability of housing in the socioeconomic region of influence. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs and the availability of housing in the region, employment-related housing impacts would have no noticeable impact.

3.2.5 Public Services: Public Utilities—Refurbishment

Public utilities is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[a]n increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability."

Since there is no water shortage in the region and public water systems located in Dutchess, Orange, and Putnam Counties have excess capacity (indicated in Table 2-9 in Chapter 2), any changes in the Indian Point site and employee public water usage would have little noticeable effect on public water supply availability in these counties. As discussed in Section 2.2.8.2, the Indian Point site acquires potable water from the Village of Buchanan water supply system, and there are no restrictions on the supply of potable water from the village.

As discussed in Section 3.2.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers at the Indian Point site for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). The additional number of refueling outage workers needed to replace the reactor vessel heads and CRDMs would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of the Indian Point site. Since the region has excess water supply capacity with no restrictions, these activities would create no impacts.

3.2.6 Public Services: Education—Refurbishment

Education is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[m]ost sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors."

As discussed in Section 3.2.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers for up to 60 days at the Indian Point site (Entergy 2008b). Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, workers would not be expected to bring families and school-age children with them; therefore, there would be no impact on educational services during this extended refueling outage.

3.2.7 Offsite Land Use—Refurbishment

Offsite land use is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "Impacts may be of moderate significance at plants in low population areas."

Since IP2 and IP3 are located in a high-population area, any changes in employment would have little noticeable effect on land use in the region. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, the additional number of refueling outage workers would not cause any permanent changes in population and tax-revenue-related land use in the immediate vicinity of IP2 and IP3.

3.2.8 Public Services: Transportation—Refurbishment

Transportation is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

The additional number of refueling outage workers and truck material deliveries needed to support the replacement of each reactor vessel head and CRDM would cause short-term level-of-service impacts on access roads in the immediate vicinity of the Indian Point site. According to Entergy, increased traffic volumes entering and leaving the Indian Point site during refueling outages, which occur at intervals of approximately 12 months for one unit or the other, have not degraded the level-of-service capacity on local roads, and the higher number of refueling outage workers during IP2 and IP3 steam generator replacement outages did not require any road improvements (Entergy 2008b). During routine periods of high traffic volume (i.e., morning and afternoon shift changes), Entergy has previously employed staggered shifts (starting and quitting times) during refueling outages to minimize level-of-service impacts on State Routes 9 and 9A (Entergy 2008b). Based on this information and because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs (up to 60 days), and given that the activity occurs at the same time as a normal refueling outage, the NRC staff finds that no transportation (level-of-service) impacts, beyond impacts from normal outages, would occur.

3.2.9 Historic and Archeological Resources—Refurbishment

Historic and archeological resources is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection.

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment. However, Entergy indicated that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). Should Entergy replace the vessel heads and CRDMs, ground-disturbing activities would be reviewed in accordance with Entergy Nuclear fleet procedures, which are designed to ensure that investigations and consultations are conducted as needed and that existing or potentially existing cultural resources are adequately protected (Enercon 2006). The procedures have been reviewed by the New York State Historic Preservation Office (NY SHPO). According to Entergy, the area of construction would be in an area that requires no prior consultation for historic, cultural, or archeological resources (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3.

Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units.

The impacts associated with this activity are not expected to adversely impact historic or archeological sites in the area of IP2 and IP3. Therefore, the potential impacts from this activity on National Register-eligible historic or archeological resources would be SMALL. However, should historic archeological resources be encountered during construction, work would cease until Entergy environmental personnel would perform an evaluation and consider possible mitigation measures through consultation with the NY SHPO.

3.2.10 Environmental Justice—Refurbishment

Environmental justice is a plant-specific refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that “[t]he need for and the content of an analysis of environmental justice will be addressed in plant specific reviews.”

Since IP2 and IP3 are located in a high-population area, the small, short duration change in employment associated with the potential replacement activities would likely have no noticeable effect on minority and/or low-income populations in the region. Because of the short duration of the replacement activity for each unit’s reactor vessel head and CRDMs, and based on the analysis of impacts for the other resource areas discussed in Section 3.2, the NRC staff concludes there would be no disproportionately high and adverse impacts to minority and low-income populations in the immediate vicinity of IP2 and IP3.

3.3 Evaluation of New and Potentially Significant Information on Impacts of Refurbishment

Entergy, in its May 14, 2008, RAI response (Entergy 2008b), indicated that it had reviewed the findings included in Chapter 3 of the GEIS and identified no new and significant information that would invalidate the findings made in the GEIS. Further, the NRC staff has reviewed Entergy’s response, has evaluated the likely impacts of the vessel head and CRDM replacement, and has not identified any new and significant information associated with these activities.

3.4 Summary of Refurbishment Impacts

The NRC staff did not identify any information that is either new or significant related to any of the applicable Category 1 issues associated with refurbishment activities at IP2 and IP3 during the renewal term. The NRC staff concludes that the environmental impacts associated with those issues are bounded by the impacts described in the GEIS (NRC 1996). For each of the Category 1 issues addressed in this section, the GEIS concludes that impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For all Category 2 issues related to refurbishment activities at IP2 and IP3, the NRC staff concluded—after reviewing guidance in the GEIS and Entergy’s description of potential activities—that refurbishment activities would have SMALL or no impacts. The NRC staff’s conclusions for Category 2 impact levels considered the activities’ limited scope and duration compared to the refurbishment programs identified in the GEIS.

3.5 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 Regulation*s, Title 10, *Energy,* Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

Enercon Services, Inc. (Enercon). 2006. "Phase 1A Literature Review and Archaeological Sensitivity Assessment of the Indian Point Site, Westchester County, New York." Tulsa, OK.

Entergy Nuclear Operations, Inc. (Entergy). 2007. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E of "IP2 and IP3, Units 2 and 3, License Renewal Application"). April 23, 2007. Agency wide Documents Access and Management System (ADAMS) Accession No. ML071210530.

Entergy Nuclear Operations, Inc. (Entergy). 2008a. "Indian Point, Units 2 and 3—Reply to Request for Additional Information Regarding Environmental Review for License Renewal Application." January 4, 2008. ADAMS Accession No. ML080110372.

Entergy Nuclear Operations, Inc. (Entergy). 2008b. "Indian Point Units 2 & 3, Reply to Request for Additional Information Regarding License Renewal Application—Refurbishment." May 14, 2008. ADAMS Accession No. ML081440052.

Kaplowitz, Michael. 2007. Letter to Pao-Tsin Kuo, "Incompleteness and Inaccurate License Renewal Application for Indian Point Energy Center, Units 2 and 3." June 27, 2007. ADAMS Accession No. ML071990093.

Shapiro, Milton B. and Susan H. Shapiro. 2007. Letter to Pao-Tsin Kuo, "Comments on Scope of Environmental Impact Statement and Scoping Process Indian Point Energy Center Unit 2 and Unit 3." October 24, 2007. ADAMS Accession No. ML073100985.

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

U.S. Nuclear Regulatory Commission. (NRC) 1999. "Generic Environmental Impact Statement for License Renewal of Nuclear Plant." NUREG-1437, Volume 1, Addendum 1. Office of Nuclear Reactor Regulation, Washington, DC.

U.S. Nuclear Regulatory Commission. (NRC) 2007. "Request for Additional Information Regarding Environmental Review for Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal (TAC Nos. MD5411 and MD5412)." December 5, 2007. ADAMS Accession No. ML073330931.

U.S. Nuclear Regulatory Commission. (NRC) 2008a. Summary of Telephone Conference Call between NRC and Entergy Nuclear Operations, Inc., Pertaining to the Indian Point Units 2 & 3, License Renewal Application—Environmental Request for Additional Information. March 18, 2008. ADAMS Accession No. ML080920983.

U.S. Nuclear Regulatory Commission. (NRC) 2008b. "Request for Additional Information Regarding the Review of the License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2 & 3 (TAC Nos. MD5411 and MD5412)." April 14, 2008. ADAMS Accession No. ML080940408.

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

Environmental issues associated with operation of a nuclear power plant during the renewal term are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[1] 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 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 Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to Indian Point Nuclear Generating Units 2 and 3 (IP2 and IP3). In Section 4.1 of this supplemental environmental impact statement (SEIS), the U.S. Nuclear Regulatory Commission (NRC) staff addresses issues applicable to the IP2 and IP3 cooling systems. In Section 4.2, the NRC staff addresses issues related to transmission lines and onsite land use. In Section 4.3, the NRC staff addresses the radiological impacts of normal operations, and in Section 4.4, the NRC staff addresses issues related to the socioeconomic impacts of normal operations during the renewal term. In Section 4.5, the NRC staff addresses issues related to ground water use and quality, while the NRC staff addresses the impacts of renewal term operations on threatened and endangered species in Section 4.6. The NRC staff addresses potential new information in Section 4.7 and addresses cumulative impacts in Section 4.8. 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 IP2 and IP3 because they are related to plant design features or site characteristics not found at IP2 and IP3 are listed in Appendix F to this SEIS.

(1) 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.

4.1 Cooling System

Generic (Category 1) issues in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 that are applicable to IP2 and IP3 cooling system operations during the renewal term are listed in Table 4-1. Entergy Nuclear Indian Point 2 and Entergy Nuclear Indian Point 3, LLC (Entergy) stated in its environmental report (ER) (Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses related to cooling system operation. The NRC staff has not identified any new and significant information related to cooling system operation during its independent review of the Entergy ER, the site visit, the scoping process, comments on the draft SEIS, or the evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the Category 1 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 warrant implementation.

A brief description of the NRC staff's review and the GEIS conclusions, as codified in 10 CFR Part 51, Table B-1, for each of these issues follows.

Table 4-1. Generic (Category 1) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Temperature effects on sediment transport capacity	4.2.1.2.3
Scouring caused by discharged cooling water	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
Water-use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY (ALL PLANTS)	
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 (e.g., shipworms)	4.2.2.1.11
HUMAN HEALTH	
Noise	4.3.7

The NRC staff reviewed information provided from Entergy's ER, the NRC staff's site visit, the scoping process, the New York State Pollutant Discharge Elimination System (SPDES) permits for IP2 and IP3 that expired in 1992 and have since been administratively continued, the subsequent draft permit, ongoing Hudson River monitoring programs and their results, and other available information. The NRC staff has not identified any new and significant information for Category 1 issues applicable to the operation of the IP2 and IP3 cooling system during the period of extended operation.

Therefore, the NRC staff concludes that there would be no impacts for these issues during the renewal term beyond those discussed in the GEIS. The following bullets identify the Category 1 issues applicable to the operation of the IP2 and IP3 cooling system during the period of extended operation and the Commission's findings as indicated in the GEIS:

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

  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.

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

  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.

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

  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.

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

  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.

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

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

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

  Effects are readily controlled through the NPDES permit[2] and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

- Discharge of other metals in wastewater. Based on information in the GEIS, the Commission found the following:

  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.

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

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

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

  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.

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

  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.

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

  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

[2] NPDES stands for National Pollutant Discharge Elimination System; in the case of IP2 and IP3, the NPDES required permit is issued by the New York State Department of Environmental Conservation (NYSDEC) and the NRC staff refers to it as the State's Pollutant Discharge Elimination System (SPDES) throughout this SEIS.

term.

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

  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.

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

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

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

  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.

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

  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.

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

  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.

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

  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.

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

  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.

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

> 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 identified no new and significant information related to these issues during its independent review (including information provided from Entergy's ER, the NRC staff's site audit, the scoping process, the SPDES permits for IP2 and IP3 that expired in 1992 and have since been administratively continued, the subsequent draft permit, ongoing Hudson River monitoring programs and their results, comments on the Draft SEIS, and other available information). Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The Category 2 issues (issues that the NRC staff must address in a site-specific review based on the framework established in the GEIS) related to cooling system operation during the renewal term that are applicable to IP2 and IP3 are discussed in the sections that follow and are listed in Table 4-2.

Table 4-2. Site-Specific (Category 2) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(a)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY			
Entrainment of fish and shellfish in early lifestages	4.2.2.1.2	B	4.1.2
Impingement of fish and shellfish	4.2.2.1.3	B	4.1.3
Heat shock	4.2.2.1.4	B	4.1.4

For power plants with once-through cooling systems, the NRC considers the impingement and entrainment of fish and shellfish and thermal impacts from nuclear power plant cooling systems to be site-specific (Category 2) issues for license renewal. The NRC staff reviewed the applicant's ER (Entergy 2007a), visited the plant site, and reviewed the applicant's existing and draft SPDES permits, fact sheets describing it, and the NYSDEC permit renewal process (NYSDEC 2003b). The NRC staff also reviewed relevant scientific publications, technical articles, and compilations associated with the study area, as well as documents and technical reports from NYSDEC, the National Marine Fisheries Service (NMFS), and other sources.

The SPDES permit for the Indian Point site, which addresses discharge from the currently operating IP2 and IP3, as well as the shutdown IP1 unit, was administratively continued by NYSDEC since a timely SPDES permit renewal application was filed 180 days prior to the current permit's stated expiration date of April 3, 1992. That permit remains in effect while

NYSDEC administrative proceedings continue.

Section 316(b) of the Clean Water Act of 1997 (CWA) (Title 33, Section 1326, of the United States Code (33 USC 1326)) requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. In the fact sheet for the site's draft SPDES permit, NYSDEC states that it has determined that the site-specific best technology available to minimize the adverse environmental impacts of the IP Units 1, 2, and 3 cooling water intake structures is closed-cycle cooling (NYSDEC 2003b). Under the terms of the draft SPDES permit, NYSDEC (2003b) states that it will evaluate proposals from Entergy to institute alternative methods to avoid adverse environmental impacts. Given NYSDEC's statements in the proposed SPDES permit, the NRC staff decided to consider the environmental impacts that may occur if Entergy institutes closed-cycle cooling at IP2 and IP3—as well as the environmental impacts of a possible alternative method of reducing impacts to aquatic life—in Chapter 8 of this SEIS. In the following sections, the NRC staff addresses impacts from the current cooling system.

<u>Applicant Assessment</u>

In the draft environmental impact statement (DEIS) for the SPDES permits for IP2 and IP3, Roseton, and the Bowline Point generating stations (CHGEC et al. 1999), as well as in the IP2 and IP3 ER (Entergy 2007a), the plant owner or owners (IP2 and IP3 had separate owners in 1999) acknowledged that some impinged fish survive and others die. Mortality can occur immediately or at a later time. The DEIS examined impingement effects by evaluating conditional mortality rates (CMR) and trends (through 1997) associated with population abundance for eight selected taxa representing 90 percent of those fish species collected from screens at IP2 and IP3. These included striped bass, white perch, Atlantic tomcod, American shad, bay anchovy, alewife, blueback herring, and spottail shiner. Estimates of CMR, defined as the fractional reduction in the river population abundance of the vulnerable age group caused by a single source of mortality (in this case impingement) were assumed to be the same as or lower than that which occurred in the years before installation of modified Ristroph screens and fish return systems at IP2 and IP3 in 1991. For species exhibiting low impingement mortality (e.g., striped bass, white perch, and Atlantic tomcod), future impingement effects were expected to be substantially lower than they were before installation and use of modified Ristroph screens and fish return systems.

The Hudson River electric-generating utilities (CHGEC et al. 1999) estimated the maximum expected total impingement CMR for white perch and other taxa to quantify impact to the species. In the ER, Entergy (2007a) stated that the results of in-river population studies performed from 1974 to 1997 did not show any negative trend in overall aquatic river species populations attributable to plant operations. The ER also stated that ongoing population studies continued to support these conclusions. Thus, the applicant asserted that impingement impacts were SMALL and did not warrant further mitigation measures. In support of this assessment, the applicant provided two reviews (Barnthouse et al. 2002, 2008) in addition to the DEIS (CHGEC et al. 1999).

Regarding entrainment, the applicant concluded that population studies performed from 1974 through 1997 have not shown any negative trend in overall aquatic populations attributable to plant operations and that current mitigation measures will ensure that entrainment impacts remain SMALL during the license renewal term. Therefore, the applicant asserted (Entergy

2007a) that continued operation of once-through cooling at the site "does not have any demonstrable negative effect on representative Hudson River fish populations nor does it warrant further mitigation measures." Barnthouse et al. (2008) used an ecological risk assessment approach to evaluate the potential for adverse impacts to the representative important species (RIS) of the Hudson River from a variety of natural and anthropogenic stressors, including the operation of the IP2 and IP3 cooling water intake system, fishing pressure, the presence of zebra mussels, predation by striped bass, and water temperature. The authors concluded that operation of the IP2 and IP3 cooling met the NRC criteria for a SMALL impact level.

NYSDEC Assessment

Under the CWA, the U.S. Environmental Protection Agency (EPA) has delegated authority for the NPDES permit and Water Quality Certification programs in the State of New York to NYSDEC. The regulatory role of NYSDEC in the operation of the IP2 and IP3 cooling system includes protecting aquatic resources from impacts associated with impingement, entrainment, and thermal and chemical discharges through issuance of State (SPDES) permits and other means. As indicated above, the SPDES permit for IP2 and IP3 has been administratively continued under provisions of the New York State Administrative Procedure Act. Regarding Section 316(b) of the CWA and New York Code, Rules and Regulations, Section 704.5 (6 NYCRR Section 704.5), NYSDEC (2003b) has determined that the site-specific best technology available to minimize the adverse environmental impact of the IP1, IP2, and IP3 cooling water intake structures is closed-cycle cooling.

In 2003, NYSDEC developed a final environmental impact statement (FEIS) (NYSDEC 2003a) in response to the DEIS submitted by the operators of IP2 and IP3, Roseton, and Bowline Point (CHGEC et al. 1999). In the FEIS, NYSDEC noted that "while the DEIS was acceptable as an initial evaluation and assessment, it was not sufficient to stand as the final document, and additional information as to alternatives and evaluation of impacts must be considered." In responding to public comments on the DEIS (CHGEC et al. 1999), NYSDEC noted that, in contrast to the utilities' assertions that the Hudson River fish community is healthy and robust, changes in "total species richness and diversity suggest that the Hudson estuary ecosystem is far from equilibrium." NYSDEC points out that the approach used by the utilities assumes "selected cropping" of individual fish species while "the impacts associated with power plants are more comparable to habitat degradation; the entire natural community is impacted" because entrainment, impingement, and warming of the water simultaneously affect the entire aquatic community of organisms. Emphasizing a more ecological approach, NYSDEC detailed the importance of food webs, trophic and other interspecies relationships, and ecosystem functioning.

NYSDEC (2003a) also stated that, while the changes to the IP2 and IP3 cooling system, including the use of dual-speed and variable-flow pumps and the installation of modified Ristroph traveling screens, "represent some level of improvement compared to operations with no mitigation or protection, there are still significant unmitigated mortalities from entrainment and impingement at all three of the Hudson River Settlement Agreement (HRSA) facilities." NYSDEC (2003a) concluded that the millions of fish killed by impingement, entrainment, and thermal effects at the HRSA power plants represent a significant source of mortality and stress on the Hudson River's fish community and must be taken into account when assessing the observed fish population declines. To help mitigate such losses, the NYSDEC (2003b) fact sheet for the draft SPDES permit states that "This permit does not require the construction of cooling towers unless: (1) the applicant seeks to renew its NRC operating licenses, (2) the NRC approves extension of the licenses, and determines that the installation and operation of closed-cycle cooling is feasible and safe, and (3) all other necessary Federal approvals are obtained." Furthermore, NYSDEC states that if the NRC grants extensions of the operating licenses, Indian Point would have to submit for NYSDEC approval a revised construction schedule for closed-cycle cooling.

NYSDEC, in Section 1, "Biological Effects," of Attachment B to the 2003 SPDES fact sheet (NYSDEC 2003b), states that operation of IP2 and IP3 results in the mortality of more than a billion fish of various lifestages per year and that losses are distributed primarily among seven species, including bay anchovy, striped bass, white perch, blueback herring, Atlantic tomcod, alewife, and American shad. Of these, NYSDEC indicates that the populations of Atlantic tomcod, American shad, and white perch are known to be declining in the Hudson River and considers current losses to be substantial.

Studies have also been conducted to detect trends of fish populations in the Hudson River. Both the applicant and NYSDEC have used the results of these studies to assess the potential for adverse effects associated with the operation of the IP2 and IP3 cooling system. The results of these assessments are described below. Some nongovernmental organizations (NGOs) and citizens have also evaluated publicly available information and data associated with the Hudson River and have expressed the opinion that many species of fish in the Hudson River are in decline and that the entrainment and impingement of all lifestages of fish and shellfish at IP2 and IP3 is contributing to the decline of these important aquatic resources.

On April 2, 2010, NYSDEC issued a Notice of Denial regarding the Clean Water Act Section 401 Water Quality Certification for IP2 and IP3. Entergy has since requested a hearing on the issue, and the matter will be decided through NYSDEC's hearing process.

NRC Assessment

Because the draft SPDES permit (which includes NYSDEC's 316(b) determination regarding the cooling water intake structure) is subject to ongoing adjudication, the NRC staff conducted an independent impact analysis for the purpose of addressing the Category 2 issues identified in Table 4-2 of this SEIS. The operation of the IP2 and IP3 cooling system can directly affect the aquatic communities of the Hudson River through impingement, entrainment, and thermal releases. Evaluating the potential for adverse impacts of the cooling system to the aquatic resources of the Hudson River estuary presents a significant challenge for three primary reasons:

(1) The potential stressor of interest (the IP2 and IP3 cooling system) occupies a fixed position on the Hudson River, while many of the RIS that the NRC staff have chosen for evaluation have the freedom to move up- and down-river during different stages in their growth and development, during different seasons of the year, and, in some cases, at different times of day.

(2) The Hudson River estuary is a dynamic, open-ended system containing a complex food web that extends from the freshwater portion of the river downstream of the Troy Dam to the Atlantic Ocean. Detectable changes in RIS populations may be influenced by natural stressors or may be the result of stressors associated with human activities, which include the operation of IP2 and IP3.

(3) Because the Hudson River estuary represents a complex system with hundreds of aquatic species, the NRC staff chose to focus its analysis of impact on a subset of RIS historically used to monitor the lower Hudson River (as indicated in Section 2.2.5.4 of this SEIS). By focusing on a subset of species that are representative of many of the species that exist in the lower Hudson River fish community, the NRC staff can more easily analyze impacts to the Hudson River community, and the NRC staff can make use of a large body of sampling data compiled over many years. The NRC staff acknowledges that the simplification inherent in relying on RIS may introduce some additional uncertainty, but the NRC staff finds that the utility of the RIS approach (due to the availability of large, long-term data sets; applicability to species with similar characteristics; and comparability to other Hudson River studies) in evaluating communitywide effects outweighs the uncertainties associated with using it.

Because impingement and entrainment are fundamentally linked, the NRC staff determined that the effects of each should be assessed using an integrated approach, described in Section 4.1.3 of this SEIS. The NRC staff assessed thermal impacts separately in Section 4.1.4. Because the analysis of the environmental impacts associated with the IP2 and IP3 cooling system is complex, the NRC staff provides summary results, analyses, and conclusions in this chapter, and provides a complete discussion of the environmental impact assessment in Appendix H, with supporting statistical analyses in Appendix I to this SEIS.

4.1.1 Impingement of Fish and Shellfish

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingent can kill organisms immediately or contribute to a slower death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwashing and fish return system that the plant operator uses. In this section, the NRC staff provides a summary assessment of impingement impacts based on the NRC staff analyses of available data. More details appear in Appendix H.

The NRC staff employed a weight-of-evidence (WOE) approach during the development of the draft SEIS to evaluate the effects of the IP2 and IP3 cooling system on the aquatic resources of the Hudson River estuary. The WOE consisted of two lines of evidence: (1) long-term population trends of RIS that live in the Hudson River and (2) strength of connection, defined by the staff as the potential for the operation of the IP2 and IP3 cooling system to directly affect aquatic resources of interest. In this SEIS, the NRC staff modified and refined some aspects of the WOE to provide a better assessment of the potential for adverse effects to aquatic resources in response to public comments received on the draft SEIS. The major changes from the draft SEIS to this SEIS included a more straightforward, simplified approach to assessing RIS population trends and the use of Monte Carlo population simulations to assess the strength of connection. The NRC staff also removed the coastal population trend information from the WOE but used it as ancillary information for RIS population trend discussions. Section 4.1.3 describes an overview of the modified WOE approach; Appendixes H and I contain specific details of the final analyses. Other changes in the final analysis were the use of updated environmental data from the operation of IP2 and IP3, which the applicant provided after the publication of the draft SEIS to replace previously submitted information that contained errors.

Thus, the data, analysis, and conclusions presented in this SEIS reflect modifications to the WOE analysis and the corrected information provided by the applicant.

Impingement monitoring at IP2 and IP3 was conducted by former plant owners and their contractors between 1975 and 1990 using a variety of techniques, as summarized in Appendix H of this SEIS. The NRC staff assessment for the effects of cooling water system operation concentrated on 18 RIS identified in Section 2.2.5.4, which include the 17 species identified in the Hudson River utilities' DEIS (CHGEC et al. 1999) for assessing power plant effects plus the Atlantic menhaden (*Brevoortia tyranus*), a member of the herring family whose young are common inhabitants of the lower Hudson River. All but one RIS are fish; the exception is the blue crab (*Callinectes sapidus*). The estimated number of impinged RIS made up greater than 90 percent of all impinged taxa for all but one year at IP2 (Figure 4-1); at IP3, the estimated number of RIS impinged was greater than 85 percent for all but one year (Figure 4-2). To assess impingement impacts, the NRC staff analyzed weekly estimated impingement numbers at IP2 and IP3 from January 1975 to November 1980 and seasonally estimated impingement numbers from January 1981 to December 1990. (The former plant owners and their contractors based estimated numbers on sampling data.) The combined numbers of young of the year (YOY), yearling, and older fish were used for analysis since these data were available for all years of sampling.

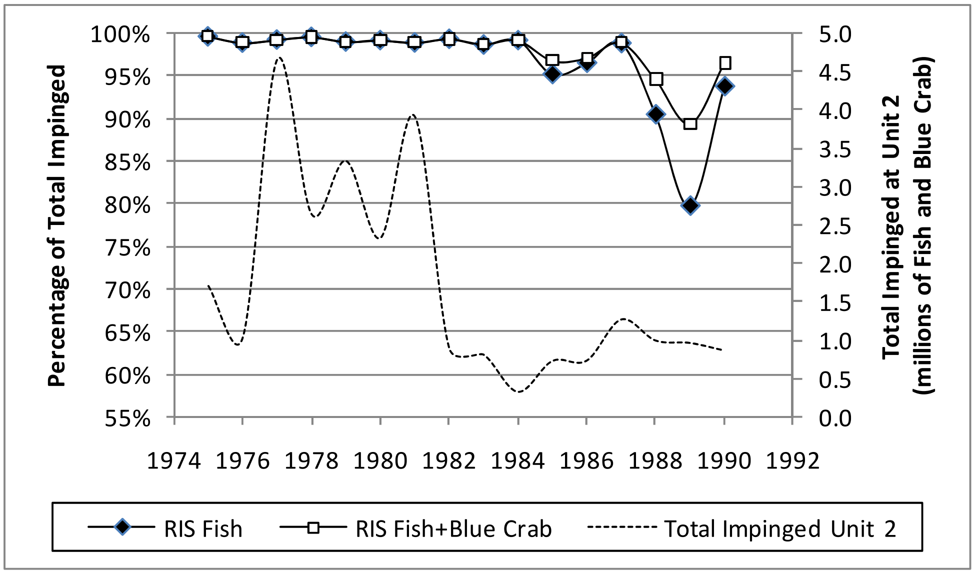


Figure 4-5. Percentage of impingement of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP2 (data from Entergy 2007b and 2009)

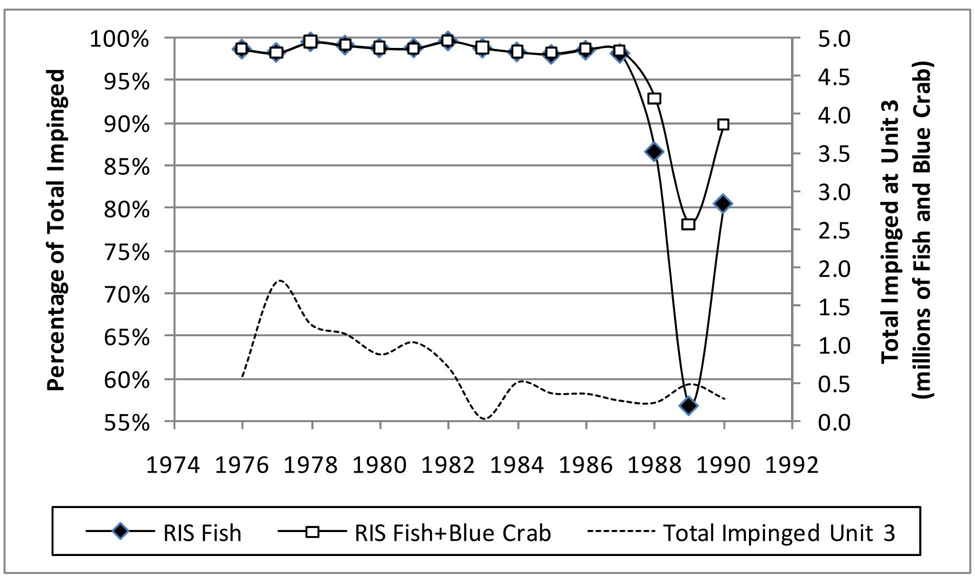


Figure 4-2. Percentage of impingement composed of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP3 (data from Entergy 2007b and 2009)

Total impingement trends at IP2 and IP3 suggest that the total number of fish and blue crab impinged tended to decrease between 1977 and 1982, then generally leveled off between 1982 and 1990 (as shown in Figures 4-1 and 4-2). If the IP2 and IP3 cooling systems are considered a relatively constant sampler of Hudson River aquatic biota (recognizing the slight increase in days of operation and volume of water circulated at IP2 and IP3 from 1975 to 1990), then the decrease in the percent of RIS impinged and total impingement would suggest that RIS and all other taxa within the vicinity of IP2 and IP3 have decreased from a high in 1977 to a relatively constant lower level between 1984 and 1990. This decline will be explored further in Section 4.1.3 of this SEIS.

In addition to evaluating trends in impingement losses, the NRC staff also reviewed the results of studies designed to evaluate impingement mortality. Before installation of modified Ristroph screen systems in 1991, impingement mortality was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species (see Appendix H for additional detail). The final design of the screens (Version 2), as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the existing (original) system in place at IP2 and IP3. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad (Table 4-3). As it was not required by NYSDEC, no further monitoring of impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991.

Table 4-3. Cumulative Mortality and Injury of Selected Fish Species after Impingement on Ristroph Screens

Species	Percent Dead and Injured
Alewife	62
American Shad	35
Atlantic Tomcod	17
Bay Anchovy	23
Blueback Herring	26
Hogchoker	13
Striped Bass	9
Weakfish	12
White Catfish	40
White Perch	14

Source: Fletcher 1990

Based on Fletcher's assessment, the NRC staff concludes that the IP2 and IP3 cooling system continues to impinge RIS of the lower Hudson River and that impingement mortality for 4 of the 10 species exceeds 25 percent. Monitoring data (Entergy 2007b and 2009), reviewed by NRC staff) also showed that impingement was greater at IP2 than at IP3 and that impingement has generally declined since 1976. Although IP2 and IP3 currently employ modified Ristroph screens and fish return systems to increase the survival rates of impinged organisms, since impingement monitoring was required by NYSDEC after 1990, the actual improvements in fish survival after installation of these systems at IP2 and IP3 have not been established (impingement monitoring last occurred in 1990). In Section 4.1.3 of this SEIS, the NRC staff includes impingement results in a weight-of-evidence (WOE) analysis to evaluate the overall impacts of the IP2 and IP3 cooling system on lower Hudson River RIS.

4.1.2 Entrainment of Fish and Shellfish in Early Lifestages

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects organisms with limited swimming ability that can pass through the screen mesh, which is typically 0.25 to 0.5 inch (in.) (6.35 to 12.7 millimeters (mm)), used on the intake systems. Organisms typically entrained include phytoplankton, zooplankton, and the eggs, larvae, and juvenile forms of many of the fish and invertebrates.

Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system (see Appendix H for a more-detailed discussion). Despite increasingly refined study techniques, entrainment survival estimates were compromised by poor ichthyoplankton survival in control samples, and entrainment survival for many species is still unresolved. The variability of entrainment data informed the NRC staff's decision to employ a WOE approach.

To assess the effects of entrainment on the aquatic resources of the lower Hudson River, the NRC staff evaluated weekly average densities of entrained taxa for a given life stage for IP2 and IP3 from data provided by the applicant. The NRC staff then multiplied the mean weekly densities by the volume of circulated water to estimate the weekly number of organisms entrained for a given life stage, and then calculated the sum over weeks and life stage of the numbers entrained per taxa and season.

The entrainment monitoring data provided Entergy (2007b) contained 66 taxa. Blue crabs, shortnose and Atlantic sturgeon, and gizzard shad were not present in the 1981–1987 entrainment data. Some RIS data included taxa identified only to family or genus (e.g., anchovy family, *Alosa* spp., and *Morone* spp.) because the identification of early life stages for these groups is difficult. As shown in Figure 4-3, RIS fish represented greater than 70 percent of all entrainment, except for 2 weeks in 1984 and 1985 (1 week in May and 1 in June) for which amphipods (*Gammarus* spp.) were present. The total number of identified fish entrained has decreased at a rate of 187 billion fish per year since 1984. This result is consistent with the decrease observed in the number of fish impinged (Figures 4-1 and 4-2).

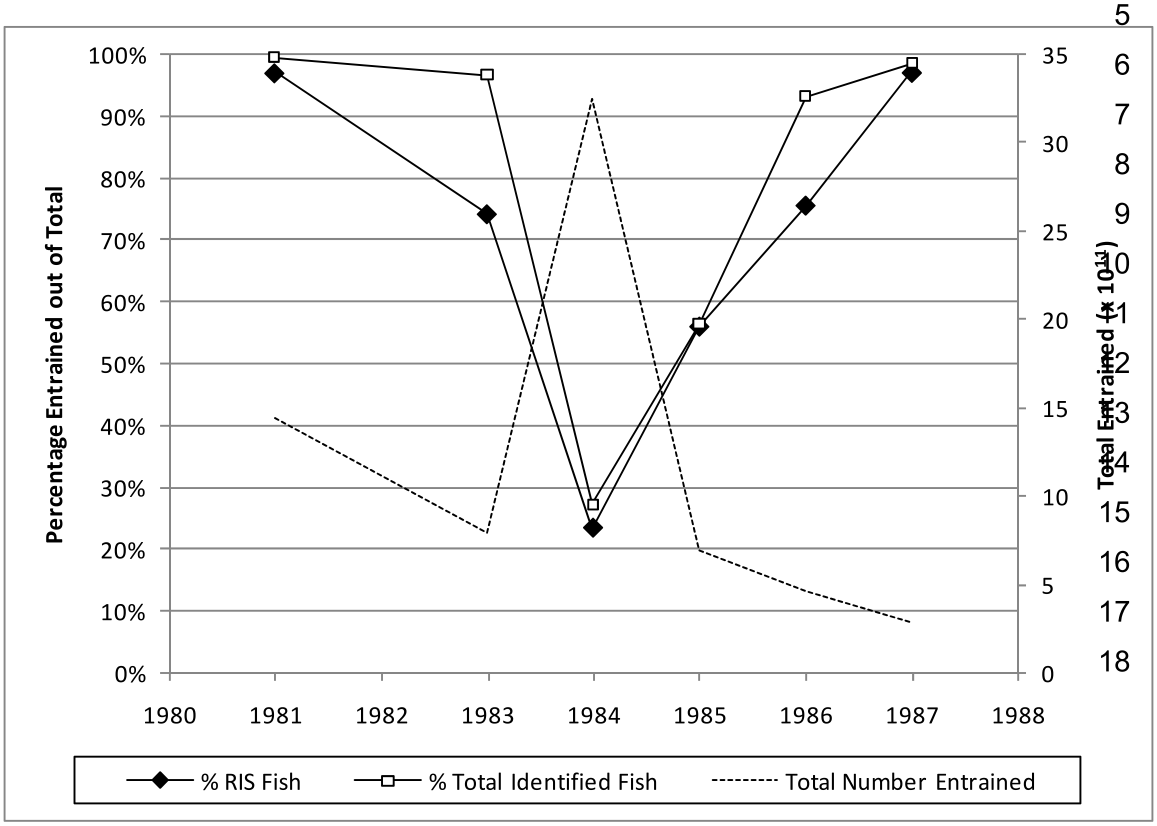
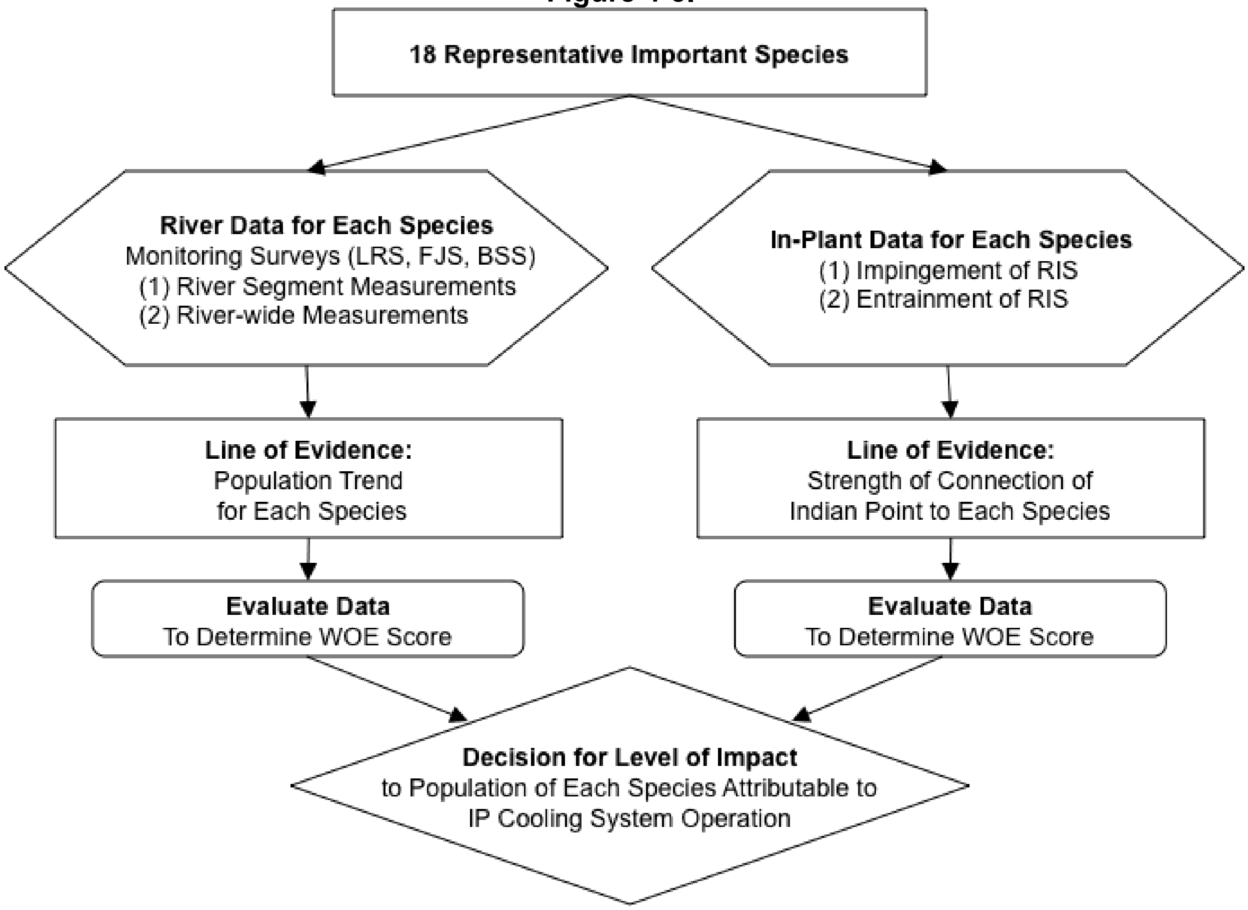


Figure 4-3. Percentage of entrainment of RIS fish and total identified fish relative to the estimated total entrainment at IP2 and IP3 combined (data from Entergy 2007b)

4.1.3 Combined Effects of Impingement and Entrainment

The NRC staff used a modified WOE approach to evaluate whether the impingement and entrainment that occur during the operation of the IP2 and IP3 cooling system has the potential to adversely affect RIS in the lower Hudson River. The NRC staff followed a WOE approach (Figure 4-4) adapted from the process described in Menzie et al. (1996), which defines WOE as "...the process by which multiple measurement endpoints are related to an assessment endpoint to evaluate whether significant risk of harm is posed to the environment." The NRC staff describes the specific steps used in its WOE approach in the sections that follow, and provides a detailed discussion of its WOE process in Appendix H.

Figure 4-5.



General weight-of-evidence approach employed to assess the level of impact to population trends attributable to IP cooling system operation

Step 1: Identify the Environmental Component or Value to Be Protected

For this assessment, the environmental component to be protected is the Hudson River aquatic resources as represented by the 18 RIS identified in Table 2-4. These species represent a variety of feeding strategies and food web classifications and are ecologically, commercially, or recreationally important. The WOE approach focuses primarily on the potential impacts to young-of-the-year (YOY) and yearling fish and their food sources. The long-term sampling programs of the Hudson River, on which this analysis is based, focused on these early lifestages. Although eggs and larval forms are important components to the food web, the natural mortality to these lifestages is high. In contrast, fish surviving to the YOY stage and older are more likely to add to the adult breeding population and are at greater risk from the cooling system operation. Any factor that decreases (or increases) the survival of those fish during juvenile and yearling stages can affect the sustainability of the population.

Step 2: Identify Lines of Evidence and Quantifiable Measurements

The goal of this step is to identify data sets and information that can be used to assess the potential for adverse environmental effects and determine whether the IP2 and IP3 cooling system is contributing to the effect. The NRC staff developed two lines of evidence (LOE) to evaluate impacts. The first LOE was the long-term population trends of RIS species in the lower Hudson River which staff used to determine whether any populations were declining. The second LOE was a measure of the potential for the operation of the IP2 and IP3 cooling system to directly affect aquatic resources of interest (strength of connection). The NRC staff required the occurrence of a detectable population decline and the presence of a high strength of connection to declare an adverse impact to an RIS. To support these analyses, the NRC staff used data provided by the applicant including impingement and entrainment monitoring data obtained from the IP2 and IP3 facility and data from the lower Hudson River collected during the Long River Survey (LRS), Fall Juvenile/Fall Shoals Survey (FJS/FSS), and Beach Seine Survey (BSS)(Table 2-3). Appendix H contains a summary of measurements for each LOE

Step 3: Quantify the Use and Utility of Each Measurement.

The following attributes of each measurement within each LOE were assigned an ordinal score corresponding to a ranking of its use and utility of low, medium, or high:

- Strength of Association: The extent to which the measurement is representative of, correlated with, or applicable to the RIS.
- Stressor-specificity: The extent to which the measurement is associated with a specific stressor or the extent to which the data used in the assessment relate to the stressor of interest.
- Site-specificity: The extent to which data used in the assessment relate to the site of interest.
- Sensitivity of the Measurement: The ability of the measurement to detect a response.
- Spatial Representativeness: The degree of compatibility between the study area and the location of measurements, known stressors, and biological receptors.
- Temporal Representativeness: The degree of compatibility between the measurement and the time period during which effects are expected to occur.
- Correlation of Stressor to Response: The degree of correlation between the levels of exposure to a stressor and levels of response observed in the measurement.

The NRC staff then calculated overall use and utility scores for each measurement for the population LOE as the average of the individual attribute rankings. The NRC staff did not apply use and utility to the strength of connection LOE because it is semi-quantitative. The scores for each LOE are available in Appendix H.

Step 4: Develop Quantifiable Decision Rules for Interpreting the Results of Each Measurement

The NRC staff developed decision rules for the first LOE to determine the historical trends in lower Hudson River RIS populations. The NRC staff used a mathematical approach to integrate the regression results (e.g., detected population decline) from each field survey to produce a single conclusion for a given RIS population trend. Appendices H and I provide detailed discussions of how the decision rules were developed and used in the environmental assessment. The possible outcomes of this analysis are as follows:

- RIS populations were not declining if their population trends had slopes that were not significantly less than zero (i.e., undetected population declines or detectable population increases). This indicated that the RIS populations had not changed appreciably over time, or were increasing.
- RIS populations were declining if their population trends had slopes that were significantly less than zero (i.e., detectable population decline).
- RIS populations were variable if historical trend data were ambiguous (i.e., some data showed detectable declines, whereas others did not).

The NRC staff applied these decision rules for each RIS species if sufficient data were available to support a determination, but defined the level of impact “unresolved” if sufficient data were not available.

The NRC staff developed decision rules for the second LOE to determine the strength of connection between the operation of the IP2 and IP3 cooling system and the RIS in the lower Hudson River. The NRC staff’s measure of the strength of connection was based on the magnitude of influence that impingement and entrainment by the IP2 and IP3 cooling system had on the RIS population abundance with respect to its temporal viability. Specifically, the staff used numerical model simulations to determine whether the difference in population abundances with and without losses from impingement and entrainment was detectable relative to annual population variability. The decision rules for this LOE were:

- A low strength of connection occurred when model simulations showed that it was not possible to detect differences in population abundance with and without impingement and entrainment losses. In this case, the RIS population variability was too large to enable detection of impingement and entrainment losses.
- The NRC staff also defined the strength of connection as low if an RIS could not be modeled with the Monte Carlo simulation because it occurred rarely in entrainment and impingement samples. Appendixes H and I provide a complete description of this process.
- A high strength of connection occurred when model simulations showed that the difference in population abundance with and without losses from impingement and entrainment was detectable with respect to annual population variability. In this case, the effects of impingement and entrainment were greater than the variability in the RIS population trends.

Step 5: Integrate the Results and Assess Impact

The NRC staff used a mathematical approach to integrate the regression results (e.g., detected population decline) from each of the field surveys to produce a single conclusion for a given RIS population trend. The staff used a logic-based approach to integrate the conclusions from the population trend LOE and the strength of connection LOE. NRC staff defined the IP2 and IP3 cooling system impact as SMALL for a given RIS if the second LOE concluded that there was a low strength of connection (i.e., no evidence that system operation was adversely influencing long-term population trends). Staff also defined the cooling system impact as SMALL for a given RIS if the first LOE concluded that there was not a detectable population decline even if the second LOE concluded that there was a high strength of connection. In that case, the losses of eggs, larvae, and YOY to the IP2 and IP3 cooling system were not sufficient to noticeably reduce the RIS population over time. The staff defined the IP2 and IP3 cooling system impact as MODERATE for a given RIS if the first LOE concluded that the RIS population trend was variable and the second LOE concluded a high strength of connection. The staff defined the cooling system impact as LARGE for a given RIS if the first LOE concluded that there was a detectable population decline and the second LOE concluded that there was a high strength of connection. Appendices H and I provide detailed descriptions of the process and statistical analysis that the NRC staff used to reach these determinations. The final cooling system impact assessments are consistent with the NRC guidelines for SMALL, MODERATE, and LARGE potential for adverse impacts as defined below:

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

What follows is the NRC staff assessment of the two LOE (population trends and strength of connection) and a determination of impact associated with impingement and entrainment at IP2 and IP3 using the above definitions.

4.1.3.1 Assessment of Population Trends—The First Line of Evidence

The NRC staff used data from the LRS, FSS, and BSS studies of the lower Hudson River from 1974 to 2005, as described above, to assess population trends. Staff obtained data from the applicant in electronic format including weekly catch density, an abundance index, total catch, and sample volumes. The staff also calculated catch-per-unit-effort values as a ratio of the total catch and sample volume. The NRC staff also used commercial and recreational harvest statistics from the Atlantic States Marine Fisheries Commission (ASMFC) as ancillary information to evaluate coastal population trends for striped bass, American shad, Atlantic sturgeon, river herring, bluefish, Atlantic menhaden, and weakfish.

The NRC staff assessed YOY population trends in river segment 4 (the region of the lower Hudson River where IP2 and IP3 are located) and the lower Hudson River from the Troy Dam to the Battery (river-wide). The final WOE score reflects an integrated result for both measurements (Table 4-4). The analysis showed that YOY American shad, Atlantic tomcod, blueback herring, bluefish, hogchoker, spottail shiner, and white perch populations were declining, and that bay anchovy and striped bass populations were not declining. Alewife, rainbow smelt, weakfish, and white catfish exhibited variable population trends, meaning some data showed detectable declines, whereas other data did not. Atlantic menhaden, Atlantic sturgeon, gizzard shad, shortnose sturgeon, and blue crab showed unresolved population trends because Hudson River monitoring programs did not collect enough of these species to support statistically significant trend analyses. The impact on these species resulting from IP2 and IP3 operation under a renewed license is discussed in section 4.1.3.3 of the SEIS.

4.1.3.2 Assessment of Strength of Connection—The Second Line of Evidence

The NRC staff conducted strength of connection analyses to determine whether the operation of the IP2 and IP3 cooling system had the potential to influence RIS populations near the facility or within the lower Hudson River. Appendix H contains a summary of this analysis, and Appendix I has detailed information on the analysis procedures.

The strength of connection analysis assumes that the IP2 and IP3 cooling system can affect aquatic resources directly through impingement or entrainment or indirectly by impinging and entraining potential food (prey). The NRC staff used model simulations to evaluate the detectability of the influence of impingement and entrainment by the IP2 and IP3 cooling system on the RIS population abundance relative to the population variability. YOY population densities near Indian Point are inherently variable, and thus the effects of the cooling system operation on a given population must be greater than the variability in the abundance of the population over time for them to be detectable. The NRC staff compared population models that included impingement and entrainment losses with modeled trends without such losses by running multiple simulations of a given population trend with its associated variability.

The applicant acknowledged after the publication of the draft SEIS that the applicant and its contractors had provided NRC staff electronic impingement data that contained errors. The staff received updated information (verified as correct by the applicant) and used this information to develop the Final SEIS. Thus, the impingement losses reported and conclusions in the draft SEIS are revised in the FSEIS.

The population simulation analysis showed that alewife, bay anchovy, blueback herring, hogchoker, rainbow smelt, spottail shiner, striped bass, weakfish, and white perch exhibited a High strength of connection with operation of the IP2 and IP3 cooling system (Table 4-4). The Monte Carlo model simulations predicted that the population abundances for those species were detectibly smaller when impingement and entrainment losses were included than when they were not. American shad, Atlantic menhaden, Atlantic sturgeon, Atlantic tomcod, bluefish, gizzard shad, shortnose sturgeon, white catfish, and blue crab populations exhibited a Low strength of connection. The Monte Carlo model simulations for those species could not detect a difference in population size for scenarios with and without impingement and entrainment losses, or those species rarely occurred in entrainment and impingement samples.

4.1.3.3 Impingement and Entrainment Impact Summary

The NRC staff used two lines of evidence (LOE to determine whether the operation of the IP2 and IP3 cooling system had the potential to cause adverse impacts to the RIS populations of the lower Hudson River. The first LOE considered RIS population trends from long-term data sets; the second considered the potential for the operation of the IP2 and IP3 cooling system to influence RIS population abundance. The NRC staff integrated the results from these LOE to determine the impacts of cooling system operation on RIS populations that are indicative of the aquatic resources of the lower Hudson River.

Based on the WOE assessment (Table 4-4), the NRC staff concludes that impacts to American shad, Atlantic menhaden, Atlantic sturgeon, Atlantic tomcod, bay anchovy, bluefish, gizzard shad, shortnose sturgeon, striped bass, white catfish, and blue crab are SMALL. The NRC staff concludes impacts to alewife, rainbow smelt and weakfish are MODERATE. The staff concludes that impacts to blueback herring, hogchoker, spottail shiner, and white perch are LARGE. The NRC staff used the river-wide abundance and CPUE data, and river segment 4 (Indian Point) density and CPUE information from FSS, BSS, and LRC studies for each RIS to support population trend analysis. Section 4.1.3.4 provides a discussion of the uncertainty associated with the impact analysis, and Section 4.1.3.5 presents the final integrated assessment of the impact of the IP2 and IP3 cooling system for all RIS combined.

Large Impacts

Blueback Herring

The NRC staff concludes that a LARGE impact is present for YOY blueback herring because a detectable population decline occurred in most of the river-wide (3 of 3) and river segment (2 of 3) data sets used in the analysis, and the strength of connection with the IP2 and IP3 cooling system is high. Blueback herring, which along with alewife are known as river herring, share many life history and distribution characteristics with alewife. An anadromous species, blueback herring migrate upriver to spawn during the spring, and live about 7-8 years. This species feeds primarily on insect larvae and copepods, and is prey for bluefish, weakfish, and striped bass (Hass-Castro 2006). Hass-Castro (2006) also reports that river herring populations are well below historic levels of the mid 20th century, possibly because of overfishing, habitat destruction, and states that a population assessment has been listed as a high priority by the Atlantic States Marines Fisheries Council (ASMFC), given that the blueback herring is listed as a species of concern by the NMFS.

Hogchoker

The NRC staff concludes that a Large impact is present for YOY hogchoker because a detectable population decline occurred in most of the river-wide (2 of 3) and river segment (3 of 3) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. This species is a right-eyed flatfish that occurs in the Hudson River estuary and surrounding bays and coastal waters. Adults are generalists, and eat annelids, arthropods, and siphons of clams; adults and juveniles are prey of striped bass. Coastal population trend data were not available for this species.

Spottail Shiner

The NRC staff concludes that a Large impact is present for YOY spottail shiner because a detectable population decline occurred in the river-wide (1 of 3) and river segment (1 of 1) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. The habitat for the spottail shiner includes small streams, lakes, and large rivers, including the Hudson. This species feeds primarily on aquatic insect larvae, zooplankton, benthic invertebrates, and fish eggs and larvae, and is the prey of striped bass. Spottail shiners spawn from May to June or July (typically later for the northern populations) over sandy bottoms and stream mouths (Smith 1985; Marcy et al. 2005); water chestnut (*Trapa natans*) beds provide important spawning habitat (CHGEC 1999). Individuals older than 3 years are rare, although some individuals may live 4 or 5 years (Marcy et al. 2005). Spottail shiner is not a marine or anadromous species, so coastal population trend data are not available.

White Perch

The NRC staff concludes that a large impact is present for YOY white perch because a detectable population decline occurred in the majority of the river-wide (3 of 3) and river segment (2 of 3) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. White perch is an estuarine species that is a year-round resident in the Hudson River and is commonly entrained by IP2 and IP3. An opportunistic feeder, this species is prey to large piscivorous fish and terrestrial vertebrates. Reported recreational and commercial landings in the Hudson River have never been great, and commercial fishing was closed in 1976 because of PCB contamination. In contrast to the Hudson River, white perch populations appear to be relatively stable in the Maryland portion of Chesapeake Bay, and the commercial harvest has generally increased since 1980 in that area (Maryland DNR 2005).

Table 4-4. Impingement and Entrainment Impact Summary for Hudson River YOY RIS

Species	Population Trend Line of Evidence	Strength of Connection Line of Evidence	Impacts of IP2 and IP3 Cooling Systems on YOY RIS
Alewife	Variable	High	Moderate
American Shad	Detected Decline	Low	Small
Atlantic Menhaden	Unresolved[a]	Low[b]	Small
Atlantic Sturgeon	Unresolved[a]	Low[b]	Small
Atlantic Tomcod	Detected Decline	Low	Small
Bay Anchovy	Undetected Decline	High	Small
Blueback Herring	Detected Decline	High	Large
Bluefish	Detected Decline	Low	Small
Gizzard Shad	Unresolved[a]	Low[b]	Small
Hogchoker	Detected Decline	High	Large
Rainbow Smelt	Variable	High	Moderate-Large[c]
Shortnose Sturgeon	Unresolved[a]	Low[b]	Small
Spottail Shiner	Detected Decline	High	Large
Striped Bass	Undetected Decline	High	Small
Weakfish	Variable	High	Moderate
White Catfish	Variable	Low	Small
White Perch	Detected Decline	High	Large
Blue Crab	Unresolved[a]	Low[b]	Small

(a) Population trend could not be established because of a lack of river survey data.
(b) Monte Carlo simulation could not be conducted because of the low rate of entrainment and impingement; a Low Strength of connection was concluded.
(c) Section 4.1.3.3 provides supplemental information.

Moderate Impacts

Alewife

The NRC staff concludes that a Moderate impact is present for YOY alewife because a detectable population decline occurred in river segment 4 (3 out of 3 data sets) and the strength of connection with the IP2 and IP3 cooling system is high. The NRC staff found that the population trend results were variable because the declines observed in river segment 4 were not confirmed by river- wide population trends. YOY alewife (river herring) are present in the lower and upper reaches of the Hudson River and feed as juveniles primarily on amphipods, zooplankton, and fish eggs and larvae, and, as adults on small fish. This species is also prey for bluefish, weakfish, and striped bass. The ASMFC implemented a combined fisheries management plan for American shad and river herring in 1985. Although the herring fishery is one of the oldest fisheries in the United States, no commercial fishery for river herring currently exists in the Hudson River. River herring population declines have been reported in Connecticut, Rhode Island, and Massachusetts, and NMFS has listed river herring as a species of concern throughout its range (Hass-Castro 2006).

Rainbow Smelt

The NRC staff concludes that the level of impact for rainbow smelt is MODERATE to LARGE because detectable population declines occurred in river-wide (1 of 2) and river segment (1 of 2) data sets and strength of connection with the IP2 and IP3 cooling system is high. Although detectable population declines occurred in two of four river data sets, indicating population trend results were variable, the staff concluded that a MODERATE to LARGE, rather than just MODERATE, impact was present based on the dramatic population declines observed for this species over the past three decades. Rainbow smelt is an anadromous species once commonly found along the Atlantic Coast. Larval and juvenile smelt feed primarily on planktonic crustaceans; adults eat crustaceans, polychaetes, and small fish. Bluefish and striped bass are primary predators of rainbow smelt. Once a prevalent fish in the Hudson River, the rainbow smelt has undergone an abrupt population decline in the Hudson River since 1994, and the species may no longer have a viable population within the Hudson River. The last tributary run of rainbow smelt was recorded in 1988, and the Hudson River Utilities' Long River Ichthyoplankton Survey showed that PYSL essentially disappeared from the river after 1995 (Daniels et al. 2005). The NRC staff's regression analysis of rainbow smelt population trends was affected by the lack of rainbow smelt caught by the Hudson River field surveys after 1995. Detectable population declines were present for CPUE data set but not for density or abundance index data, given the disappearance of this species from the Hudson river. Thus, the WOE conclusion of moderate impact may, in fact, be an underestimate of the true impact. Therefore, the staff concluded that a MODERATE to LARGE impact assessment was more appropriate.

Weakfish

The NRC staff concludes that a MODERATE impact is present for weakfish because detectable population declines occurred in river-wide (1 of 2) and river segment (1 of 2) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. Because detectable declines occurred in two of four river data sets, staff determined that the population trend results were variable. The weakfish is historically one of the most abundant fish species along the Atlantic coast and is fished recreationally and commercially. Small weakfish prey primarily on crustaceans, whereas larger individuals eat small fish. Bluefish, striped bass, and larger weakfish are the primary predators of smaller weakfish. Weakfish are thought to be in decline based on decreased commercial landings in recent years. The weakfish stock declined suddenly in 1999 and approached even lower levels by 2003, which the ASMFC determined to be because of higher natural mortality rates rather than fishing mortality (ASMFC 2007). A leading hypothesis suggests that reduced prey availability and increased predation by striped bass may contribute significantly to rising natural mortality rates in the weakfish population (ASMFC 2007a).

4.1.3.4 Discussion of Uncertainty

This analysis generally follows the EPA (1998) guidelines for ecological risk assessment. In reporting risks of adverse effects, EPA (1998) recommends that practitioners acknowledge and summarize the major areas of uncertainty in their analyses. Uncertainty, as described by EPA, has many sources. The two lines of evidence in NRC’s WOE approach have different sources of uncertainty.

NRC's population trends line of evidence (LOE-1) applies statistical tests to determine if YOY RIS populations have remained stable over time or have declined. The Hudson River utilities had collected the data used to assess aquatic RIR population trends continuously over three decades from a variety of locations along the Hudson River using standard protocols. They had applied accepted principles of experimental design and accepted sampling protocols. Over the years, they conducted special studies to resolve uncertainties identified in review of the studies by NYSDEC and others. They reported methods and results including both means and variances or other measures of central tendency and uncertainty. The NRC staff considers the data to be of high quality with minimal or known uncertainties and both useful and relevant for NRC's WOE analysis. A gear change in the FSS introduced an unquantifiable source of uncertainty in the RIS population trend results. The NRC applied analytic methods to minimize possible bias, but gear changes in monitoring programs almost always introduce uncertainties.

The NRC's strength of connection line of evidence (LOE-2) incorporates estimates of conditional mortality rate in Monte Carlo analyses to simulate changes in population trends with and without entrainment and impingement. The NRC calculated the conditional entrainment mortality rate and used estimates of conditional impingement mortality rate calculated by Entergy consultants. Both have quantifiable estimates of uncertainty. NRC provides the statistical basis for determining if simulated changes in population trends with and without entrainment and impingement differ. An unquantifiable source of uncertainty arises from the lack of studies at IP2 and IP3 since 1990 and 1987, respectively, confirming reductions of impingement mortality rates from improvements made to the IP2 and IP3 Ristroph screens and fish return system that appeared to reduce impingement mortality for some species in a pilot study (Fletcher 1990). The conditional impingement mortality rates used in NRC's analysis include adjustment for partial survival associated with the installation of Ristroph screens at IP2 and IP3.

NRC followed recommendations of the Massachusetts Weight-of-Evidence Workgroup (Menzie et al. 1996) in describing the overall value, use and utility, and uncertainties associated with the overall WOE approach. Consistent with Menzie et al. (1996), NRC staff used professional judgment to select and refine WOE methods before analyzing data and documented all steps (see Appendices H and I) to allow interested readers to gain an understanding of the assumptions, limitations, and uncertainties associated with this assessment. The NRC staff has also employed a similar methodology to assess effects of power plant operation on fish populations in its GEIS Supplement 22, regarding Millstone Power Station, Units 2 and 3 (NRC 2005). The NRC's staff's findings for impact from impingement and entrainment at IP2 and IP3, as described in Table 4-4, represent the NRC staff's best estimates based on the WOE derived from the available data and they contain both quantifiable and unquantifiable uncertainties.

4.1.3.5 Overall Impingement and Entrainment Impact

Because the WOE assessment results can be expressed numerically with respect to IP2 and IP3 adverse impacts (e.g. small adverse impacts = 1, moderate impacts = 2, large impacts = 4), it is possible to determine the overall impacts of the IP2 and IP3 cooling system using the WOE impact summary conclusions presented in Table 4-4. This type of scoring is reflective of an equally spaced interval on a logarithmic scale for which the magnitude of harm is doubled at each step. The NRC staff used these scoring criteria to calculate an average for the 18 RIS impact assessment results. Based on the assumption that the chosen RIS are representative surrogates for the aquatic community important to the lower Hudson River, the NRC staff concludes that the overall impact of the operation of IP2 and IP3 cooling systems to the aquatic resources of the lower Hudson River is MODERATE during the relicensing period.

4.1.4 Heat Shock

As discussed in Chapter 2, thermal discharges associated with the operation of the once-through cooling water system for IP2 and IP3 are regulated by NYSDEC. Temperature limitations are established and imposed on a case-by-case basis for each facility subject to 6 NYCRR Part 704.

Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR Part 704 as follows:

> (5) Estuaries or portions of estuaries.
>
> (i) The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point.
>
> (ii) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or a maximum of 83°F, whichever is less.
>
> (iii) From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than an 83°F increase in temperature not to exceed 1.5°F at any point of the estuarine passageway as delineated above, may be permitted.
>
> (iv) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than 4°F from the temperature that existed immediately prior to such lowering.

Thermal discharges associated with the operation of IP2 and IP3 are regulated under existing SPDES permit NY-0004472. This permit imposes effluent limitations, monitoring requirements, and other conditions to ensure that all discharges are in compliance with Title 8 of Article 17 of the Environmental Conservation Law (ECL) of New York State, 6 NYCRR Part 704, and the CWA. Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified by NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110°F (43°C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2°F (34°C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2°F (34°C) on more than 15 days during that period in any year.

4.1.4.1 Potential Effects of Heated Water Discharges on Aquatic Biota

The discharge of heated water into the Hudson River can cause lethal or sublethal effects on resident fish, influence food web characteristics and structure, and create barriers to migratory fish moving from marine to freshwater environments. The potential for harm associated with the discharge of heated water into streams, rivers, bays, and estuaries became known during the early 1960s as new power facilities were being considered or constructed, and resulted in the definition of waste heat as a pollutant in the Federal Water Pollution Control Act of 1965. Waste heat discharges can directly kill sensitive aquatic organisms if the duration and extent of the organism's exposure exceeds its upper thermal tolerance limit. Indirect effects associated with exposure to nonlethal temperatures can result in disruptions or changes to spawning behavior, accelerated or diminished growth rates of early lifestages (both positive and negative), or changes in growth or survival in response to changes to food web dynamics or predator/prey interactions (CHGEC et al. 1999). Indirect effects can also occur if the presence of a thermal plume restricts or blocks a species' migratory pattern during a critical lifestage, or results in avoidance behavior that affects species' viability or increases the likelihood of predation.

Adverse thermal effects can also occur when thermal discharges are interrupted, resulting in cold shock. To evaluate the nature and extent of thermal discharges, it is necessary to have an understanding of the characteristics of the thermal plume when it enters the receiving water, the lethal and sublethal tolerance limits for key aquatic species and lifestages of interest, and the possible exposure scenarios (nature and extent). Thus, regulatory agencies tasked with developing thermal discharge criteria that are protective of aquatic resources (in this case, NYSDEC) generally set limits on the extent, magnitude, and duration of the thermal plume to ensure it addresses potential lethal and sublethal effects associated with the temperature of heated water discharged into the environment, and its characteristics when it enters receiving waters.

4.1.4.2 Historical Context

Thermal impacts associated with the operation of IP2 and IP3, Roseton, and the Bowline Point electrical generating stations have been a concern of NYSDEC, the NRC's predecessor organization (the U.S. Atomic Energy Commission (USAEC)), and the NRC. In the 1972 final environmental statement (FES) for the IP2 operating license (USAEC 1972), the USAEC concluded that, although operation of IP2 would meet New York thermal standards for river surface water temperature, there was evidence to suggest that the IP2 discharge could exceed New York State standards for surface area and cross-sectional area enclosed within the 4°F isotherm. The USAEC, accordingly, issued an operating license for IP2 with the following conditions related to potential thermal impacts:

- operation of the once-through system would be permitted until January 1, 1978, and thereafter a closed-cycle system would be required;
- the applicant would perform an economic and environmental impact analysis of an alternative closed-cycle system, and provide the evaluation to the USAEC by July 1, 1973; and
- after approval by the USAEC, the required closed-cycle cooling system would be designed, built, and placed in operation no later than January 1, 1978.

The operating license also required the applicant to monitor dissolved oxygen in the discharge water and thermal plume, and monitor the size, shape, and locations of isotherms in the thermal plume (USAEC 1972). In the FES developed for the IP3 operating license, the NRC staff assessed the impact of thermal discharges from once-through cooling for all units (IP1, IP2, and IP3) and again concluded that, under certain conditions, the thermal discharges from the three units would exceed New York State thermal criteria (NRC 1975). The NRC issued an operating license to IP3 with conditions similar to those of IP2, but reflecting the decisions of the Atomic Safety and Licensing Board in 1974 that required closed-cycle cooling by May 1, 1979.

In 1976, the former owners of IP2 and IP3 submitted an environmental report to the NRC that evaluated various alternative closed-cycle cooling systems from an economic and environmental standpoint. In 1978, the former owners submitted a 316(a) determination to NYSDEC asserting that the facility complied with thermal standards established by New York State (6 NYCRR 704). In 1980, litigation between New York State and electric generating station owners, associated with the operation of electric generation stations along the Hudson River, resulted in the HRSA. In place of the cooling tower requirement, HRSA required a variety of mitigation measures including seasonal outages and the installation of dual-speed or variable-speed pumps at IP2 and IP3. The existence of HRSA also superseded the 1978 section 316(a) study. In support of the Fourth Amended Consent Order to HRSA (NYSDEC 1997), the owners of IP2 and IP3 developed flow efficiency curves for each unit that related flow to inlet temperature. For both units, flows of 500,000 gallons per minute (gpm) (1900 cubic meters per minute (m^3/min)) were generally attainable during the winter months (December–March when water inlet temperatures were less than 50°F (10°C), while flow rates of 700,000 gpm (2650 m^3/min) were required during the summer months when inlet temperatures exceeded 70°F (21°C) (NYSDEC 1997, Figures B-1 and B-2). The Fourth HRSA Consent Order also developed a system of “flow variation points” as a means of evaluating changes in plant operations at IP2 and IP3, Bowline Point, and Roseton that offset exceedences of recommended flows with reductions at other times.

4.1.4.3 Thermal Studies and Conclusions

A detailed discussion of the thermal studies conducted at IP2 and IP3 to supplement the initial 316(a) work performed in the late 1970s is presented in CHGEC et al. (1999). The studies included thermal modeling of near-field effects using the Cornell University Mixing Zone Model (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology (MIT) dynamic network model (also called the far-field thermal model). For the purpose of modeling, near field was defined as the region in the immediate vicinity of each station discharge where cooling water occupies a clearly distinguishable, three-dimensional temperature regime in the river that is not yet fully mixed; far field was defined as the region farthest from the discharges where the plumes are no longer distinguishable from the river, but the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed sufficient by the utilities and their contractor and was designed and configured to account for time-variable hydraulic and meteorological conditions and heat sources of artificial origins. Model output included a prediction of temperature distribution for the Hudson River from the Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the permit applicants applied CORMIX modeling to develop a three-dimensional plume configuration of near-field thermal conditions that could be compared to applicable water quality criteria (CHGEC et al. 1999).

The former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September (CHGEC et al. 1999). These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available, and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

(1) Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.

(2) Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each station, and concurrent operation of all three generating stations at maximum permitted capacity (CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX model runs were integrated with the riverwide temperature profiles developed by the MIT dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises above ambient) for various operating scenarios, the surface width of the plume, the depth of the plume, the percentage of surface width relative to the river width at a given location, and the percentage of cross-sectional area bounded by the 4°F (2°C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999).

For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86°F (1.18 to 1.59°C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4°F (2°C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24°F (1.80°C) during June ebb tides to 4.63°F (2.57°C) during flood tides in August. Temperature increases exceeded 4°F (2°C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near

IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4°F (2°C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events. These results suggest that the 4°F (2°C) lateral extent and cross-sectional criteria may sometimes be exceeded at IP2 and IP3. Exceedences generally occurred under scenarios that the applicants indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding, CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

Entergy has been engaged in discussions with the NYSDEC concerning the thermal impacts of IP2 and IP3 cooling water system operation. As a result of those discussions, the NRC staff notes that Entergy recently performed a triaxial thermal study of the Hudson River from September 9 to November 1 of 2009 (Entergy 2010). Given the months involved in this study, the study period did not include days with the highest average annual water temperature. Entergy has indicated that it will perform modeling of the river based on its field data in order to determine whether the power plant is in compliance with conditions of its permit; it also indicated that it may conduct additional monitoring in 2010. The NYSDEC, in its recent Notice of Denial of Water Quality Certification, indicated that additional verification of any modeled results would be necessary (NYSDEC 2010). Entergy did conduct additional studies in 2010. This issue continues to be subject to NYSDEC authority and review.

4.1.4.4 Assessments of Thermal Impacts

In this section, the NRC staff provides a summary of the various assessments of impacts associated with thermal discharges from the IP2 and IP3 cooling system. The applicant's assessment is based primarily on statements made in the ER (Entergy 2007a). The conclusions of NYSDEC concerning the thermal impacts of the IP2 and IP3 cooling system are presented in the final impact statement associated with the SPDES permits for Roseton Units 2 and 3, Bowline Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a). The NRC staff also notes that NGOs and members of the public have expressed concern that the applicant's assessment of the effect of thermal discharges is incomplete, and that there is evidence to suggest that the existing thermal discharges do not consistently meet applicable criteria as defined in 6 NYCRR 704.2(b)(5).

<u>Applicant's Assessment</u>

The IP2 and IP3 ER (Entergy 2007a) discusses the potential environmental impacts of thermal discharges from IP2 and IP3. The conclusions provided in the ER indicate that the current owners of IP2 and IP3 hold a NYSDEC SPDES permit (NY-0004472) and that the station is complying with the terms of this permit. The conclusions of the ER also describe the current mitigation required under the terms of the Fourth HRSA Consent Order that include flow reductions to limit aquatic impacts and extensive studies in the Hudson River to evaluate temporal and spatial trends. The applicant concludes that “continued operation in the manner required by the current SPDES permit and the associated agreement to continue implementation of the fourth Consent Degree ensures that thermal impacts will satisfy the requirements of CWA 316(a) and will thus remain SMALL during the license renewal term. Therefore, no further mitigation measures are warranted” (Entergy 2007a).

As noted in 4.1.4.3, Entergy conducted additional studies in 2009. While Entergy indicated it would likely undertake additional modeling and verification of modeled results (if necessary), Entergy (2010) concluded that IP2 and IP3 are in compliance with NYSDEC’s thermal requirements.

<u>NYSDEC Assessment</u>

In the FEIS associated with the SPDES permits for Roseton Units 1 and 2, Bowline Point Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a), NYSDEC concludes that “Thermal modeling indicates that the thermal discharge from IP2 and IP3 causes water temperatures to rise more than allowed, which is 4°F over the temperature that existed before the addition of heat, or a maximum of 83°F, whichever is less, in the estuary cross sections specified in 6 NYCRR § 704.2(b)(5).”

According to NYSDEC (2003b), the last SPDES permit for the Indian Point facility has been administratively continued under provisions of the NY State Administrative Procedure Act since 1992. The fact sheet published by NYSDEC (2003b) in November 2003 describes the environmental and facility operational issues and permit conditions of the draft SPDES permit that NYSDEC has proposed to issue for IP2 and IP3. In Section IV, “Overview of the Permit” (Section B, “Thermal Discharges”), NYSDEC indicates that the permittee must satisfy the provisions of Section 316(a) of the CWA and related requirements in 6 NYCRR Section 704.2 “which provide that the thermal discharges from IP2 and IP3 to the Hudson River should meet regulatory temperature criteria for estuaries, and must meet the NYS standard of ensuring the propagation and survival of a balanced, indigenous population of shellfish, fish, and other aquatic species.”

To meet this goal, NYSDEC requires, within the first 2 years of the SPDES permit term, that Entergy conduct a triaxial (three-dimensional) thermal study to document whether the thermal discharges associated with the operation of IP2 and IP3 comply with New York State water quality criteria. In the event the discharges do not comply, the permittee is allowed to apply for a modification of one or more criteria as provided by 6 NYCRR Section 704.4, but must demonstrate to the satisfaction of NYSDEC “that one or more of the criteria are unnecessarily restrictive and that the modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish, and wildlife in the Hudson River” (NYSDEC 2003a). In the ongoing proceeding before NYSDEC, Entergy has indicated that it would propose an alternative study. This matter is still under review before NYSDEC, and may not be resolved before NRC issues a final SEIS (Entergy 2007c).

Entergy conducted a thermal study in 2009. In its 2010 Notice of Denial related to Entergy’s application for Water Quality Consistency Review, the NYSDEC noted that Entergy’s 2009 thermal study did not directly address the period of highest river temperatures, and as such, would require additional confirmatory monitoring to determine whether any modeled results accurately show compliance with thermal standards (NYSDEC 2010).

4.1.4.5 NRC Staff Assessment of Thermal Impacts

In the absence of a completed thermal study proposed by NYSDEC (or an alternative proposed by Entergy and accepted by NYSDEC), existing information must be used to determine the appropriate thermal impact level to sensitive life stages of important aquatic species. Since NYSDEC modeling in the FEIS (NYSDEC 2003a) indicates that discharges from IP2 and IP3 could raise water temperatures to a level greater than that permitted by water quality criteria that are a component of existing NYSDEC permits, the staff must conclude that adverse impacts are possible. Cold water fish species such as Atlantic tomcod and rainbow smelt may be particularly vulnerable to temperature changes caused by thermal discharges. The population of both species has declined, and rainbow smelt may have been extirpated from the Hudson River. The NYSDEC's issuance of a SPDES permit provides a basis to conclude that the thermal impacts of IP2 and IP3 discharges could meet applicable regulatory temperature criteria. The NYSDEC's recent pronouncements and its ongoing re-examination of this issue create uncertainty, and this issue is currently being addressed in NYSDEC administrative proceedings. Accordingly, in the absence of specific studies, and in the absence of results sufficient to make a determination of a specific level of impact, the NRC staff concludes that thermal impacts from IP2 and IP3 potentially could range from SMALL to LARGE depending on the extent and magnitude of the thermal plume, the sensitivity of various aquatic species and life stages likely to encounter the thermal plume, and the probability of an encounter occurring that could result in lethal or sublethal effects. This range of impact levels expresses the uncertainty accruing from the current lack of studies and data. Either additional thermal studies or modeling and verification of Entergy's 2009 thermal study might generate data to further refine or modify this impact level. For the purposes of this Final SEIS, the NRC staff concludes that the impact level could range from SMALL to LARGE. This conclusion is meant to satisfy NRC's NEPA obligations and is not intended to prejudice any determination the NYSDEC may reach in response to new studies and information submitted to it by Entergy.

4.1.5 Potential Mitigation Options

Potential mitigation options related to the operation of the IP2 and IP3 once-through cooling system are discussed in Chapter VII of the DEIS (CHGEC et al. 1999). Impacts associated with impingement were assumed by the Hudson River utilities to be adequately mitigated because previous IP2 and IP3 owners installed dual- and variable-speed pumps at IP2 and IP3, respectively, in 1994, and also installed modified Ristroph screens at both units in the early 1990s (CHGEC et al. 1999). The summary conclusion of the DEIS in 1999 was that the Hudson River utilities considered the system to be the best technology available to mitigate impingement losses (CHGEC et al. 1999). The NYSDEC, however, has determined that closed-cycle cooling is the best technology available to protect aquatic resources (NYSDEC 2003b).

CHGEC et al. (1999) also discusses the mitigation of entrainment losses at IP2 and IP3 by ensuring that minimum flows are used for reactor cooling through the use of dual- or variable-speed pumps. In the ER (Entergy 2007a), the applicant concludes that, because impingement and entrainment are not having any demonstrable negative effects on Hudson River RIS, further mitigation measures are not warranted. NYSDEC's FEIS (2003a) indicated that "a range of available technologies exist to minimize aquatic resource mortality from the cooling water intake structures" at the Hudson River power plants, including IP2 and IP3. While NYSDEC indicated that IP2 and IP3 pump systems and modified Ristroph screens help mitigate impingement mortality, it also indicated that “significant unmitigated mortalities from entrainment and impingement” remain at all of the Hudson River power plants (NYSDEC 2003a).

The NRC staff, in the results of its analysis provided in Sections 4.1.3 and 4.1.4 of this SEIS, has found that impingement and entrainment from the operation of IP2 and IP3 are likely to have an adverse effect on aquatic ecosystems in the lower Hudson River during the period of extended operation. The available evidence suggests that the operation of the cooling systems directly affects RIS by impingement and entrainment, and indirectly affects these resources through the impingement and entrainment of their prey. The thermal discharges may also be influencing RIS, but the extent of this influence cannot be determined without further studies, such as those proposed in the draft SPDES permit for IP2 and IP3 and ongoing proceedings before the NYSDEC.

To assess potential mitigation options, the NRC staff reviewed the comments and responses provided in NYSDEC (2003a) and information provided by EPA in support of its Phase II 316(b) program (EPA 2008a). Based on this review, additional mitigation options that may be available for the existing cooling system include the following:

- additional flow reductions or planned outages
- use of wedgewire or fine-mesh screens
- use of barrier systems at the intake locations
- use of behavioral deterrent systems
- closed-cycle cooling using cooling towers (e.g., hybrid wet/dry mechanical draft towers)

What follows is an overview of the effects of employing the above mitigation options to the existing system currently in operation at IP2 and IP3. Because NYSDEC indicated closed-cycle cooling is the best technology available for IP2 and IP3 (NYSDEC 2003b), the NRC staff will review a cooling tower alternative in Chapter 8. Because the NRC staff will address a cooling tower alternative in greater depth in Chapter 8, closed-cycle cooling will not be addressed further in this chapter.

Costs and benefits of these measures have been addressed in the 1999 DEIS and evaluated by NYSDEC in the FEIS. Of these alternative options, NYSDEC received comments indicating that the cost figures for closed-cycle cooling in the DEIS were inflated by the Hudson River utilities. After reviewing cost data with consultants, however, NYSDEC indicated that costs were generally reasonable (noting that site-specific factors and changes in the cost of replacement power may affect cost estimates) (NYSDEC 2003a).

The measures the NRC staff addresses below and in Chapter 8, as well as any other measures to reduce entrainment and impingement at Indian Point, fall under the regulatory authority of NYSDEC and the powers delegated to it by the EPA under the CWA. While the NRC has no role in regulating or enforcing water quality standards, the NRC staff has included a discussion of these mitigation measures in the interest of fulfilling the NRC’s obligations under the National Environmental Policy Act (NEPA) (42 USC 4321, et. seq) and 10 CFR Part 51.

Additional Flow Reductions or Shutdowns

As discussed in Section 4.1.1.1 of this SEIS, under the conditions of HRSA and the subsequent consent orders, the operators of IP2 and IP3 developed programs to employ flow-reduction measures and scheduled outages to reduce impingement and entrainment impacts. Because flow rates were dependent on water temperature, greater flows were required during the months of May through October when river water temperatures were above 15°C. It may be possible to further reduce flows or increase the length or frequency of scheduled outages, though these options will cause the plant operator to lose revenue from operating IP2 and IP3. In the 1999 DEIS, CHGEC et al. estimated that outages could cost between $14 million and $73 million per year.

Wedgewire or Fine-Mesh Screens

In some cases, the use of wedgewire or fine-mesh screens has shown potential for decreasing entrainment at once-through powerplants. Wedgewire screens typically have a screen size of 0.5 to 10 mm and are designed to reduce entrainment by physical exclusion and exploiting hydrodynamic patterns (EPA 2008a). Fine-mesh screens generally employ a mesh size of 0.5 mm or less, and reduce entrainment by gently trapping organisms and reintroducing them back into the environment via plant-specific collection and transfer systems. Factors influencing the use of this technology include the screen size, the location, and configuration of the system relative to the intake, the intake flow rates, the presence and magnitude of a “sweeping” current that can limit impingement or move organisms past the screen into safe water, and the size of the organism present near the intake. In its evaluation of wedgewire and fine-mesh screens, EPA (2008a) indicated that these technologies showed promise for reducing entrainment, but expressed concerns about the maintenance required to prevent clogging and the potential for this technology to reduce entrainment but increase impingement. EPA (2008a) considered the use of wedgewire screen technology to be more suitable for use in closed-cycle makeup water systems where lower flow rates exist and fewer screens are required.

Because the portion of the Hudson River near IP2 and IP3 is subject to tidal influence, there are periods of time when a sweeping current is not present. During this time, impingement against wedgewire or fine-mesh screen systems would be exacerbated. Although the use of these technologies at IP2 and IP3 is possible, numerous technical challenges would exist, including how to configure and clean the screens, how to evaluate capture and removal success, and how to assess the environmental effects and tradeoffs that would occur when one type of impact (entrainment) is reduced while another impact (impingement) may increase. CHGEC estimated that wedgewire screens could cost $44 million to $55 million per year in lost electricity production, and indicated that fine-mesh screens would not be feasible.

The NRC staff notes that NYSDEC has indicated that Wedgewire screens would not be adequate for meeting NYSDEC’s BTA requirements under 316(b)(NYSDEC 2010). The NRC staff includes wedgewire screens here as an option that could reduce impacts from operation of the once-through cooling system and reiterates that only NYSDEC has the authority to establish requirements for mitigation measures to address aquatic impacts of the cooling system.

Barrier Systems

Gunderboom® and Marine Life Exclusion System™ (MLES™) technologies provide additional exclusion of entrainable-sized organism from cooling systems. Nets or screens are deployed during peak periods of entrainment to reduce overall entrainment. Gunderboom technology has been evaluated at the Lovett fossil fuel generating station since 1994. The system deployed in 2000 consisted of a two-ply fabric 500 feet (ft) (150 meters (m)) long, with a surface area of

8000 square feet (ft^2) (743 square meters (m^2)), and equipped with 500-micrometer (0.020 in.) perforations. The system extended to a depth of 20–30 ft (6.1–9.1 m) and was held in place with anchors. An automated airburst system with strain gages and head differential monitors was used to release compressed air at depth to clean the screens. The preliminary results from the 2000 deployment documented by Raffenberg et al. (2008) suggested that the system resulted in an 80-percent reduction in ichthyoplankton entering the facility, and that periodic elevated densities of ichthyoplankton inside the barrier were linked to breaches of the system. Impingement investigations suggested that eggs did not adhere to fabric, and mortality was below 2 percent in laboratory studies. Based on observational data, larvae did not orient toward the flow, and did not impinge on the fabric with a through-fabric velocity of 5 gallons per minute per square foot or 0.20 meters per minute (Raffenberg et al. 2008).

The use of barrier systems may be feasible at IP2 and IP3 as a mitigation action, but further study may be needed to determine the long-term impacts of these systems. CHGEC et al. (1999) indicated that barrier nets or fine-mesh barrier nets would not be feasible at Indian Point, and did not assign a cost. EPA (2008), however, has indicated that barrier systems like Gunderboom show significant promise for minimizing entrainment, but considers the technology "experimental in nature." Some advantages of the systems are that they can be deployed, retrieved, and replaced seasonally as needed. They are suitable for use in all types of water bodies and appear to reduce entrainment and impingement losses. The disadvantages are related to the limited number of long-term studies available to assess the performance of the technology, the durability of the systems in high-energy areas, the level of maintenance and monitoring required, the effects of biofouling on system performance, and the large volume of water that IP2 and IP3 withdraw. Additionally, it may be necessary to determine whether potential safety issues associated with the deployment of the systems at a nuclear generating station can be addressed.

Behavioral Deterrent Systems

Behavioral deterrent systems such as noncontact sound barriers or the use of light sources to reduce impingement have been evaluated at a variety of power generating stations in marine, estuarine, and freshwater environments (EPA 2008a). At present, a sonic deterrent system is being used at the Danskammer Point fossil energy plant on the Hudson River, and a similar system has been evaluated at Roseton. The advantage to these systems is that they can be configured and deployed at a variety of locations at costs that are not prohibitively high for simple system configurations. The disadvantages of the systems are that pneumatic air guns, hammers, and fishpulser systems are not considered reliable, the cost of sophisticated acoustic sound-generating systems can be high, and the use of high-technology equipment requires maintenance at the site (EPA 2008a). EPA (2008a) further states that, although many studies have been conducted to evaluate the feasibility of sound and light to reduce impingement and entrainment, the results "have either been inconclusive or shown no tangible reduction in impingement or entrainment" (EPA 2008a). There is, however, evidence that the use of acoustic sound barriers at a site in Pickering, Ontario, did appear to reduce the impingement and entrainment of alewife, but no benefits were realized for rainbow smelt or gizzard shad. At the Roseton facility, the use of sound barriers provided little or no deterrence for any species (EPA 2008a). In its review, the EPA concluded that it may be possible to employ acoustic or light barrier systems in conjunction with other technologies to reduce impingement or entrainment, but further studies are likely necessary to evaluate the feasibility of various technology combinations. The 1999 DEIS from CHGEC et al. indicated an unknown cost associated with implementing behavioral deterrence systems.

4.2 Transmission Lines

The two transmission lines and right-of-ways (ROWs) built to connect IP2 and IP3 with the transmission system that existed before their construction are described in Section 2.1.7 and mapped on Figure 2-3 of this SEIS. The lines are each about 2000 ft (610 m) in length, and have ROW widths of approximately 150 ft (46 m). The transmission lines are located within the site except for a terminal, 100-ft (30.5-m) segment of each that crosses the facility boundary and Broadway (a public road) to connect to the Buchanan substation (Entergy 2007a).

Of the total of 4000 ft (1220 m) of transmission line, about 3500 ft (1070 m) traverses buildings, roads, parking lots, and other developed areas. The remaining 500 ft (150 m) of ROW is vegetated. In these segments, the growth of trees is prevented and a cover of mainly grasses and forbs is maintained.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to the IP2 and IP3 transmission lines are listed in Table 4-5 of this SEIS. The applicant stated in its ER that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses (Entergy 2007a). The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, the NRC staff's site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS. 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 warrant implementation.

Table 4-5. Category 1 Issues Applicable to the IP2 and IP3 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 wetland on power line right-of-way	4.5.7
AIR QUALITY	
Air quality effects of transmission lines	4.5.2
LAND USE	
Onsite land use	4.5.3
Power line right-of-way	4.5.3

A brief description of the 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 the following:

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

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

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

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

  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.

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

  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.

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

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

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

  Projected on-site 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.

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

  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 identified no new and significant information associated with these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The NRC staff has identified one Category 2 issue and one uncategorized issue related to transmission lines. These issues are listed in Table 4-6 and are discussed in Sections 4.2.1 and 4.2.2 of this SEIS.

Table 4-6. Category 2 and Uncategorized Issues Applicable to the IP2 and IP3 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	4.2.2

4.2.1 Electromagnetic Fields—Acute Effects

Based on the GEIS, the Commission determined 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, the NRC staff found that, without a review of the conformance of each nuclear plant transmission line to National Electrical Safety Code (NESC) (IEEE 1997) 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.

As described in Section 2.1.7 of this SEIS, two 345-kilovolt (kV) transmission lines were built to distribute power from IP2 and IP3 to the electric grid. Also, two 138-kV lines that use the same transmission towers supply offsite (standby) power to IP2 and IP3. These lines are contained within the IP2 and IP3 site, except for where they cross Broadway (a public road) to connect to the Buchanan substation. Electric lines having voltages exceeding 98 kV of alternating current to ground must comply with the NESC provision on minimum vertical clearance, adopted in 1977, that limits the steady-state current from electrostatic effects to 5 milliamperes (mA) if the largest anticipated truck, vehicle, or equipment under the line were short circuited to ground. The New York Public Service Commission (NYPSC) requires a more restrictive induced current limit of 4.5 mA (Entergy 2007a).

Entergy indicates that at the time it acquired IP2 from the Consolidated Edison Company of New York, the transmission lines connecting IP2 and IP3 to the Buchanan substation were in compliance with the applicable NESC provisions for preventing electric shock from induced current. The lines were also in compliance with the NYPSC 4.5-mA criterion, as calculated using the methods described in the Electric Power Research Institute (EPRI) document "Transmission Line Reference Book" (Con Edison 2007). There have been no configuration or operation changes made to these lines since transfer of their ownership to Entergy (Entergy 2007a). Entergy indicates that it has maintenance procedures to ensure that the transmission lines continue to conform to ground clearance standards (Entergy 2008a).

Entergy commissioned a study of the two 345-kV lines that connect IP2 and IP3 to the electric transmission system to demonstrate to the NRC staff that they meet the NESC and NYPSC requirements (Enercon 2008). The two 138-kV lines, which are at similar ground-crossing heights to the 345-kV lines, are also addressed by the study. The analysis was performed using the EPRI TL Workstation calculation software to determine the highest ground-level electric field strengths at the ROWs where they cross Broadway. Enercon employed procedures and calculations from the EPRI "Transmission Line Reference Book, 200kV and Above (Third Edition)", which Enercon indicates is the industry-accepted reference for transmission line design and field effects. Enercon notes that The EPRI parameters for a 55-ft- (17-m)-long tractor trailer were used, with the length increased to 65 ft (20 m) to represent the maximum allowed under New York size restrictions. The analysis revealed a maximum calculated induced current for the 345-kV lines of 1.3 mA, below the NYPSC 4.5-mA limit (Enercon 2008).

In the GEIS, the NRC staff found that electrical shock is of SMALL significance for transmission lines that are operated in adherence with the NESC criteria for limiting hazards. Based on a review of the available information, including that provided in the ER (Entergy 2007a), the NRC staff's environmental site audit, the scoping process, the NRC staff's evaluation of Entergy's

2008 study (Enercon 2008), and existing NESC requirements, the NRC staff concludes that the transmission lines associated with IP2 and IP3 meet NESC criteria for limiting hazards, and thus the potential impact from electric shock during the renewal term is SMALL.

The NRC staff identified measures that could further mitigate potential acute EMF impacts resulting from continued operation of the IP2 and IP3 transmission lines, including installing road signs at road crossings and increasing transmission line clearances. These mitigation measures could reduce human health impacts by minimizing public exposures to electric shock hazards. The staff did not identify any cost benefit studies applicable to the mitigation measures mentioned above.

4.2.2 Electromagnetic Fields—Chronic Effects

In the GEIS, the chronic effects of 60-hertz EMFs from power lines were not designated as Category 1 or 2, and a designation will not be made until 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 1999 report of the NIEHS and DOE Working Group (NIEHS 1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF [extremely low frequency-electromagnetic field] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the NRC to reach a conclusion with respect to the chronic effects of EMFs as detailed below (from 10 CFR Part 51, Subpart A, Appendix B, Table B-1):

> If, in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

The NRC staff considers the GEIS finding of "uncertain" still appropriate and continues 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, applicable to IP2 and IP3 in regard to radiological impacts of normal operations are listed in Table 4-7. Entergy stated in its ER that it was aware of one new issue associated with the renewal of the IP2 and IP3 operating licenses—potential ground water contamination and a new radioactive liquid effluent release pathway as a result of leakage from the plant. The NRC staff has discussed this issue and the various studies relating to it in Section 2.2.7 of this SEIS, and addresses the significance of this issue in Section 4.5. The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER, during its independent review of Entergy's ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information.

As discussed in Sections 2.2.7 and 4.5 of this SEIS, the NRC staff concludes that the new issue is not significant, and thus does not challenge the finding in the GEIS. According to the GEIS, the impacts to human health during license renewal term are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-7. 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

The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER concerning potential ground water contamination and a new radioactive effluent release pathway for leakage from the plant, during its independent review of Entergy's ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information. The NRC evaluated the detailed information provided by the applicant, State agencies, and NRC inspections on the new issue and concluded that the new issue is not significant and that the impacts to human health during the license renewal term are SMALL. Therefore, the NRC staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

The NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20, "Standards for Protection against Radiation," and are not considered to have a significant impact on plant workers, the public, or the environment. Furthermore, the NRC staff acknowledges that the commitments made by Entergy—and identified in Section 2.2.7 of this SEIS—for long-term monitoring and remediation will help to minimize the potential impacts from contaminated ground water and help maintain radiological impacts within NRC radiation safety standards.

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

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

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

  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 identified no information that was both new and significant on these issues during the review of the IP2 and IP3 LRA. Therefore, the NRC staff expects that there would be no impacts 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 Term

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B–1, applicable to socioeconomic impacts during the renewal term are listed in Table 4-8 of this SEIS. As stated in the GEIS, the impacts associated with these Category 1 issues were determined to be SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

Table 4-8. Category 1 Issues Applicable to Socioeconomics during the Renewal Term

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

The NRC staff reviewed and evaluated the IP2 and IP3 ER, scoping comments, and other available information. The NRC staff also visited IP2 and IP3 in search of new and significant information that would change the conclusions presented in the GEIS. No new and significant information was identified during this review and evaluation. Therefore, the NRC staff concludes that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS.

The results of the review and brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, for each of the socioeconomic Category 1 issues are provided below:

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

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

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

  Only impacts of small significance are expected.

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

  No significant impacts are expected during the license renewal term.

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

  No significant impacts are expected during the license renewal term.

The NRC staff identified no new and significant information regarding these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

Table 4-9 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and an environmental justice impact analysis, which was not addressed in the GEIS.

Table 4-9. Category 2 Issues Applicable to Socioeconomics and Environmental Justice during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
SOCIOECONOMICS			
Housing impacts	4.7.1	I	4.4.1
Public services: public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public services: transportation	4.7.3.2	J	4.4.4
Historic and archeological 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 plant-specific reviews.

4.4.1 Housing Impacts

Appendix C to the GEIS presents a population characterization method based on two factors, sparseness and proximity (see Section C.1.4). Sparseness measures population density within 20 miles (mi) (32 kilometers (km)) of the site, and proximity measures population density and city size within 50 mi (80 km). Each factor has categories of density and size (see Table C.1 of the GEIS). A matrix is used to rank the population category as low, medium, or high (see Figure C.1 of the GEIS).

In Chapter 2 of this SEIS, the NRC staff describes the local population around IP2 and IP3. As NRC staff indicated in Section 2.2.8.5, the 2000 U.S. Census noted that approximately 1,113,089 people lived within 20 mi (32 km) of IP2 and IP3, which equates to a population density of 886 persons per square mi (332 persons per square km). This density translates to the least sparse Category 4 (greater than or equal to 120 persons per square mi within 20 mi). Approximately 16,791,654 people live within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a). This equates to a population density of 2138 persons per square mi (825 persons per square km). Applying the GEIS proximity measures, the IP2 and IP3 site is classified as proximity Category 4 (greater than or equal to 190 persons per square mi within 50 mi). Therefore, according to the sparseness and proximity matrix presented in the GEIS, IP2 and IP3 ranks of sparseness Category 4 and proximity Category 4 result in the conclusion that Indian Point is located in a high population area.

Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, states that impacts on housing availability are expected to be of small significance in high-density population areas where growth-control measures are not in effect. Since Indian Point is located in a high population area and Dutchess, Orange, Putnam, and Westchester Counties are not subject to growth-control measures that would limit housing development, any changes in IP2 and IP3 employment would have little noticeable effect on housing availability in these counties. Because Entergy has indicated in its ER that there would be no hiring of additional workers to support license renewal, nonoutage employment levels at IP2 and IP3 would remain relatively constant with no additional demand for permanent housing during the license renewal term (Entergy 2007a). In addition, the number of available housing units has kept pace with or exceeded the low growth in the area population. Based on this information, the NRC staff concludes that there would be no impact on permanent housing during the license renewal term beyond what is currently being experienced.

However, as stated in section 3.1 of this SEIS, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms (CRDMs) during the license renewal term,. Entergy estimates that this replacement activity at IP2 and IP3 would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would increase the demand for temporary (rental) housing in the immediate vicinity of IP2 and IP3. The NRC staff has reviewed the potential environmental impacts of this replacement activity, as discussed in Chapter 3 of this SEIS.

4.4.2 Public Services—Public Utility Impacts

The GEIS indicates that impacts on public utilities are SMALL if the existing infrastructure could accommodate plant-related demand without a noticeable effect on the level of service. The GEIS indicates that MODERATE impacts arise when the demand for service or use of the infrastructure is sizeable and would noticeably decrease the level of service or require additional resources to maintain the level of service. The GEIS indicates that LARGE impacts would result when new programs, upgraded or new facilities, or substantial additional staff are required because of plant-related demand.

In the absence of new and significant information to the contrary, the only impacts on public utilities that the NRC staff found in the GEIS could be significant during license renewal are impacts on public water supplies. The NRC staff's analysis of impacts on the public water and sewer systems considered both plant demand and plant-related population growth. In the GEIS, the NRC staff found that impacts from license renewal on public water supplies could range from SMALL to MODERATE, with the site-specific impact depending on factors that exist at each plant site.

As previously discussed (in Section 2.2.8.2) of this SEIS, potable water and process water is supplied to IP2 and IP3 by the Village of Buchanan water supply system (VBNY 2006). IP2 and IP3 use approximately 2.3 million ft^3 (65,000 m^3]) or 17.4 million gallons of potable water per month, and there is no indicated restriction on the amount of potable water that IP2 and IP3 can use. Further, Entergy (Entergy 2007a) does not project an increase in plant demand.

Because Entergy has indicated that there would be no hiring of additional workers during the license renewal period (Entergy 2007a), overall employment levels at IP2 and IP3 would remain relatively unchanged with no additional demand for public water and sewer services. Public water systems in the region would remain adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no impact to public water and sewer services during the license renewal term beyond what is currently being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of refueling outage workers needed for this replacement activity would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this SEIS.

4.4.3 Offsite Land Use—License Renewal Period

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," And effects can be small, moderate, or large.

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.

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. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land use impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues, (2) the nature of the community's existing land use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant's tax payments are projected to be small relative to the community's total revenue, tax-driven land use changes during the plant's license renewal term would be SMALL, especially where the community has preestablished patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be SMALL. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land use changes would be MODERATE. 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 preestablished pattern of development or has not provided adequate public services to support and guide development.

4.4.3.1 Population-Related Impacts

Since Entergy has indicated that it has no plans to add nonoutage employees during the license renewal period, there would be no noticeable population change to drive changes in land use conditions in the vicinity of IP2 and IP3 that is attributable to the plant. Therefore, there would be no population-related land use impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Because of the short amount of time needed for this replacement activity, the NRC staff finds that additional number of refueling outage workers would not cause any permanent population-related land use changes in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this SEIS.

4.4.3.2 Tax-Revenue-Related Impacts

As discussed in Chapter 2 of this SEIS, Entergy pays annual real estate taxes to the Town of Cortlandt, Hendrick Hudson Central School District, and the Village of Buchanan (see Table 2-18 in Chapter 2 for more detail). As reported in Chapter 2, tax payments to the Town of Cortlandt represented between 11 and 16 percent of the town's total annual tax revenues for the 3-year period from 2003 through 2005, and payments to the Hendrick Hudson Central School District represented approximately 30 to 38 percent of the school district's total revenues over the same time period. Entergy's tax payments to the Village of Buchanan make up a high percentage of the village's tax collection. For the period 2003 through 2005, tax payments to the Village of Buchanan represented 39 to 44 percent of the village's total revenues.

The NRC staff notes that since Entergy started making payments to local jurisdictions, population levels and land use conditions in the Town of Cortlandt, Village of Buchanan, and Westchester County have not changed significantly, which might indicate that these tax revenues have had little or no effect on land use activities within the county.

Entergy has indicated that it plans no license-renewal-related construction activities to support the continued operation of IP2 and IP3 during the license renewal period. Accordingly, the NRC staff expects that there would be no increase in the assessed value of IP2 and IP3 and that the annual payment-in-lieu-of-taxes and property taxes paid to the Town of Cortlandt, the Hendrick Hudson Central School District, and the Village of Buchanan would remain relatively unchanged throughout the license renewal period. Based on this information, there would be no tax-revenue-related land use impacts during the license renewal term beyond those currently being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). This replacement activity would not likely increase the assessed value of IP2 and IP3, and property tax payments would remain unchanged. These impacts are discussed in Chapter 3 of this SEIS.

4.4.4 Public Services: Transportation Impacts during Operations

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states the following:

> Transportation impacts (level of service) of highway traffic generated...during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

All applicants are required by 10 CFR 51.53(c)(3)(ii)(J) to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license.

Since Entergy has no plans to add non-outage employees during the license renewal period, there would be no noticeable change in traffic volume and levels of service on roadways in the vicinity of IP2 and IP3. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of outage workers and truck material deliveries needed to support this replacement activity could cause short-term transportation impacts on access roads in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this SEIS.

4.4.5 Historic and Archeological Resources

The National Historic Preservation Act (NHPA), as amended, requires Federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places. The criteria for eligibility are listed in 36 CFR 60.4, “Criteria for Evaluation,” and include (1) association with significant events in history, (2) association with the lives of persons significant in the past, (3) embodies distinctive characteristics of type, period, or construction, and (4) yielded or is likely to yield important information (ACHP 2008). The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, “Protection of Historic Properties.” The issuance of a renewed operating license for a nuclear power plant is a Federal action that could possibly affect either known or currently undiscovered historic properties located on or near the plant site and its associated transmission lines. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effect. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve possible adverse effects of the undertaking.

4.4.5.1 Site-Specific Cultural Resources Information

A review of the New York State Historic Preservation Office (NYSHPO) files shows that there are no previously recorded archeological or above-ground historic architectural resources identified on the IP2 and IP3 property. As noted in Section 2.2.9.1 of this SEIS, a Phase 1A survey (literature review and background research) of the plant property was conducted in 2006; however, no systematic pedestrian or subsurface archeological surveys have been conducted at the IP2 and IP3 site. In 2009, however, Entergy conducted a Phase 1b survey of possible locations for cooling towers, should proceedings before the NYSDEC require that they be installed at the site (Entergy 2009b). The survey addressed only those portions of the site likely to be affected by cooling tower installation. Subsurface investigation – shovel testing – revealed no artifacts or other resources in the areas considered for the northernmost of two cooling towers. Investigations for the southern tower, however, identified historical artifacts at multiple locations within the potential tower footprint, as well as prehistoric artifacts (primarily lithic shatter) in a portion of the potential tower footprint.

Background research revealed a total of 76 resources listed on the National Register of Historic Places within a 5-mile radius of IP2 and IP3 Also, as noted in Chapter 2, Stony Point Battlefield State Historic Site – a National Historic Landmark – is located across the Hudson River and south of IP2 and IP3. None of these historic resources, however, are located within the boundaries of the property.

The NRC staff noted in the draft SEIS that there is potential for archeological resources to be present on some portions of the IP2 and IP3 property. As noted in Section 2.2.9.2 of this SEIS, because of disturbances associated with site preparation and construction, the power block area at IP2 and IP3 has little or no potential for archeological resources. There is potential for archeological resources to be present in the wooded area northeast of the power block area outside the area surveyed for possible cooling tower installation. A portion of the property south and east of the power block area, which contains a variety of ancillary plant facilities, has been disturbed by construction activities over the course of the plant's history. It is possible, however, that portions of that area not disturbed by construction activities – including those investigated in the recent Phase 1b survey – may contain intact subsurface archeological deposits. In addition, the IP1 reactor was one of three "demonstration plants" that began operation in the early 1960s. It is representative of the earliest era of commercial reactors to operate in the United States. To date, no formal significance or eligibility evaluation has been conducted for IP1; however, the plant could become eligible for inclusion on the National Register of Historic Places. As mandated by Section 106 of the NHPA, an evaluation would be conducted if it was determined that a project could affect IP1.

4.4.5.2 Conclusions

Entergy has proposed no specific new facilities, service roads, or transmission lines for the IP2 and IP3 site associated with continued operation and refurbishment (which does not include the installation of cooling towers). However, Entergy indicated that it plans to replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal period. This activity could involve ground-disturbing activities associated with the construction of a storage building for the existing reactor vessel heads and CRDMs. Ground-disturbing activities would be reviewed in accordance with Entergy nuclear fleet procedures, which are designed to ensure that investigations and consultations are conducted as needed, and that existing or potentially existing cultural resources are adequately protected by Entergy such that the applicant can meet State and Federal expectations (Enercon 2007). The NRC staff considers the potential impacts to historic and archaeological resources on the IP2 and IP3 site that may result from installation of cooling towers, should such towers be required by the NYSDEC, in the discussion of alternatives in Chapter 8 of this SEIS.

The potential for impacts from continued operation of IP2 and IP3 on historic or archeological resources eligible for the National Register is SMALL. However, as noted in the NRC staff walkover survey discussed in Chapter 2 of this SEIS, there is a potential for prehistoric and historic archeological resources to be present on the northeastern portion of the site, although this area was previously disturbed by surface mining in the 19th century, the potential for intact prehistoric/historic and archeological resources remains. Further, recent investigations have identified existing historic and prehistoric resources on less-disturbed portions of the site south of the power block (Entergy 2009b). . Section 106 of the NHPA requires that lands not previously surveyed in the vicinity of IP2 and IP3 would require investigation by a professional archeologist in consultation with the NYSHPO before any ground-disturbing activities. To mitigate any potential adverse impacts to historic and archeological resources from continued plant operations in these areas, field surveys (archeological investigations) and consultation under the NHPA should be conducted before any ground-disturbing activities take place. Entergy's procedures should be followed to mitigate any potential adverse impacts to historic and archeological resources.

4.4.6 Environmental Justice

Under Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations" (Volume 59, page 7629 of the *Federal Register* (59 FR 7629)), Federal agencies are responsible for identifying and addressing potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued its "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions" (69 FR 52040), which states, "The Commission is committed to the general goals set forth in E.O. 12898, and strives to meet those goals as part of its NEPA review process."

The Council of Environmental Quality (CEQ) provides the following information in its publication entitled, "Environmental Justice: Guidance under the National Environmental Policy Act" (1997):

- **Disproportionately High and Adverse Human Health Effects.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).

- **Disproportionately High and Adverse Environmental Effects.** A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of IP2 and IP3 during the renewal term. In assessing the impacts, the following CEQ (1997) definitions of minority individuals and populations and low-income population were used:

(1) **Minority individuals**. Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.

(2) **Minority populations**. Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

(3) **Low-income populations**. Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

<u>Minority Population in 2000</u>

According to 2000 census data, 48.7 percent of the population (approximately 16,805,000 individuals) residing with a 50-mi (80-km) radius of IP2 and IP3 identified themselves as minority individuals. The largest minority group was Black or African American (3,480,000 persons or 20.7 percent), followed by Hispanic or Latino of any race (3,439,000 or about 20.5 percent) (USCB 2003—LandView 6). About 36 percent of the Westchester County population were minorities, with Hispanic or Latino the largest minority group (15.6 percent) followed by Black or African American (13.6 percent) (USCB 2008).

Census block groups with minority populations exceeding 50 percent were considered minority block groups. Based on 2000 census data, Figure 4-5 of this SEIS shows minority block groups within a 50-mi (80-km) radius of IP2 and IP3 in which more than 50 percent of the block group population is minority.

<u>Low-Income Population in 2000</u>

According to 2000 census data, approximately 484,000 families (approximately 11.7 percent) residing within a 50-mi (80-km) radius of the IP2 and IP3 were identified as living below the

Federal poverty threshold in 1999 (USCB 2003—LandView 6). The 1999 Federal poverty threshold was $17,029 for a family of four.

According to census data, the median household income for New York in 2004 was $45,343, while 14.5 percent of the State's population was determined to be living below the Federal poverty threshold. Westchester County had a much higher median household income ($63,924) and a lower percentage (8.9 percent) of individuals living below the poverty level when compared to the State. Dutchess, Orange, and Putnam Counties also had much higher median household incomes in 2004 ($56,971, $54,771, and $75,514, respectively) and lower percentages (7.7 percent, 10.2 percent, and 4.5 percent, respectively) of individuals living below the poverty level when compared to the State (USCB 2008).

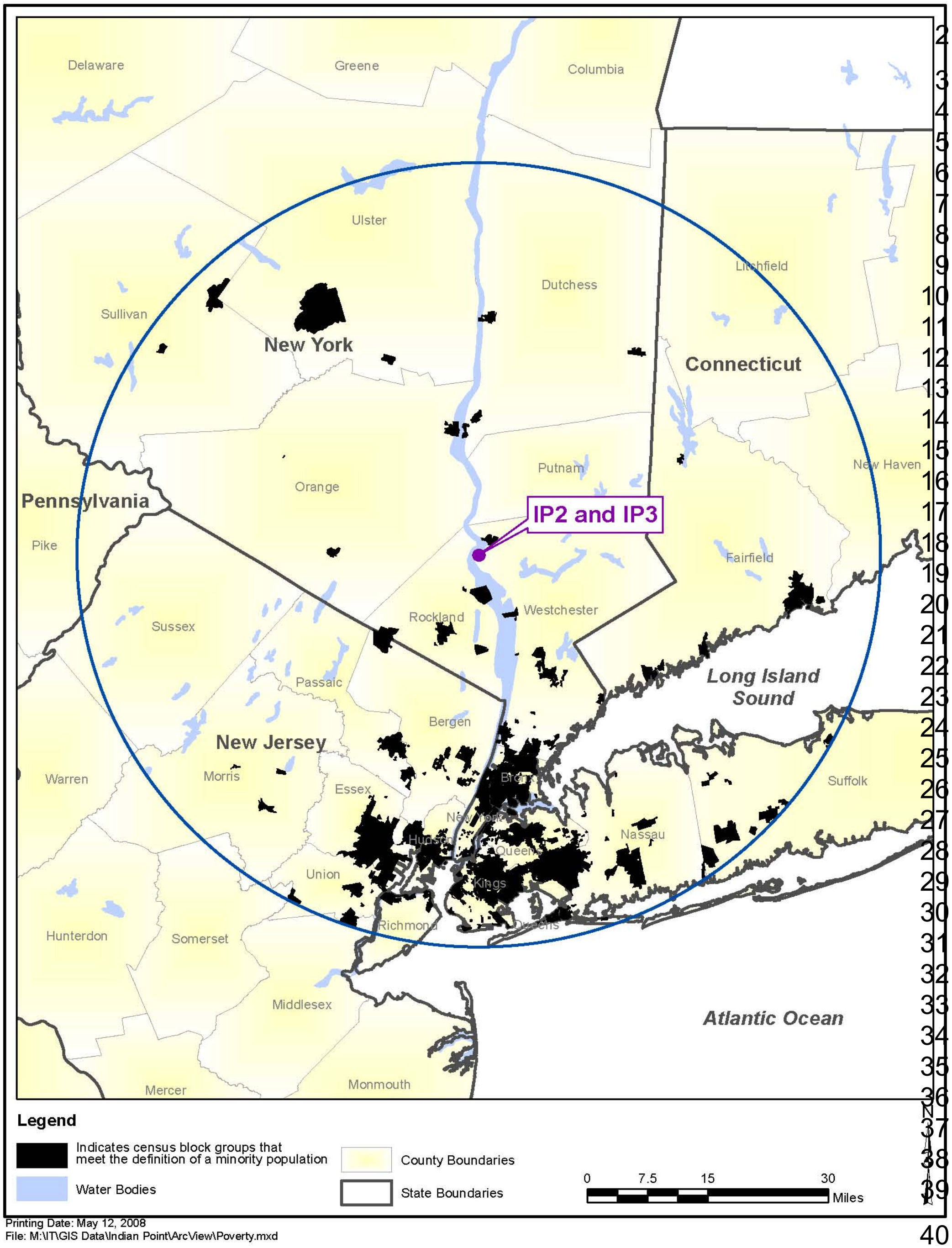


Figure 4-5. Minority block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

Census block groups were considered low-income block groups if the percentage of the population living below the Federal poverty threshold exceeded the State percentage of 14.5 percent. Based on 2000 census data, Figure 4-6 of this SEIS shows low-income block groups within a 50-mi (80-km) radius of IP2 and IP3.

Analysis of Impacts

The NRC addresses environmental justice matters for license renewal through (1) identification of minority and low-income populations that may be affected by the proposed license renewal, and (2) examining any potential human health or environmental effects on these populations to determine if these effects may be disproportionately high and adverse.

The discussion and figures above indentify the location of minority and low-income populations residing within a 50-mile (80-kilometer) radius of IP2 and IP3. This area of impact is consistent with the impact analysis for public and occupational health and safety, which also considers the radiological effects on populations located within a 50-mile (80-kilometer) radius of IP2 and IP3. As previously discussed for the other resource areas in Chapter 4, the analyses of impacts for all environmental resource areas indicated that the impact from license renewal would be SMALL.

Socioeconomic conditions in minority and low-income communities would not change as a result of renewing the IP2 and IP3 operating licenses. Employment levels and tax revenue would remain relatively unchanged, so direct and indirect employment opportunities caused by IP2 and IP3 would remain unchanged. Therefore, there would be no additional socioeconomic impact to minority and low-income populations during the license renewal term beyond what is currently being experienced.

Potential impacts to minority and low-income populations would mostly consist of radiological effects; however radiation doses from continued operations associated with license renewal are expected to continue at current levels, and would remain within regulatory limits. Chapter 5 discusses the environmental impacts from postulated accidents that might occur during the license renewal term, which include both design basis and severe accidents. In both cases, the Commission has generically determined that impacts associated with such accidents are SMALL because nuclear plants are designed and operated to successfully withstand design basis accidents, and the probability weighted impacts risks associated with severe accidents were also SMALL.

Therefore, based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5 of this SEIS, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of IP2 and IP3 during the license renewal period.

As discussed in Section 4.4.1, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Entergy estimates that this would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). This replacement activity would have little noticeable affect on minority and/or low-income populations in the region. These impacts are discussed in Chapter 3 of this SEIS.

As part of addressing environmental justice associated with license renewal, the NRC also analyzed the risk of radiological exposure through the consumption patterns of special pathway receptors, including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Subsistence Consumption of Fish and Wildlife

Section 4-4 of Executive Order 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this SEIS, the NRC staff considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the IP2 and IP3 site were considered.

Entergy has a comprehensive Radiological Environmental Monitoring Program (REMP) at IP2 and IP3 to assess the impact of site operations on the environment. Samples are collected from the aquatic and terrestrial pathways in the vicinity of IP2 and IP3. The aquatic pathways include fish, Hudson River water, ground water, aquatic vegetation, sediment, and shoreline soil. The terrestrial pathways include airborne particulates, broad leaf vegetation, and direct radiation. During 2006, Entergy or its contractors performed 1342 analyses on collected samples of environmental media as part of the required REMP which showed no significant or measurable radiological impact from IP2 and IP3 operations (ENN 2007).

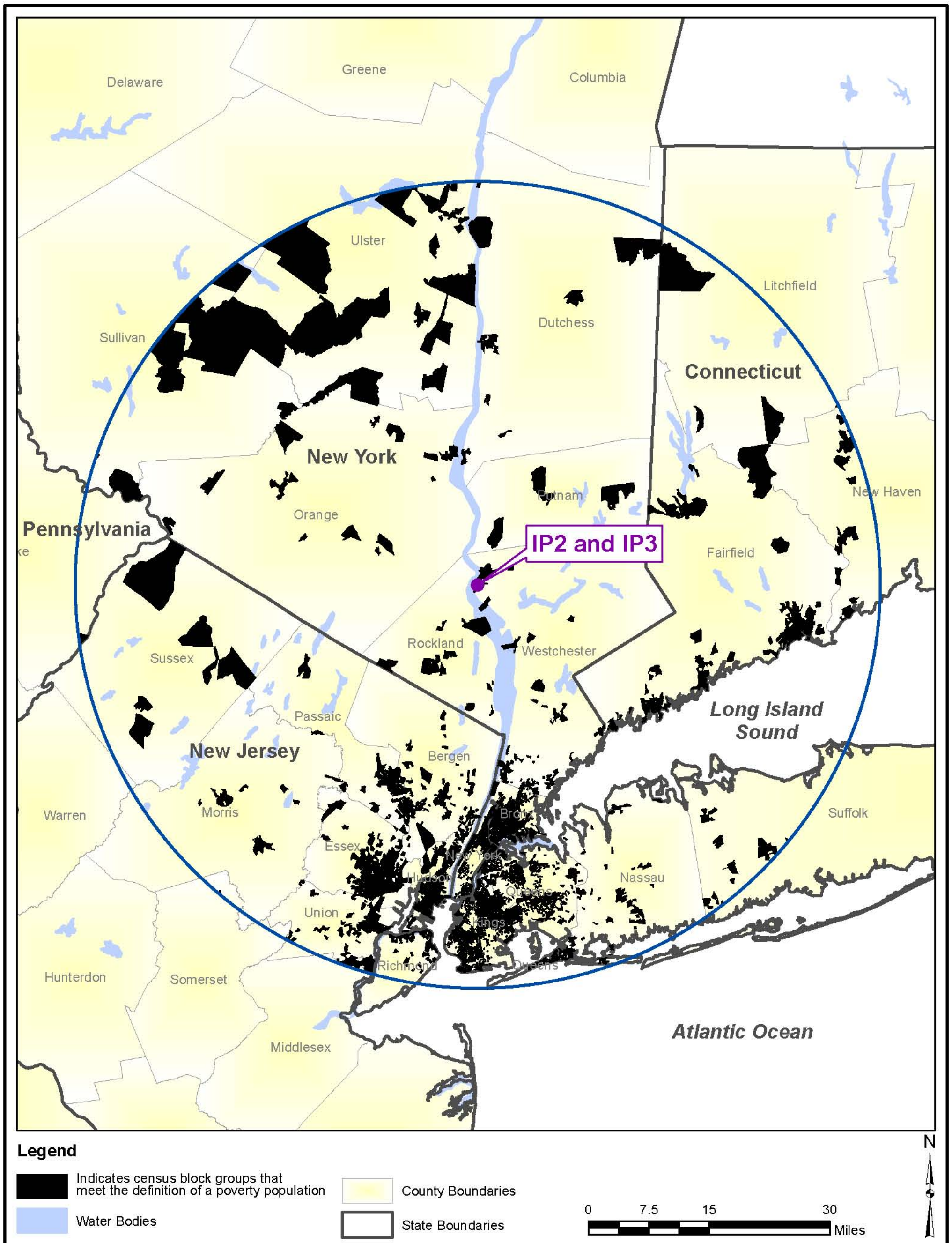


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Figure 4-6. Low-income block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

The NRC staff presents a summary of results from the IP2 and IP3 REMP program in Section 2.2.7 of this SEIS. The results of the 2006 REMP (the most recent available) demonstrate that the routine operation at the IP2 and IP3 site has had no significant or measurable radiological impact on the environment. No elevated radiation levels were detected in the offsite environment as a result of plant operations and the storage of radioactive waste. The results of the REMP continue to demonstrate that the operation of IP2 and IP3 did not result in a significant measurable dose to a member of the general population or adversely impact the environment as a result of radiological effluents. The REMP continues to demonstrate that the dose to a member of the public from the operation of IP2 and IP3 remains significantly below the Federally required dose limits specified in 10 CFR Part 20 and 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

The NRC staff's review of recent REMP monitoring results shows that concentrations of contaminants in native leafy vegetation, soils and sediments, surface water, and fish in areas surrounding IP2 and IP3 have been quite low (at or near the threshold of detection) and seldom above background levels. Consequently, the NRC staff concludes that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

4.5 Ground Water Use and Quality

No Category 1 or Category 2 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, are potentially applicable to IP2 and IP3 ground water use and quality during the renewal term. The applicant stated in its ER that IP2 and IP3 do not use any ground water, though onsite monitoring wells exist for the purpose of monitoring ground water conditions.

In the IP2 and IP3 ER, Entergy identified leakage from onsite spent fuel pools as potentially new and significant information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this SEIS. Based on the NRC staff's review of Entergy's analysis, the NRC staff's adoption of the NRC inspection report findings in this SEIS, and Entergy's subsequent statements (all discussed in Section 2.2.7), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

4.6 Threatened or Endangered Species

Potential impacts to 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 4-10.

Table 4-10. Category 2 Issues 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 under Section 7 of the Endangered Species Act of 1973 (ESA 1973) 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 facility during the license renewal term. The presence of threatened or endangered species in the vicinity of the IP2 and IP3 site is discussed in Sections 2.2.5.5 and 2.2.6.2 of this SEIS. In 2007, the NRC staff contacted NMFS and the U.S. Fish and Wildlife Service (FWS) to request information on the occurrence of threatened or endangered species in the vicinity of the site and the potential for impacts on those species from license renewal. NMFS identified in its response two Federally protected sturgeon species under its jurisdiction as having the potential to be affected by the proposed action (NMFS 2007a). FWS provided a link to the Web site of its New York Field Office, where lists of species occurrences were available by county (FWS 2007). Three terrestrial species with a Federal listing status were identified as potentially occurring at or near the site—the Indiana bat (*Myotis sodalis*), bog turtle (*Clemmys muhlenbergii*), and New England cottontail (*Sylvilagus transitionalis*).

Because the NRC recognizes that there is the potential that the continued operation of IP2 and IP3 could adversely affect the Federally listed species shortnose sturgeon (*Acipenser brevirostrum*), the NRC staff has prepared a biological assessment (BA) for NMFS that documents its review. The BA is provided in Appendix E to this SEIS. During informal consultation regarding the potential for effects on terrestrial threatened or endangered species, FWS determined that a BA was not needed because there was no likelihood of adverse effects on potentially occurring species under its jurisdiction (NRC 2008).

4.6.1 Aquatic Special Status Species

Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA 1973), the NRC staff requested in a letter dated August 16, 2007 (NRC 2007a), that NMFS provide information on Federally listed endangered or threatened species, as well as proposed candidate species. In its response on October 4, 2007 (NMFS 2007b), NMFS expressed concern that the continued operation of IP2 and IP3 could have an adverse impact on the shortnose sturgeon, an endangered species that occurs in the Hudson River. NMFS also noted that the Atlantic sturgeon (*A. oxyrinchus*) also occurs in the river and is currently a candidate for listing as threatened or endangered. The NRC staff also reviewed the list of threatened and endangered fish species available at the NYSDEC Web site (NYSDEC 2008a) and determined that the only listed species occurring in the Hudson River near the IP2 and IP3 facility was the shortnose sturgeon. Based on this information, the NRC staff determined that an analysis of impacts was required only for the shortnose sturgeon. The NRC staff has also included an assessment of impact for the Atlantic sturgeon in this section on special status species given its status as a candidate for listing.

As described in Section 2.2.5.5 of this SEIS, the shortnose sturgeon is amphidromous, with a range extending from St. Johns River, Florida, to St. John River, Canada. Unlike anadromous species, shortnose sturgeons spend the majority of their lives in freshwater and move to salt water periodically, independent of spawning periods (Collette and Klein-MacPhee 2002). The shortnose sturgeon was listed on March 11, 1967, as endangered under the Endangered Species Act of 1973, as amended. In 1998, a recovery plan for the shortnose sturgeon was finalized by NMFS (NMFS 1998).

Shortnose sturgeon are found in the lower Hudson River and are dispersed throughout the river-estuary from late spring to early fall, congregating to winter near Sturgeon Point (RKM 139; RM 86). The population of shortnose sturgeon in the Hudson River has increased 400 percent since the 1970s, according to Cornell University researchers (Bain et al. 2007). Woodland and Secor (2007) estimate a fourfold increase in sturgeon abundance over the past 3 decades, but report that the population growth slowed in the late 1990s as evidenced by the nearly constant recruitment pattern at depressed levels relative to the classes in 1986–1992. Although the Hudson River appears to support the largest population of shortnose sturgeon in the region, Bain et al. (2007) report that other populations along the Atlantic coast are also increasing and some appear to be nearing safe levels, suggesting that the overall population could recover if full protection and management continue.

As described in Section 2.2.5.5 of this SEIS, the Atlantic sturgeon is an anadromous species with a range extending from St. Johns River, Florida, to Labrador, Canada. This species is long lived, matures slowly, and can reach 60 years of age (ASMFC 2007b; Gilbert 1989). In 1996, the State of New York placed a moratorium on harvesting Atlantic sturgeon when it became apparent that the Hudson River stock was overfished. Unfortunately, the American shad gill net fishery continues to take subadult sturgeon as bycatch (e.g., the unintentional collection of some species during the harvest or others). The Status Review Team for Atlantic Sturgeon concluded in 2007 that the Hudson River subpopulation has a moderate risk (less than 50 percent) of becoming endangered in the next 20 years because of the threat of commercial bycatch. However, the New York Bight distinct population segment, which includes the Hudson River subpopulation, was determined to have a greater than 50-percent chance of becoming endangered in the foreseeable future. Despite this, the Hudson River supports the largest subpopulation of spawning adults and juveniles, and the abundance appears to be stable or even increasing (ASSRT 2007). Recent work by Sweka et al. (2007) suggests that a substantial population of juvenile Atlantic sturgeon is present in Haverstraw Bay, and that this area should be the focus of future monitoring studies to obtain the greatest statistical power for assessing population trends.

To determine the potential adverse impacts of the IP2 and IP3 cooling system on these species, the NRC staff evaluated the potential effects of entrainment, impingement, and thermal discharges for all RIS, including both sturgeon species, in Sections 4.1.1, 4.1.2, and 4.1.3 of this SEIS. Based on an evaluation of entrainment data provided by the applicant, there is no evidence that the eggs or larvae of either species are commonly entrained at IP2 or IP3. The potential impacts of thermal discharges on shortnose and Atlantic sturgeon cannot be determined at this time because additional studies are required to quantify the extent and magnitude of the thermal plume, as discussed in Section 4.1.4 of this SEIS.

Corrected impingement data provided by the applicant after the publication of the draft SEIS (Entergy 2007b and 2009) shows that both species of sturgeon have been impinged at IP2 and

IP3, with impingement of Atlantic sturgeon accounting for the largest losses (Table 4-11). The corrected data, however, reflect an order of magnitude less impingement than had been suggested earlier. The corrected impingement data for the endangered shortnose sturgeon show that from 1975 to 1990, 20 fish were impinged at IP2 and 11 fish were impinged at IP3. Impingement of Atlantic sturgeon was much greater than that observed for shortnose sturgeon, with 250 fish impinged at IP2 and 265 fish impinged at IP3 between 1975 and 1988. Installation of modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement levels. Nonetheless, because more recent data are not available, the NRC staff cannot determine whether the current impingement losses are similar to the past observations.

Table 4-11. Impingement Data for Shortnose and Atlantic Sturgeon at IP2 and IP3, 1975–1990 (data from Entergy 2009 and Barnthouse et al. 2009)

Study Year	IP2		IP2 Total	IP3		IP3 Total	Grand Total
	Shortnose Sturgeon	Atlantic Sturgeon		Shortnose Sturgeon	Atlantic Sturgeon		
1975	1	118	119	NS[a]	NS	NS	119
1976	2	8	10	0	8	8	18
1977	6	44	50	1	153	154	204
1978	2	16	18	3	21	24	42
1979	2	32	34	2	38	40	74
1980	0	9	9	1	10	11	20
1981	0	3	3	0	5	5	8
1982	0	1	1	0	1	1	2
1983	0	3	3	0	0	0	3
1984	1	3	4	1	5	6	10
1985	0	8	8	0	17	17	25
1986	0	2	2	0	4	4	6
1987	2	2	4	1	1	2	6
1988	3	1	4	1	0	1	5
1989	0	0	0	1	0	1	1
1990	1	0	1	0	2	2	3
Grand Total	20	250	270	11	265	276	546

[(a)] – = not sampled, unit not in operation

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from NMFS. Based on the WOE information presented in Table 4-4, The NRC staff concludes that the impacts associated with the IP2 and IP3 cooling system are Small for both Atlantic and shortnose sturgeon. The population trend LOE evaluation was unresolved because the Hudson River monitoring programs were not designed to catch either species. The NRC staff was also unable to determine the strength of connection for either species using the Monte Carlo simulation modeling. Because historical impingements of sturgeon have been relatively low, especially for shortnose sturgeon, the NRC staff concluded that the strength of connection was low. Based on the WOE analysis described above, a determination of Moderate or Large impact is not supported, and the NRC staff concludes that the impacts of an additional 20 years (beyond the current term) of operation and maintenance of the site on aquatic species that are Federally listed as threatened or endangered is SMALL.

The NRC staff is sending a revised biological assessment (BA) of the impacts of license renewal on the shortnose sturgeon to NMFS to review as this SEIS goes to press (the BA will be publicly available at ML102990042). Should NMFS determine that continued operation of IP2 and IP3 has the potential to adversely impact the shortnose sturgeon, NMFS will issue a biological opinion. Included in the biological opinion would be any reasonable and prudent measures that the applicant could undertake, as well as the terms and conditions for the applicant to comply with the formal Section 7 consultation. Possible mitigation measures could range from a resumption of monitoring to determine the number of shortnose sturgeon impinged at IP2 and IP3 to changes in the cooling water intake system, as described in Section 4.1.5 of this FEIS. Additionally, as described in Chapter 8, the installation of cooling towers could reduce impingement, entrainment, and thermal impacts for all aquatic resources, including those that are Federally listed.

4.6.2 Terrestrial Threatened or Endangered Species

There are two Federally listed terrestrial species that have the potential to occur at or near the IP2 and IP3 site and its associated transmission line ROWs, the endangered Indiana bat (M. *sodalis*) and the threatened bog turtle (C. *muhlenbergii*). A candidate species, the New England cottontail (S. *transitionalis*), also may occur in the vicinity. The characteristics, habitat requirements, and likelihood of occurrence of each of these species are discussed in Section 2.2.6.2 of this SEIS.

Although Westchester County is within the potential range of the Indiana bat in New York, winter hibernacula and summer maternity colonies and bachelor colonies are not known to be present in the county or the vicinity of the site (NYNHP 2008a). The NRC staff notes that it is possible that the 70-acre (ac) (28-hectare (ha)) forest at the north end of the site could provide summer habitat for the Indiana bat because of the presence of suitable foraging habitat and possible roosting trees in the forest and the presence of large hibernacula within migration distance of the site. The ER indicated that no expansion of existing facilities or disturbance of forest or other land on the site would occur during the renewal period. Thus, even if Indiana bats currently utilize habitat on the site, it is not likely that they would be adversely affected by ongoing operations and maintenance activities during the renewal period.

In Section 2.2.6.2, the NRC staff noted that the IP2 and IP3 site area does not have suitable habitat for the bog turtle, and that bog turtles have not been observed in the region of Westchester County near the IP2 and IP3 site (NYSDEC 2008b). The NRC staff acknowledged that wetlands nearest the site had not, however, been evaluated for the presence of the bog turtle. Given the available information, the NRC staff concludes that the bog turtle is not likely to occur on or in the immediate vicinity of the site.

The known locations of the New England cottontail in Westchester County are in the central and northeastern areas of the county (NYNHP 2008b), not in the northwestern area where the site is located. The forests on the site consist mainly of mature hardwoods and do not contain early successional habitats, such as thickets, that are required by the New England cottontail, so the

NRC staff does not expect the species to occur on or in the immediate vicinity of the site.

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from FWS. Operation of IP2 and IP3 is not expected to adversely affect any threatened or endangered terrestrial species during the license renewal term. Therefore, the NRC staff concludes that the impacts of an additional 20 years of operation and maintenance of the site, on terrestrial species that are Federally listed as threatened or endangered would be SMALL. Because no listed species are known to be present in the area of the IP2 and IP3 site, there are no recommended mitigation measures, unless the applicant becomes aware of the presence of a listed species, in which case appropriate protective action should be taken, and the NRC and FWS should be notified. Informal consultation with FWS indicated that formal consultation and a BA are not required for terrestrial threatened or endangered species.

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

The NRC staff has conducted its own independent review of environmental issues through staff research, consultation with State and Federal agencies, and comments delivered to the NRC by the public during the environmental scoping period and comments on the draft SEIS to identify potentially new and significant information about environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, related to operation of IP2 and IP3 during the renewal term. Processes for identification and evaluation of new information are described in Section 1.2.2 of this SEIS.

As discussed in Section 2.2.7 of this SEIS and synopsized in Section 4.5 of this chapter, Entergy identified leakage from onsite spent fuel pools as potentially new information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this SEIS. Based on the NRC staff's review of Entergy's ground water analyses, the NRC ground water inspection report, and Entergy's subsequent statements (all discussed in Section 2.2.7 of this SEIS), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while constituting new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff did not identify any other information that was both new and significant. As such, the NRC staff adopts the GEIS findings for Category 1 issues applicable to Indian Point, as described in the previous sections of this chapter.

4.8 Cumulative Impacts

The NRC staff considered potential cumulative impacts on the environment resulting from past, present, and reasonably foreseeable future actions. The geographical area over which past, present, and future actions are assessed is dependent on the affected resource.

The impacts of the proposed action, license renewal, as described in previous sections of

Chapter 4 of this SEIS, are combined with other past, present, and reasonably foreseeable future actions in the potentially affected area regardless of which agency (Federal or non-Federal) or entity is undertaking the actions. The combined impacts are defined as "cumulative" in 40 CFR 1508.7, "Cumulative Impact," and include individually minor but collectively significant actions taking place over a period of time (CEQ 1997). It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL direct or indirect impact could be important if it contributes to or accelerates the overall resource decline.

The NRC staff has identified the principal past, present, and reasonably foreseeable future actions potentially impacting the environment affected by IP2 and IP3. The potential cumulative impacts of these actions are discussed below.

4.8.1 Cumulative Impacts on Aquatic Resources

The purpose of this section is to address past, present, and future actions that have created or could result in cumulative adverse impacts to the aquatic resources of the lower Hudson River. In Section 2.2.5.2 of this SEIS, the NRC staff discussed a wide variety of historical events that have affected the Hudson River and its resources. The NRC staff notes that these historical events are contributors to the cumulative effects on the Hudson River. In addition to the past events in Section 2.2.5.2, the NRC staff has identified a variety of current and likely future stressors that may also contribute to cumulative impacts. These stressors, included in the following list, are consistent with those identified by the Pew Oceans Commission (2003).

- the continued operation of the IP2 and IP3 once-through cooling system (addressed in Section 4.1 of this Chapter)
- continued withdrawal of water to support fossil fuel electrical generation or water for human use
- the presence of invasive or nuisance species
- fishing pressure
- habitat loss
- changes to water and sediment quality
- climate change

Each of these potential stressors may influence the structure and function of freshwater, estuarine, and marine food webs and result in observable changes to the aquatic resources in the lower Hudson River estuary. Examples of measurable changes to aquatic resources could include the following:

- reductions or increases in RIS populations or changes in their distribution
- changes in predator-prey relationships or noticeable alterations to food webs, including the permanent loss of species

- changes in contaminant body-burdens in fish and shellfish that result in the imposition or lifting of consumption advisories
- introduction of exotic or nuisance species and increases or decreases in populations of existing invasive species

What follows is a brief discussion of how the stressors listed above might have cumulative impacts on aquatic resources of the lower Hudson River estuary. An expanded discussion of cumulative impacts is presented in Appendix H to this SEIS. Because in most cases it is not possible to quantitatively determine the impact of each stressor, or a collection of stressors, on the aquatic resources of the lower Hudson River, the following is a general discussion of cumulative impacts.

Continued Operation of the IP2 and IP3 Once-Through Cooling System

Based on the assessment presented in Sections 4.1.3 and 4.1.4 of this SEIS, the NRC staff concludes that the operation of IP2 and IP3 has the potential to adversely affect a variety of RIS species that currently exist in the Hudson River between Troy Dam and the Battery. Based on the staff's analysis of entrainment and impingement impacts, effects to RIS range from SMALL to LARGE, depending on the species affected. As discussed in Section 4.6.1 of this SEIS, it is also possible that the operation of IP2 and IP3 could be affecting the endangered shortnose sturgeon and the listed Atlantic sturgeon. If the IP2 and IP3 once-through cooling system continues to operate as it has for the past 3 decades, the NRC staff finds that it will continue to contribute to cumulative effects.

Continued Water Withdrawals

As described in Section 2.2.5 of this SEIS, water is withdrawn from the Hudson River to support fossil fuel electrical generation and to provide a source of drinking water. Although some fossil fuel electrical generating stations that use natural gas or oil operate only intermittently, coal-fired electrical generation stations that employ once-through cooling systems are expected to continue to operate in the future. Likewise, water withdrawals in the freshwater portions of the Hudson River will continue to occur and increase in the future. Because the NRC staff concludes that water withdrawals from the Hudson River to support human needs will continue and will likely increase during the relicensing term, this stressor will continue to contribute to the cumulative effects in the river.

Invasive and Nuisance Species

As discussed in Section 2.2.5 of this SEIS, the presence of invasive or nuisance species in the Hudson River estuary has been documented for over 200 years. While the presence of new or exotic species can benefit some existing species, introductions of new species often have a negative impact on their new environment. A classic example of the latter is the appearance of the zebra mussel in the freshwater portion of the Hudson River in 1991. Since 1992, zebra mussels have been a dominant species in the freshwater tidal portion of the Hudson River and constitute more than half of heterotrophic biomass. Strayer (2007) estimated that the current population is capable of filtering a volume of water equal to all of the water in the estuary every 1 to 4 days during the summer.

Some evidence suggests that the presence of zebra mussels can affect the species composition in the Hudson River and the abundance of some Hudson River RIS. Strayer et al.

(2004) hypothesized that the abundance or growth rates of American shad, blueback herring, alewife, gizzard shad, white perch, and striped bass would decline following the zebra mussel invasion or that their distributions within the river would shift downriver away from the zone of greatest zebra mussel impacts. The authors found that significant decreases in the estimated river-wide abundance of early life stages of several species of fish, including American shad and white perch, coincided with the zebra mussel invasion. Barnthouse et al. (2008) also concluded that zebra mussels may have contributed to declines in white perch populations but rejected the hypothesis that zebra mussels were affecting American shad. The NRC staff's independent analysis concluded that the presence of zebra mussels in the river would have a Small potential for adverse impacts to the alewife, American shad, blueback herring, spottail shiner, striped bass, white catfish, and white perch (Appendices H and I). The presence of invasive or nuisance species in the lower Hudson River will continue to be a concern, as it is in other locations throughout the world, and the presence of these species will continue to represent an important source of cumulative impacts to the river.

<u>Fishing Pressure</u>

Many RIS are commercially or recreationally important, and are thus subject to effects from fishing pressure. In many cases, the commercial or recreational catches of RIS are regulated by Federal or State agencies or entities, but losses of some RIS continue to occur as the result of bycatch. The extent and magnitude of fishing pressure and its relationship to overall cumulative impacts to the aquatic resources of the lower Hudson River is difficult to determine because of the large geographic scale and the natural variation that exists in the system. Recent work by Barnthouse et al. (2008) has suggested that fishing pressure is contributing to the decline of some RIS in the lower Hudson River, but this could not be confirmed by the staff. The staff does acknowledge that fishing pressure (or the lack of it due to catch restrictions) has the potential to influence the freshwater, estuarine, and marine food webs present in the lower Hudson River and may contribute to cumulative impacts in the future.

<u>Habitat Loss</u>

As described in Section 2.2.5 of this SEIS, alterations to terrestrial, wetland, nearshore, and aquatic habitats have occurred in the Hudson River estuary since colonial times. During the colonization of the region, upland habitat alterations profoundly influenced watershed dynamics. The creation of dams and the filling or isolation of wetlands to support industrial activities have dramatically changed patterns of nutrients and sediment loading to the estuary. In addition, historic dredging activities altered aquatic environments and affected river flow patterns, and future activities, as described in Section 2.2.10 of this SEIS, may continue to influence the river. Finally, development along the shores of the Hudson has resulted in the loss or isolation of nearshore habitat, and the armoring of the shoreline in the lower portions of the river from Yonkers to the Battery has effectively eliminated nearshore habitat. The NRC staff recognizes that Federal, State, and local agencies, as well as many NGOs, are interested in restoring habitat lost during past development and notes that the identification of four locations along the lower Hudson River estuary for inclusion in the National Estuarine Research Reserve System in 1982 represents an important step in protecting and restoring important habitats.

Because habitat loss remains a concern, the NRC staff concludes that this stressor will continue to be an important contributor to cumulative impacts to the lower Hudson River.

Water and Sediment Quality

In general, there is evidence to conclude that the overall quality of water and sediment in the lower Hudson River is improving. Cleanup of polychlorinated biphenyls in stretches of the river above the Troy Dam continues, and upgrades to wastewater treatment facilities during the past 20 years have reduced the amount of untreated sewage discharged into the river and contributed to reductions in nutrients and an apparent increase in dissolved oxygen. Chemical contaminants continue to persist in the tissues of fish and invertebrates inhabiting the lower Hudson River, and the presence of nonpoint discharges of chemicals and constituents continues to be a concern of local, State, and Federal regulatory agencies and NGOs. The NRC staff concludes that the quality of water and sediment in the lower Hudson River will continue to be a concern and a potential contributor to cumulative impacts.

Climate Change

The potential cumulative effects of climate change on the Hudson River watershed, whether from natural cycles or related to anthropogenic activities, could result in a variety of changes that would affect aquatic resources. The environmental factors of significance identified by Kennedy (1990) that could affect estuarine systems included sea level rise, temperature increase, salinity changes, and wind and water circulation changes. Changes in sea level could result in dramatic effects to nearshore communities, including the reduction or redistribution of submerged aquatic vegetation, changes to marsh communities, and influences to wetland areas adjacent to nearshore systems. Water temperature increases could affect spawning patterns or success, or influence the distribution of key RIS when cold-water species move northward while warm-water species become established in new habitats. Changes to river salinity and the presence of the salt front could influence the spawning and distribution of RIS and the range of exotic or nuisance species. Fundamental changes in precipitation could profoundly influence water circulation and change the nature of sediment and nutrient inputs to the system. This could result in changes to primary production and influence the estuarine food web on many levels. Kennedy (1990) also concluded that some fisheries and aquaculture enterprises might benefit from climate change, while others would suffer extensive economic losses.

The extent and magnitude of climate change impacts to the aquatic resources of the lower Hudson River are an important component of the cumulative assessment analyses and could be substantial.

Final Assessment of Cumulative Impacts on Aquatic Resources

Based on the NRC staff’s review, it is clear that Hudson River RIS are affected (some to a lesser degree than others) by multiple stressors. The NRC staff’s analysis (Appendix H) demonstrated that the food web and abundance of RIS were noticeably altered, and many RIS appeared to be directly influenced by the operation of the IP2 and IP3 cooling system (e.g., high strength of connection). The impacts of some of the stressors may be addressed by management actions (e.g., IP2 and IP3 cooling system operation, fishing pressure, and water quality) and some cannot (e.g., long-term impacts associated with climate change). Although the impacts associated with increased human populations and associated development of the Hudson River basin, climate change, redistribution of resources, and the presence of invasive species and disease cannot be quantitatively calculated, the cumulative impacts on aquatic resources have had destabilizing effects on Hudson River living resources, including threatened and endangered species (i.e., the net effect of all stressors destabilized some populations) and are considered by the NRC staff to be LARGE.

4.8.2 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in cumulative adverse impacts on terrestrial resources, including wildlife populations, vegetation communities of uplands and riparian zones, wetlands, and land use. For purposes of this analysis, the geographic area considered consists of the IP2 and IP3 site, which encompasses its associated transmission line ROWs, and the surrounding region of the lower Hudson Valley.

The changes in land use associated with historical settlement and development of this region are described in Section 2.2.5.2 of this SEIS. During precolonial and colonial settlement by European immigrants, large areas of the forest that had almost completely covered the region were cleared for agriculture, and by 1880, 68 percent of the Hudson River watershed had become farmland. Also in the 19th century, major changes in land use occurred in the region in conjunction with the industrial revolution as human populations grew and houses, roads, railroads, bridges, and industrial facilities were constructed. These historical trends of increasing development and decreasing terrestrial habitat in the region continued through the 20th century to the present, resulting in large reductions in native forests and other habitats for terrestrial wildlife, increases in precipitation runoff due to impervious surfaces, and pollution (Swaney et al. 2006).

Before the historical clearing of land at the IP2 and IP3 site, the terrestrial communities of the area consisted mainly of upland and riparian forests (NRC 1975). The site was originally purchased in 1683 by a Dutch settler, who established a homestead there. By the latter 19th century, the north end of Indian Point was being surface mined for iron, and a lime kiln and blast furnace were located at the shoreline. By 1900 a brickyard existed on the site, and farming still occurred there. In 1920 an amusement park was built on the site. The park closed in 1956, and construction of the first commercial nuclear reactor in the United States then began at the site (Enercon 2007). Thus, the site had been largely cleared of forest and developed for various uses for well over a century before its development for power generation began in the second half of the 20th century. Power plant development resulted in over half of the site (134 ac (54.2 ha)) being covered by facilities and pavement, with forest having regenerated at the north end of the site where mining occurred historically. Remaining native forest habitat in central and southern portions of the site has been fragmented by roads, ROWs, parking areas, and other development, a phenomenon that has commonly occurred in the region.

Developed areas with impervious surfaces have increased precipitation runoff and reduced infiltration into the soil, thus reducing ground water recharge, altering streamflow, and increasing soil erosion. Maintenance of vegetation in ROWs and other developed areas, such as by mowing and spraying of herbicides, has altered the ecological communities in these areas by preventing natural succession. It also likely has resulted in increases in invasive species, such as Japanese knotweed (*Fallopia japonica*), which typically are more aggressive than native species in colonizing disturbed areas; increases in species that prefer edge habitat; and decreases in species that prefer interior forest habitat. Such effects from development within the IP2 and IP3 site contribute to cumulative impacts from similar effects on native ecological communities from other development in the region.

Land use data provide an indication of the impacts on terrestrial resources that have resulted from historical and ongoing development. Current land uses in the region are discussed by county in Section 2.2.8.3 of this SEIS. In Westchester County, based on 1992 data, forest was the predominant type of land cover (53 percent), followed by residential (30 percent), agricultural and recreational (7 percent), and commercial/industrial/transportation uses (3 percent) (Entergy 2007a). In four nearby counties in the lower Hudson Valley (Rockland, Orange, Putnam, and Dutchess), forest also was the predominant type of land cover, followed by residential or agricultural, and commercial/industrial/transportation land uses ranged from about 1 to 4 percent (Entergy 2007a). Thus, commercial, industrial, and transportation facilities, including the IP2 and IP3 site, have had a relatively small impact on the loss of native terrestrial forest habitats in the region compared to residential and agricultural development. The commercial, industrial, and transportation facilities that have impacted terrestrial resources in the region in addition to the IP2 and IP3 site include six power generation facilities on the Hudson River between RM 37 and 67 (RKM 60 to 97), highways, railways along both sides of the river, and manufacturing plants.

Although development of the site has contributed to cumulative impacts on terrestrial resources from historical and ongoing development in the region, portions of the site have been protected from development. The 70-ac (28-ha) forest community at the north end of the site has been and, under the proposed action, would continue to be preserved, providing a beneficial effect by reducing the potential for cumulative impacts from further loss of forests in the region. In conjunction with this onsite forest tract, public lands in the region also preserve forest habitat and have a beneficial cumulative impact on terrestrial resources. These lands include three State parks in Westchester County and a total of 22 others in Rockland, Orange, Putnam, and Dutchess Counties (Entergy 2007a), as well as forested lands of the New York State National Guard's Camp Smith and the U.S. Military Academy at West Point.

Ultimately, development of the IP2 and IP3 site for power generation contributed incrementally to a substantial, cumulative reduction in terrestrial resources resulting from other development activities in the region that have occurred since precolonial times. However, as discussed in Section 4.4.3 of this SEIS, there would be no population-related land use impacts attributable to IP2 and IP3 during the license renewal term beyond those already being experienced, and there would be no noticeable change in land use conditions in the vicinity of IP2 and IP3.

The NRC staff concludes that the impact of past, present, and reasonably foreseeable future actions in the region on terrestrial resources is considered LARGE relative to predevelopment conditions, and that much of this impact had occurred before the construction and operation of IP2 and IP3.

4.8.3 Cumulative Radiological Impacts

The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of the IP2 and IP3 site was included. The radiological environmental monitoring program conducted by Entergy in the vicinity of the IP2 and IP3 site measures radiation and radioactive materials from all sources; therefore, the monitoring program measures cumulative radiological impacts. Within the 50-mi (80-km) radius of the IP2 and IP3 site there are no other nuclear power reactors or uranium fuel cycle facilities. The NRC staff reviewed the 1993 and 1994 radiological environmental monitoring data from the area around IP2 and IP3 reported by New York State; the data showed no adverse environmental impact. For the new issue identified by Entergy concerning the tritium leak into the Hudson River, the NRC staff also reviewed the information reported by Entergy, the NYSDEC and NYSDOH, and by the NRC. No adverse impacts were identified (Entergy 2007b, NYSDEC and NYSDOH 2008, NRC 2006b, NRC 2007b).

Radiation monitoring results for the 5-year period from 2002 to 2006 were reviewed as part of the cumulative impacts assessment. In Sections 2.2.7 and 4.3 of this SEIS, the NRC staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of IP2 and IP3 during the renewal term are SMALL. The NRC and the State of New York would regulate any future actions in the vicinity of the IP2 and IP3 site that could contribute to cumulative radiological impacts (Entergy 2003, 2004, 2005, 2006, 2007b).

Entergy constructed an independent spent fuel storage installation (ISFSI) on the IP2 and IP3 site in 2008 for the storage of its spent fuel. The installation and monitoring of this facility is governed by NRC requirements in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste." Radiation from this facility as well as from the operation of IP2 and IP3 must not exceed the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 72 (Entergy 2007a).

In addition, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and CRDMs during the period of extended operation. Such an action is not expected to change the applicant's ability to maintain radiological doses to members of the public well within regulatory limits because the amount of radioactive liquid, gaseous, and solid waste is not expected to increase significantly (see Sections 2.1.4 and 2.2.7 of this SEIS for the detailed discussion).

For these reasons, the NRC staff concludes that cumulative radiological impacts are SMALL, as are the contribution to radiological impacts from continued operation of IP2 and IP3 and their associated ISFSI. The NRC and the State of New York will continue to regulate operation of IP2 and IP3 for radiological impacts.

4.8.4 Cumulative Socioeconomic Impacts

As discussed in Section 4.4 of this SEIS, continued operation of IP2 and IP3 during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already being experienced. Since Entergy has indicated that it plans to hire no additional non-outage workers during the license renewal term, overall expenditures and employment levels at IP2 and IP3 would be expected to remain relatively constant with no additional demand for permanent housing, public utilities, and public services. In addition, since employment levels and the value of IP2 and IP3 would not change, there would be no population and tax-revenue-related land use impacts. Also, there would be no disproportionately high and adverse health and environmental impacts on minority and low-income populations in the region.

Entergy has indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs, Entergy estimates that this replacement activity would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would create short-term increases in the demand for temporary (rental) housing, increased use of public water and sewer services, and transportation impacts on access roads in the immediate vicinity of IP2 and IP3. Given the short amount of time needed for this replacement activity, the cumulative effects of these replacement activities on socioeconomic conditions in the vicinity of IP2 and IP3 would not likely be noticeable. Also, there would be no long-term cumulative socioeconomic impacts after the reactor vessel heads and CRDMs are replaced.

In general, the region surrounding IP2 and IP3 has experienced growing population, increasing economic activity and tax revenue, and changes in demographics over time. These effects in the region have been LARGE, though the contribution of IP2 and IP3 to these effects have been SMALL, except, in some cases, locally. Additionally, development in the region has had a significant effect on historical and archaeological resources, which could be LARGE, as the region is home to significant historic and prehistoric resources (as noted in 4.4.5, however, continued operation of the plant would only have SMALL effects on historic and archaeological resources).

4.8.5 Cumulative Impacts on Ground Water Use and Quality

In 2005 tritium was located in ground water beneath the IP2 and IP3 site. During a subsequent subsurface monitoring program at the site, radioactive forms of cesium, cobalt, nickel, and strontium also were found. The radiological impact of these elements to the ground water is discussed in Section 2.2.7 of this SEIS, and referenced in Sections 4.5 and 4.7.

The topography of the site and the foundation drains around the structures result in a flow regime that transports ground water towards the Hudson River. As a result, the contaminated ground water will be transported to the Hudson River and not offsite in a direction that might lead it to be captured by an offsite ground water user. The results of monitoring programs support this conclusion.

Because the water travels offsite and into the Hudson River, there are no users for onsite ground water. Any effects from the plant, previous development, or future development on site will likely remain confined to effects on ground water transiting the site to the Hudson River, and thus, are likely to be limited.

On the basis of the topography of the site, the characteristics of the subsurface media, location of the plant relative to the Hudson River, recent ground water monitoring observations, and the fact that there are no users for the site's ground water, the NRC staff concludes that the cumulative impact on the site's ground water use and quality are SMALL.

4.8.6 Conclusions Regarding Cumulative Impacts

The NRC staff considered the potential impacts resulting from the operation of IP2 and IP3 and resulting from other past, present, and reasonably foreseeable future actions in the vicinity. The NRC staff's determination is that the cumulative impacts to the environment surrounding IP2 and IP3 from past and present human activities (beyond impacts from IP2 and IP3) have generally been LARGE and could continue to be LARGE in some issue areas. Future development is likely to continue to affect these resources.

4.9 Summary of Impacts of Operations during the Renewal Term

The NRC staff did not identify any information that is both new and significant related to any of the applicable Category 1 issues associated with the operation of IP2 and IP3 during the renewal term, including information related to ground water contamination at Indian Point. 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.

Thirteen of the site-specific environmental issues identified in the GEIS related to operational impacts and postulated accidents during the renewal term are discussed in detail in this SEIS. These include 11 Category 2 issues and two uncategorized issues (environmental justice and the chronic effects of EMFs). The NRC staff did not evaluate the chronic effects of EMFs because research is continuing in the area and no scientific consensus on human health impacts exists. The NRC staff's will evaluation of severe accident mitigation alternatives is in Chapter 5.

For 6 of the remaining 10 Category 2 issues and environmental justice, the NRC staff concluded that the potential impacts of continued plant operation during the license renewal period on these issues are of SMALL significance in the context of the standards set forth in the GEIS. For four of these issues, the NRC staff concluded that the impacts of continued operation would have a significant effect. On the issue of heat shock on the aquatic ecology, the NRC staff concludes that effects are of SMALL to LARGE significance, given uncertainty about actual thermal effects of the plant. The NRC staff evaluated the combined effects of entrainment and impingement on aquatic life and found the impacts to be MODERATE. However, these impact level conclusions are based on historical data as previously discussed in this SEIS. Finally, unlike in the draft SEIS, the NRC staff found that impacts to threatened and endangered aquatic species are likely to be SMALL, based on corrected data submitted by Entergy.

4.10 References

Abood, K.A., T.L. Englert, S.G. Metzger, C.V. Beckers, Jr., T.J. Groninger, and S. Mallavaram. 2006. Current and evolving physical and chemical conditions in the Hudson River Estuary. American Fisheries Society Symposium 51:39-61.

Achman, D.R., B.J. Brownawell, and L. Zhang. 1996. Exchange of polychlorinated biphenyls between sediment and water in the Hudson River Estuary. Estuaries 19(4):950-965.

Atlantic States Marine Fisheries Commission (ASMFC). 2006. "Species Profile: Atlantic Striped Bass, The Challenges of Managing a Restored Stock." Available at URL: http://www.asmfc.org/speciesDocuments/stripedBass/speciesprofile.pdf. Accessed December 10, 2007.

Atlantic States Marine Fisheries Commission (ASMFC). 2007a. "Species Profile: Weakfish—The Challenge of Managing a Stock Decline When Fishing is Not the Cause." ASMFC Fisheries Focus, Vol. 16, Issue 4: May/June 2007. Accessed at http://www.asmfc.org/speciesDocuments/weakfish/weakfishProfile.pdf on February 17, 2008.

Atlantic States Marine Fisheries Commission (ASMFC). 2007b. "Species Profile: Atlantic Sturgeon, Ancient Species' Slow Road to Recovery." Available at URL: http://www.asmfc.org/speciesDocuments/sturgeon/sturgeonProfile.pdf. Accessed December 6, 2007. ADAMS

Accession No. ML083360698.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. "Status Review of Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus)." Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp. Available at URL: http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/atlanticsturgeon2007.pdf. Accessed December 7, 2007.

Baird, D., and R.E. Ulanowicz. 1989. The seasonal dynamics of the Chesapeake Bay ecosystem. Ecological Monographs 59(4):329–364.

Bain, M.B., N. Haley, D.L. Peterson, K.K. Arend, K.E. Mills, and P.J. Sullivan. 2007. "Recovery of a US Endangered Fish." PLoS ONE 2(1): e168. Department of Natural Resources, Cornell University, Ithaca, New York. Available at URL: http://www.plosone.org/article/info percent3Adoi percent2F10.1371 percent2Fjournal.pone.0000168#s3. Accessed December 11, 2007.

Barnthouse, L.W., C.C. Coutant, and W. Van Winkle. 2002. "Status and Trends of Hudson River Fish Populations and Communities Since the 1970's: Evaluation of Evidence Concerning Impacts of Cooling Water Withdrawals." January 2002. ADAMS Accession No. ML083360704.

Barnthouse, L.W., D.G. Heimbuch, W. Van Winkle, and J. Young. 2008. "Entrainment and Impingement at IP2 and IP3: A Biological Impact Assessment." January 2008. ADAMS Accession No. ML080390059.

Barnthouse, L.W., D.G. Heimbuch, M. Mattson, and J.R. Young. 2009. Review of NRC's Impingement and Entrainment Assessment for IP2 and IP3. (Data from Table A-1). March 16, 2009. Enclosure 6 *in* Entergy Nuclear Northeast (Entergy). 2009. Letter from F. Dacimo, Vice President, Entergy Nuclear Northeast, to U.S. Nuclear Regulatory Commission, Chief, Rulemaking, Directives and Editing Branch. Reference NL-09-036. Subject: Comments on NUREG-1437, Draft Supplement 38. March 18, 2009. ADAMS Accession No. ML091040133.

Brosnan, T.M. and M.L. O'Shea. 1996. Long-term improvements in water quality due to sewage abatement in the lower Hudson River. Estuaries 19(4)890–900.

Central Hudson Gas and Electric Corporation; Consolidated Edison Company New York, Inc.; New York Power Authority; and Southern Energy New York (CHGEC et al.). 1999. "Draft Environmental Impact Statement for State Pollutant Discharge Elimination System Permits for Bowline Point, Indian Point 2 and 3, and Roseton Steam Electric Generating Stations." December 1999. ADAMS Accession No. ML083400128.

Clean Water Act of 1977 (CWA). 33 U.S.C. 1326 et seq. (common name of the Federal Water Pollution Control Act of 1977).

Cochran, W.G. 1997. Sampling Techniques. John Wiley and Sons, New York, New York. 428 pp.

Collette, B.B., and G. Klein-MacPhee (eds.). 2002. Bigelow and Schroeder's Fishes of the Gulf Of Maine. (3rd Ed.) 748 pp. Smithsonian Institute Press, Herndon, Virginia.

Consolidated Edison Company of New York (Con Edison). 1976a. "IP2 and IP3 Impingement Study Report for the Period 1 January 1975–31 December 1975." Prepared by Texas Instruments, Inc. ADAMS Accession No. ML083360750.

Consolidated Edison Company of New York (Con Edison). 1976b. "Predation by Bluefish in the Lower Hudson River." Prepared by Texas Instruments, Inc. ADAMS Accession No. ML

Consolidated Edison Company of New York (Con Edison). 1977. "Hudson River Ecological Study in the Area of IP2 and IP3 1976 Annual Report." Prepared by Texas Instruments, Inc. ADAMS Accession No. ML08309161.

Consolidated Edison Company of New York (Con Edison). 1979. "Hudson River Ecological Study in the Area of IP2 and IP3 1977 Annual Report." Prepared by Texas Instruments, Inc. ADAMS Accession No. ML083091068.

Consolidated Edison Company of New York (Con Edison). 1980. "Hudson River Ecological Study in the Area of IP2 and IP3 1979 Annual Report." Prepared by Texas Instruments, Inc. ADAMS Accession No. ML083360740.

Consolidated Edison Company of New York (Con Edison). 1984a. "Hudson River Ecological Study in the Area of IP2 and IP3 1981 Annual Report." ADAMS Accession No. ML083091069.

Consolidated Edison Company of New York (Con Edison). 1984b. "Precision and Accuracy of Stratified Sampling to Estimate Fish Impingement at Indian Point Unit No. 2 and Unit No. 3." Prepared by Normandeau Associates, Inc. ADAMS Accession No. ML083360792.

Consolidated Edison Company of New York, Inc. (Con Edison). 2007. Letter from J. McAvoy, Vice President, ConEdison, to F. Dacimo, Vice President, Entergy Nuclear Operations. January 19, 2007.

Consolidated Edison Company of New York (Con Edison) and New York Power Authority (NYPA). 1984. "Indian Point Generating Station Entrainment Abundance and Outage Evaluation 1993 Annual Report." Prepared by EA Science and Technology, Inc.

Consolidated Edison Company of New York (Con Edison) and New York Power Authority (NYPA). 1986. "Hudson River Ecological Study in the Area of IP2 and IP3 1985 Annual Report." Prepared by Normandeau Associates, Inc. ADAMS Accession No. ML083091074.

Consolidated Edison Company of New York (Con Edison) and New York Power Authority (NYPA). 1987. "Hudson River Ecological Study in the Area of IP2 and IP3 1986 Annual Report." Prepared by Normandeau Associates, Inc. ADAMS Accession No. ML083091087.

Consolidated Edison Company of New York (Con Edison) and New York Power Authority (NYPA). 1988. "Hudson River Ecological Study in the Area of IP2 and IP3 1987 Annual Report." Prepared by EA Science and Technology. ADAMS Accession No. ML083091084.

Consolidated Edison Company of New York (Con Edison) and New York Power Authority (NYPA). 1991. "Hudson River Ecological Study in the Area of IP2 and IP3 1990 Annual Report." Prepared by EA Science and Technology. ADAMS Accession No. ML083091086.

Council on Environmental Quality (CEQ). 1997. "Environmental Justice: Guidance under the National Environmental Policy Act." Executive Office of the President, Washington, DC.

Daniels, R.A., K.E. Limburg, R.E. Schmidt, D.L. Strayer, and R.C. Chambers. 2005. "Changes in Fish Assemblages in the Tidal Hudson River, New York." American Fisheries Society Symposium 45:471–503. Available at URL: http://www.ecostudies.org/reprints/daniels_et_al_2005.pdf. Accessed March 13, 2008.

Ecological Analyses, Inc. (EA). 1981a. "Indian Point Generating Station Entrainment Survival and Related Studies. 1979 Annual Report." Prepared for Consolidated Edison Company of New York, Inc., and Power Authority of the State of New York. Ecological Analysts, Inc. January 1982. ADAMS Accession No. ML073330733.

Ecological Analyses, Inc. (EA). 1981b. "1981 Con Edison Automated Abundance Sampling (AUTOSAM) and Laboratory Processing Standard Operating Procedures." Prepared for Consolidated Edison Company of New York, Inc. Ecological Analysts, Inc. May 1981. ADAMS Accession No. ML083100602.

Ecological Analyses, Inc. (EA). 1982. "Indian Point Generating Station Entrainment Survival and Related Studies. 1980 Annual Report." Prepared for Consolidated Edison Company of New York, Inc., and Power Authority of the State of New York. Ecological Analysts, Inc. April 1981. ADAMS Accession No. ML073330737.

Ecological Analyses, Inc. (EA). 1984. "Indian Point Generating Station Entrainment Abundance and Outage Evaluation, 1983 Annual Report." Prepared for Consolidated Edison Company of New York, Inc., and Power Authority of the State of New York. EA Engineering, Science, and Technology, Inc. September 1984. ADAMS Accession No. ML083101084.

Ecological Analyses, Inc. (EA). 1985. "Indian Point Generating Station Entrainment Abundance and Outage Evaluation, 1983 Annual Report." Prepared for Consolidated Edison Company of New York, Inc., and Power Authority of the State of New York. EA Science and Technology. July 1985. ADAMS Accession No. ML083101091.

Ecological Analyses, Inc. (EA). 1989. "Indian Point Generating Station 1988 Entrainment Survival Study." Prepared for Consolidated Edison Company of New York, Inc., and Power Authority of the State of New York. EA Engineering, Science, and Technology, Northeast Regional Operations, Report No. 10648.03. August 1989. ADAMS Accession No. ML083101103.

Enercon Services Inc. (Enercon). 2007. "Phase 1A Literature Review and Archaeological Sensitivity Assessment of the Indian Point Site, Westchester County, New York." Enercon Services Inc., Tulsa, Oklahoma. March 2007.

Enercon. 2008. "Enercon Study ELEC-IP-08001 for IP2 and IP3 License Renewal Project 345 kV Transmission Line-Induced Shock Study." April 11, 2008. Prepared for Entergy Nuclear Operations, Inc.

Entergy Nuclear Northeast (ENN). 2007. "Indian Point Nuclear Power Plants Units 1, 2, and 3, Annual Radiological Environmental Operating Report for 2006." Buchanan, New York. May 2007.

Entergy Nuclear Operations Inc. (Entergy). 2003. "Indian Point Nuclear Plant Units No. 1, 2, and 3—Annual Radiological Environmental Operating Report for 2002." Docket Numbers 50-3, 50-247, and 50-286. Buchanan, New York. Agencywide Documents Access and Management System (ADAMS) Accession No. ML031220085.

Entergy Nuclear Operations Inc. (Entergy). 2004. "Indian Point Nuclear Power Plants Units 1, 2, and 3—Annual Radiological Environmental Operating Report for 2003." Docket Numbers 50-3, 50-247, and 50-286. Buchanan, New York. ADAMS Accession No. ML041340492.

Entergy Nuclear Operations Inc. (Entergy). 2005. "Indian Point Units 1, 2, and 3—2004 Annual Radiological Environmental Operating Report." Docket Numbers 50-3, 50-247, and 50 286. Buchanan, New York. ADAMS Accession No. ML051220210.

Entergy Nuclear Operations Inc. (Entergy). 2006. "Indian Point, Units 1, 2 and 3—Annual Radiological Environmental Operating Report for 2005." Docket Numbers 50-3, 50-247, and 50 286. Buchanan, New York. ADAMS Accession No. ML061290085.

Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application). April 23, 2007. ADAMS Accession No. ML 071210530.

Entergy Nuclear Operations Inc. (Entergy). 2007b. "IP2 and IP3, Units 1, 2, and 3—Annual Radiological Environmental Operating Report for 2006." Docket Numbers 50-3, 50-247, and 50 286. Buchanan, New York. ADAMS Accession No. ML071420088.

Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from F.R. Dacimo, Vice President, Entergy Nuclear Operations, Inc. to Document Control Desk, U.S. Nuclear Regulatory Commission. Subject: Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 & 3; Docket Nos. 50-247 and 50-286; Supplement to License Renewal Application (LRA) – Environmental Report References. ADAMS Nos. ML080080205, ML0800080209, ML080080214, ML0800802161, ML0800080291, ML080080298, ML080080306, and ML080080313.

Entergy Nuclear Operations, Inc. (Entergy). 2008a. Letter from F. Dacimo, Vice President, Entergy Nuclear Operations, to U.S. Nuclear Regulatory Commission Document Control Desk. Subject: Reply to Document Request for Additional Information Regarding Site Audit Review of License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2 and 3. April 23, 2008. ADAMS Accession No. ML081230243.

Entergy Nuclear Operations, Inc. (Entergy). 2008b. Letter from F. Dacimo, Vice President, License Renewal, to U.S. Nuclear Regulatory Commission Document Control Desk. Subject: Reply to Document Request for Additional Information Regarding License Renewal Application—Refurbishment. May 14, 2008. ADAMS Accession No. ML081440052.

Entergy Nuclear Northeast (Entergy). 2009a. Letter from F. Dacimo, Vice President, Entergy Nuclear Northeast, to U.S. Nuclear Regulatory Commission Document Control Desk. Reference NL-09-160. Subject: Request for Additional Information Related to License Renewal Indian Point Nuclear Application Environmental Report - Impingement Data Indian Point Nuclear Generating Unit Nos. 2 & 3 Docket Nos. 50-247 and 50-286 License Nos. DPR-26 and DPR-64. November 24, 2009. ADAMS Accession No. ML093420528.

Entergy Nuclear Northeast (Entergy). 2009b. "Documents Related to License Renewal Application – Environmental Report. Indian Point Nuclear Generating Unit Nos. 2 & 3. Docket Nos. 50-247 and 50-286. License Nos. DPR-26 and DPR-64." December 17, 2009. Buchanan, NY. ADAMS No. ML100290495 (cover letter only; report withheld to protect sensitive archaeological data).

Entergy Nuclear Northeast (Entergy). 2010. "Detailed Responses to the New York State Department of Environmental Conservation's (the Department) Request for Information, dated May 13, 2009 (the "RFI"), Exhibit K: Thermal Compliance Report." February 10, 2010. Available URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/elecbdrexhj-k.pdf.

Environmental Protection Agency (EPA). 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F. Risk Assessment Forum, Washington, D.C. Available at URL: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12460. Accessed December 12, 2008.

Environmental Protection Agency (EPA). 2004. "Total Maximum Daily Loads, Listed Water Information, Cycle: 2004. Hudson River, Lower Hudson River." U.S. Environmental Protection Agency. Available at URL: http://oaspub.epa.gov/tmdl/enviro.control?p_list_id=NY-1301-0002andp_cycle=2004. Accessed February 23, 2008.

Environmental Protection Agency (EPA). 2008a. "Phase II—Large Existing Electric Generating Plant. Proposed Rule, Technical Development Document." Available at URL: http://www.epa.gov/waterscience/316b/phase2/devdoc/. Accessed April 10, 2008.

Environmental Protection Agency (EPA). 2008b. "Hudson River PCB Superfund Site, Dredge Area 2 Delineation Fact Sheet, 2008." Available at URL: http://www.epa.gov/hudson/factsheet_2nd_phaselow.pdf. Accessed February 4, 2008. ADAMS Accession No. ML083360712.

Endangered Species Act of 1973 (ESA). 16 U.S.C 1531, et seq.

Fish and Wildlife Service (FWS). 2007. Letter from R.A. Niver, Endangered Species Biologist, to Rani Franovich, Branch Chief, Projects Branch 2, Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC. Response to letter from the U.S. Nuclear Regulatory Commission requesting information on Federally listed, proposed, and candidate species and critical habitat in the vicinity of Indian Point Nuclear Generating Unit Nos. 2 and 3. August 29, 2007. ADAMS Accession No. ML0732307840.

Fletcher, R.I. 1990. Flow dynamics and fish recovery experiments: Water intake systems. Transactions of the American Fisheries Society. 119:393–415.

Frank, K.T., B. Petrie, and N.L. Shackell. 2007. The ups and downs of trophic control in continental shelf ecosystems. Trends in Ecology and Evolution 22(5):236–242.

Greenwood, M.F.D. 2008. Trawls and cooling-water intakes as estuarine fish sampling tools: Comparisons of catch composition, trends in relative abundance, and length selectivity. Estuarine, Coastal and Shelf Science 76:121–130.

Gilbert, C.R. 1989. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic Bight)—Atlantic and Shortnose Sturgeons." U.S. Fish and Wildlife Service Biological Report 82 (11.122). U.S. Army Corps of Engineers TR EL-82-4. 28 pp.

Haas-Castro, R. 2006. "Status of Fishery Resources off the Northeastern U.S.: River Herring." Northeast Fisheries Science Center Resource Evaluation and Assessment Division, National Oceanic and Atmospheric Administration. Accessed at http://www.nefsc.noaa.gov/sos/spsyn/af/herring/archives/38_RiverHerring_2006.pdf on December 17, 2007. ADAMS Accession No. ML083390029.

Institute of Electrical and Electric Engineers (IEEE). 1997. "National Electric Safety Code." New York.

Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005. "Spottail Shiner." In: Fishes of the Middle Savannah River Basin. Athens, GA: University of Georgia Press, pp. 153–156.

Maryland Department of Natural Resources, Fisheries Service, Chesapeake Finfish Program (MDNR). February 2005. 2004 Stock Assessment of Selected Resident and Migratory Recreational Finfish Species within Maryland's Chesapeake Bay. Accessed at http://dnr.maryland.gov/fisheries/management/tidalmng.html (under the link for White Perch) on February 4, 2010.

Mayhew, D.A., L.D. Jensen, D.F. Hanson, and P.H. Muessig. 2000. A comparative review of entrainment survival studies at power plants in estuarine environments. Environmental Science and Policy 3:295–301.

Menzie, C., M.H. Henning, J. Cura, K. Finkelstein, J. Gentile, J. Maughan, D. Mitchell, S. Petron, B. Potocki, S. Svirsky, and P. Tyler. 1996. Report of the Massachusetts Weight-of-Evidence Workgroup: A weight-of-evidence approach for evaluating ecological risks. Human and Ecological Risk Assessment 2:277–304.

Munch, S.B., and D.O. Conover. 2000. Recruitment dynamics of bluefish (Pomatomus saltatrix) from Cape Hatteras to Cape Cod, 1973–1995. ICES Journal of Marine Sciences 57(2):393–402.

National Environmental Policy Act of 1969 (NEPA). 42 U.S.C. 4321 et seq.

National Institute of Environmental Health Sciences (NIEHS). 1999. "NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields." NIH Publication No. 99-4493, Research Triangle Park, North Carolina.

National Marine Fisheries Service (NMFS). 1998. "Recovery Plan for the Shortnose Sturgeon (Acipenser brevirostrum)." Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pp. Available at URL: http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_shortnose.pdf. Accessed December 11, 2007.

National Marine Fisheries Service (NMFS). 2007a. Letter from M. Colligan, Assistant Regional Administrator for Protected Resources, to Chief, Rules and Directives Branch, Division of Administrative Services, U.S. Nuclear Regulatory Commission, Washington, DC. Response to letter of August 10, 2007, from the U.S. Nuclear Regulatory Commission requesting information on Federally listed, proposed, and candidate species, critical habitat, and designated essential fish habitat in the vicinity of Indian Point Nuclear Generating Unit Nos. 2 and 3. October 4, 2007. ADAMS Accession No. ML073230796.

National Marine Fisheries Service (NMFS). 2007b. "Species of Concern: Atlantic Sturgeon, Acipenser oxyrinchus." Available at URL: http://www.nmfs.noaa.gov/pr/pdfs/species/atlanticsturgeon_detailed.pdf. Accessed December 6, 2007.

New York Natural Heritage Program (NYNHP). 2008a. "Online Conservation Guide for Myotis sodalis." Available at URL: http://www.acris.nynhp.org/guide.php?id=7405. Accessed March 21, 2008. ADAMS Accession No. ML083390018.

New York Natural Heritage Program (NYNHP). 2008b. "Online Conservation Guide for Sylvilagus transitionalis." Available at URL: http://www.acris.nynhp.org/guide.php?id=7415. Accessed March 21, 2008. ADAMS Accession No. ML083390017.

New York Power Authority. 1986. "Size Selectivity and Relative Catch Efficiency of a 3-m Beam Trawl and a 1-m2 Epibenthic Sled for Sampling Young of the Year Striped Bass and Other Fishes in The Hudson River Estuary." Prepared by Normandeau Associates, Inc. January 1986. (HR Library #7180). ADAMS Accession No. ML083360641.

New York State Department of Environmental Conservation (NYSDEC). 1997. NRDC vs. NYSDEC, et al. Fourth Amended Consent Order. Letter from Keith Silliman on April 23, 1997. New York State Department of Environmental Conservation, Office of General Counsel.

New York State Department of Environmental Conservation (NYSDEC). 2003a. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2, Bowline 1 and 2, and Indian Point 2 and 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties. Hudson River Power Plants FEIS." June 25, 2003. ADAMS Accession No. ML083360752.

New York State Department of Environmental Conservation (NYSDEC). 2003b. Fact Sheet. "New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal with Modification, IP2 and IP3 Electric Generating Station, Buchanan, NY." November 2003. Available at URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf. Accessed July 12, 2007. ADAMS Accession No. ML083360743.

New York State Department of Environmental Conservation (NYSDEC). 2007. State of New York Petition submitted to the U.S. Nuclear Regulatory Commission, November 30, 2007, on the Application of Entergy Nuclear Operations, Inc., for the 20-year Relicensing of Indian Point Nuclear Power Plants 1 and 2, Buchanan, New York. Summary of Some of the Key Contentions. Available at URL: http://www.dec.ny.gov/permits/40237.html. Accessed March 18, 2008. ADAMS Accession No. ML083360757.

New York State Department of Environmental Conservation (NYSDEC). 2008a. "List of Endangered, Threatened and Special Concern Fish and Wildlife Species of New York." Available at URL: http://www.dec.ny.gov/animals/7494.html. Accessed May 3, 2008. ADAMS Accession No. ML083380558.

New York State Department of Environmental Conservation (NYSDEC). 2008b. "New York State Amphibian and Reptile Atlas Project." Available at URL: http://www.dec.ny.gov/animals/7479.html?showprintstyles. Accessed March 13, 2008.

New York State Department of Environmental Conservation (NYSDEC). 2010. Letter from William R. Adriance, Chief Permit Administrator, to Dara F. Gray, Entergy Nuclear Operations, Inc. "Joint Application for CWA § 401 Water Quality Certification, NRC License Renewal – Entergy Nuclear Indian Point Units 2 and 3, DEC Nos.: 3-5522-00011/00030 (IP2) and 3-5522-00105/00031 (IP3), *Notice of Denial*." April 2, 2010. Albany, NY. Available URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/ipdenial4210.pdf.

New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH). 2008. "Groundwater Investigation." Albany, New York. Available at URL: http://www.dec.ny.gov/permits/44014.html.

Normandeu Associates (Normandeu). 1987a. Prepared for Consolidated Edison Company of New York, Inc., and New York Power Authority. Prepared by Normandeu Associates, Inc. Report R-332-1062. April 1987. ADAMS Accession No. ML0803091074.

Normandeu Associates (Normandeu). 1987b. "Indian Point Generating Station Entrainment Abundance Program, 1986 Annual Report." Prepared for Consolidated Edison Company of New York, Inc., and New York Power Authority. Prepared by Normandeu Associates, Inc. Report R 220. June 1987. ADAMS Accession No. ML083091087.

Normandeu Associates (Normandeu). 1988. "IP2 and IP3 Generating Station Entrainment Abundance Program, 1987 Annual Report." Prepared for Consolidated Edison Company of New York, Inc., and New York Power Authority. Prepared by Normandeu Associates, Inc. Report R 1110. May 1988. ADAMS Accession No. ML083360798.

Northeast Fisheries Science Center (NEFSC). 2005. 41st Northeast Regional Stock Assessment Workshop (41st SAW): 41st SAW Assessment Report. Northeast Fisheries Science Center Reference Document 05-14.

Nuclear Regulatory Commission (NRC). 1975. "Final Environmental Statement Related to the Operation of IP2 and IP3 Nuclear Generating Plant Unit No. 3, Consolidated Edison Company of New York, Inc." NUREG-75/002.

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

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." NUREG-1437, Volume 1, Addendum 1, Washington, DC

Nuclear Regulatory Commission (NRC). 2005. "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 22 Regarding Millstone Power Station, Units 2 and 3, Final Report." NUREG-1437. Office of Nuclear Reactor Regulation. Washington, D.C.

Nuclear Regulatory Commission (NRC). 2006a. NUREG-1437, Supplement 20, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants Regarding Donald C. Cook Nuclear Plant, Units No. 1 and 2," Washington, DC.

Nuclear Regulatory Commission (NRC). 2006b. "Indian Point Nuclear Generating Unit 2—NRC Special Inspection Report No. 05000247/2005011." Docket Number 50-247. Washington, DC. ADAMS Accession No. ML060750842.

Nuclear Regulatory Commission (NRC). 2007a. Letter from R. Franovich to Mr. Peter Colosi, National Marine Fisheries Service, Gloucester, Massachusetts. Re: Request for List of Protected Species and Essential Fish Habitat within the Area under Evaluation for the IP2 and IP3 Nuclear Generating Unit Nos. 2 and 3 License Renewal Application Review. August 16, 2007. ADAMS Accession No. ML072130388.

Nuclear Regulatory Commission (NRC). 2007b. "Indian Point Nuclear Generating Unit 2—Routine Integrated Inspection Report No. 05000247/07003." Docket Number 50-247. Washington, DC. ADAMS Accession No. ML072150161.

Pew Oceans Commission. 2003. America's Living Oceans: Charting a Course for Sea Change. Pew Oceans Commission, Arlington, VA. Available at http://www.pewoceans.org.

Raffenberg, M.J., J.A. Matousek, W.D. Saksen, A.J. McCusker, and E.W. Radle. 2008. "Development of Filter Fabric Barrier to Reduce Aquatic Impacts at Water Intake Structures." Available at URL: http://www.epa.gov/waterscience/presentations/raffenberg.pdf. Accessed April 9, 2008.

Riverkeeper. 2007. Re: Acceptance Review for Entergy Nuclear IP2 and IP3 License Renewal Application. Letter to Mr. Bo Pham, Environmental Project Manager, Division of License Renewal, on June 4, 2007, from Phillip Musegaas, Riverkeeper Staff Attorney.

Secor, D.H. and E.D. Houde. 1995. Temperature effects on the timing of striped bass egg production, larval viability, and recruitment potential in the Patuxent River (Chesapeake Bay). Estuaries 18:527–533.

Shepherd G. 2006. 'Atlantic Striped Bass." December 2006. Accessed at: http://www.nefsc.noaa.gov/sos/spsyn/af/sbass/archives/40_StripedBass_2006.pdf on December 10, 2007. ADAMS Accession No. ML083360766.

Shepherd, G. 2006. "Bluefish." Available at URL: http://www.nefsc.noaa.gov/sos/spsyn/op/bluefish/archives/25_Bluefish_2006.pdf. Accessed October 2, 2008. ADAMS Accession No. ML083360690.

Smith, C.L. 1985. "Spottail Shiner." In: The Inland Fishes of New York State, pp. 194–195. New York State Department of Environmental Conservation, Albany, NY.

Snedecor, G.W. and W.G. Cochran. 1980. Statistical Methods. The Iowa State University Press, Ames, Iowa, 507 pp.

Steinberg, N., D.J. Suszkowski, L. Clark, and J. Way. 2004. "Health of the Harbor: The First Comprehensive Look at the State of the NY.NY Harbor Estuary. A Report to the New York/New Jersey Harbor Estuary Program." Hudson River Foundation. New York, New York. ADAMS Accession No. ML083360712.

Strayer, D.L., K.A. Hattala, and A.W. Kahnle. 2004. Effects of an invasive bivalve (Dreissena polymorpha) on fish in the Hudson River Estuary. Canadian Journal of Fisheries and Aquatic Sciences 61:924–941.

Sweka, J.A., J. Mohler, M.J. Millard, T. Kehler, A. Kahnle, K. Hattala, G. Kenney, and A. Higgs. 2007. Juvenile Atlantic sturgeon habitat use in Newburgh and Haverstraw Bays of the Hudson River: Implications for population monitoring. North American Journal of Fisheries Management 27:1058–1067.

Ulanowicz, R.E. 1995. "Trophic Flow Networks as Indicators of Ecosystem Stress." In G.A. Polis and K.O. Winemiller (eds). Food Webs: Integration of Patterns and Dynamics, Chapman and Hall, New York. pp. 358–368.

U.S. Atomic Energy Commission (USAEC). 1972. "Final Environmental Statement Related to the Operation of Indian Point Nuclear Generating Plant No. 2." Docket No. 50-247. United States Atomic Energy Commission, Directorate of Licensing. September 1972.

U.S. Census Bureau (USCB). 2003. "LandView 6—Census 2000 Profile of General Demographic Characteristics DP-1 (100 percent) and Census Profile of Selected Economic Characteristics DP-3, Summary of Census Block Groups in a 50-Mile Radius around the IP2 and IP3 Energy Center (41.269722 Lat., -73.952083 Long.)." December 2003.

U.S. Census Bureau (USCB). 2008. "American FactFinder, Census 2000 Information and State and County QuickFacts on Dutchess, Orange, Putnam, and Westchester Counties." Available at URL: http://factfinder.census.gov and http://quickfacts.census.gov. Accessed April 2008.

Wolfe, D.A., E.R. Long, and G.B. Thursby. 1996. Sediment toxicity in the Hudson-Raritan Estuary: Distribution and correlations with chemical contamination. Estuaries 19(4):901–912.

Woodland, R.J. and D.H Secor. 2007. Year-class strength and recovery of endangered shortnose sturgeon in the Hudson River, New York. Transactions of the American Fisheries Society 136:72–81.

5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

Environmental issues associated with postulated accidents are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[(1)] 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 unless new and significant information is identified.

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

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

5.1 Postulated Plant Accidents

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

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 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.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the

(1) 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.

plant can withstand normal and abnormal transients, as well as 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 Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) and 10 CFR Part 100, "Reactor Site Criteria."

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license. The results of these evaluations are found in licensing documentation such as the applicant's final safety analysis report, the NRC staff's safety evaluation report, the final environmental statement (FES), and Section 5.1 of this draft 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 DBAs are evaluated for the hypothetical maximally exposed individual. Changes in the plant's surroundings, including local population, will not affect the evaluation for the maximally exposed individual. 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 period of extended operation. 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 Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The early resolution of the DBAs makes them a part of the current licensing basis (CLB) of the plant; the CLB of the plant, which is maintained by the licensee under its current license, will continue to be maintained under a renewed license in accordance with 10 CFR 54.33, "Continuation of CLB and Conditions of Renewed License." Therefore, under the provisions of 10 CFR 54.30, "Matters Not Subject to a Renewal Review," the CLB is not subject to review under license renewal. This issue, applicable to Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3), is listed in Table 5-1.

Table 5-1. Category 1 Issues 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 the following:

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

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER)

(Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses. The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or evaluation of other available information. 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, traditionally have not been discussed in quantitative terms in FESs and were not specifically considered for IP2 and IP3 in the GEIS. 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. The GEIS for license renewal documents a discretionary analysis of acts of sabotage in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the Commission concluded 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 (see Volume 1 of the GEIS, page 5-18).

Based on information in the GEIS, the Commission found the following:

> 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 IP2 and IP3, is listed in Table 5-2.

Table 5-2. Category 2 Issues Applicable to Postulated Accidents during the Renewal Term

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

The NRC staff has not identified any new and significant information with regard to the consequences from severe accidents during its independent review of the IP2 and IP3 ER

(Entergy 2007a), the site visit, the scoping process, or evaluation of other available information. 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 IP2 and IP3. The results of its review are discussed in Section 5.2 of this draft SEIS.

5.2 Severe Accident Mitigation Alternatives

As required by 10 CFR 51.53(c)(3)(ii)(L), license renewal applicants must consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant’s plant in an environmental impact statement (EIS), or related supplement, or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for IP2 and IP3; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

This section presents a summary of the SAMA evaluation for IP2 and IP3, conducted by Entergy, and the NRC staff's review of that evaluation. The NRC staff performed its review with contract assistance from Information Systems Laboratories, Inc. and Sandia National Laboratory. The NRC staff’s review is available in greater detail in Appendix G to this draft SEIS; the SAMA evaluation is available in Entergy’s ER and subsequent submittals identified herein.

The SAMA evaluation for IP2 and IP3 was conducted using a four-step approach. In the first step, Entergy 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, Entergy 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. Entergy initially identified 231 and 237 potential SAMAs for IP2 and IP3, respectively. For each unit, Entergy performed an initial screening in which it eliminated SAMAs that are not applicable to IP2 and IP3 because of design differences, have already been implemented at IP2 and IP3, or are similar in nature and could be combined with another SAMA candidate. This screening reduced the list of potential SAMAs to 68 for IP2 and 62 for IP3.

In the third step, Entergy 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 also was 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 (a positive cost benefit). Entergy concluded in its ER that several of the SAMAs evaluated for each unit are potentially cost beneficial (Entergy 2007b). However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs, the meteorological data used in the analysis, and lower cost alternatives, several additional potentially cost-beneficial SAMAs were identified (Entergy 2008a, Entergy 2009). The NRC staff identifies potentially cost-beneficial SAMAs in Section 5.2.5.

The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they are not required to be implemented as part of license renewal pursuant to 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Entergy's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.2 Estimate of Risk

Entergy submitted an assessment of SAMAs for IP2 and IP3 as part of the ER (Entergy 2007b). This assessment was based on the most recent IP2 and IP3 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 IP2 and IP3 individual plant examination (Con Ed 1992; NYPA 1994) and individual plant examination of external events (Con Ed 1995 and NYPA 1997).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 1.79×10^{-5} per year for IP2 and 1.15×10^{-5} per year for IP3. The CDF values are based on the risk assessment for internally initiated events. Entergy did not include the contributions from external events within the IP2 and IP3 risk estimates; however, it did perform separate assessments of the CDF from external events and did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of approximately 3.8 for IP2 and 5.5 for IP3 (as discussed in Appendix G, Sections G.2.2, G.3.1, and G.6.2). The breakdown of CDF by initiating event for IP2 and IP3 is provided in Table 5-3.

IP2 and IP3 Core Damage Frequency (Entergy, 2007a)

Initiating Event	IP2		IP3	
	CDF (Per Year)	% Contribution to CDF	CDF (Per Year)	% Contribution to CDF
Loss of offsite power[1]	6.7×10^{-6}	38	1.2×10^{-7}	1
Internal flooding	4.7×10^{-6}	26	2.2×10^{-6}	20
Loss-of-coolant accident (LOCA)	1.5×10^{-6}	8	2.2×10^{-6}	19
Transients[1]	1.2×10^{-6}	7	8.5×10^{-7}	7
Anticipated transient without scram	9.9×10^{-7}	6	1.5×10^{-6}	13
Station blackout	8.5×10^{-7}	5	7.2×10^{-7}	6
Steam generator tube rupture	7.2×10^{-7}	4	1.6×10^{-6}	14
Loss of component cooling water	5.8×10^{-7}	3	1.1×10^{-7}	<1
Loss of nonessential service water	3.0×10^{-7}	2	2.8×10^{-7}	2
Interfacing systems LOCA	1.5×10^{-7}	<1	1.5×10^{-7}	1
Reactor vessel rupture	1.0×10^{-7}	<1	1.0×10^{-7}	<1
Loss of 125 volts direct current power	5.8×10^{-8}	<1	1.0×10^{-6}	9
Total loss of service water system	4.4×10^{-8}	<1	5.4×10^{-7}	5
Loss of essential service water	1.9×10^{-10}	<1	1.8×10^{-8}	<1
Total CDF (internal events)	**1.79×10^{-5}**	**100**	**1.15×10^{-5}**	**100**

[1]Contributions from SBO and ATWS events are noted separately and not included in the reported values for loss of offsite power or transients.

As shown in Table 5-3, for IP2, loss of offsite power sequences, including station blackout (SBO) events, and internal flooding initiators are the dominant contributors to CDF. For IP3, internal flooding initiators, loss-of-coolant accidents (LOCAs), steam generator tube rupture (SGTR) events, and anticipated transient without scram (ATWS) events are the dominant contributors to CDF. The differences in the CDF contributions are attributed, in large part, to several significant differences between the IP2 and IP3 units.

As shown in Table 5-4 below, Entergy's SAMA analysis, as revised, estimated the dose to the population within 80 kilometers (50 miles) of the IP2 and IP3 site to be approximately 0.87 person-sievert (Sv) (87 person-rem) per year for IP2, and 0.95 Sv (95 person-rem) per year for IP3 (Entergy 2009). The breakdown of the total population dose by containment failure mode is summarized in Table 5-4. SGTR events and late containment failures, caused by gradual overpressurization by steam and noncondensable gases, dominate the population dose risk for both units.

The NRC staff has reviewed Entergy's data and evaluation methods, as revised, 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 staff based its assessment of offsite risk on the CDFs and offsite doses reported by Entergy.

Table 5-4. Breakdown of Population Dose by Containment Failure Mode (Entergy 2009)

Containment Failure Mode	IP2		IP3	
	Population Dose (Person-Rem[1] Per Year)	% Contribution	Population Dose (Person-Rem[1] Per Year)	% Contribution
Intact Containment	<0.1	<1	<0.1	<1
Basemat Melt-through	4.1	5	2.4	3
Gradual Overpressure	28.3	32	16.8	18
Late Hydrogen Burns	3.6	4	2.1	2
Early Hydrogen Burns	8.6	10	3.2	3
In-Vessel Steam Explosion	0.6	<1	0.2	<1
Reactor Vessel Rupture	4.1	5	1.5	2
Interfacing System LOCA	6.6	8	4.2	4
SGTR	31.5	36	64.4	68
Total	**87.4**	**100**	**94.8**	**100**

[1]One person-rem = 0.01 person-sievert

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, Entergy searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, Entergy considered insights from the plant-specific PSA and SAMA analyses performed for other operating plants that have submitted license renewal applications. In its 2007 ER, Entergy identified 231 and 237 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training for IP2 and IP3, respectively.

As discussed in Entergy's ER, for IP2, Entergy removed all but 68 of the SAMAs from further consideration because they are not applicable to IP2 as a result of design differences, have already been implemented at IP2, or are similar in nature and could be combined with another SAMA candidate. For IP3, all but 62 of the SAMAs were removed from further consideration based on similar criteria. A detailed cost-benefit analysis was performed for each of the remaining SAMAs.

The staff has concluded that Entergy's ER SAMA analysis used a systematic and comprehensive process for identifying potential plant improvements for IP2 and IP3, and that the set of potential plant improvements identified by Entergy is reasonably comprehensive and, therefore, acceptable.

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

In its ER, Entergy evaluated the risk-reduction potential of the remaining candidate SAMAs that were applicable to each unit (68 for IP2 and 62 for IP3). The SAMA evaluations were performed using realistic assumptions with some conservatism.

Entergy estimated the costs of implementing the candidate SAMAs through the application of engineering judgment and the use of other licensees' estimates for similar improvements. The cost estimates reported in the ER conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they account for inflation.

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

The staff reviewed the basis for the applicant's cost estimates. For certain improvements, the 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 staff found the cost estimates to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The staff concluded that the risk reduction and the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

5.2.5 Cost-Benefit Comparison

The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook" (NRC 1997) and was executed consistent with this guidance. NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NRC 2004), has recently been revised to reflect the agency'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). Entergy provided both sets of estimates (Entergy 2007b).

As described in Section G.6.1, Entergy identified 10 potentially cost-beneficial SAMAs (5 for IP2 and 5 for IP3) in the baseline analysis (using a 7-percent discount rate) and sensitivity analysis (using a 3-percent discount rate) contained in the ER. Based on consideration of analysis uncertainties, Entergy identified two additional potentially cost-beneficial SAMAs for IP2 in the ER (IP2 SAMAs 44 and 56).

In response to an NRC staff request, Entergy provided the results of a revised uncertainty analysis in which the impact of lost tourism and business was accounted for in the baseline analysis (rather than as a separate sensitivity case) (Entergy 2008a). The revised uncertainty analysis resulted in the identification of two additional potentially cost-beneficial SAMAs for IP2 (IP2 SAMAs 9 and 53) and one additional potentially cost-beneficial SAMA for IP3 (IP3 SAMA 53), as reported in the draft Supplemental Environmental Impact Statement (DSEIS). Subsequent to issuance of the DSEIS, in response to NRC staff questions, Entergy identified an error in the Indian Point site meteorological file used to calculate offsite consequences of severe accidents, and submitted a SAMA re-analysis based on corrected meteorological data (Entergy 2009). The SAMA re-analysis resulted in identification of three additional potentially cost – beneficial SAMAs for IP2 (IP2 SAMAs 21, 22, and 62) and three additional potentially cost-beneficial SAMAS for IP3 (IP3 SAMAs 7, 18, and 19).

The potentially cost-beneficial SAMAs for IP2 include the following:

- SAMA 9 – Create a reactor cavity flooding system to reduce the impact of core-concrete interaction from molten core debris following core damage and vessel failure.
- SAMA 21 – Install additional pressure or leak monitoring instrumentation to reduce the frequency of interfacing system loss of coolant accidents.
- SAMA 22 – Add redundant and diverse limit switches to each containment isolation valve. This modification would reduce the frequency of an interfacing system loss of coolant activity.
- SAMA 28 – Provide a portable diesel-driven battery charger to improve direct current (dc) power reliability. Safety-related disconnect would be used to change a selected battery. This modification would enhance the long-term operation of the turbine-driven auxiliary feed water (AFW) pump on battery depletion.
- SAMA 44 – Use fire water as backup for steam generator inventory to increase the availability of steam generator water supply to ensure adequate inventory for the operation of the turbine-driven AFW pump during SBO events.
- SAMA 53 – Keep both pressurizer power-operated relief valve block valves open. This modification would reduce the CDF contribution from loss of secondary heat sink by improving the availability of feed and bleed.
- SAMA 54 – Install a flood alarm in the 480-volt (V) alternating current (ac) switchgear room to mitigate the occurrence of internal floods inside the 480-V ac switchgear room.
- SAMA 56 – Keep residual heat removal (RHR) heat exchanger discharge valves, motor-operated valves 746 and 747, normally open. This procedure change would reduce the CDF contribution from transients and LOCAs.
- SAMA 60 – Provide added protection against flood propagation from stairwell 4 into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within stairwell 4 adjacent to the 480-V ac switchgear room.
- SAMA 61 – Provide added protection against flood propagation from the deluge room into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within the deluge room adjacent to the 480-V ac switchgear room.

- SMA 62 – Provide a hard-wired connection to a safety injection (SI) pump from the alternate safe shutdown system (ASSS) power supply. This modification would reduce the CDF from events that involve loss of power from the 480V vital buses.
- SAMA 65 – Upgrade the alternate safe shutdown system to allow timely restoration of reactor coolant pump seal injection and cooling from events that cause loss of power from the 480-V ac vital buses.

The potentially cost-beneficial SAMAs for IP3 include the following:

- SAMA 7 – Create a reactor cavity flooding system. This modification would enhance core debris cooling and reduce the frequency of containment failure due to core-concrete interaction.
- SAMA 18 – Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove fission products.
- SAMA 19 – Install additional pressure or leak monitoring instrumentation to reduce the frequency of interfacing system loss of coolant accidents.
- SAMA 30 – Provide a portable diesel-driven battery charger to improve dc power reliability. A safety-related disconnect would be used to change a selected battery. This modification would enhance the long-term operation of the turbine-driven AFW pump on battery depletion.
- SAMA 52 – Proceduralize opening the city water supply valve for alternative AFW system pump suction to enhance the availability of the AFW system.
- SAMA 53 – Install an excess flow valve to reduce the risk associated with hydrogen explosions inside the turbine building or primary auxiliary building.
- SAMA 55—Provide the capability of powering one safety injection pump or RHR pump using the Appendix R diesel (MCC 312A) to enhance reactor cooling system injection capability during events that cause loss of power from the 480-V ac vital buses.
- SAMA 61 – Upgrade the alternate safe-shutdown system to allow timely restoration of reactor coolant pump seal injection and cooling from events that cause loss of power from the 480-V ac vital buses.
- SAMA 62 – Install a flood alarm in the 480-V ac switchgear room to mitigate the occurrence of internal floods inside the 480-V ac switchgear room.

In response to an NRC staff inquiry regarding estimated benefits for certain SAMAs and lower cost alternatives, Entergy identified one additional potentially cost-beneficial SAMA (regarding a dedicated main steam safety valve gagging device for SGTR events in both units; this was unnumbered for each unit because the applicant did not initially identify them) (Entergy 2008b); and Entergy determined that one SAMA that was previously identified as potentially cost beneficial was no longer cost beneficial based on correction of an error in the ER (IP3 SAMA 30) (Entergy 2008a, Entergy 2009).

Based on its review of Entergy's SAMA analysis, as revised, the staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than their associated benefits.

5.2.6 Conclusions

The NRC staff reviewed Entergy's analysis, as revised, and concludes that the methods used, and the implementation of those methods, were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by Entergy are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process and inclusion of a multiplier to account for external events.

Based on its review of the SAMA analysis, as revised, the staff concurs with Entergy'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 potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the staff considers that further evaluation of these SAMAs by Entergy is appropriate. However, none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of IP2 and IP3 license renewal pursuant to 10 CFR Part 54.

In a decision issued on June 30, 2010, the Atomic Safety and Licensing Board ("Board") admitted two contentions for litigation, which had been filed by the State of New York in the Indian Point Units 2 and 3 license renewal adjudicatory proceeding. Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), LBP-10-13, 71 NRC __ (2010). These contentions generally assert that the NRC staff must reach a final determination of the cost-beneficial SAMAs, from the slate of SAMAs that have been found to be potentially cost-beneficial, and that (a) the cost-beneficial SAMAs must be imposed as a "backfit" on the plants' current licensing basis ("CLB"), as a condition for license renewal, or (b) the staff must provide a sufficient explanation for not imposing such a license renewal condition. In this regard, the NRC staff has provided a detailed discussion of SAMA costs and benefits in this SEIS, which satisfies the NRC's obligation, under NEPA and related case law, to consider SAMAs in a license renewal proceeding such as the IP2 and IP3 proceeding. Indeed, as the Board found, while NEPA requires consideration of environmental impacts and alternatives, it does not require that SAMAs be imposed to redress environmental impacts. LBP-10-13, slip op. at 29.

Moreover, the NRC staff has determined that none of the potentially cost-beneficial SAMAs are related to the license renewal requirements in 10 CFR Part 54 (i.e., managing the effects of aging) (SEIS § 5.2.6). Under the NRC's regulatory system, any potentially cost-beneficial SAMAs that do not relate to 10 CFR Part 54 requirements would be considered, to the extent necessary or appropriate, under the agency's oversight of a facility's current operating license in accordance with 10 CFR Part 50 requirements, inasmuch as such matters would pertain not just to the period of extended operation but to operations under the current operating license term as well. Thus, there is no regulatory basis to suggest that potentially cost-beneficial SAMAs that are unrelated to Part 54 requirements must be imposed as a backfit to the CLB, as a condition for license renewal.

Finally, the NRC staff notes that SAMAs, by definition, pertain to severe accidents – i.e., those accidents whose consequences could be severe, but whose probability of occurrence is so low that they may be excluded from the spectrum of design basis accidents ("DBAs) that have been postulated for a plant (see GEIS §§ 5.3.2, 5.3.3, 5.4); this is consistent with the conclusions reached in § 5.2.2 of this SEIS concerning severe accidents at IP2 and IP3. The Commission has previously concluded, as a generic matter, that the probability-weighted radiological consequences of severe accidents are SMALL. GEIS § 5.5.2; 10 CFR Part 51, App. B, Table B

1. As stated in §§ 5.1.1 and 5.1.2 above, no significant new information has been identified that would remove IP2 and IP3 from these generic determinations. Thus, there is no regulatory basis to impose any of the potentially cost-beneficial SAMAs as a condition for license renewal of IP2 and IP3 – even if those potentially cost-beneficial SAMAs are "finally" found to be cost-beneficial.

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."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy,* Part 100, "Reactor Site Criteria."

Atomic Safety and Licensing Board Panel (ASLBP). *Entergy Nuclear Operations, Inc.* (Indian Point Nuclear Generating Units 2 and 3), LBP-10-13, 71 NRC __ (2010).

Consolidated Edison (Con Ed). 1992. Letter from Stephen B. Bram to U.S. Nuclear Regulatory Commission, Subject: Generic Letter 88-20, Supplement 1: Individual Plant Examination (IPE) for Severe Accident Vulnerabilities—10 CFR 50.54, Indian Point Unit No. 2, August 12, 1992.

Consolidated Edison (Con Ed). 1995. Letter from Stephen E. Quinn to U.S. Nuclear Regulatory Commission, Subject: Final Response to Generic Letter 88-20, Supplement 4: Submittal of Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities, Indian Point Unit No. 2, December 6, 1995.

Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application; Attachment E: Severe Accident Mitigation Alternatives). April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210562.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Indian Point Energy Center License Renewal Application, NL-07-039, April 23, 2007. ADAMS Accession No. ML071210512.

Entergy Nuclear Operations, Inc. (Entergy). 2008a. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Reply to Request for Additional Information Regarding License Renewal Application—Severe Accident Mitigation Alternatives Analysis, NL-08-028, May 22, 2008. ADAMS Accession No. ML080420264.

Entergy Nuclear Operations, Inc. (Entergy). 2008b. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Supplemental Reply to Request for Additional Information Regarding License Renewal Application—Severe Accident Mitigation Alternatives Analysis, NL-08-086, May 22, 2008. ADAMS Accession No. ML081490336.

Entergy Nuclear Operations, Inc. (Entergy). 2009. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: License Renewal Application – SAMA Reanalysis Using Alternate Meteorological Tower Data, NL-09-165, December 11, 2009. ADAMS Accession No.

ML093580089.

New York Power Authority (NYPA). 1994. Letter from William A. Josiger to U.S. Nuclear Regulatory Commission, Subject: Indian Point 3 Nuclear Power Plant Individual Plant Examination for Internal Events, June 30, 1994.

New York Power Authority (NYPA). 1997. Letter from James Knubel to U.S. Nuclear Regulatory Commission, Subject: Indian Point 3 Nuclear Power Plant Individual Plant Examination of External Events (IPEEE), September 26, 1997.

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

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

Nuclear Regulatory Commission (NRC). 1999. "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report," Section 6.3, "Transportation," Table 9.1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, DC.

Nuclear Regulatory Commission (NRC). 2004. "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission." NUREG/BR-0058, Rev. 4, Washington, DC. ADAMS Accession No. ML042820192.

6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE, SOLID WASTE MANAGEMENT, AND GREENHOUSE GAS EMISSIONS

Environmental issues associated with the uranium fuel cycle and solid waste management are discussed in NUREG-1437, Volumes 1 and 2, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants” (hereafter referred to as the GEIS) (NRC 1996, 1999.)[(1)] 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; 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 that are listed in Table B-1 of Appendix B to Subpart A, “Environmental Effect of Renewing the Operating License of a Nuclear Power Plant,” of Title 10, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). The generic potential radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, “Table of Uranium Fuel Cycle Environmental Data,” and 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

(1) 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.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to IP2 and IP3 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; 6.2.2.2; 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; 6.4.4
Mixed waste storage and disposal	6.1; 6.4.5; 6.6
Onsite spent fuel	6.1; 6.4.6; 6.6
Nonradiological waste	6.1; 6.5; 6.6
Transportation	6.1; 6.3, Addendum 1; 6.6

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses, though it did identify leaks to ground water as a potential new issue. The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant). The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site audit, the scoping process, or evaluation of other available information. 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 high-level waste 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's review and the GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, for each of these issues follows:

- Off-site radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste). Based on information in the GEIS, the Commission found the following:

  Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part (10 CFR 51.51(b)). Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (individual effects) of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Off-site radiological impacts (collective effects). Based on information in the GEIS, the Commission found the following:

  The 100 year environmental dose commitment to the United States (U.S.) population from the fuel cycle, high level waste 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 U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next one 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 of the uncertainty, some judgement as to the National Environmental Policy Act of 1969, as amended (NEPA) implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the 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 IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (spent fuel and high-level waste disposal). Based on information in the GEIS, the Commission found the following:

  For the high-level waste (HLW) and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for off-site 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" (NAS 1995), and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem (mrem) (1millisevert [mSv]) per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 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 (1 mSv) per year. The lifetime individual risk from 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 U.S. Department of Energy (DOE) 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 high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of

> potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR Part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric ton (MT) repository.
>
> Nevertheless, despite all of the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

On February 15, 2002, based on a recommendation by the Secretary of the DOE, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and HLW. The U.S. Congress approved this recommendation on July 9, 2002, in 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 designates Yucca Mountain as the repository for spent nuclear waste. The staff notes that, on March 3, 2010, the U.S. Department of Energy (DOE) submitted a motion to the Atomic Safety and Licensing Board to withdraw with prejudice its application for a permanent geologic repository at Yucca Mountain, NV. The NRC is currently considering DOE's request. Nevertheless, the NRC has evaluated the safety and environmental effects of spent fuel storage and, as set forth in 10 CFR 51.23, "Temporary Storage of Spent Fuel after Cessation of Reactor Operation—Generic Determination of No Significant Impact" (known as the Waste Confidence Rule).

> The Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the

> first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time.

That rule is the subject of an ongoing rulemaking proceeding, as discussed in "Waste Confidence Decision Update," 73 F.R. 59551 (Oct. 9, 2008).

In 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," onsite spent fuel storage is classified as a Category 1 issue that applies to all nuclear power reactors. While the Commission did not assign a single level of significance (i.e., SMALL, MODERATE, or LARGE) in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51 for the impacts associated with spent fuel and HLW disposal, it did conclude that the impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion that for any plant, the option of extended operation under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," should be eliminated.

The GEIS for license renewal (NUREG-1437) evaluated a variety of spent fuel and waste storage scenarios, including onsite storage of these materials for up to 30 years following expiration of the operating license, transfer of these materials to a different plant, and transfer of these materials to an ISFSI. During dry cask storage and transportation, spent nuclear fuel must be "encased" in NRC-approved casks. An NRC-approved cask is one that has undergone a technical review of its safety aspects and been found to meet all of the NRC's requirements, as specified in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste" (for storage casks), and 10 CFR Part 71, "Packaging and Transportation of Radioactive Material" (for transportation casks). For each potential scenario involving spent fuel, the GEIS determined that existing regulatory requirements, operating practices, and radiological monitoring programs were sufficient to ensure that impacts resulting from spent fuel and waste storage practices during the term of a renewed operating license would be small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts related to spent fuel and high-level waste disposal during the renewal term beyond those discussed in the GEIS.

- <u>Nonradiological impacts of the uranium fuel cycle</u>. Based on information in the GEIS, the Commission found the following:

  > 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 IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information pertaining to the IP2 and IP3 license renewal application. Therefore, the NRC staff concludes that there are no nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found the following:

  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 IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found the following:

  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 IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are 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 the following:

  The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

- Nonradiological waste. Based on information in the GEIS, the Commission found the following:

  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 IP2 and IP3 ER, the site, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

- Transportation. Based on information contained in the GEIS, the Commission found the following:

  The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 megawatt-days per metric ton of uranium (MWd/MTU) and the cumulative impacts of transporting high-level waste 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 10 CFR 51.52.

IP2 and IP3 meet 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 IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.2 Greenhouse Gas Emissions

6.2.1 Introduction

The NRC staff received many comments during the scoping period from individuals and groups regarding the impact of the proposed relicensing of IP2 and IP3 on the release of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions relative to potential alternative energy sources, including fossil fuels, renewable energy sources, and conservation programs.

6.2.2 IP2 and IP3

The NRC staff has not identified any studies specifically addressing GHGs produced by IP2 and IP3 or their fuel cycles. Although Entergy developed a study identifying gas emissions that would result if IP2 and IP3 were to be decommissioned and their generating capacity replaced with fossil-fuel based sources (Entergy Nuclear Northeast 2002), Entergy did not evaluate GHG emissions related to the existing facility. This study evaluated emissions of CO_2, sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulates (i.e., particulate matter, 10 microns or less in diameter [PM_{10}]), carbon monoxide (CO), and volatile organic compounds (VOCs). The study was intended as an evaluation of the impact of IP2 and IP3 shutdown on air quality in the local New York City area, rather than an evaluation of the impact of IP2 and IP3 shutdown on global GHG emissions.

6.2.3 GEIS

The GEIS provided only qualitative discussions regarding the GHG impacts of the nuclear fuel cycle. In the analysis of potential alternatives to nuclear power plant relicensing, the GEIS referenced CO_2 emissions as one of the substantial operating impacts associated with new coal-fired and oil-fired power plants, although no direct quantitative assessment of GHG emissions was presented. The GEIS also did not address GHG impacts of the nuclear fuel cycle relative to other potential alternatives, such as natural gas, renewable energy sources, or conservation programs.

6.2.4 Other Studies

Since the development of the GEIS, extensive further research into the relative volumes of GHGs emitted by nuclear and other electricity generating methods has been performed. In support of the analysis for this SEIS, the NRC staff performed a survey of the recent literature on the subject. Based on this survey, the NRC staff found that estimates and projections of the carbon footprint of the nuclear power lifecycle vary widely, and considerable debate exists regarding the relative impacts of nuclear and other electricity generation methods on GHG emissions. These recent studies take two different forms:

(1) qualitative discussions of the potential use of nuclear power to address GHG emissions and global warming

(2) technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle

6.2.4.1 Qualitative Studies

The qualitative studies primarily consist of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, and/or politically feasible means of achieving global GHG reductions. Examples of the studies that commenters referenced during the scoping period or that the NRC staff identified during the subsequent literature search include the following:

- Studies conducted to evaluate whether investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider 2000; International Atomic Energy Agency [IAEA] 2000; NEA 2002; and Nuclear Information and Resource Service and World Information Service on Energy [NIRS/WISE] 2005). Ultimately, the parties did not approve nuclear power as a component under the Clean Development Mechanism (CDM), but not because of concerns about GHGs from the nuclear fuel cycle (NEA 2002). Instead, it was eliminated from consideration for the CDM because it was not considered to meet the criterion of helping developing nations achieve sustainable development because of safety and waste disposal concerns (NEA 2002).

- Analyses developed to assist governments (including the U.S. Government) in making long-term investment and public policy decisions in nuclear power (Keepin 1988; Hagen et al. 2001; Massachusettes Institute of Technology [MIT] 2003).

Although the qualitative studies sometimes reference and critique the rationale contained in the existing quantitative estimates of GHGs produced by the nuclear fuel cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are not directly applicable to the evaluation of GHG emissions that will be associated with the proposed relicensing of IP2 and IP3.

6.2.4.2 Quantitative Studies

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature. Examples of these studies include Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), Paliamentery Office of Science and Technology (POST; 2006), AEA (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparison of the different studies is difficult because the assumptions and components of the lifecycles included within each study vary widely. Examples of differing assumptions that make comparability between the studies difficult include the following:

- the type of energy source that may be used to mine uranium deposits in the future
- the amount of reprocessing of nuclear fuel that will be performed in the future
- the type of energy source and process that might be used to enrich uranium in the future
- different calculations regarding the grade and volume of recoverable uranium deposits in the world
- different estimates regarding the GHG emissions associated with declining grades of recoverable coal, natural gas, and oil deposits
- the release of GHG gases other than CO_2, including the conversion of the masses of these gases into grams of CO_2 equivalents per kilowatt-hour (g C_{eq} /kWh)

- the technology to be used for future fossil fuel power systems, including cogeneration systems
- the projected capacity factors assumed for the different generation alternatives
- the different types of nuclear reactors used currently and in the projected future (light water reactor, pressurized-water reactor, Canadian deuterium-natural uranium reactor, breeder)

In addition, studies are inconsistent in their application of full lifecycle analyses, including plant construction, decommissioning, and resource extraction (uranium ore, fossil fuel). For instance, Storm van Leeuwen and Smith (2005) present comparisons of GHG emissions from nuclear versus natural gas that incorporate GHG emissions associated with nuclear plant construction and decommissioning in the values used for comparison.

In the case of the proposed IP2 and IP3 relicensing, the relicensing action will not involve additional GHG emissions associated with construction because the facility already exists. In addition, the proposed relicensing action will not involve additional GHG emissions associated with facility decommissioning, because that decommissioning must occur whether the facility is relicensed or not. In many of these studies, the contribution of GHG emissions from facility construction and decommissioning cannot be separated from the other lifecycle GHG emissions that would be associated with IP2 and IP3 relicensing. Therefore, these studies overestimate the GHG emissions attributed to the proposed IP2 and IP3 relicensing action.

In an early study on the subject, Dr. Nigel Mortimer conducted an analysis of the GHG emissions resulting from the nuclear fuel cycle in 1990 (Mortimer 1990). In this study, Mortimer stressed that the GHG implications of the nuclear fuel cycle were substantially related to the ore grade of uranium that must be mined to support nuclear power generation. Using ore grades that were current as of 1990, this study concluded that nuclear power offered a dramatic reduction in GHG emissions over conventional coal-fired power plants over an estimated 35-year lifecycle. The analysis estimated that a nuclear power plant would generate 230,000 tons (209,000 metric tons (MT)) of CO_2 over a 35-year life span, or about 3.9 percent of the 5,912,000 tons (5,363,000 MT) that an equivalent coal-fired plant would generate (Mortimer 1990). The study also projected that most of this 230,000 tons (209,000 MT) of CO_2 resulted from the use of a coal-fired plant to perform uranium enrichment by gaseous diffusion, and that using nuclear power and alternative enrichment methods in the future could reduce the amount to 21,000 tons (19,000 MT) (Mortimer 1990).

Mortimer's study went on to demonstrate that the GHG impact of the nuclear fuel cycle would increase as the grade of uranium ore mined dropped, and that the net emissions of CO_2 from the nuclear and coal-fired alternatives would become equal once uranium ore grades reached 0.01-percent uranium oxide. However, Mortimer does not address differences in energy consumption from future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements. Based on his cutoff ore grade and projections of ore reserves, Mortimer estimated GHG emissions of nuclear and natural gas generation would be similar after a period of 23 years (Mortimer 1990). The analysis also compared GHG emissions associated with the nuclear fuel cycle with other electricity generation and efficiency options, including hydroelectric, wind, tidal power, and new types of insulation and lighting (but not including natural gas). The conclusion was that nuclear power had lower GHG emissions compared to coal, but that GHG emissions associated with the nuclear fuel cycle still exceeded those for renewable generation and conservation options (Mortimer 1990).

The Mortimer (1990) study is not presented here to support a definitive conclusion regarding whether nuclear energy produces fewer GHG emissions than other alternatives and similar discussions will not be presented in this SEIS for each of the available studies. Instead, the NRC staff presents the Mortimer (1990) study to provide an example of the types of considerations underlying the calculations and arguments presented by the various authors. Almost every existing study has been critiqued, and its assumptions challenged, by later authors. Therefore, no single study has been selected to represent definitive results in this SEIS. Instead, the results from a variety of the studies are presented in Tables 6-2, 6-3, and 6-4 to provide a weight-of-evidence argument comparing the relative GHG emissions resulting from the proposed IP2 and IP3 relicensing compared to the potential alternative use of coal-fired plants, natural gas-fired plants, and renewable energy sources.

6.2.5 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Because coal is the fuel most commonly used to generate electricity in the United States, and the burning of coal results in the largest emissions of GHGs for any of the likely alternatives to nuclear power, most of the available quantitative studies have focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent coal-fired plant, are presented in Table 6-2.

Table 6-2. Nuclear GHG Emissions Compared to Coal

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade
Andseta et al. 1998	Nuclear energy produces 1.4 percent of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).

Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Coal—264 to 357 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Authors did not evaluate nuclear versus coal.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Coal—950 g C_{eq}/kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Coal—>1000 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq} /kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90 percent.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Coal—950 to 1250 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones 2007	Author did not evaluate nuclear versus coal.

6.2.6 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent natural gas-fired plant, are presented in Table 6-3.

Table 6-3. Nuclear GHG Emissions Compared to Natural Gas

Source	GHG Emission Results
Mortimer 1990	Author did not evaluate nuclear versus natural gas.
Andseta 1998	Author did not evaluate nuclear versus natural gas.
Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Natural Gas—120 to 188 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Nuclear fuel cycle produces 20 to 33% of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.

Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Cogeneration Combined Cycle Natural Gas—150 g C_{eq}/kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Natural Gas—500 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90%.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Natural Gas—440 to 780 g C_{eq}/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones 2007	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15 to 27% of the GHG emissions of natural gas.

6.2.7 Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6-4. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because the efficiencies of the different energy sources vary so much by location. For instance, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved. Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources.

Table 6-4. Nuclear GHG Emissions Compared to Renewable Energy Sources

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.

Andseta 1998	Author did not evaluate nuclear versus renewable energy sources.
Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Solar PV—27.3 to 76.4 g C_{eq}/kWh Hydroelectric—1.1 to 64.6 g C_{eq}/kWh Biomass—8.4 to 16.6 g C_{eq}/kWh Wind—2.5 to 13.1 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Author did not evaluate nuclear versus renewable energy sources.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Solar PV—125 g C_{eq}/kWh Hydroelectric—50 g C_{eq}/kWh Wind—20 g C_{eq}/kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Biomass—25 to 93 g C_{eq}/kWh Solar PV—35 to 58 g C_{eq}/kWh Wave/Tidal—25 to 50 g C_{eq}/kWh Hydroelectric—5 to 30 g C_{eq}/kWh Wind—4.64 to 5.25 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Solar PV—43 to 73 g C_{eq}/kWh Hydroelectric—1 to 34 g C_{eq}/kWh Biomass—35 to 99 g C_{eq}/kWh Wind—8 to 30 g C_{eq}/kWh
Fthenakis and Kim (2007)	Nuclear—16 to 55 g C_{eq}/kWh Solar PV—17 to 49 g C_{eq}/kWh
Dones 2007	Author did not evaluate nuclear versus renewable energy sources.

6.2.8 Conclusions

Estimating the GHG emissions associated with current nuclear energy sources is challenging because of differing assumptions and noncomparable analyses performed by the various authors. The differences and complexities in these assumptions and analyses increase when using them to project future GHG emissions. However, even with these differences, the NRC staff can draw several conclusions.

First, the studies indicate a consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation. Based on the literature review, the lifecycle GHG emissions from the complete nuclear fuel cycle currently range from 2.5 to 33 g C_{eq}/kWh. The comparable lifecycle GHG emissions from the current use of coal range from 264 to 1250 g C_{eq}/kWh, and GHG emissions from the current use of natural gas range from 120 to 780 g C_{eq}/kWh. The existing studies also provided estimates of GHG emissions from five renewable energy sources, based on current technology. These estimates included solar-photovoltaic (17 to 125 g C_{eq}/kWh), hydroelectric (1 to 64.6 g C_{eq}/kWh), biomass (8.4 to 99 g C_{eq}/kWh), wind (2.5 to 30 g C_{eq}/kWh), and tidal (25 to 50 g C_{eq}/kWh). The range of these estimates is very wide, but the general conclusion is that the current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as those for these renewable energy sources.

Second, the studies indicate no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors regarding the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists regarding future GHG emissions associated with coal and natural gas electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources, and are expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur at all.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed IP2 and IP3 relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The NRC staff bases this conclusion on the following rationale:

(1) The current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.

(2) IP2 and IP3 license renewal will involve continued uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not).

(3) Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the IP2 and IP3 periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements could extend this timeframe.

With respect to comparison of GHG emissions between the proposed IP2 and IP3 license renewal action and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, and constructing facilities in both areas. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same range. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power, and because most renewable energy sources lack a fuel component, it is likely that GHG emissions from renewable energy sources would be lower than those associated with IP2 and IP3 at some point during the period of extended operation.

6.3 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."

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."

73 FR 59551. "Nuclear Regulatory Commission, 10 CFR Part 51, Waste Confidence Decision Update." (October 9, 2008).

AEA Technology (AEA). 2006. "Carbon Footprint of the Nuclear Fuel Cycle, Briefing Note." Prepared for British Energy. March 2006.

Andseta, S., M.J. Thompson, J.P. Jarrell, and D.R. Pendergast. 1998. "CANDU Reactors and Greenhouse Gas Emissions." Canadian Nuclear Association, 11th Pacific Basin Nuclear Conference, Banff, Alberta, Canada. May 1998.

Department of Energy (DOE). 1980. "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste." DOE/EIS-0046F, Washington, DC.

Dones, R. 2007. "Critical Note on the Estimation by Storm Van Leeuwen J.W. and Smith P. of the Energy Uses and Corresponding CO_2 Emissions for the Complete Nuclear Energy Chain." Paul Sherer Institute. April 2007.

Entergy Nuclear Northeast. 2002. "Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC, Village of Buchanan, New York, Emissions Avoidance Study." Prepared by TRC Environmental Corporation, Lyndhurst, New Jersey. August 2002.

Entergy Nuclear Operations, Inc. (Entergy). 2007. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application). April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210530.

Fritsche, U.R. 2006. "Comparison of Greenhouse-Gas Emissions and Abatement Cost of Nuclear and Alternative Energy Options from a Life-Cycle Perspective." Oko-Institut, Darmstadt Office. January 2006.

Fthenakis, V.M., and H.C. Kim. 2007. Greenhouse-gas emissions from solar electric- and nuclear power: A life cycle study. *Energy Policy*, Volume 35, Number 4.

Hagen, R.E., J.R. Moens, and Z.D. Nikodem. 2001. "Impact of U.S. Nuclear Generation on Greenhouse Gas Emissions." International Atomic Energy Agency, Vienna, Austria. November 2001.

International Atomic Energy Agency (IAEA). 2000. "Nuclear Power for Greenhouse Gas Mitigation under the Kyoto Protocol: The Clean Development Mechanism (CDM)." November 2000.

Joint Resolution 87, 2002. Public Law 107-200, 116 Stat 735.

Keepin, B. 1988. "Greenhouse Warming: Efficient Solution of Nuclear Nemesis?" Rocky Mountain Institute. Joint Hearing on Technologies for Remediating Global Warming, Subcommittee on Natural Resources, Agriculture Research and Environment and Subcommittee on Science, Research and Technology, United States House of Representatives. June 1988.

Massachusetts Institute of Technology (MIT). 2003. "The Future of Nuclear Power: An Interdisciplinary MIT Study."

Mortimer, N. 1990. World warms to nuclear power. *SCRAM Safe Energy Journal*. December 1989 and January 1990. Available at URL: http://www.no2nuclearpower.org.uk/articles/mortimer_se74.php. Accessed February 29, 2007.

National Academy of Sciences (NAS). 1995. "Technical Bases for Yucca Mountain Standards." Washington, DC.

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

Nuclear Information and Resource Service and World Information Service on Energy (NIRS/WISE). 2005. Nuclear power: No solution to climate change. *Nuclear Monitor*, Numbers 621 and 622. February 2005.

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

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." NUREG-1437, Volume 1, Addendum 1, Washington, DC.

Nuclear Energy Agency (NEA). 2002. Organization for Economic Co-Operation and Development, *Nuclear Energy and the Kyoto Protocol.*

Parliamentary Office of Science and Technology (POST). 2006. "Carbon Footprint of Electricity Generation." Postnote, Number 268. October 2006.

Schneider, M. 2000. *Climate Change and Nuclear Power*. World Wildlife Fund for Nature. April 2000.

Spadaro, J.V., L. Langlois, and B. Hamilton. 2000. "Greenhouse Gas Emissions of Electricity Generation Chains: Assessing the Difference." IAEA Bulletin 42/2/2000, Vienna, Austria.

Storm van Leeuwen, J.W., and P. Smith. 2005. *Nuclear Power—The Energy Balance*. August

2005.

Weisser, D. 2006. “A Guide to Life-Cycle Greenhouse Gas (GHG) Emissions from Electric Supply Technologies.” Available at URL: http://www.aseanenvironment.info/abstract41015146.pdf. Accessed March 3, 2008.

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 NUREG-0586, Supplement 1, “Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors” (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 discussed in NUREG-1437, Volumes 1 and 2, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants” (hereafter referred to as the GEIS) (NRC 1996, 1999).[(1)] 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; therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

7.1 Decommissioning

Category 1 issues in Table B-1 of Appendix B to Subpart A, “Environmental Effect of Renewing the Operating License of a Nuclear Power Plant,” of Title 10, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” of the *Code of Federal Regulations* (10 CFR Part 51) that are applicable to IP2 and IP3 decommissioning following the renewal term are listed in Table 7-1. Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and significant information regarding the environmental impacts of IP2 and IP3 license renewal, though it did identify leaks from spent fuel pools as a potential new issue. The NRC staff

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[(1)] 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.

addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff has not identified any information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site visit, the scoping process, or its evaluation of other available information that is both new and significant. Therefore, the NRC staff concludes that there are no impacts related to the Category 1 issues applicable to the decommissioning of IP2 and IP3 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 IP2 and IP3 Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation doses	7.3.1
Waste management	7.3.2
Air quality	7.3.3
Water quality	7.3.4
Ecological resources	7.3.5
Socioeconomic impacts	7.3.7

A brief description of the NRC staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found the following:

  Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem 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 IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are 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 the following:

  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 IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are 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 the following

  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 IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are 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 the following:

  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 IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are 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 the following:

  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 IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are 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 the following:

> 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 IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 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."

Entergy Nuclear Operations, Inc. (Entergy). 2007. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application). April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210530.

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

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."

NUREG-1437, Volume 1, Addendum 1, Washington, DC.

Nuclear Regulatory Commission (NRC). 2002. "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors." NUREG-0586, Volumes 1 and 2, Supplement 1, Washington, DC.

8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES TO LICENSE RENEWAL

This chapter examines the potential environmental impacts associated with (1) a closed-cycle cooling system alternative to replace the Indian Point Nuclear Generating Unit No. 2 (IP2) and Unit No. 3 (IP3) existing once-through cooling-water systems, (2) denying the renewal of both operating licenses for IP2 and IP3 (i.e., the no-action alternative), (3) replacing the electric generation capacity of both units with alternative electric-generation sources or energy conservation, (4) importing electric power from other sources to replace power generated by IP2 and IP3, and (5) combinations of generation and conservation measures to replace power generated by IP2 and/or IP3. In addition, this chapter briefly discusses other alternatives that were deemed unsuitable to replace power generated collectively by IP2 and IP3.

As NRC staff indicated in its 1996 statements of consideration in promulgating the final license renewal environmental rules (61 FR 28467; June 5, 1996), NRC staff evaluates alternative energy sources as direct alternatives to license renewal, and not simply as consequences of the no-action alternative. Many comments received by the staff after the publication of the draft SEIS appear to conflate energy alternatives with the no-action alternative. Whether NRC renews a license or not, all alternatives to license renewal are available to energy planning decision makers. Continued operation, however, is only an available option if NRC grants renewed licenses. NRC evaluates, in this chapter, likely environmental impacts from alternatives in order to provide a comparison that allows NRC to determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable (NRC's "decision standard" from 10 CFR 51.95(c)(4)).

This chapter contains a number of updated or revised discussions in response to comments on the draft SEIS. First, NRC staff no longer considers a restoration-based alternative for complying with New York State Department of Environmental Conservation (NYSDEC) determinations on aquatic impacts from IP2 and IP3. As indicated in several comments NRC staff received on the draft SEIS, the U.S. Second Circuit Court of Appeals has held that habitat restoration is an impermissible means of complying with 316(b) (in *Riverkeeper I* and *Riverkeeper II*). Because the restoration alternative relied on habitat restoration to meet 316(b) goals, and would not be capable of meeting 316(b) goals in the absence of the restoration portion, the NRC staff has removed the restoration alternative from this SEIS.

The NRC staff has also removed the coal-fired alternative from the range of alternatives considered in depth (though staff has retained the discussion from the draft SEIS in Section 8.3.4, Alternatives Dismissed from Individual Consideration, based partly on comments regarding greenhouse gas and permitting restrictions in New York State, as well as on indications from the U.S. Department of Energy that coal use in New York State power generation is markedly declining. The Staff has also updated its combination alternatives, recognized that a gas-fired facility could also be a repowering project at an existing power plant, and upgraded its consideration of energy conservation to a full alternative given projections from New York State's energy efficiency (here used interchangeably with energy conservation) programs.

As in the draft SEIS, the NRC staff considered an alternative to the existing IP2 and IP3 cooling-water systems because the New York State Department of Environmental Conservation

(NYSDEC) identified closed-cycle cooling (e.g., cooling towers) as the best technology available (BTA) to reduce fish mortality in the draft New York State Pollutant Discharge Elimination System (SPDES) discharge permit (NYSDEC 2003a). This alternative is described in Section 8.1 of this SEIS. IP2 and IP3 have been operating under timely renewal provisions of the New York SPDES permit process since 1992. In 2004, NYSDEC issued a revised draft SPDES permit, including the BTA determination. The requirements, limits, and conditions of the draft SPDES permit had not been finalized at the time the NRC staff performed the assessment presented in this SEIS, and are subject to ongoing adjudication.

The environmental impacts of alternatives are evaluated using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed based on the Council on Environmental Quality (CEQ) guidelines and set forth in the footnotes to Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). The following definitions are used for each category:

> 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 NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999)[(1)] with the additional impact categories of environmental justice and transportation.

8.1 Alternatives to the Existing IP2 and IP3 Cooling-Water System

IP2 and IP3 currently use once-through cooling-water systems that withdraw water from and discharge water to the Hudson River as described in Section 2.1.3 of this SEIS. The circulating water systems for IP2 and IP3 include two intake structures, each containing seven pumps. The maximum flow rate for the facility is 6,553,000 lpm (1,731,000 gpm) IP2 uses dual-speed pumps and IP3 uses variable-speed pumps.

Warm discharge water from IP2 and IP3 flows from the condensers through six pipes that are 2.4 meters (m) (94 inches (in.)) in diameter and exits beneath the water surface into a discharge canal 12 m (39 feet (ft)) wide. Water flows from the discharge canal to the Hudson River through an outfall structure located south of IP3 at a discharge velocity of about 3.7 meters per second (mps) (12 feet per second (fps)). The design of the outfall is intended to reduce the thermal impact the warm water may potentially have on the river. An assessment of the impacts

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(1) 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.

of the current cooling-water system on the environment is presented in Section 4.1 of this SEIS.

Surface water withdrawals and discharges at IP2 and IP3 are regulated under the New York SPDES permit program. In 1975, the U.S. Environmental Protection Agency (EPA) issued National Pollutant Discharge Elimination System (NPDES) permits for the facility. Subsequently, the NYSDEC issued an SPDES permit for the facility in 1987. In 1992, a timely renewal application was filed with the NYSDEC, and terms of the 1992 SPDES have been continued under provisions of the NY State Administrative Procedure Act. Petitioners commenced proceedings in 2002 to mandate that the NYSDEC act on the SPDES permit renewal application. On April 8, 2003, the NYSDEC proposed to modify the SPDES permit to require that IP2 and IP3 reduce the impacts to aquatic organisms caused by the once-through cooling systems and that Entergy Nuclear Operations, Inc. (Entergy), complete a water quality review. NYSDEC published a draft SPDES permit in 2003 (NYSDEC 2003), and then issued a revised draft SPDES permit on March 2, 2004 (NYSDEC 2010a). The 2003 draft and 2004 revised draft identified closed-cycle cooling as the BTA. NYSDEC affirmed this perspective in its April 2, 2010, Notice of Denial of Entergy's Clean Water Act Section 401 Water Quality Certification (NYSDEC 2010b), indicating that closed cycle cooling would minimize aquatic impacts (the denial itself is currently subject to further state-level adjudication). Also, NYSDEC has published a draft policy on BTA (NYSDEC 2010c) indicating that "Wet closed-cycle cooling or its equivalent" is the "minimum performance goal for existing industrial facilities that operate a CWIS [cooling water intake system] in connection with a point source thermal discharge. . ." The policy is in draft form and NYSDEC received public comments through July 9, 2010.

The revised draft SPDES permit requires that immediate and long-term steps be taken to reduce the adverse impacts on the Hudson River estuary once the permit is issued (NYSDEC 2004). The short-term steps include mandatory outage periods, reduced intake during certain times, continued operation of fish-impingement mitigation measures, the payment of $24 million to a Hudson River Estuary Restoration Fund, and various studies. In the long term, IP2 and IP3 will have to implement the BTA to minimize environmental impacts to the aquatic ecology. Should the BTA determination in the revised draft SPDES permit go into effect, final implementation of the BTA is subject to NRC's approval only insofar as the NRC oversees the plant's safety performance and ability to cool itself.).

Specifically, the revised draft SPDES permit states the following:

> Within six months of the effective date of this permit, the permitee must submit to the NYSDEC…its schedule for seeking and obtaining, during its permit term, all necessary approvals from the NRC, Federal Energy Regulatory Commission (FERC), and other government agencies to enable construction and operation of closed-cycle cooling at Indian Point.

NYSDEC (2004) has also indicated that any alternative technology or technologies may be proposed for IP2 and IP3 within 1 year of the permit's effective date. These technologies must be able to minimize the adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3 (NYSDEC 2004).

The NYSDEC identified construction and operation of a closed-cycle cooling system at IP2 and IP3 as its preferred alternative to meet current national performance standards for impingement and entrainment losses. Entergy indicates that Entergy or its predecessors have proposed and

NYSDEC has rejected the following alternative cooling technologies as described in the IP2 and IP3 ER (Entergy 2007). As a result, these options are not discussed further in this SEIS.

- Evaporative ponds, spray ponds, or cooling canals all require significantly more land area than exists at the site.
- Dry cooling towers, which rely totally on sensible heat transfer, lack the efficiency of wet or hybrid towers using evaporative cooling, and thus require a far greater surface area than is available at the site. Additionally, because of their lower efficiency, dry towers are not capable of supporting condenser temperatures necessary to be compatible with IP2 or IP3 turbine design and, therefore, are not a feasible technology.
- Natural draft cooling towers, while potentially feasible, would be 137 to 152 m (450 to 500 ft) above ground level with significant adverse aesthetic impacts in an important viewshed corridor. This option also would raise water vapor plume-related and sound effects concerns. In the original EPA permitting proceeding, New York State opposed natural draft cooling towers on aesthetic grounds.
- Single-stage mechanical-draft wet cooling towers were eliminated for a number of reasons including, but not limited to, the dense water vapor plumes that may compromise station operations (including visual signaling) and equipment over time, and result in increased noise (Enercon 2003).

The EPA has concluded that, in some circumstances, retrofitting a plant to a closed-cycle cooling system lacks demonstrated feasibility or economic practicality (EPA 2004). In addition, Entergy asserts that retrofitting facilities the size and configuration of IP2 and IP3 with a closed-cycle cooling system is neither tried nor proven (Entergy 2007). Entergy also considers mitigation measures currently implemented to protect aquatic wildlife as part of the once-through cooling system to be adequate in terms of minimizing impacts from current operations and operations during the license renewal period (Entergy 2007).

Entergy expressed a number of concerns regarding financial or technical issues related to a closed-cycle cooling retrofit (Entergy 2007), including high cost, a lengthy forced outage, and lost power output due to parasitic losses from new cooling system components

Entergy notes that replacement power during the outage may carry negative air quality impacts, and that the outage may have negative impacts on electric-system reliability and market pricing.

Finally, Entergy indicates that closed-cycle cooling would result in a loss of generating capacity due to lowered thermal efficiency and parasitic loads related to cooling system pumps and auxiliary systems (an average annual loss of 88 megawatts electric [MW(e)], per unit) because of power demands of the closed-cycle system (Entergy 2010).

In the following chapter, the NRC staff will evaluate the environmental impacts associated with installing a closed-cycle cooling system at Indian Point, as well as the environmental impacts associated with a potentially-equivalent combination of plant modifications and restoration activities. Regardless of the NRC staff's findings, the NRC does not have the regulatory authority to implement the requirements of the Clean Water Act (CWA), and it is not up to the NRC staff to judge the validity of Entergy's or others' claims in the ongoing NYSDEC SPDES permit process.

In 2004, EPA issued regulations for reducing impingement and entrainment losses at existing electricity-generating facilities (EPA 2004). These regulations, known as the Phase II rule, established standards for compliance with the requirements of Section 316(b) of the CWA, which calls for intake structures to reflect the BTA for minimizing adverse environmental impact. The EPA's Phase II rule established two compliance alternatives that reduce impingement mortality by 80 to 95 percent of baseline and reduce organism entrainment by 60 to 90 percent of baseline (EPA 2004). These regulations supported the requirements of the draft New York SPDES permit's requirement that immediate and long-term steps be taken to minimize adverse impacts on the Hudson River estuary.

The EPA's rules concerning Phase II of Section 316(b) of the CWA were struck down by the U.S. Court of Appeals in the Second Circuit in January 2007. The Court also mandated the conduct of a cost-benefit analysis under Section 316(b) of the CWA. Specifically, the EPA suspended 40 CFR 122.2(r)(1)(ii) and (5) and Subpart J, "Requirements Applicable to Cooling Water Intake Structures for Phase II Existing Facilities Under Section 316(b) of the Act," of 40 CFR Part 125, "Criteria and Standards for the National Pollutant Discharge Elimination System," with the exception of 40 CFR 125.90(b) (EPA 2007). On April 1, 2009, the Supreme Court ruled that EPA may permissibly use cost-benefit analyses in its Phase II rule, though EPA has yet to reinstate or reissue the rule. Nonetheless, the 1987 SPDES permit remains in effect, pending the conclusion of State-level administrative and legal proceedings.

8.1.1 Closed-Cycle Cooling Alternative

Entergy's preferred close-cycle alternative consists of two hybrid mechanical-draft cooling towers (Enercon 2003, Entergy 2007). IP2 and IP3 would utilize one cooling tower, each, for a total of two towers onsite. Entergy rejected single-stage mechanical draft cooling towers, indicating that the dense water vapor plumes from the towers may compromise station operations (including visual signaling) and equipment over time, and single-stage towers may result in increased noise (Enercon 2003).

Entergy asserts that a hybrid mechanical-draft cooling tower system, also referred to as a "wet/dry" or "plume-abated" mechanical-draft cooling tower, addresses some of the shortcomings of the cooling system types described in Section 8.1 (Entergy 2007). In the ER, Entergy indicates that hybrid towers are "appreciably more expensive" than single-stage towers (Entergy 2007).

A hybrid tower consists of a standard efficiency wet tower segment combined with a dry heat exchanger section above it. The dry section eliminates visible plumes in the majority of atmospheric conditions. After the plume leaves the lower "wet" section of the tower, it travels upward through a "dry" section where heated, relatively dry air is mixed with the plume in the proportions required to achieve a nonvisible plume. Because of the "dry" section, which is on top of the "wet" section, hybrid towers are slightly taller than comparable wet towers and require a larger footprint (Entergy 2007). A potential exists for increased noise from additional fans in the dry section, although Entergy indicates that sound effects can be attenuated (Entergy 2007).

Portions of the site where Entergy could construct cooling towers are heavily forested, with rocky terrain and some steep slopes. Entergy indicates that these areas can be more environmentally sensitive and costly to build on.

The NRC staff has previously assessed closed cycle cooling with a hybrid cooling tower in the license renewal SEIS for Oyster Creek Nuclear Generating Station (OCNGS) (NRC 2006). The NRC staff finds that a hybrid cooling tower system is a reasonable design for the purpose of evaluating potential environmental impacts in a NEPA document. However, the NRC staff does not intend for this analysis to prejudice potential requirements imposed by NYSDEC or other authorities.

8.1.1.1 Description of the Closed-Cycle Cooling Alternative

As described in the Entergy's "Engineering Feasibility and Costs of Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration" (Enercon 2010, prepared for Entergy), new hybrid cooling towers would be large, approximately 160 m (525 ft) in diameter and 50 m (165 ft) high. To provide construction access for tower erection and clearance for air intake, the excavation diameter for each tower would be approximately 215 m (700 ft) (Enercon 2010). The locations for the IP2 and IP3 towers are expected to be approximately 305 m (1000 ft) north of the IP2 reactor and approximately 305 m (1000 ft) south of the IP3 reactor, respectively (Entergy 2007). A detailed description of a round hybrid cooling tower conceptual design is presented in the 2010 engineering feasibility and cost evaluation (Enercon 2010). Crews excavating areas for the cooling tower basins and associated piping will need to blast substantial amounts of rock during the construction process.

As noted in Section 8.1, the closed-cycle cooling alternative would introduce parasitic losses from additional pumps and other equipment. The new circulating pumps would likely be housed in a new pumphouse located along the discharge canal (Enercon 2010). The new, enclosed pumphouse would supply circulating water to the new towers via two concrete-lined steel pipes 3 m (10 ft) in diameter. Flow from the cooling tower basin to the condenser is expected via two pipes 3.7 m (12 ft) in diameter (Enercon 2010).

Enercon also reported that two dedicated substations would likely supply electricity to the closed-cycle cooling system from the 138-kilovolt (kV) offsite switchyard. The substation transformers, switch gear, and system controls for each tower and pumphouse would be housed in prefabricated metal buildings (Enercon 2003).

8.1.1.2 Environmental Impacts of the Closed-Cycle Cooling Alternative

In this section, the NRC staff addresses the impacts that would occur if Entergy constructs and operates the closed-cycle cooling system described in Section 8.1.1.1. The NRC staff summarizes anticipated impacts of the closed-cycle cooling alternative in Table 8-1. In the areas of land use, terrestrial ecology, terrestrial threatened and endangered species, waste, transportation and aesthetics, the environmental impacts of constructing and operating this closed-cycle cooling system would be greater than the impacts associated with the existing once-through cooling system, primarily due to construction-stage impacts. The closed-cycle cooling alternative significantly reduces impacts to aquatic ecology, including impacts from entrainment, impingement, and heat shock. Impacts to aquatic threatened and endangered species – already SMALL – are also likely to further decline. In the following sections, the NRC staff presents the potential environmental impacts of installing and operating a closed-cycle cooling alternative at Indian Point. The NRC staff addresses impacts for each resource area.

- **Land Use**

Construction of two hybrid mechanical-draft cooling towers would entail significant clearing and excavation of the currently timbered areas within the IP2 and IP3 exclusion area. Each cooling tower requires an excavated area of approximately 3.6 hectares (ha) (9 acres (ac)). Ultimately, approximately 16 ha (40 ac), most of which is presently wooded (though previously disturbed; ENN 2007), would need to be cleared for the two cooling towers, access roads, and support facilities (Enercon 2003). The towers would be located within the property exclusion area boundary adjacent to existing facilities as described in Section 8.1.1.1.

Unlike the IP2 tower, the proposed IP3 cooling tower would be located in the permanent right-of-way (ROW) easement granted to the Algonquin Gas Transmission Company (AGTC) for constructing, maintaining, and operating the two natural gas pipelines that traverse the IP2 and IP3 site (Entergy 2007, ENN 2010, Enercon 2010). These pipelines transport natural gas under the Hudson River, across the IP2 and IP3 site, and exit the site between Bleakley Avenue and the Buchanan substation (see Figure 2-3 in Chapter 2 of this SEIS for a graphical representation).

Entergy indicates that roughly 305 m (1000 ft) of river bank would be clear-cut and excavated to allow for the installation of the four large-diameter water pipes (two 3-m-diameter supply pipes and two 3.7-m-diameter pipes to each condenser) required for each tower (Entergy 2007). In addition, Enercon reports that the base of each tower would be constructed on bedrock at an elevation of about 9.1 m (30 ft) above mean sea level. This would entail the removal of approximately 2 million cubic yards (cy) (1.5 million cubic meters (m^3)) of material, primarily rock and dirt, using traditional excavation methods as well as a significant amount of blasting (Enercon 2010). This volume of material includes material excavated to allow rerouting of the Algonquin pipeline. Disposal of 2 million cy (1.5 million m^3) of material from the excavations for the cooling towers would create some offsite land use impacts. Excavated material also may be recycled or reused, which would reduce these impacts.

Entergy indicates that ROW easement agreement calls for AGTC to relocate the pipelines at Entergy's request. The FERC would first have to review and approve any such action. Entergy must also provide a suitable location for the pipeline on its land or land that it has acquired (Entergy 2007). Entergy indicates that pipeline relocation may require blasting and could also require Entergy to purchase additional land adjacent to the IP2 and IP3 site if onsite areas aren't suitable for the pipeline (Entergy 2007). Entergy's 2010 feasibility and cost evaluation indicates that relocation would be feasible, through additional regulatory approvals (Enercon 2010).

The IP2 and IP3 site is within New York's Coastal Zone. As indicated in Chapter 2, the IP2 and IP3 site is located adjacent to a Significant Coastal Fish and Wildlife Habitat, as well as a Scenic Area of Statewide Significance. Construction activities, such as grading, excavating, and filling, would require a coastal erosion management permit. Permitting restrictions would influence the construction of the cooling towers but they would not likely prevent Entergy from building the towers.

Excavation for the cooling towers would cut into the side of the hills east of IP2 and IP3, resulting in the removal of approximately 2 million cy (1.5 million m^3) of material, including mostly rock as well as dirt (Enercon 2010). In areas where the excavation intersects onsite plumes of groundwater contaminated with tritium, strontium-90, and other radionuclides, Entergy expects that excavated material will also be contaminated. The 2010 feasibility and cost evaluation indicates that at least 6350 cy may be contaminated (Enercon 2010). Any contaminated material would require appropriate disposal as radioactive waste. Currently, the only available disposal site for low-level radioactive wastes is in Clive, Utah.

Entergy's 2010 feasibility and cost study indicated that clean spoils from blasting could be marketed as commodity crushed stone for construction projects, used as mine fill. Entergy could also dispose of spoils in artificial reef projects off the New Jersey and New York coasts, though their analysis indicates that additional permitting requirements may result (Enercon 2010). The NRC staff concludes that construction activities associated with cooling tower installation at IP2 and IP3 would likely result in SMALL to LARGE land use impacts, depending largely on how much material Entergy is able to reuse or recycle, and where Entergy disposes of excavated material that cannot be reused or recycled.

- **Ecology**

Aquatic ecology. Land-clearing and construction activities can cause short-term, localized impacts on streams and rivers from increased site runoff. These impacts are generally mitigated through the use of erosion and sediment controls. Because of the size of the construction area needed for the cooling towers at the IP2 and IP3 site, such measures would be necessary to limit erosion and sediment deposition in the Hudson River. Construction impacts, however, would be relatively short-lived, and would be offset to some degree by reduced water consumption during prolonged outages at IP2 and IP3 when Entergy or its contractors would connect the closed-cycle cooling system to the units.

Following construction, the closed-cycle cooling alternative will significantly reduce operational impacts on streams and rivers compared to the current once-through cooling system. During the summer months, when water use is at its highest, service and cooling tower makeup water would be withdrawn at a rate of approximately 314,000 lpm (83,000 gpm) for the combined needs of IP2 and IP3. This would be a 95.2-percent reduction in water use compared to the existing IP2 and IP3 once-through systems, which have a maximum flow rate of 6,553,000 lpm (1,731,000 gpm). Without modifications to the intake screening technologies, the NRC staff assumes that the reduction in water intake results in an equivalent reduction in entrainment and impingement. Entergy's feasibility and cost evaluation indicates that 4 of the existing 6 circulating water intake bays would be used at each unit, and the existing service water intake bays would also remain in service (Enercon 2010). The staff concludes that this significant reduction in water demand would likely result in a similarly significant reduction in entrainment- and impingement-related losses compared to the losses created by the current once-through cooling system.

New circulating-water intake pumps would likely continue to utilize the Ristroph traveling screens and fish-return system currently in operation (Entergy 2007). The greatest impact of the closed-cycle system would be a reduction in entrainment and impingement of aquatic species. As described in Section 4.1.3.3 of this SEIS, the NRC staff has concluded that the once-through cooling system has a MODERATE impact from impingement and entrainment. The reduction in flow may also reduce impingement or entrainment of the endangered shortnose sturgeon (*Acipenser brevirostrum)* and macroinvertebrates, such as small clams and mussels (bivalves), snails, worms, crustaceans, and aquatic insects. In Section 4.6.1, the NRC staff had indicated that the impacts to the shortnose sturgeon are already SMALL, though additional reductions in effects may occur as a result of reduced flow.

Under a closed-cycle cooling system, most discharged blowdown water is unheated. Because the closed-cycle cooling system discharges a smaller volume of water, and because the water is cooler than in a once-through system, the extent of thermal impacts - which could range from SMALL to LARGE for the current once-through system, given uncertainty in the facility's thermal impacts – would be reduced. Thus, the effects of thermal shock also decline. However, the discharge water may be higher in salinity and may contain higher concentrations of biocides, minerals, trace metals, or other chemicals or constituents. To maintain compliance with discharge permits, the water may need to be treated.

Overall, operation of the closed-cycle cooling alternative would produce substantially fewer impacts to the aquatic environment relative to those caused by the existing once-through system. The NRC staff concludes that the aquatic ecological impacts (including those to threatened and endangered species) from the construction and operation of the hybrid mechanical-draft closed-cycle cooling alternative for IP2 and IP3 would be SMALL.

Terrestrial ecology. Construction of the closed-cycle cooling alternative would entail clear-cutting of onsite trees and excavation of areas for the two cooling towers as described in the Land Use section. These activities would destroy fragments of onsite eastern hardwood forest habitat (NYSDEC 2007; NYSDEC 2008a; Enercon 2010). Effects of removing these habitats could include localized reductions in productivity or relocations of some species.

Operation of the cooling towers also could have adverse localized impacts on terrestrial ecology. The cooling towers would be 50 m (165 ft) tall and may produce a visible plume as well as minimal ground fog under certain conditions, though hybrid towers of a round configuration minimize these conditions to the maximum extent possible (Enercon 2010). The potential physical impacts from a cooling tower plume include icing and fogging of surrounding vegetation during winter conditions. Icing can damage trees and other vegetation near the cooling towers. The salt content of the entrained moisture (drift) also has the potential to damage vegetation, depending on concentrations (Enercon 2010), though this is reduced by the higher release height and minimized entrainment inherent in the round, hybrid design. Entergy's feasibility and cost evaluation indicate deposition rates for both towers in the area of highest exposure (between the two towers – an area that includes parking lots, Unit 1, and site infrastructure) is 70 percent of the natural ambient salt deposition rate (Enercon 2010). The hybrid cooling towers evaluated in this section have a drift rate of 0.001 percent (Enercon 2010). This amounts to 26 lpm (7 gpm (0.00001 x 70,000 gpm of water)) drift for both towers. The amount and effects of drift would vary depending on a number of factors, including the concentration of salt in the droplets, the size of the droplets, the number of droplets per unit of surface area, the species of plant affected, and the frequency of local precipitation.

Actual measurements of drift deposition have been collected at only a few nuclear plants. These measurements indicate that, beyond about 1.5 kilometer (km) (about 1 mile (mi)) from nuclear plant cooling towers, salt deposition is generally near natural levels (NRC 1996). The NRC staff reported in the GEIS that the salt-drift rate estimated to cause acute injury to the eastern/Canadian hemlock (a particularly sensitive species) is in excess of 940 kilograms (kg) per square kilometer (km^2) (8.4 pounds per acre) per week (NRC 1996), well above the anticipated deposition rates from the IP2 and IP3 cooling towers. Natural deposition is 160 kg per km^2, while the maximum deposition from both towers is 112 kg per km^2 (Enercon 2010).

The NRC staff does not expect bird collisions with cooling towers to be a significant issue. The NRC staff found in the GEIS that impacts from collisions would be SMALL at all plants with existing cooling towers (NRC 1996).

Section 4.6.2 of this SEIS discusses the effects of license renewal on threatened or endangered terrestrial species. The section identifies the endangered Indiana bat (*Myotis sodalis*), the threatened bog turtle (*Clemmys muhlenbergii*), and the New England cottontail (*Sylvilagus transitionalis*), a candidate species, as being potentially affected. However, because of both the site-specific environment and the lack of evidence of the species existing at the facility, potential impacts to these threatened or endangered species are considered SMALL. Nonetheless, should NYSDEC decide that cooling towers must be installed at the site, then appropriate consultation with Fish and Wildlife Service would need to take place regarding the potential for impacts to these species. Entergy noted in its comments (included in Appendix A of this SEIS) that constructing cooling towers may have an effect on the Indiana Bat or its habitat.

While the effects of this alternative—including onsite land clearing and introduction of cooling tower drift—are greater than the effects of the continued operation of the once-through cooling system and are likely to be noticeable, they are not so great that they will have a destabilizing effect on terrestrial resources in the vicinity of IP2 and IP3. The NRC staff concludes that the overall effect on terrestrial ecology would be SMALL to MODERATE.

- **Water Use and Quality**

During construction of the alternative closed-cycle cooling systems at IP2 and IP3, changes in water usage would likely be negligible. Increases may be seen in potable water demand for construction workers and, if concrete is mixed on site, there would be additional demands. However, these water needs would be short lived and would be at least partially offset by a reduction in water use while IP2 and IP3 are in outages to install the closed-cycle cooling system. For the term of construction, the additional water demands would need to be met by the Village of Buchanan, which supplies water to the site. The Village of Buchanan purchases public drinking water from surface water supplies.

The NYSDEC requires a construction general permit for storm water discharges from a project such as construction of the hybrid cooling towers. In addition, the NYSDEC will require a stormwater pollution prevention plan describing the use of silt fencing and other erosion-control management practices that will be used to minimize impacts on surface water quality. The construction project could also affect ground water as a result of dewatering excavations.

Circulating water makeup (30,000 to 61,000 lpm (7800 to 16,000 gpm) for the cooling towers (Enercon 2010) will have a negligible impact on water flow past the site. The estimated flow 150 m (500 ft) off the shoreline is about 34 million lpm (9 million gpm) in a 150-to-180-m (500-to-600-ft)-wide section (Entergy 2007). Therefore, the evaporation loss would be approximately 0.1 percent of the river flow. Further, the estuarine Hudson River is at sea level, and thus the river's water level would not be affected by the cooling towers' consumptive water use.

To compensate for evaporative and discharge losses, makeup water from the Hudson River would be treated to remove silt, suspended solids, biological material, and debris. Makeup water may also need lime softening, a water treatment process that produces a waste sludge that requires disposal. Biocides, such as hypochlorite, are often added to cooling water to diminish the affects of the biofouling organisms (Entergy 2007). Other chemicals, such as acids, dispersants, scale inhibitors, foam suppressants, and dechlorinators may also be needed for water treatment (NRC 1979).

To manage the chemicals and elevated concentrations of dissolved solids in the discharge water, treatment would likely be necessary in accordance with the IP2 and IP3 site SPDES permit. The use of biocides or any other chemicals would likely require discharge treatment and additional monitoring.

The IP2 and IP3 site does not utilize ground water for cooling operations, service water, or potable water. As such, the continued operation of the site is not expected to affect local ground water supplies (EPA 2008a). Localized dewatering of ground water from excavations will likely be necessary during construction operations, but because this ground water is not used by Entergy or entities off site, and because the ground water discharges to the Hudson River after exiting the IP2 and IP3 site, construction is not likely to affect either ground water quality or ground water use. Any radiologically contaminated groundwater that construction crews encounter on site would need to be treated to meet release criteria before being discharged. As a result of onsite contamination, crews will need to monitor for radionuclides in liquid discharges and in excavations.

Proper controls of runoff and treatment of other site discharges, as well as appropriate treatment of any contaminated groundwater, will not result in significant impacts on the surface water (Hudson River) and evaporation losses are very small. Also, ground water impacts from construction and operation of the cooling towers are expected to be minor. Therefore, the NRC staff concludes that overall impacts to water resources and water quality from the closed-cycle cooling alternative would be SMALL.

- **Air Quality**

The IP2 and IP3 site is located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13, "New Jersey-New York-Connecticut Interstate Air Quality Control Region"). The air quality nonattainment issues associated with the portions of these States located within a 50-mi radius are related to ozone (8-hour standard) and particulate matter less than 2.5 microns (μm) in diameter ($PM_{2.5}$). The entire States of New Jersey and Connecticut are designated nonattainment areas for ozone (8-hour standard). Several counties in Central and Southeastern New York within a 50-mi radius are also in nonattainment status for the 8-hour ozone standard (EPA 2008b). Air quality would be affected by three different factors: replacement power during construction-related outages, construction activities and vehicles (including worker transportation), and cooling tower operations.

Entergy contractors indicate that prolonged outages of IP2 and IP3, such as would be required to install cooling towers (TRC Environmental Corp [TRC] 2002) would require replacement power from existing generating facilities within the New York City metropolitan area. They assert that replacement of IP2 and IP3 energy output during cooling tower installation would result in substantial increases in regulated air pollutants. To the extent that coal- and natural-gas-fired facilities replace IP2 and IP3 output, the NRC staff finds that some air quality effects would occur. The NRC staff finds that these effects would largely cease when IP2 and IP3 return to service, with the exception of any output lost to lower efficiency and new parasitic loads from the closed-cycle cooling system (an average of approximately 88 MW, with peak losses of 157.6 MW). Additional air quality impacts could result from power that replaces these parasitic and efficiency losses.

Air quality at or near IP2 and IP3 during the construction of the IP2 and IP3 cooling towers would be affected mostly by exhaust emissions from internal combustion engines. These emissions would include carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur oxides (SO_x), carbon dioxide (CO_2), and particulate matter 10 μm or less in diameter (PM_{10}) from operation of gasoline- and diesel-powered heavy-duty construction equipment, delivery vehicles, and workers' personal vehicles (these vehicles would also produce or contribute to production of $PM_{2.5}$). The amount of pollutants emitted from construction vehicles and equipment and construction worker traffic would likely be small compared with total vehicular emissions in the region.

As noted in Section 3.3 of the GEIS, a conformity analysis is required for each pollutant when the total direct and indirect emissions caused by a proposed Federal action would exceed established threshold emission levels in a nonattainment area. In the GEIS, the NRC determined that a major refurbishment activity may increase the facility workforce by up to 2300 construction, refurbishment, and refueling personnel during a significant refurbishment outage period. The construction of two new cooling towers at IP2 and IP3 could approximate such conditions; however, Entergy estimates that the construction activities would require an average workforce of 300 additional workers with a maximum of about 600 workers (Enercon 2003). Because IP2 and IP3 are in a nonattainment area for ozone, and emissions from vehicles of the additional workforce may exceed the ozone air quality thresholds, a conformity analysis would be required before construction.

Fugitive dust, a contributor to PM_{10}, would be generated from site clearing and construction traffic, blasting, and excavation. Given the size of the disturbed area that would be involved (about 16 ha (40 ac)), and assuming that dust management practices would be applied (e.g., watering, silt fences, covering soil piles, revegetation), the fugitive dust impacts generated during construction should be minor. Furthermore, the amount of road dust generated by the vehicles traveling to and from the site transporting workers or hauling rock and dirt would contribute to PM_{10} concentrations. Construction stage impacts, though significant, would be relatively short lived.

Operation stage impacts could be more significant. As previously discussed, the cooling towers would emit tower drift consisting of water, salt, and suspended solids. These emissions would be considered PM_{10}, and some portion may include $PM_{2.5}$. Because IP2 and IP3 are located in a nonattainment area for $PM_{2.5}$, a conformity analysis for the cooling towers would be necessary and may result in additional restrictions on emissions, additional compensatory measures, or further control of drift from the towers. Entergy's feasibility and cost study indicates that particulate emissions would be so great that it may not be possible to obtain construction and air permits (Enercon 2010).

Should operational air quality impacts cause air quality to worsen and thus further exceed limits, the effect would be MODERATE or greater, though some level of emissions trading would limit this impact. During construction, air quality effects would be controlled by site practices and compensatory measures required to maintain compliance with the Clean Air Act (CAA) (should a conformity analysis show the need to take other action). Also, replacement power would be required to comply with CAA requirements (and it would be short lived). Overall, the air quality effects would be driven by operational impacts, and could be SMALL to LARGE, depending on the towers' compliance with CAA requirements and the availability of PM2.5 allowances.

- **Waste**

Construction of the closed-cycle cooling alternative at IP2 and IP3 would generate some construction debris and an estimated 2 million cy (1.5 million m^3) of rock and soil (Entergy

2007). This material may be affected by onsite radiological contamination or by other previous site activities. Depending on the characteristics of the material, it may be possible to reuse or recycle much of it, as discussed in the Land Use portion of this section. If the material cannot be reused or recycled, it will have to be properly managed as a waste. Whether reused, recycled, or disposed of, the material will have to be transported off site. Given the likely size of blasting spoil particles, an onsite crushing operation may be necessary (Enercon 2010).

If disposed of, rather than reused or recycled, the waste may require additional offsite land use. Entergy's feasibility and cost evaluation indicates that at least 6350 cy (4850 m^3; approximately 0.3 percent) is likely to be contaminated, and that contaminated spoils would need to be disposed of as Class A Waste (Enercon 2010). The only current outlet for Class A Waste is in Clive, Utah. Contaminated wastes would need to be appropriately packaged and transported. However, Entergy's feasibility and cost evaluation also indicates that all material, even if it contains low levels of contamination, could possibly be disposed of in the ocean.

Some solid wastes may be generated by water treatment processes. Any such waste would be treated and/or disposed of in accordance with State solid waste regulations. During operation, Entergy will have to maintain release of solids and chemicals to the blowdown water and, subsequently, to the discharge canal and the Hudson River in accordance with IP2 and IP3 SPDES permits. Other solid wastes from tower operation and maintenance (including sludge from the tower basins) would be managed and disposed of in accordance with applicable State regulations at approved offsite facilities. As noted in the Water Quality portion of this section, any contaminated ground water produced by dewatering operations will need to be properly treated before discharge.

Though a large volume of rock and soil would require offsite transportation, at least one disposal option – ocean dumping – would require no additional land.. The NRC staff concludes that waste-related impacts associated with the closed-cycle cooling alternative at IP2 and IP3 could range from SMALL to LARGE, depending on where Entergy disposes of the material, whether the material can be reused or recycled, and the extent to which contaminated spoils require special disposal.

- **Human Health**

Human health impacts for an operating nuclear power plant are identified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Potential impacts on human health from the operation of closed-cycle cooling towers at nuclear power plants are evaluated in Section 4.3.6 of the GEIS.

During construction activities there would be risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices.

Depending on the level of contaminated spoils and groundwater removed during the construction process, it is possible that additional occupational exposures to radiation may occur. Crews would need to comply with existing radiation exposure standards. Given the low level of contamination in soil and groundwater, as well as the limited extent of the contamination, this is likely not to be a significant issue at the construction site.

Hybrid cooling towers at IP2 and IP3 would be equipped with sound attenuators (Enercon 2010). The topography of the area would provide additional attenuation of the noise levels. An analysis of potential offsite noise levels resulting from both cooling towers operating continuously indicated that the increase in noise levels at sensitive receptor sites would be 1 decibel or less, a level most likely not noticeable by the residents of the Village of Buchanan (Enercon 2010). These sound levels would comply with Village of Buchanan requirements.

The GEIS evaluation of health effects from plants with cooling towers focuses on the threat to workers from microbiological organisms whose presence might be enhanced by the thermal conditions found in cooling towers. The microbiological organisms of concern are freshwater organisms that are present at nuclear plants that use cooling ponds, lakes, or canals and that discharge to small rivers (NRC 1996). Because the closed-cycle system at IP2 and IP3 would operate using brackish water, and because the Hudson River at Indian Point does not meet the NRC's definition of a small river, thermal enhancement of microbiological organisms is not expected to be a concern.

Furthermore, as described in Section 4.3 of this SEIS, the NRC concludes that continued operation of the facility would not increase the impacts of occupational radiation exposures during the relicensing period. Overall, the NRC staff concludes that human health impacts from the closed-cycle cooling alternative would also be SMALL.

- **Socioeconomics**

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a closed-cycle cooling could affect regional employment, income, and expenditures. Two types of job creation result from this alternative: (1) construction-related jobs, and (2) operation-related jobs, which have the greater potential for permanent, long-term socioeconomic impacts.

Entergy estimates that construction of the cooling towers would require an average workforce of 300 mostly temporary employees or contractors and could take an estimated 62 months. During the outage phase of the effort, the temporary workforce could peak at 600 (Entergy 2007). For comparison purposes, a workforce of approximately 950 additional workers is on site during a routine refueling outage (Entergy 2007).

As previously described, the impacts of relicensing and refurbishing IP2 and IP3 are addressed in a site-specific case study presented in Appendix C (Section C.4.4) to the GEIS. The case study postulated that major refurbishment activities could result in as many as 2300 workers on site. In the case study, the workers were engaged in a variety of component replacement and inspection activities. The case study employment estimate is significantly larger than Entergy's estimate in the previous paragraph and is considered by the NRC staff to be the maximum potential size of the temporary workforce because the GEIS estimate includes a variety of activities that will not be occurring at Indian Point during an outage to install a closed-cycle cooling system. As of June 2006 the site had approximately 1255 full-time workers (Entergy employees and baseline contractors) during normal plant operations (Entergy 2007).

The GEIS case study concluded that, because the surrounding counties are high population density areas as described in Section 4.4.1 of this SEIS, there will be available housing to support the influx of workers. Therefore, the GEIS concluded that any construction-related impact on housing availability would likely be small. With even fewer workers on site than anticipated in the GEIS, impacts would be even less noticeable.

As reported by Levitan and Associates, Inc. (2005), payments-in-lieu-of-taxes (PILOT) are made by Entergy to surrounding taxing jurisdictions. The PILOT amounts would not likely be affected by the construction of new closed-cycle cooling systems or other capital expenditures. In accordance with the PILOT agreements, this payment schedule will remain fixed through the term of the current site licenses (Levitan and Associates, Inc. 2005). Because plant valuation is not likely to change drastically with the installation of closed-cycle cooling (though it may increase), PILOT payments are likely to stay at similar relative levels throughout the renewal term.

Electricity costs and grid reliability are outside of the scope of NRC's review, though many commenters have expressed concern about these two issues. The NRC staff notes that the New York Independent System Operator (NYISO) would continue to monitor grid function and reliability, and prices would be established on New York State's restructured electricity market. Approximately 42 weeks of outage would be necessary to complete construction and implement closed-cycle cooling (Enercon 2010).

The NRC staff concludes that most socioeconomic impacts related to construction and operation of cooling towers at the site would be SMALL.

- **Transportation**

Adverse transportation impacts would be likely during construction of cooling towers. The greatest impacts would occur during site excavation and would decline later in construction. These impacts would return to current levels following construction.

Offsite disposal of approximately 2 million cy (1.5 million m^3) of rock and soil from the excavation of the two cooling tower sites would be expected to have a significant impact on local transportation infrastructure. As indicated by Entergy's feasibility and cost evaluation, the blasting and excavation phase of construction would take approximately four years to complete (Enercon 2010). Given 20 cy dump trucks, approximately 100,000 round trips would be needed to remove the excavated materials. During peak excavation periods, 364 to 518 truck loads would leave the site each day. Much of this material could leave the site on barges in the Hudson River (Enercon 2010). Entergy's feasibility and cost evaluation indicates that barge transportation is the most likely option for reused and recycled blasting spoils (Enercon 2010). Earlier estimates by Entergy indicated that each barge may hold 1000 tons of spoils.

Road traffic in the area is heavy and the additional traffic from construction and site workers would cause increased traffic delays, particularly along US Highway 9 and State Highway 9A (Entergy 2007). Barged material may be transferred to trucks at transshipment points along the Hudson, though this is likely to have markedly lower impacts on transportation than if all spoils were trucked offsite along surface roads near Indian Point. In some cases, though, impacts could still be significant. If barged material were transported out to sea and disposed of there, then NRC staff expects that impacts on transportation would be minor.

During operations, NRC staff anticipates that the closed-cycle cooling system would have little to no effect on transportation, and would likely be limited to occasional shipments of waste cleaned out from cooling tower basins, occasional deliveries of chemicals used to prevent fouling of the towers, and any replacement components necessary throughout the life of the towers. As noted previously, fogging and icing is not expected to be significant.

Based on independent calculations of expected waste volumes from site excavations that were on the same order of magnitude as the Entergy estimates, the NRC staff concludes that impacts from transportation activities, primarily during excavation of the construction site, could be significant and destabilizing, though temporary, during construction and will not be noticeable during operations. Impacts, then, will be SMALL during operations, but SMALL to LARGE during construction.

- **Aesthetics**

IP2 and IP3 are already visible from the Hudson River, scenic overlooks on area highways, and the Palisades Interstate State Park. The property is adjacent to the Scenic Area of Statewide Significance. The addition of the two cooling towers, standing 50 m (165 ft) in height, would make the entire facility more visible as the developed footprint of the facility would be expanded (Entergy's feasibility and cost evaluation includes site renderings to illustrate visual impacts; Enercon 2010. The towers are more aesthetically similar to austere, international-style performance or convention centers than to the hyperbolic natural draft towers many associate with nuclear power plant sites). The clear-cutting of wooded areas for construction of the towers would remove a visual buffer for some site structures. The towers themselves would be clearly visible from offsite vantage points. Entergy has indicated that it would preserve as many trees as possible and that it would plant new trees to reestablish some visual buffers and help attenuate noise (Entergy 2007). Remaining and new trees could act as a partial visual buffer between the construction sites and the river and a visual and noise buffer on land (Entergy 2007).

While the hybrid mechanical-draft cooling towers under consideration are designed to reduce fog and ice production in the local area and minimize presence at ground level, fog and ice produced during operation could still occur. In particular, a visible plume, though attenuated by the hybrid design, may occur under certain meteorological conditions during the year (Enercon 2010). In most cases, these plumes would occur immediately over the towers and Indian Point property, though under worst case conditions, plumes may extend several hundred to thousands of meters (Enercon 2010). Given tower design, it is likely to remain aloft and not occur at ground level thereby reducing the likelihood and severity of fog and ice. Less noticeable moisture and salt deposition from the plume may increase dampness and corrosion on surrounding property, which could affect the visual environment. The circular hybrid design proposed by Entergy disperses remaining drift over a greater area at a lower intensity than a single-stage wet mechanical-draft cooling tower (Enercon 2003).

Given proximity to a Scenic Area of Statewide Significance, Entergy's feasibility and cost evaluation indicates that cooling towers may be incompatible with NYSDEC Visual Policy. From NRC's perspective, this is an issue for Entergy and the State to reconcile, should NYSDEC require cooling towers.

The NRC staff concludes that the impact of construction and operation of a closed-cycle cooling system at IP2 and IP3 on aesthetics would likely be MODERATE to LARGE, given the proximity to important visual resources. Impacts will be greater when atmospheric conditions result in large, visible plumes, and the towers will always be clearly visible.

- **Historic and Archeological Resources**

Should NYSDEC decide that Indian Point must install cooling towers, extensive consultation and further study of onsite historical resources will be necessary. As noted in Section 4.4.5.1 of this SEIS, Entergy's Phase 1b study identified historic and prehistoric resources in the area identified for the south tower (ENN 2009). Based on Entergy's consultation with the New York State Historic Preservation Office, significant additional site study and consultation with other interested groups, particularly Tribal representatives, will be necessary should NYSDEC require cooling tower installation (ENN 2009, NYSHPO 2009). Prior to Entergy's Phase 1b study, a Phase 1A survey was conducted on the property in 2006. The NRC staff identified 76 resources listed on the National Register of Historic Places (NRHP) within 5 miles of IP2 and IP3.

There are registered historically significant buildings and sites within several kilometers of IP2 and IP3 and other nonregistered sites or buildings that may be eligible for registration (NRC 1996). However, the NRC case study presented in the GEIS indicated that some unregistered sites may go unprotected because the sites' significance may be discounted because of their proximity to the IP2 and IP3 facility.

Further studies and consultation with the State Historic Preservation Office and appropriate Native American Tribes, would occur under Section 106 of the National Historic Preservation Act (NHPA) should NYSDEC require that cooling towers be constructed onsite. Any historic or archeological resources are present in previously disturbed areas or in undisturbed areas, they would have to be evaluated for eligibility for listing on the NRHP.

Entergy has procedures for addressing historic and archeological resources (as noted in Section 4.4.5.2), and it has acknowledged the need to survey for unknown resources before construction. As noted in this section, further evaluation and consultation would be necessary prior to cooling tower installation. Historic and archeological resources could be adversely impacted given the potential for historic and prehistoric resources to be discovered on the cooling tower sites. Entergy's early coordination, consultation, and planning could help to reduce or minimize most impacts. . Nonetheless, the NRC staff concludes that the impact from the closed-cycle cooling alternative would likely range from SMALL to MODERATE if historic and archeological resources cannot be avoided.

- **Environmental Justice**

The NRC staff addresses environmental justice impacts of continued operations in Section 4.4.6 of this SEIS. Construction and operation of cooling towers at IP2 and IP3 could have an impact on minority and low-income populations.

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a closed-cycle cooling system at Indian Point. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceeds the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas previously discussed in this section. For example, increased demand for rental housing during construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around IP2 and IP3, and all are exposed to the same hazards generated from constructing and operating a closed-cycle cooling system.

Potential impacts to minority and low-income populations from the construction and operation of a closed-cycle cooling system at Indian Point would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. However, minority and low-income populations residing along site access roads could be affected by increased commuter vehicle traffic during shift changes. Increased demand for rental housing during construction of the closed-cycle cooling system could affect low-income populations in the vicinity of IP2 and IP3. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Since IP2 and IP3 are located in a high population area and the number of available housing units exceeds demand, any increase in employment would have little or no noticeable effect on the availability of housing in the region. Given the close proximity to the New York metropolitan area, most construction workers would commute to the site thereby reducing the potential demand for rental housing.

As noted earlier in this section, replacement power required during a 42-week outage could increase air quality effects in minority and low-income communities, depending on the location and characteristics of generator units used to replace IP2 and IP3 output. These effects are likely to be short-lived (most will be no longer than the outage period), and may vary with time of year, scheduled outages at other facilities, and generator pricing on the New York Independent System Operator (NYISO) grid. Additionally, impacts would occur near existing facilities and would result from incremental increases rather than new effects. As a result, impacts are likely to be small. Nonetheless, some additional power generation may have to come from other sources to make up for parasitic and efficiency losses. These could contribute to additional air quality and human health impacts. However, it is assumed that emissions from these generator facilities would meet air quality standards.

Based on this information and the analysis of human health and environmental impacts presented in this section, the construction and operation of the closed-cycle cooling system would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of IP2 and IP3.

Table 8-1. Summary of Environmental Impacts of a Closed-Cycle Cooling Alternative at IP2 and IP3

Impact Category	Impact	Closed-Cycle Cooling Alternative Comments
Land Use	SMALL to LARGE	Construction of towers requires about 16 ha (40 ac). Waste disposal may require much offsite land.
Ecology: Aquatic	SMALL	Entrainment and impingement of aquatic organisms, as well as heat shock, would be reduced.
Ecology: Terrestrial	SMALL to MODERATE	Onsite forest habitats disturbed with possible effects to endangered species.
Water Use and Quality	SMALL	Releases to surface water would be treated as necessary to meet permit requirements. Runoff from construction activities is likely to be controlled.
Air Quality	SMALL to LARGE	Primary impacts from operational emissions, as well as replacement power. Existing regulations may limit effects.
Waste	SMALL to LARGE	Construction would generate soil, rock, and debris requiring disposal; impacts vary greatly with disposal options.
Human Health	SMALL	Workers experience minor accident risk and may encounter contaminated blasting spoils during construction, though monitoring will limit potential for impacts.
Socioeconomics	SMALL	No impact to offsite housing or public services occurs.
Transportation	SMALL to LARGE	Increased traffic associated with construction (workers and waste disposal) may be significant, though little effect during operations.
Aesthetics	MODERATE to LARGE	Construction of two towers, 165 ft tall, would have a noticeable impact on the aesthetics of the site. Plume may be highly visible on some days.
Historical and Archeological Resources	SMALL to MODERATE	Recent study indicates potential for resources, though existing procedures should help protect resources on the largely-disturbed site.
Environmental Justice	SMALL	Impacts are not anticipated to be disproportionately high and adverse for minority and low-income communities.

8.2 No-Action Alternative

The NRC regulations implementing the National Environmental Policy Act of 1969, as amended (NEPA) (see 10 CFR Part 51, Subpart A, Appendix A, paragraph 4), specify that the no-action alternative will be discussed in an NRC environmental impact statement.

For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the IP2 and IP3 operating licenses and Entergy would then cease operating both units on or before the expiration of their current operating licenses. Following the shutdown of each unit, Entergy would initiate decommissioning of the facility in accordance with the NRC decommissioning requirements in 10 CFR 50.82, “Termination of License.” Full dismantling of structures and decontamination of the site may not occur for up to 60 years after plant shutdown.

Regardless of whether or not the IP2 and IP3 operating licenses are renewed, the facility’s owner will eventually be required to shut down the reactors and decommission the IP2 and IP3 facility. If the operating licenses are renewed, shutdown and decommissioning activities would not be avoided but would be postponed for up to an additional 20 years.

The environmental impacts associated with decommissioning, following a license renewal period of up to 20 years or following the no-action alternative, would be bounded by the discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this SEIS, and NUREG-0586, “Final Environmental Impact Statement on Decommissioning of Nuclear Facilities” (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.

Table 8-2. 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 is expected to result in few changes to offsite and onsite land use, and transition to alternate uses is expected over an extended timeframe.
Ecology	SMALL	Negative impacts to aquatic ecology of the Hudson River will cease. The overall impact is SMALL.
Water Use and Quality	SMALL	Impacts are expected to be SMALL as no new impacts occur with plant shutdown.
Air Quality	SMALL	Impacts are expected to be SMALL because emissions related to plant operation and worker transportation will decrease.
Waste	SMALL	Impacts are expected to be SMALL because generation of high-level waste will stop and generation of low-level and mixed waste will 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, will be reduced.
Socioeconomics	SMALL to MODERATE	Impacts vary by jurisdiction, with some areas experiencing MODERATE effects.
Socioeconomics (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 will remain after plant shutdown.
Historic and Archeological Resources	SMALL	Impacts are expected to be SMALL because shutdown of the plant will not immediately change land use.
Environmental Justice	SMALL	Impacts are not anticipated to be disproportionately high and adverse for minority and low-income populations.

Impacts from the decision to permanently cease operations are not considered in NUREG-0586, or its Supplement 1.[2] Therefore, immediate impacts that occur between plant shutdown and the beginning of decommissioning are considered here. These impacts will occur when the units shut down regardless of whether the license is renewed (see Table 8-2).

Plant shutdown will result in a net loss of power generating capacity. The power not generated by IP2 and IP3 during the license renewal term would likely be replaced by (1) power supplied by other producers (either existing or new units) using generating technologies that may differ from that employed at IP2 and IP3, (2) demand-side management and energy conservation, or (3) some combination of these options. The environmental impacts of these options are discussed in Section 8.3 of this SEIS. While these options can be alternatives to license renewal (given sufficient resource availability), they also constitute potential consequences of the no-action alternative. Impacts from these options will addressed in their respective portions of this Section.

This SEIS does not assess the specifics of the need for corrections to reactive power that would be required if IP2 and IP3 were shut down. Reactive power (i.e., power stored in magnetic fields throughout the power grid) is essential for the smooth operation of the transmission grid because it helps hold the voltage to desired levels. It may be possible to use the existing generators at IP2 and IP3 as a source of reactive power even if IP2 and IP3 are shut down. As "synchronous condensers," the generators could add reactive power (but not real power) to the transmission system (National Research Council 2006). Because it is assumed that the generators would be operated as synchronous condensers only until the reactive power could be supported by new, real replacement power generation, their operation is not considered as a significant contributor to the impacts described below. Further, as a shut-down nuclear power plant may not be decommissioned for many years after shutdown, the continued operation of IP2 and IP3 generators would not necessarily slow or impede decommissioning activities.

- **Land Use**

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on land use would be SMALL. Onsite land use will not be affected immediately by plant shutdowns. Plant structures and other facilities are likely to remain in place until decommissioning. In the near term, the transmission lines associated with IP2 and IP3 will likely remain in place. In the long term, it is possible that the transmission lines that extend from the onsite switchyard to major transmission corridors will be removed. As a result, the transmission line ROWs will no longer be maintained and the ROW will be available for other uses. Also, as a result of plant shutdowns, there would be a reduction in uranium mining activity on approximately 870 ha (2150 ac), or 405 ha (1000 ac) per 1000 MW(e) (NRC 1996). Therefore, the staff concludes that the impacts on land use from plant shutdown would be SMALL.

(2) Appendix J, "Socioeconomic and Environmental Justice Impacts Related to the Decision to Permanently Cease Operations," to NUREG-0586, Supplement 1, discusses the socioeconomic impacts of plant closure, but the results of the analysis in Appendix J are not incorporated in the analysis presented in the main body of the NUREG.

- **Ecology**

In Chapter 4 of this SEIS, the NRC staff concluded that entrainment and impingement of aquatic species would have MODERATE impacts. The NRC staff also concluded that thermal shock could have a SMALL to LARGE impact. Terrestrial ecological impacts were SMALL. Cessation of operations will eliminate cooling water intakes from and discharges to the Hudson River. The environmental impacts to aquatic species, including threatened and endangered species, associated with these changes are generally positive because entrainment and impingement issues will be eliminated, as would impacts from the plant's thermal plume. The NRC staff expects that impacts to aquatic ecology would decline to SMALL if the plant shuts down.

The impacts of plant closure on the terrestrial ecosystem could be both negative and positive, depending on final disposition of the IP2 and IP3 site. Currently, there is a fragment of eastern deciduous hardwood habitat in the exclusion area of the facility that Entergy indicates has not been previously developed. This fragment could be destroyed by new development once access is no longer restricted. Plant closure will not directly affect this fragment, however, and a prolonged period prior to site decontamination may also provide protection for this fragment. Overall, the NRC staff concludes that ecological impacts from shutdown of the plant would be SMALL.

- **Water Use and Quality**

When the plant stops operating and cooling water is no longer needed, there will be an immediate reduction in water withdrawals from and discharge to the Hudson River. This will reduce evaporation from the river in the vicinity of the plant and will result in decreased discharges of biocides and other chemicals. Therefore, the staff concludes that the impacts on surface water use and quality from plant shutdown would be less noticeable than current operations and would remain SMALL.

Ground water at the IP2 and IP3 site contains elevated concentrations of tritium (EPA 2004). In Sections 2.2.7 and 4.5 of this SEIS, the NRC staff examined available information on leakage to ground water and determined that the issue, while new, is not significant. The source of the contamination is believed to be historical leakage from the IP1 and IP2 spent fuel pools. Since discovering the leaks, Entergy has removed fuel from the IP1 spent fuel pool and drained it. The no-action alternative would not, on its own, affect ground water contamination. Consequently, the NRC staff concludes that ground water quality impacts from shutdown of the plant would be SMALL.

- **Air Quality**

In Chapter 4 of this SEIS, the NRC staff adopted the findings in the GEIS that the impacts of continued plant operation on air quality would be SMALL. When the plant stops operating, there will be a reduction in emissions from activities related to plant operation (e.g., use of diesel generators and vehicles to transport workers to the site). As such, the NRC staff concludes that the impact 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 of this SEIS. The impacts of low-level and mixed waste from plant operation are characterized as SMALL. When IP2 and IP3 stop operating, the plant will stop generating high-level waste and generation of low-level and mixed waste associated with plant operation will briefly increase, and then will decline. Therefore, the staff concludes that the impacts of waste generated after shutdown of the plant would be SMALL.

Wastes associated with plant decommissioning are unavoidable and will be significant whether the plant is decommissioned at the end of the initial license term or at the end of the period of extended operation. The no-action alternative will not have an appreciable effect on waste volumes associated with decommissioning.

- **Human Health**

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on human health are SMALL. After cessation of plant operations, the amount of radioactive material released to the environment in gaseous and liquid forms, which are currently within regulatory limits, will be reduced. Therefore, the NRC staff concludes that the impact of plant shutdown on human health also would be SMALL. In addition, the variety of potential accidents at the plant will be reduced to a limited set associated with shutdown events and fuel handling. In Chapter 5 of this SEIS, the staff concluded that impacts of accidents during operation are SMALL. Therefore, the NRC staff concludes that the impacts of potential accidents following shutdown of IP2 and IP3 also 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. Should the plant shut down, there would be immediate socioeconomic impacts from loss of jobs (some, though not all, of the approximately 1255 full-time employees and baseline contractors would begin to leave the site); property tax payments to Westchester County may be reduced. These impacts, however, would not be considered significant on a countywide basis because of the large population in the area and because plant workers' residences are not concentrated in a single municipality or county.

PILOT payments and other taxes from IP2 and IP3 are paid directly to the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District. Entergy paid a combined $21.2 million in PILOT payments, property taxes, and other taxes to Westchester County, the Town of Cortlandt, the Village of Buchanan, the Verplanck Fire District, and the Hendrick Hudson Central School District in 2005 (Entergy 2007). PILOT payments, property taxes, and other taxes paid by the site account for a significant portion of revenues for these Government agencies.

The Village of Buchanan, which has over 2100 residents, is the principal local jurisdiction that receives direct revenue from IP2 and IP3. In fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed about 39 percent of the Village of Buchanan's total revenue of $5.08 million (Entergy 2007). The revenues generated from IP2 and IP3 are used to fund police, fire, health, transportation, recreation, and other community services. Additionally in fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District, which serves approximately 3000 students (Entergy 2007).

The shutdown of IP2 and IP3 may result in increased property values of the homes in the communities surrounding the site (Levitan and Associates, Inc. 2005). This would result in some increases in tax revenues. However, to fully offset the revenues lost from the shutdown of IP2 and IP3, taxing jurisdictions most likely would have to compensate with higher property taxes (Levitan and Associates, Inc. 2005). The combined increase in property values and increased taxes could have a noticeable effect on some area homeowners and business, though Levitan and Associates did not indicate the magnitude of this effect and whether the net effect would be positive or negative.

Revenue losses from Indian Point operation would affect the communities closest to and most reliant on the plant's tax revenue and PILOT. If property values and property tax revenues increase, some of these effects would be smaller. The NRC staff concludes that the socioeconomic impacts of plant shutdown would likely be SMALL to MODERATE (MODERATE effects for the Hendrick Hudson Central School District, Village of Buchanan, Town of Cortlandt, and the Verplanck Fire District). See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of the potential impacts of plant shutdown.

- **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 will be accompanied by reduced traffic in the vicinity of the plant. Most of the reduction will be associated with a reduction in plant workforce, but there will also be a reduction in shipment of maintenance materials to and from the plant. Therefore, the 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. Major plant structures and other facilities, such as the containment buildings and turbine buildings, are likely to remain in place until decommissioning begins. The NRC staff also anticipates that the overall appearance of the facility and its grounds would be maintained through the decommissioning. Since no significant changes would occur between shut down and decommissioning, the staff concludes that the aesthetic impacts of plant closure would be SMALL.

- **Historic and Archeological Resources**

In Chapter 4 of this SEIS, the staff concluded that the impacts of continued plant operation on historic and archeological resources would be SMALL. Onsite land use will not be affected immediately by the cessation of operations since plant structures and other facilities are likely to remain in place until decommissioning. Following plant shutdown, there would be no foreseeable need for archeological surveys of the area. Therefore, the NRC staff concludes that the impacts on historic and archeological resources from plant shutdown would be SMALL.

- **Environmental Justice**

In Chapter 4 of this SEIS, the NRC staff concluded that the environmental justice impacts of continued operation of the plant would be SMALL because continued operation of the plant would not have a disproportionately high and adverse impact on minority and low-income populations. Although the NRC staff concluded that the socioeconomic impacts of the plant shutdown would be MODERATE for some jurisdictions, the impacts of the plant shutdown are likely to be felt across the entire community and could disproportionately affect some minority and low-income populations. Some minority and low-income populations located in urban areas could be affected by reduced air quality and increased health risks due to the burning of fossil fuel in existing power plants used to replace the lost power generated by Indian Point.

As described in Section 2.2.8.6, the site contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District in 2005. The Hendrick Hudson Central School District has only an 18-percent minority population (compared to a 47-percent Statewide average) and only 5 percent of the students are eligible for a free or reduced-price lunch program (compared to a Statewide average of 44 percent). Therefore, the loss of funding to the Hendrick Hudson Central School District would not disproportionately affect minority and low-income populations (GreatSchools 2008).

The site contributed about 39 percent of the Village of Buchanan's total revenue in 2005 (Entergy 2007). In 2000, less than 4 percent of the population were minorities and less than 4 percent of the individuals were below the poverty level (US Census Bureau 2000). Therefore, the loss of funding to the Village of Buchanan would not disproportionately affect minority and low-income populations.

The NRC staff concludes that the environmental justice impacts of plant shutdown would be SMALL. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.3 Alternative Energy Sources

This section discusses the environmental impacts associated with developing alternative sources of electric power to replace power generated by IP2 and IP3. The order of alternative energy sources presented in this section does not imply which alternative would be most likely to occur or which is expected to have the least environmental impacts. The NRC staff notes that discussion of supercritical coal-fired generation has been relocated to Section 8.3.

The following central generating station alternatives are considered in detail in the identified sections of this SEIS:

- natural gas combined-cycle (NGCC) generation at either the IP2 and IP3 site or an alternate site (Section 8.3.1)

The NRC staff considers the following nongeneration alternatives to license renewal in detail in the identified sections of this SEIS:

- purchased electrical power (Section 8.3.2)
- energy conservation and efficiency (Section 8.3.3)

The NRC staff also considers two combinations of alternatives that include new or existing generation along with conservation or purchased power in the identified sections of this SEIS:

- continued operation of either IP2 or IP3, renewable generation, and conservation programs (Section 8.3.5.1)
- repowering a retired facility with a new NGCC power plant, renewable generation, and conservation (Section 8.3.5.2)

Alternatives considered by the NRC staff but dismissed from further evaluation as stand-alone alternatives are addressed in Section 8.3.4 of this SEIS. Several of the alternatives discussed in Section 8.3.4 are included in the combinations addressed in Section 8.3.5.

<u>Alternatives Process</u>

Since IP2 and IP3 have a net electric output of 2158 MW(e), the NRC staff evaluated the impacts of alternatives with comparable capabilities.

Of the alternatives mentioned in this section, the NRC staff expects that only a NGCC generation alternative could be wholly developed at the IP2 and IP3 facility because the site is too small to host other alternatives. As noted elsewhere in this Chapter, the NGCC alternative could also be constructed as part of a repowering operation of another existing but retired power plant.

While the alternate site considered need not be situated in New York State, the availability of transmission line capacity to deliver power from a location outside the New York metropolitan region to current IP2 and IP3 customers could constrain siting choices. The DOE has identified critical congestion areas where it is critically important to remedy existing or growing electrical transmission congestion problems because the impacts of the congestion could be severe. It is conceivable that these transmission congestion patterns would influence selection of an alternate site for generating power that is needed in the New York metropolitan region. For purposes of this analysis, however, the NRC staff assumes that adequate transmission will exist – either through planned, new projects (e.g., the proposed New York Regional Interconnect – NYRI , or the Champlain-Hudson Power Express, Inc. – CHPEI – Project, among others) – or by locating the alternatives near to downstate loads.

All of New York's constrained transmission paths move power from areas to the west, south, and north of the State to the loads in and around New York City and Long Island. The New York City metropolitan area consumes major quantities of electricity with less generation capacity than load. Therefore, the region is dependent on imports. Because of the area's current dependence on local power generation from natural gas and oil fuels, the area has high electricity rates (DOE 2006). The replacement of limited local generation sources with additional imported power would place even more demands on the constrained transmission system moving power into the New York City area, though direct current transmission, like CHPEI, could allow greater flexibility. As noted in Section 8.2, it may be necessary to continue operating the IP2 and IP3 generators as synchronous condensers to supply virtual power to the local transmission system after the IP2 and IP3 reactors shut down.

Finally, the NRC staff notes that an infinite number of potential combination alternatives exists, based on varying the amounts or types of power generation means employed or varying the extent to which alternatives rely on energy conservation. The following alternatives are based on available research and input from the draft SEIS comment process, and represent, in the staff's professional judgment, reasonable examples of combinations that address comments received, ongoing State-level programs, and resource availability in New York State. The staff also notes that none of these combinations are intended to place a limit on available capacities, nor are they intended to supplant State or utility level policy decisions about how to generate electricity, reduce or add to load, set prices, or promote different approaches to generating electricity or managing loads.

EIA Projections

Each year the Energy Information Administration (EIA), a component of DOE, issues an annual energy outlook. In its "Annual Energy Outlook 2010 with Projections to 2035," EIA projects that natural gas-fired plants will account for approximately 46 percent of electric generating capacity additions through 2035 (DOE/EIA 2010), while coal-fired plants will account for approximately 12 percent of generating capacity additions through 2035 (DOE/EIA 2010). EIA projects that renewable energy sources will account for 36 percent of capacity additions through 2035 (DOE/EIA 2010). New nuclear units are expected to account for only 3 percent of additions over the same time period (DOE/EIA 2010).

EIA bases its projections on the assumption that providers of new generating capacity will seek to add generating sources that are cost effective and meet applicable environmental requirements, like air emissions standards. Particularly, uncertainty about future limits on greenhouse gases (GHGs), along with Federal incentives, State energy programs, and rising fossil fuel prices increase competitiveness for renewable and nuclear power (DOE/EIA 2010). Aspects of the American Recovery and Reinvestment Act (ARRA) have also supported renewable capacity growth and will likely continue to do so. EIA notes that regulatory uncertainty also drives capacity decisions. For example, EIA notes that potential future requirements for carbon capture and sequestration (CCS) could result in higher costs for coal generation. Given a smaller future role for coal-fired power, in line with New York State's declining reliance on coal (DOE/EIA 2009) and GHG restrictions imposed by the Regional Greenhouse Gas Initiative (RGGI), the NRC staff has relocated the supercritical coal-fired alternative to Section 8.3.4., Alternatives Dismissed from Individual Consideration. NRC staff addresses the impacts of a new NGCC plant located at either the IP2 and IP3 site or an alternate site in Section 8.3.1 of this SEIS, and considers combinations of alternatives that include substantial amounts of renewable energy sources in Section 8.3.5.

In contrast to many recent AEO editions, EIA no longer indicates, in its overview of future electrical generation capacity, that any new capacity will be fired with oil. NRC staff notes that some gas-fired facilities may fire with oil during periods of high gas demand, but does not consider new oil-fired capacity in this SEIS..

The NRC staff uses EIA's projections to help select reasonable alternatives to license renewal. In the following sections of this chapter, the NRC staff will examine several alternatives in depth, and identify a range of others that staff considered but rejected.

8.3.1 Natural Gas-Fired Combined-Cycle (NGCC) Generation

In this section, the NRC staff examines the environmental impacts of the NGCC alternative at both IP2 and IP3 and at an alternate site. The NRC staff assumed that a natural gas-fired plant would use a closed-cycle cooling system.

This replacement NGCC plant would likely use combined-cycle technology. Compared to simple-cycle combustion turbines, combined-cycle plants are significantly more efficient, and thus provide electricity at lower costs. NGCC power plants also tend to operate at markedly higher thermal efficiencies than other fossil-fuel or nuclear power plants, and require less water for condenser cooling than other thermoelectric alternatives. As such, the NGCC alternative would require smaller cooling towers and substantially less makeup water than the cooling system proposed in Section 8.1.1 of this SEIS. Typically, these plants support intermediate loads but they are capable of supporting a baseload duty cycle; thus they provide an alternative to renewing the IP2 and IP3 operating licenses. Levitan and Associates indicated that gas-fired generation was the most likely alternative to take the place of IP2 and IP3 (Levitan and Associates 2005). Further, New York State is increasingly reliant on natural gas for electrical power.

The NRC evaluated environmental impacts from gas-fired generation alternatives in the GEIS, focusing on combined-cycle plants (NRC 1996). 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 steam generator, which then powers a steam turbine electrical generator. The combination of two cycles can be as much as 60 percent efficient.

EIA projects that advanced combined-cycle gas turbines can operate at a heat rate as low as 6333 BTU/kWh for units with net output of 400 MW(e) (DOE/EIA 2010b). These units are more efficient than the 408-MW(e) units Entergy considered in its ER, and would consume less fuel, while producing fewer emissions per unit of electrical output. Using five, 400-MW(e) units would slightly underestimate the total impact to some resources, but it provides a useful approximation using more-current technology. .

The NRC staff discusses the overall impacts of the NGCC generating system in the following sections and summarizes them in Table 8-4 of this SEIS. The extent of impacts at an alternate site would depend on the location of the site selected. A third option is that this NGCC alternative could be constructed at an existing, retired or underutilized fossil facility as part of a facility repowering. Impacts would be essentially the same for a repowered facility as for a facility constructed at Indian Point, though available site infrastructure could result in slightly lower or higher impacts at the repowering project. Regardless, a repowered site would already have transmission access, likely access to cooling water, and possible access to gas transmission infrastructure.

- **Land Use**

Existing facilities and infrastructure would be used to the extent practicable if a NGCC complex were to be developed at IP2 and IP3. Specifically, the NRC staff assumed that this alternative would use the existing switchyard, offices, and transmission line ROWs. However, a new mechanical-draft cooling tower would need to be constructed to support the new closed-cycle cooling system.

The GEIS estimated that 45 ha (110 ac) are needed for a 1000-MW(e) natural gas-fired facility. Scaling up for the 2000-MW(e) facility would indicate a land requirement of approximately 90 ha (220 ac). The NRC staff notes that some existing NGCC facilities require less space than the GEIS indicates, and may be more on the order of 16 ha (40 ac) per 1000 MW(e), inclusive of cooling towers. (Entergy's withdrawn proposal for combined-cycle capacity on the IP2 and IP3, for example, required only 2 ha (5 ac) for 330 MW(e) of capacity (as noted in Levitan and Associates 2005)). The IP2 and IP3 site is only 98 ha (242 ac) with some land unsuitable for construction. Also, much of the site is covered by the IP2 and IP3 containment structures, turbine buildings, other IP2 and IP3 support facilities, and AGTC gas pipeline. Land covered by some IP2 and IP3 facilities would not be available until decommissioning, though land covered by some support facilities may be available prior to the end of the current license. The AGTC pipeline ROW would remain unavailable. Based on previous Entergy proposals and experience at other combined-cycle plants, however, the NRC staff finds it possible that a NGCC alternative could be constructed and operated on the IP2 and IP3 site.

As reported by Levitan and Associates, Inc. (2005), the existing Algonquin pipeline that passes through the IP2 and IP3 site may be adequate for a 330-MW(e) simple-cycle plant that would operate in peaking mode during the summer season, when gas supplies are less constrained by winter-season heating demands. Levitan and Associates (2005) concluded that substantial and expensive pipeline upgrades would probably be necessary to supply natural gas to a combined-cycle alternative throughout the winter heating season and for the additional baseload capacity throughout the year. Given firm demand for natural gas during the winter heating season, it is possible that the NGCC alternative may need to burn fuel oil during several weeks of the year, should conditions of limited supply emerge. This practice is common at gas-fired power plants in the northeastern United States. Another option is that future, proposed liquefied natural gas (LNG) facilities in the northeastern United States or Canadian maritime provinces could reduce demands on the Algonquin pipeline system.

The environmental impacts of locating the NGCC facility at an alternate location would depend on the past use of the location. If the site is a previously undisturbed site the impacts would be more significant than if the site was a previously developed site, or if the site is a repowered, existing facility. Construction and operation of the NGCC facility at an undeveloped site would require construction of a new cooling system, switchyard, offices, gas transmission pipelines, and transmission line ROWs. A previously industrial site may have closer access to existing infrastructure, which would help to minimize environmental impacts. A NGCC alternative constructed at the IP2 and IP3 site would have direct access to a transmission system, an existing pipeline ROW, and an existing dock to receive major components. A repowered facility is likely to have similar access to supporting infrastructure as a facility sited at the Indian Point site, and may have other benefits, like existing connections to natural gas pipelines. In some cases, other onsite support structures may also be repurposed to support the repowering operation.

Regardless of where a NGCC alternative is built, the GEIS indicates that additional land would be required for natural gas wells and collection stations. According to the GEIS, a 1000-MW(e) gas-fired plant requires approximately 1500 ha (3700 ac) for wells, collection stations, and pipelines, or about 3000 ha (7400 ac) for a 2000-MW(e) facility (NRC 1996).

Overall, land use impacts of the NGCC alternative are considered SMALL to MODERATE at the IP2 and IP3 site. NGCC land use impacts at a new previously industrial site or a repowered facility are considered to be SMALL to MODERATE; while NGCC generation at a new undeveloped site would have MODERATE to LARGE impacts.

- **Ecology**

At the IP2 and IP3 site, there would be terrestrial ecological impacts associated with siting a

NGCC facility. These impacts would likely be less than those described in Section 8.1.1.2 of this SEIS, which discusses the ecological impacts of the construction of a closed-cycle cooling system to support IP2 and IP3, as existing portion of the site currently used for support structures like parking lots or outbuildings could be redeveloped for a gas fired alternative. Also, substantially less soil and rock removal would be necessary. The duration of impacts from construction would be less.

Improvements to the existing pipeline network would also be necessary, with some impacts along the already-disturbed ROW. Levitan and Associates (2005) indicated that no transmission system improvements would be necessary to accommodate the NGCC alternative at the IP2 and IP3 site. Overall, construction effects are limited in both scope and duration. Impacts to terrestrial ecology of constructing the NGCC alternative on site are likely to be SMALL. In most cases, impacts at a repowering project would be similarly SMALL, depending on the extent to which existing site structures can be reused. Some transmission improvements may be necessary if the repowered site was previously of smaller capacity.

Ecological impacts at an alternate site would depend on the nature of the land used for the plant and the possible needs for a new gas pipeline and/or transmission lines. Construction of the transmission line and construction and/or upgrade of the gas pipeline to serve a new plant at an alternate site, if necessary, would have substantial ecological impacts, though these would be temporary. Ecological impacts to the plant site and in utility ROWs could include impacts on threatened or endangered species, habitat loss or fragmentation, reduced productivity, and a local reduction in biological diversity. Impacts to terrestrial ecology would likely be SMALL to MODERATE, depending on site characteristics.

Operation of the NGCC alternative at the IP2 and IP3 site or another site would likely not introduce noticeable new terrestrial ecological effects after construction.

The NGCC alternative is unlikely to create significant impacts for aquatic ecology during construction, regardless of location. Because the plant has a relatively small footprint, and because crews would likely implement some measures to control site runoff, it is unlikely that impacts to aquatic ecology would be noticeable. Noticeable effects could occur during construction if new transmission line ROWs or gas pipelines would need to cross streams or rivers.

During operations, aquatic ecological resources would experience significantly smaller effects than they would from a comparable nuclear or coal-fired power plant. The combined-cycle gas plant using closed-cycle cooling would require less than half the cooling water of IP2 and IP3 using closed-cycle cooling. Construction of intake and discharge structures at an alternate site could trigger some impacts to aquatic ecology, but because these impacts are very limited in scope and time, they will likely not affect any important resource characteristics. Thus, aquatic ecological impacts of the NGCC alternative are likely to be SMALL.

At an alternate site, impacts to ecology may range from SMALL to MODERATE, while they are likely to be SMALL if constructed at the existing IP2 and IP3 site or a repowered site.

- **Water Use and Quality**

Surface Water: NGCC plants are highly efficient and require less cooling water than other generation alternatives. Plant discharges would consist mostly of cooling tower blowdown, with the discharge having a slightly higher temperature and increased concentration of dissolved solids relative to the receiving water body, as well as intermittent, low concentrations of biocides (e.g., chlorine). All discharges from a new plant at the IP2 and IP3 site would be regulated through a New York SPDES permit, which would be issued by NYSDEC. Finally, some erosion would probably occur during construction (NRC 1996), though the GEIS indicates this effect would be SMALL. Plant construction crews would employ at least basic runoff control measures. Because crews would likely not have to construct entirely new intake structures, transmission lines, or a gas pipeline, most activities that could affect water use and quality will not occur for an alternative constructed at the IP2 and IP3 site, or at a repowered site. Like the existing IP2 and IP3, a NGCC alternative located on the site would likely not rely on ground water. Overall, impacts to water use and quality at the IP2 and IP3 site from a NGCC alternative would likely be SMALL for both construction and operation.

At an alternate site, a NGCC alternative would likely rely on surface water for cooling makeup water and blowdown discharge. Intake and discharge would involve relatively small quantities of water compared to once-through cooling and less than a nuclear or coal-fired power plant. 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. If a NGCC plant discharges to surface water, the plant would have to meet the requirement of a SPDES permit. The NRC staff expects that any new facility would comply with requirements of the discharge permits issued for its operation. Thus discharges from the plant would be legally obligated to conform to applicable water quality standards. Water withdrawals from a small river or cooling pond, however, could lead to potential water use conflicts. The impacts would be SMALL to MODERATE during operations depending on receiving water characteristics, though they would likely be SMALL at a repowered site. During construction, some erosion would probably occur though the GEIS indicates this would have a SMALL effect (NRC 1996).

<u>Ground Water</u>: IP2 and IP3 currently use no ground water. It is likely that a NGCC alternative at the IP2 and IP3 site would also use no ground water. Impacts at the IP2 and IP3 site would thus be SMALL. Ground water impacts from operations at an alternate site or a repowered site may vary widely depending on whether the plant uses ground water for any of its water needs, though it would be unlikely that a plant on an alternate site would use ground water for cooling system makeup water given the quantity of water required. Ground water impacts at an alternate site could range from SMALL to MODERATE, depending on the quantity of ground water used and characteristics of aquifers used. Construction-stage impacts at both the existing site and a new site are likely to be SMALL.

- **Air Quality**

Natural gas is a relatively clean-burning fuel relative to relative to other fossil fuels. The NGCC alternative would release a variety of emissions, however.

The NRC staff calculates that approximate emissions from the five-unit, 2000-MW NGCC alternative with a heat rate of 6333 BTU/kWh would be:

- SO_x—150 MT/yr (164 tons/yr)
- NO_x—493 MT/yr (543 tons/yr)
- CO—103 MT/yr (113 tons/yr)

- Filterable particulates (PM_{10})—83 MT/yr (92 tons/yr)[(3)]

NGCC power plants primarily emit pollutants as a result of combustion conditions. These pollutants include NO_x, CO, and particulates. Regulations in place to reduce potential health effects from air emissions, especially those promulgated in response to the CAA, drive the types of emissions controls this NGCC alternative would use to limit its effects on air quality. CAA mechanisms like new source performance standards, nonattainment areas, State implementation plans, and specialized programs, including one that limited overall NO_x emissions throughout the Eastern United States, all drive emissions control technologies used in this NGCC alternative.

NO_x is typically the pollutant of greatest concern for a NGCC power plant. Given the proper atmospheric conditions, NO_x helps to form ozone, as well as smog. The NGCC alternative in this case relies on selective catalytic reduction (SCR) to reduce NO_x emissions. As previously discussed, IP2 and IP3 are located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13). All of the States of New Jersey and Connecticut, as well as several counties in Central and Southeastern New York within a 80-km (50-mi) radius of IP2 and IP3, are designated as nonattainment areas for ozone (8-hour standard) (EPA 2008b). Operators or owners of a NGCC power plant constructed in a nonattainment area would need to purchase offsets for ozone precursor emissions. In this case, NOx is the major ozone precursor emitted by the NGCC power plant. In accordance with NYSDEC regulations, "Emission offsets must exceed the net increase in annual actual emissions from the air contamination source project" (NYSDEC, Chapter 3, Parts 231–15). By design, this regulatory requirement should result in a net reduction in ozone emissions in the region.

A new NGCC generating plant located in a nonattainment area (like that at the IP2 and IP3 site) would need a nonattainment area permit and a Title IV operating permit under the CAA. The plant would need to comply with the new source performance standards for such plants set forth in 40 CFR Part 60, Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), SO_2 (40 CFR 60.43(a)), and NO_x (40 CFR 60.44(a)).

In December 2000, EPA issued regulatory findings on emissions of HAPs from electric utility steam-generating units (EPA 2000a). NGCC power plants were found by EPA to emit arsenic, formaldehyde, and nickel (EPA 2000a). Unlike coal- and oil-fired plants, EPA did not determine that emissions of HAPs from NGCC power plants should be regulated under Section 112 of the CAA.

A NGCC plant would have unregulated CO_2 emissions of about 117 pounds per MMBtu (DOE/EIA 2008a). The NRC staff calculates that a five-unit NGCC alternative with technologically advanced turbines rated at 6333 BTU/kWh would emit approximately 5,516,000 MT (6,076,000 tons) of CO_2 per year. Section 6.2 of this SEIS contains a discussion of current and future relative GHG emissions from several energy alternatives including coal, natural gas, nuclear, and renewables. Other emissions and losses during natural gas production or transportation could also increase the relative GHG impact.

Construction activities also would result in some air effects, including those from temporary fugitive dust, though construction crews likely would employ dust control practices to limit this impact. Exhaust emissions also would come from vehicles and motorized equipment used

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(3) Additional particulate emissions associated with the cooling towers were not quantified.

during the construction process, though these emissions are likely to be intermittent in nature and will occur over a limited period of time. As such, construction stage impacts would be SMALL.

The overall air quality impact for operation of a new NGCC plant at the IP2 and IP3, at an alternate site, or at a repowered site would be SMALL to MODERATE, depending on air quality in the surrounding airshed. Air quality impacts during construction would be SMALL.

- **Waste**

Burning natural gas fuel generates small amounts of waste. However, a plant using SCR to control NO_X will generate spent SCR catalyst and small amounts of solid waste products (i.e., ash). In the GEIS, the NRC staff concluded that waste generation from gas-fired technology would be minimal (NRC 1996). Waste generation impacts would be minor and would not noticeably alter any important resource attribute.

Constructing a NGCC alternative would generate small amounts of waste, though many construction wastes can be recycled. Construction either at the Indian Point site or at a repowered site would likely require little land-clearing, though some existing on-site structures at either Indian Point or a repowered site may need to be dismantled or demolished. Most of this type of debris would be recycled, transported offsite, or, in the case of demolished concrete, parking lots, and roads, could be reused at road bed material, laydown areas, or for clean fill onsite. Land-clearing debris from construction at an alternate location could be land filled on site. Overall, the waste impacts would be SMALL for a NGCC plant sited at an alternate site or a repowered site.

Cooling towers for a new NGCC alternative would be much smaller than those proposed in 8.1.1, and would not need to be constructed on slopes near the Hudson. Waste generation from plant construction, then, is much less than in 8.1.1.2. The waste-related impacts associated with construction of a five-unit NGCC plant with closed-cycle cooling systems at the IP2 and IP3 site would be SMALL.

- **Human Health**

Human health effects from the operation of a NGCC alternative with SCR emissions controls would likely not be detected or would be sufficiently minor that they would neither destabilize nor noticeably alter any important attribute of the resource.

During construction activities there would be a risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry, and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices. Fewer workers would be on site for a shorter period of time to construct a NGCC plant than other new generation alternatives, and so exposure to occupational risks tends to be lower than other alternatives.

Overall, the impacts on human health of a NGCC alternative sited at IP2 and IP3, a repowered site, or at an alternate site would be considered SMALL.

- **Socioeconomics**

Construction of a NGCC plant would take approximately 3 years (DOE/EIA 2007b). Peak labor force would be approximately 1090 workers (NRC 1996). The NRC staff assumed that construction of an offsite alternative would take place while IP2 and IP3 continue operation and would be completed by the time the plants permanently cease operations. Entergy indicates that a gas-fired facility could be producing power before IP2 and IP3 shut down (Entergy 2007). Construction time periods and employment figures may vary somewhat a repowering project depending on the extent to which existing structures can be reused.

At the end of construction, the local population would be affected by the loss of as many as 1090 construction jobs. However, this loss would be partially offset by a postconstruction permanent employment. An additional construction workforce would be needed for the decommissioning of IP2 and IP3 which could temporarily offset the impacts of the lost construction and IP2 and IP3 jobs at the IP2 and IP3 site. A new NGCC plant at the IP2 and IP3 site would offset a small portion of lost employment, though, according to Levitan and Associates, it may provide more revenues to the surrounding jurisdictions than IP2 and IP3 do (2005). The large and diverse economic base of the region would help to offset or minimize the significance of job losses.

The NRC staff concludes that the overall socioeconomic impacts from the NGCC alternative could be SMALL to MODERATE during construction and could be SMALL to MODERATE during operation at most sites, depending largely on tax impacts.

- **Transportation**

Impacts associated with transportation of the construction and operating personnel to the plant site would depend on the population density and transportation infrastructure in the vicinity of the site. During the 3-year construction period of the NGCC facility, approximately 1090 construction workers may be working at the site. The addition of these workers would increase traffic on highways and local roads that lead to the construction site. The impact of this additional traffic would have a SMALL to MODERATE impact on nearby roadways, depending on road infrastructure and existing traffic demands. Rural areas would typically experience a greater impact than urban or suburban areas. Impacts associated with plant operating personnel commuting to and from work are considered SMALL at all sites. Because the NGCC alternative relies on pipelined fuel, transportation impacts from natural gas supply are not likely to be noticeable, though plant operators will have to ensure that sufficient gas transportation capacity exists.

- **Aesthetics**

The combustion turbines and the heat-recovery boilers of the NGCC plant would be relatively low structures compared to existing plant facilities, but could be visible from the Hudson River if located at the current IP2 and IP3 site. Some facility structures could be visible from offsite locations as well. The impact on aesthetic resources of a NGCC plant is likely less than the impact of the current nuclear plant, excepting when cooling towers produce noticeable plumes. Overall, aesthetic impacts from a NGCC plant constructed at the IP2 and IP3 site would likely be SMALL. Impacts on a repowered site would be similar to those at the Indian Point site. In some cases, substantial portions of onsite infrastructure may be reused such that the aesthetic impacts of a repowered facility differ little from those of the facility prior to repowering.

At an alternate site, new buildings, cooling towers, cooling tower plumes, and electric transmission lines would be visible off site. Visual impacts from new transmission lines or a pipeline ROW would also be significant, though these may be minimized by building near existing transmission lines or on previously developed land. Additionally, aesthetic impacts would be minimized if the plant were located in an industrial area adjacent to other power plants. Overall, the aesthetic impacts associated with the NGCC alternative at alternate site could be SMALL to LARGE, though LARGE impacts would be expected only in cases where substantial new transmission is necessary, and the lines have a significant effect on important aesthetic values.

- **Historic and Archeological Resources**

As noted in Section 8.1.1.2, Entergy's recent Phase 1b survey revealed additional onsite historic and prehistoric resources.A cultural resource inventory would be needed for any property at a new site or adjacent to the IP2 and IP3 site that has not been previously surveyed. The survey would include an inventory of field cultural resources, identification and recording of existing historic and archeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site. 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 ROWs).

The impacts to historic and archeological resources for the NGCC alternative at the IP2 and IP3 site would be similar to, or less than those described in Section 8.1.1.2 of this SEIS for the closed-cycle cooling alternative (given that the NGCC alternative would require less than half the cooling tower capacity needed by IP2 and IP3. These impacts can likely be effectively managed, and could range from SMALL to MODERATE if surveys reveal unavoidable conflicts between the new facility and onsite resources. Impacts at a repowered site would likely entail similar impacts of disturbance. At a repowered site, it may be possible to begin construction in power block areas at a repowering site, while such reuse or repurposing would not be possible until after Indian Point structures are no longer needed (and, perhaps, until decommissioning occurs).

Historic and archeological resource impacts can generally be effectively managed on alternate sites and, as such, would be considered SMALL to MODERATE at a new, undeveloped site. For a previously developed site, impact on cultural and historic resources would also be SMALL to MODERATE. Previous development would likely have either removed items of archeological interest or may have included a survey for sensitive resources. Any significant resources identified would have to be handled in accordance with the NHPA.

- **Environmental Justice**

As described in Section 8.1.1.2 of this SEIS, impacts to the environment or community from actions at the IP2 and IP3 site, including the construction of a NGCC plant, are not likely to disproportionately affect minority or low-income populations because these populations in the area around the site are proportionately small compared to the geographical region's population. Therefore, the NGCC alternative constructed at the IP2 and IP3 site would have SMALL impacts on environmental justice. At a repowered site or at an alternate site, impacts would depend upon the site chosen, nearby population characteristics, and economic conditions. These impacts would range from SMALL to LARGE, depending on impacts and the distribution of low-income and minority populations. At a repowered site, impact levels would also depend on the current status of the existing power plant. If the plant is currently operating, then repowering may reduce effects; if the plant is no longer operating, then repowering with a baseload NGCC facility will create more significant impacts.

Table 8-3. Summary of Environmental Impacts of the NGCC Alternative Located at IP2 and IP3 and an Alternate Site

Impact Category	At IP Site or a Repowered Site Impact	Comments	New Site Impact	Comments
Land Use	SMALL to MODERATE	Onsite land used; most has been previously disturbed.	MODERATE to LARGE	About 90 ha (220 ac) needed for plant construction; additional land may be needed for pipeline and transmission line ROWs.
Ecology	SMALL	Both terrestrial and aquatic impacts would be SMALL because the plant uses mostly disturbed land and uses relatively little water.	SMALL to MODERATE	Impacts would depend on the nature of the land used for the plant and whether a new gas pipeline and/or transmission lines are needed; cooling water would have SMALL aquatic resource impacts.
Water Use and Quality	SMALL	Minor erosion and sedimentation may occur during construction. The plant would use no groundwater.	SMALL to MODERATE	With closed-cycle cooling, the impact would likely be SMALL. Impact depends on the volume of used and characteristics of the water body; impacts from water use conflicts could be MODERATE.
Air Quality	SMALL to MODERATE	• SO_x: 150 MT/yr (164 tons/yr) • NO_x: 493 MT/yr (543 tons/yr) • PM_{10}: 83 MT/yr (92 tons/yr) • CO: 103 MT/yr (113 tons/yr) • CO_2: 5.5 million MT/yr (6.1 million tons/yr)	SMALL to MODERATE	Operational impacts are the same as onsite plant but more emissions from additional construction activities.

1 **Table 8-3** (continued)

Impact Category	At IP Site or a Repowered Site Impact	Comments	At a New Site Impact	Comments
Waste	SMALL	Small amounts of construction waste would be generated.	SMALL	Small amounts of construction waste with some recycling options; land-clearing debris could be land filled on site.
Human Health	SMALL	Minor risk to workers associated with construction and industrial accidents. Health effects from operational emissions are likely to be SMALL.	SMALL	Same as onsite plant.
Socioeconomics	SMALL to MODERATE	Impacts on housing and jobs in the area surrounding IP2 and IP3 during onsite construction and operation would be relatively minor based on the large population of the area surrounding IP2 and IP3; similar at a repowered site.	SMALL to MODERATE	Construction impacts would likely be no larger than MODERATE at most sites. The largest impacts occur during construction.
Transportation	SMALL to MODERATE	Increased traffic associated with construction could be noticeable, though the number of construction workers is smaller than the number of workers currently at IP2 and IP3; impacts at repowered site likely similar.	SMALL to MODERATE	Transportation impacts associated with construction and operating personnel to the plant site would depend on the population density and infrastructure in the vicinity of the site.

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Table 8-3 (continued)

Impact Category	At IP Site or a Repowered Site		At a New Site	
	Impact	Comments	Impact	Comments
Aesthetics	SMALL	The impact is likely less than the impacts of the current plant; more land would be cleared and new structures built; repowered site impacts likely to be similar to those of existing structures.	SMALL to LARGE	The greatest impacts would be from new transmission lines, gas line ROW, and plant structures. Impacts depend on the nature of the site.
Historical and Archeological Resource	SMALL to MODERATE	Impacts may reach MODERATE on IP site; most repowerings likely to be SMALL.	SMALL to MODERATE	An alternate location would necessitate cultural resource studies; construction would likely avoid highly sensitive areas. Impacts likely would be managed or mitigated.
Environmental Justice	SMALL to LARGE	SMALL at IP site; SMALL to LARGE at repowered site.	SMALL to LARGE	Impacts would vary depending on population distribution and location of the new plant site.

8.3.2 Purchased Electrical Power

Based on currently scheduled unit retirements and demand growth projections, the NYISO predicted in 2006 that up to 1600 MW(e) from new projects not yet under construction would be needed by 2010 and a total of up to 3300 MW(e) by 2015 (National Research Council 2006).

Within the New York Control Area (NYCA), State power regulators require that load-serving entities (LSE), or power buyers, purchase enough generating capacity to meet their projected needs plus a reserve margin (National Research Council 2006). Entergy is not an LSE. In New York, Entergy owns and operates power plants, but not transmission or distribution systems; therefore, Entergy does not purchase power from other power generators. To replace the output from IP2 and IP3, LSEs, like Consolidated Edison, would need to purchase additional electric power from other sources, which could include new fossil-fueled power plants or renewable alternatives, or it could purchase power from existing facilities at other sites outside the NYCA (National Research Council 2006). Given New York State's power market, all alternatives considered here could supply purchased power. The only constraint on the purchase of electrical power then becomes electric transmission capacity.

Power sources within NYCA have an installed capacity of about 38,000 MW(e) and more than 6300 km (3900 mi) of high-voltage transmission lines (National Research Council 2006). The current power transmission infrastructure makes it difficult to purchase power from outside the southern regions of the NYCA (namely the New York City and Long Island load zones) because there are power transmission constraints or “bottlenecks” between the southern load zones and other power generating areas to the east and north, including Canada. These neighboring areas would be needed to supply additional purchased power to replace power generated by IP2 and IP3. Because of the bottlenecks in the transmission lines, new transmission capacity would likely be necessary to efficiently move purchased power into the southern load zones and provide a partial solution to the retirement of IP2 and IP3 (National Research Council 2006). Such new transmission capacity would likely come in the form of either an expansion of the existing high-voltage alternating current transmission system or the addition of new high-voltage direct current transmission facilities (National Research Council 2006).

The National Research Council found that improvements in transmission capability could significantly relieve congestion in the NYCA and increase delivery capacity from existing and potential electric generation resources to the southern load zones. The Council has proposed a 550-MW(e) west-to-east line across the Hudson River and a new north-to-south transmission line (up to 1000 MW(e)) for better access to upstate New York and Canadian electric resources to provide useful capacity in the 2010 and 2015 time period (National Research Council 2006). However, a variety of institutional and financial obstacles often stand in the way of such plans. In 2006, the Council determined that a “concerted, well-managed, and coordinated effort would be required to replace IP2 and IP3 by 2015 (National Research Council 2006).

Several new transmission projects are currently in planning stages. NRC staff will address two of the proposed projects here as illustrative of the potential for new transmission in congested areas of New York State.

As of November 2010, New York Regional Interconnection (NYRI is seeking the approval of the New York Public Service Commission (NYPSC) to build a 306-km (190-mi) transmission line with a rated power flow of 1200 MW(e) from the Town of Marcy in Oneida County to the towns of Hamptonburgh and New Windsor in Orange County, New York (NYRI 2010). In accordance with the NYRI application to the NYPSC, overhead transmission lines will make up approximately 89 percent of the proposed route, and underground cable will constitute the remainder of the route (NYRI 2008). NYRI has placed the proposed route within or parallel to existing or inactive railroads and energy ROWs for approximately 78 percent of its distance. For the remaining 22 percent of its distance, NYRI will construct the transmission lines in undeveloped areas or areas where there are no existing ROWs. The proposed transmission corridor includes 1155 ha (2854 ac). If approved, NYRI will clear 768 ha (1898 ac) of forested habitat during construction. While the proposed route minimizes the amount of land clearing and habitat destruction necessary, the proposed route also crosses sensitive habitats such as streams and wetlands (NYRI 2008).

NYRI has proposed to construct additional transmission capacity that could be used to import power into the southern load zones for the NYCA, with the potential for it to expand its proposed 1200-MW(e) capacity to 2400 MW(e). In addition, other proposed projects, like CHPEI, have the potential to import additional power from Canada. In the case of CHPEI, the total project would include 2000 MW(e) of transmission, though only 1000 MW(e) would be targeted to the New York metropolitan area (CHPEI 2010). CHPEI is currently in the permitting process, and expects to be operational by 2015. The NRC staff recognizes that purchased power could be an alternative to IP2 and IP3. To the extent that new transmission projects allow other existing facilities to provide additional power to downstate New York, the environmental impacts are likely to be only the incremental impacts of additional operation. Upstate hydropower, wind power, biomass, nuclear and fossil-fueled plants would likely contribute to additional power supply. On CHPEI, project developers indicate that they expect Canadian hydro and wind power to dominate their power supply (Canada relies extensively on hydropower for its current generation).

To the extent that new generation capacity supplies power to these new projects, construction impacts may be similar to those of other alternatives in this SEIS. New hydropower in Canada, for example, may have substantial environmental impacts during construction and operation.

The actual environmental impacts of purchased power are difficult to determine, Each type of power generation alternative has its own set of potential environmental costs and benefits, and each must be evaluated with respect to the specific location and features of the generator. As a result, the specific environmental impacts of purchased power cannot be reasonably evaluated in the absence of more information. Nonetheless, it is highly likely that any generating source of purchased power will have environmental impacts, the type and magnitude of which cannot be assessed for comparative purposes as an alternative to license renewal of IP2 and IP3. It is also highly likely that projects like NYRI and CHPEI will have separate State, and in the case of CHPEI, Federal, processes for determining environmental impacts. In general, any transmission project will serve to make environmental impacts of power generation more distant from load centers in downstate New York. Impacts from the projects themselves are highly variable and may or may not be substantial. For example, visual impacts from aboveground projects like NYRI could be substantial. CHPEI, in contrast, is likely to be partially constructed underwater or underground along existing waterways and transportation right-of-ways, which should help to reduce effects, but its construction may have short-term impacts on aquatic ecology or affect traffic in the transportation corridors along which it will be installed.

Both of these projects are independent of any decision to grant or deny renewal of the IP2 and IP3 operating licenses, and are subject to other environmental review and regulatory processes over which NRC has no control. Transmission system construction and operation have their own environmental impacts, the specific nature and magnitude of which will vary depending on the length and location of the proposed route. For example, construction through wetland areas could entail significant ecological impacts, while construction through residential areas could entail significant aesthetic impacts. In the absence of any specific route information, NRC staff will not independently evaluate impacts of the transmission projects in this SEIS. They do, however, serve as meaningful illustrations of projects that may improve the availability of power from other regions of the State or Canada to reach the same end-use markets currently served by IP2 and IP3.

8.3.3 Conservation

In this section, the NRC staff evaluates conservation[(4)] as an alternative to license renewal.

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(4) The NRC staff notes that conservation typically refers to all programs that reduce energy consumption, while energy efficiency refers to programs that reduce consumption without reducing services. For this section, some conservation measures considered by the NRC staff are also energy efficiency measures.

According to the American Council for an Energy-Efficient Economy (ACEEE) State Energy Efficiency Scorecard for 2006, New York ranks seventh in the country in terms of implementation of energy efficiency programs, suggesting that the State's conservation efforts are significant when compared to other States (ACEEE 2006). New York scored well (2 out of 3) on tax incentives and appliance standards. The State scored low on energy efficiency resource standards (0 out of 5) and utilities' per-capita spending on energy efficiency (5 out of 15), suggesting there is room for improvement in these areas.

The IP2 and IP3 ER (Energy 2007) dismissed conservation as a replacement alternative for IP2 and IP3 because conservation does not meet the criterion of a "single, discrete source." Also, because Entergy is a generator of electricity and not a distributor, it indicated that it does not have the ability to implement regionwide conservation programs (Entergy 2007). However, because of efforts made by the State of New York and comments received during preparation of this SEIS, the NRC staff examines conservation in this SEIS as an alternative to replace at least part of the output of IP2 and IP3.

The New York State Energy Research and Development Authority (NYSERDA) is pursuing initiatives in conservation. Within NYSERDA, the Energy Efficiency Services Program and Residential Efficiency and Affordability Program deploy programs and services to promote energy efficiency and smart energy choices (NYSERDA 2007). According to the NYSERDA, implementation of conservation in the following program areas has resulted in significant energy savings:

- existing buildings and structures
- new buildings and structures
- market/workforce development
- distributed generation and renewables
- industrial process
- transportation

In 2006, the National Research Council's Committee on Alternatives to Indian Point for Meeting Energy Needs developed a report that specifically addressed alternatives to IP2 and IP3 for meeting Statewide power needs (National Research Council 2006). The document reports that in 2005, NYSERDA estimated that its energy efficiency programs had reduced peak energy demands in New York by 860 MW(e). NYSERDA further forecasted that the technical potential of its efficiency programs in New York would result in a cumulative 3800 MW(e)-reduction of peak load by 2012 and 7400 MW(e) by 2022 (National Research Council 2006). "Technical potential" refers to the complete deployment of all applications that are technically feasible.

In addition to the currently anticipated peak load reductions resulting from the NYSERDA energy efficiency initiatives, additional conservation measures and demand-side investments in energy efficiency, demand response, and combined heat and power facilities could significantly offset peak demand Statewide. The National Resource Council estimated that peak demand could be reduced by 1000 MW(e) or more by 2010 and 1500 MW(e) by 2015 (National Research Council 2006).

The National Research Council estimates that economic potential peak demand in the IP2 and

IP3 service area could be expanded by approximately 200 MW(e) by 2010 and 300 MW(e) by 2015 assuming a doubling of the program budgets (National Research Council 2006). "Economic potential" is defined as that portion of the technical potential that the National Research Council judged to be cost effective. This estimate is based partly on the experience with three NYSERDA programs that avoided the need for 715 MW(e) of Statewide peak demand in 2004. Cost-effectiveness is based on a conservation option's ability to lower energy costs (consumers' bills) while energy prices continue to increase using EIA price forecasts. The National Research Council concludes that energy efficiency and demand-side management have great economic potential and could replace at least 800 MW(e) of the energy produced by IP2 and IP3 and possibly much more (National Research Council 2006).

More recently, New York State launched its Energy Efficiency Portfolio Standard program, calling for a 15 percent reduction in energy usage by 2015 compared to forecast levels (sometimes referred to as "15 by 15", and later combined with an augmented renewable portfolio standard in the 45 by 15 plan). Between June 2009 and January 2010, the Public Service Commission approved 45 electric energy efficiency programs and 44 gas efficiency programs (NYSPSC 2010)

Given New York State's aggressive efforts in energy efficiency, as amplified by comments received on the draft SEIS, the NRC staff here considers an energy conservation/energy efficiency alternative, and will also include energy conservation in the combination alternatives.

Analyses in recent NRC license renewal SEISs (See NUREG-1437, Supplements 33 and 37, regarding Shearon Harris and Three Mile Island, Unit 1, respectively), indicate that all impacts from conservation are SMALL. The NRC staff adopts the analyses from those SEISs here, insofar as they identified all SMALL impacts from conservation as an alternative. The NRC staff also notes that loss of tax and PILOT revenue paid to municipalities near IP2 and IP3, as well as lost jobs, may result in SMALL to MODERATE socioeconomic impacts, which will not be offset by conservation.

8.3.4 Alternatives Dismissed from Individual Consideration

Other generation technologies the NRC staff considered but determined to be individually inadequate to serve as alternatives to IP2 and IP3 are discussed in the following paragraphs. The NRC staff has moved the supercritical coal-fired alternative to this section based on comments, a staff review of likely generating alternatives in New York State, and policies like the Regional Greenhouse Gas Initiative that make coal-fired generation unlikely in New York State. The discussion of the supercritical coal-fired alternative in this section has not been updated from the draft SEIS.

8.3.4.1 Wind Power

Studies conducted for the New York State Department of Public Service indicates that the total wind resource potential by 2015 is 8527 MW (NYSDPS 2009). This includes both onshore and offshore resources. offshore wind resources. Wind currently accounts for approximately 1275 MW(e), statewide (NYISO 2010). The NYSIO is managing wind generation projects that are proceeding through the grid interconnection process. These projects have a potential of generating almost 7000 MW(e) if all are completed (NYISO 2010). NYISO indicates approximately 10% capacity credit, or 124 MW(e) for the 1275 MW(e) of existing wind power based on availability of the resource. Thus, 7000 additional MW(e) of wind capacity would be credited for less than 700 MW(e) of firm capacity(NRC staff further discusses this issue in the combination alternatives later in this chapter).

Generally, wind power, by itself, is not suitable for large baseload capacity. As discussed in Section 8.2.1 of the GEIS, wind has a high degree of intermittency, and average annual capacity factors for wind facilities are relatively low (on the order of 30 to 40 percent). Wind power, in conjunction with energy storage mechanisms or other readily dispatchable power sources like hydropower, might serve as a means of providing baseload power. However, current energy storage technologies are too expensive to allow wind power to serve as a large baseload generator.

Areas of class 3 or higher wind energy potential occur throughout much of the northeastern United States (DOE 1986, 2008). The primary areas of good wind energy resources are the Atlantic coast, the Great Lakes, and exposed hilltops, ridge crests, and mountain summits. Winter is the season of maximum wind power throughout the Northeast when all except the most sheltered areas have class 3 or better wind resource; exposed coastal areas and mountain summits can expect class 6 or 7 wind resource. In summer, the season of minimum wind power, class 3 wind resource can be found only on the outer coastal areas and highest mountain summits (DOE 1986).

Wind power of class 3 and higher is estimated for the high elevations of the Adirondack Mountains of northeastern New York (DOE 1986, 2008). Annual average wind power of class 3 or 4 is found along the coastal areas of both Lake Erie and Lake Ontario, while class 5 winds are estimated to exist in the central part of both lakes (DOE 1986, 2008).

The National Research Council estimated that offshore wind could meet most of the IP2 and IP3 load by 2014 (National Research Council 2006).

Given the difficulties inherent in relying on wind power as a baseload alternative, the NRC staff does not consider wind power to be a suitable stand-alone alternative, though the staff recognizes New York's utility-scale wind resources and active wind resource development. Therefore, the NRC staff includes wind power in the combination alternatives addressed in Section 8.3.5 of this SEIS.

8.3.4.2 Wood and Wood Waste

Wood-burning electric generating facilities can provide baseload power. However, the economic feasibility of a wood-burning facility is highly dependent on the availability of fuel sources and the location of the generating facility. Most wood-fired and other biomass plants are independent power producers and cogenerating stations with capacities on the order of 10 to 25 MW(e), with some plants operating in the 40 to 50 MW(e) range. In the 2007 New York Renewable Electricity Profile (DOE/EIA 2009), New York's power industry reported only 37 MW(e) of generating capacity for wood or wood waste derived power. Power generated by burning wood waste qualifies as renewable under New York's Renewable Portfolio Standard.

Wood-burning energy generation continues to be developed in the northeastern U.S. In 2005, about 16 percent of the nation's energy derived from wood and wood wastes was generated in the New England and Middle Atlantic census divisions (DOE/EIA 2007). Within the region, about 12 percent of this generating capacity is from wood and wood wastes.

Walsh et al estimated New York's wood resources in a study published in 1999 (Walsh et al 1999). The study presents the amount of resources available in tons per year given a specified price per dry ton delivered. Wood feedstock categories included forest residues, defined as "logging residues; rough, rotten, and salvable dead wood; excess saplings; and small pole trees," and primary mill residues (Walsh 1999). The annual resources available for each of these categories at a delivery cost of less than $50 per dry ton are 1,746,400 and 1,274,000 tons, respectively (Walsh 1999). These volumes, respectively, account for about 4 percent and 1.5 percent of the total resource available in the 48 contiguous States. The neighboring States of New Jersey, Connecticut, Massachusetts, and Vermont have significantly less wood resource. Pennsylvania, however, has comparable resources to New York available. Assumptions in the analysis include transportation distances of less than 50 mi and accessibility of 50 percent of the forest residues from existing roads.

The NRC staff finds that New York has utility-scale wood waste resources, but given uncertainties in supply estimates, as well as the small size and high number of installed facilities necessary to replace IP2 and IP3, the NRC staff does not find wood biomass to be a suitable alternative to IP2 and IP3 operating license renewals. The NRC staff will include wood waste facilities as a contributor to biomass generating capacity in combinations of alternatives addressed in Section 8.3.5 of this SEIS.

8.3.4.3 Hydropower

New York State receives an abundant supply of hydroelectric power from Niagara Falls and other sites. Hydropower accounts for 5990 MW(e)—or about 15 percent—of the State's generating capacity (NYISO 2008).

Studies conducted for the New York State Department of Public Service indicate a potential for 2527 MW of hydroelectric power by 2022 (NYSDPS 2009). NYSDPS estimates that 289 MW of hydropower will come online by 2015, based on Renewable Portfolio Standard supply curves. Though the likely potential by 2015 is too little to replace IP2 or IP3, it is sufficient for inclusion in combination alternatives.

8.3.4.4 Oil-Fired Generation

Oil accounts for about 8 percent of the generating capacity—or 3515 MW(e)—Statewide (NYISO 2008). EIA projects that oil-fired plants will account for very little new generation capacity in the United States during the next 20 years, and higher fuel prices will lead to a decrease in overall oil consumption for electricity generation (DOE/EIA 2007a).

EIA no longer addresses oil as a significant contributor to capacity additions (DOE/EIA 2010), as discussed in Section 8.3. The relatively high cost of oil—even prior to 2008's record high prices—had prompted a steady decline for use in electricity generation. The NRC staff has not evaluated oil-fired generation as an alternative to the renewal of the IP2 and IP3 operating licenses, though the NRC staff notes that oil may temporarily be burned in a gas-fired alternative should gas capacity become constrained during winter heating season.

8.3.4.5 Solar Power

New York has enacted demand-side policies aimed at encouraging the adoption of photovoltaic (PV) technology for residents and businesses. These policies had resulted in the installation of more than 1.5 MW(e) of demand-side PV energy as of summer 2005 (National Research Council 2006). Through its Clean Energy Initiative, the Long Island Power Authority had issued rebates for PV systems totaling more than 2.63 MW(e) (National Research Council 2006). The National Research Council indicates that PV systems may be in the economic interests of New York customers because of high retail electricity rates and the falling prices of PV-generated electricity (National Research Council 2006).

The National Research Council reported that PV-generated electricity can provide high-value peak-time distributed generation power with minimal environmental emissions, and PV can contribute significantly to grid stability, reliability, and security (National Research Council 2006). Distributed generation refers to the production of electricity at or close to the point of use. Under an aggressive development scenario, the National Research Council estimates that 70 MW(e) of distributed PV could be installed in the NYCA by 2010 and 335 MW(e) by 2015. However, the National Research Council states that there would have to be “reductions in PV costs and a long-term commitment to expand New York’s PV programs” in order to reach these goals (National Research Council 2006). Finally, the National Research Council considers most of the projected PV distributed generation as demand-side reductions in peak energy demands. Therefore, the energy-saving impacts of solar power are included in the conservation estimates described in Section 8.3.4 of this SEIS.

More recently, the NRC staff notes that new solar projects are moving forward in the State, including, for example, a proposed 32 MW(e) facility at Brookhaven National Laboratory and a 15 MW(e) facility (with potential to expand to 20 MW(e)) in Coxsackie. Additionally, the New York Power Authority has its own solicitation for 100 MW(e) of photovoltaic power. The New York State Department of Public Service projects that solar photovoltaics will contribute 52.57 MW(e) of capacity for the customer-sited tier of the State’s Renewable Portfolio Standard by 2015 (NYSDPS 2009).

The NRC staff does not consider solar power to be a suitable stand-alone alternative to the renewal of the IP2 and IP3 operating licenses, and the capacities being added in New York State are relatively small. The NRC staff does, however, recognize that solar energy is an important component of the NYSERDA demand-side reductions in peak load demands from generating facilities, including IP2 and IP3, as well as a contributor to the Renewable Portfolio Standard. Solar power may contribute to the combination alternatives addressed in Section 8.3.5 of this SEIS as a part of the conservation-derived demand reductions (as described in Section 8.3.4), and may support other generation at peak times.

8.3.4.6 New Nuclear Generation

Given the expressed industry interest in new nuclear construction, the NRC staff has previously evaluated the construction of a new regional nuclear power plant as an alternative to license renewal in SEISs for other nuclear power plant license renewal requests.

Given the current combined license (COL) application schedule, the time needed to review an application, and the anticipated length of construction, the NRC staff does not consider the construction and operation of a new nuclear power plant specifically for the purpose of replacing IP2 and IP3 to be a feasible alternative to license renewal at this time.

8.3.4.7 Geothermal Energy

Geothermal plants are most likely to be sited where hydrothermal reservoirs are prevalent, such as in the western continental United States, Alaska, and Hawaii. There are no feasible eastern locations for geothermal capacity to serve as an alternative to IP2 and IP3 (NRC 1996), and the New York Renewable Electricity Profile did not indicate any geothermal energy production in New York in 2007 (DOE/EIA 2009). As such, the NRC staff concludes that geothermal energy would not be a feasible alternative to renewal of the IP2 and IP3 operating licenses.

8.3.4.8 Municipal Solid Waste

According to the Integrated Waste Services Association (IWSA), fewer than 90 waste-to-energy plants are operating in the United States, generating approximately 2700 MW(e) of electricity or an average of approximately 30 MW(e) per plant (IWSA 2007). The existing net capacity in the region of IP2 and IP3 is 156 MW(e) generated by six plants, while the technical potential within the region is 1096 MW(e) by 2014 (National Research Council 2006). The 2014 estimate includes production from fuels containing municipal solid waste and construction and demolition wood (a portion likely to be at least partially captured in Walsh et al and referenced in the Wood Waste section of 8.3.4).

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant would be approximately the same as that for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts than coal-fired technologies (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid waste plants are greater than for comparable steam turbine technology at coal facilities or at wood waste facilities because of the need for specialized waste separation and handling equipment.

The decision to burn municipal waste to generate energy (waste-to-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; with energy prices increasing, however, it is possible that municipal waste combustion facilities may become attractive. Congress has included waste-to-energy in the Production Tax Credit legislation to encourage development of waste-to-energy and other renewable technologies (IWSA 2008).

Given the small average installed size of municipal solid waste plants, it would take about 70 plants to replace IP2 and IP3. Furthermore, NYSERDA estimates that the Statewide economically achievable potential for summer peak load from municipal solid-waste-derived energy by 2022, well into the relicensing period for IP2 and IP3, is only 190 MW(e) (NYSERDA 2003). Therefore, the NRC staff does not consider municipal solid waste combustion to be a feasible alternative to license renewal. Certain types of refuse-derived fuel, however, may qualify for inclusion in New York's Renewable Portfolio Standard (RPS) as biomass to the extent that they make use of renewable waste streams. Staff addresses biomass contributions as part of the combination alternatives.

8.3.4.9 Other Biomass Derived Fuels

In addition to wood and wood waste fuels, there are several other biomass fuels used for generating electricity. These include burning crops, converting crops to a liquid fuel such as ethanol, gasifying crops, and biogas. Additionally, the National Research Council identifies animal and avian "manure" and wastewater methane as biomass derived fuel sources. The National Research Council estimates that the NYCA has a potential capacity of 41 MW(e) from biogas by 2014 (National Research Council 2006). NYSERDA estimates that the Statewide economically achievable annual load from biomass-derived energy by 2022, well into the relicensing period for IP2 and IP3, is 1.7 million MW(h) (NYSERDA 2003) or about 190 MW(e). In the period between 2005 and 2007, IP2 and IP3 produced more than 16 million MW(h) annually (Blake 2008). Furthermore, the New York Renewable Electricity Profile did not indicate any energy production in New York from biomass fuels other than wood and wood waste in 2007 (DOE/EIA 2009), which is considered above. For these reasons, the NRC staff concludes that power generation from biomass fuels alone does not offer a feasible alternative to the renewal of the IP2 and IP3 operating licenses. It will, however, be considered as a portion of a combination alternative grouped with wood waste. NRC staff notes that, under New York's RPS, certain other waste streams, which may include source-separated portions of municipal solid waste, may qualify as biomass. This is distinguished from municipal solid waste in that certain portions of a municipal solid waste stream that may qualify as biomass are segregated from other portions of the municipal solid waste stream prior to further treatment (e.g., gasification) or direct combustion.

8.3.4.10 Fuel Cells

Fuel cells work by oxidizing fuels without combustion and the accompanying environmental side effects. The only byproducts are heat, water, and, if the fuel is not pure hydrogen, CO_2. 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.

The only current program that was identified as being initiated by one of the three major power providers in downstate New York is a program being conducted by the New York Power Authority that involves nine fuel cell installations totaling 2.4 MW(e) using waste gas produced from sewage plants (National Research Council 2006).

At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. NYSERDA estimates that the Statewide technical potential for annual supply from fuel cells by 2022 is more than 37 million MW(h); however, NYSERDA indicated that the economical potential for 2022 is zero (NYSERDA 2003). NYSERDA defines economic potential as "that amount of technical potential available at technology costs below the current projected costs of conventional electric generation that these resources would avoid." Therefore, while it may be possible to use a distributed array of fuel cells to provide an alternative to IP2 and IP3, it currently would be prohibitively costly to do so. Since fuel cells are not currently economically feasible on such a large scale, the NRC staff concludes that fuel cell-derived power is not a feasible alternative to the IP2 and IP3 license renewals.

8.3.4.11 Delayed Retirement

Plants scheduled for retirement are aging and have higher emissions than newer plants. Keeping older plants online may not be technically or economically achievable when emissions controls or necessary environmental mitigation measures are taken into account. Furthermore, given that the demand for electricity is increasing and, in the near term, planned new sources within the NYCA are just keeping pace with retirements, the NRC staff does not consider additional delays in the retirements of existing plants to be a feasible alternative to compensate for the loss of power from IP2 and IP3. In section 8.3.1, however, NRC staff contemplates the repowering of a shutdown or underutilized facility with a natural gas combined-cycle power plant.

8.3.4.12 Combined Heat and Power

In course of preparing this SEIS, the NRC staff has received comments indicating that it should consider combined heat and power (CHP) as an alternative to license renewal. In some cases, these suggestions have also included an indication of the potential that CHP could have, as well as the environmental advantages of CHP applications.

CHP facilities provide electrical power as well as heat (often in the form of steam) for use by nearby industries or buildings. CHP installations are commonly found on large industrial facilities or in urban centers where many buildings are near to one another. Modern CHP tends to be efficient, in that CHP systems make effective use of some heat that would be wasted by conventional electrical generation. CHP systems can be designed to produce relatively larger proportions of electrical power or heat depending on existing demands.

The NRC staff notes that the current IP2 and IP3 are only used to produce electrical power, and do not supply heat to any offsite users. Combined heat and power, then, fulfills a need not currently met by IP2 and IP3 and is not a direct alternative to IP2 and IP3 license renewal.

8.3.4.13 Supercritical Coal-Fired Generation

The NRC staff has moved the supercritical coal-fired alternative to this section based on public draft SEIS comments, a staff review of likely generating alternatives in New York State, and policies like the Regional Greenhouse Gas Initiative that all suggest that new coal-fired generation is unlikely in New York State. The discussion of the supercritical coal-fired alternative in this section has not been updated from the draft SEIS.

Supercritical coal-fired plants are similar to other coal burners except that they operate at higher temperatures and pressures, which allows for greater thermal efficiency. Supercritical coal-fired boilers are commercially proven and represent an increasing proportion of new coal-fired power plants. In evaluating the supercritical coal-fired alternative, the NRC staff assumed that a new plant located at an alternate site would use a closed-cycle cooling system.

Construction of a coal-fired plant at an alternate site may necessitate the acquisition of additional ROWs for new transmission lines and construction of new lines to transmit power. Transmission line and ROW length would vary with distance to suitable existing lines. In addition, construction at an alternate site may necessitate the construction of an appropriate railroad spur (or other transportation infrastructure) for coal and limestone (used in scrubbers to remove sulfur oxides) deliveries.

For purposes of this analysis, the NRC staff will rely on data published by EIA indicating that a new, scrubbed coal plant constructed in 2015 will operate at a heat rate of 8661 BTU per kilowatt hour (BTU/kWh) (DOE/EIA 2007b). (This reduces the level of emissions for this alternative when compared to the coal-fired alternative Entergy analyzed in the ER for IP2 and IP3 ER by approximately 15 percent for some impact areas).

Impacts of a coal-fired alternative evaluated by the NRC staff assume that the new plant would have a gross electrical capacity of 2200 MW(e). The NRC staff's analysis of the 2200-MW(e) coal-fired plant is based on the factors used to calculate the impacts of the plant that would replace the 2158 MW(e) of power produced by the IP2 and IP3 plants (Entergy 2007). Because up to 10 percent of gross generation may be consumed on site by the coal-fired plant (or its pollution control equipment), the NRC staff's evaluation of a 2200-MW(e) plant may actually slightly understate impacts from this alternative. This ensures, however, that impact levels for alternatives are not overstated when compared to the proposed action.

The NRC staff will present most impacts on an annualized basis. While the renewal period for the IP2 and IP3 operating licenses is only 20 years, the operating lifespan for a new coal-fired plant is likely closer to 40 years, and may even be longer given the lifespans of some existing coal-fired plants. Most impacts will be independent of plant lifespan, though total land area used for waste disposal, for example, will be larger after 40 years than after 20 years. Where these differences exist, the NRC staff will identify them.

For replacing IP2 and IP3, the NRC evaluated an alternative that would use four 550-MW(e)-net coal-fired units to replace the power output of IP2 and IP3. Advanced coal and conventional combined-cycle coal plants could operate at even greater efficiencies (about 7477 and 6866 BTU/kWh, respectively, or greater) by 2015 (DOE/EIA 2007b).

The supercritical coal-fired plant, with a gross output of about 2200 MW(e), would consume approximately 4.9 million metric tons (MT) (5.4 million tons) per year of pulverized bituminous coal with an ash content of approximately 7.11 percent and sulfur content of 1.12 percent (based on New York coal consumption) (DOE/EIA 2001). The NRC staff assumed a capacity factor of 0.85 for the supercritical coal-fired alternative.

Based on Table 8-1 of the GEIS, a pulverized coal-fired facility requires approximately 0.7 ha (1.7 ac) of land per MW of generating capacity. Based on this relationship, a 1540-ha (3805-ac) site would be needed to replace the nuclear power output of IP2 and IP3 with an equivalent capacity coal-fired facility. In more recent SEIS documents, however, the NRC staff indicated that smaller quantities of land may be sufficient to construct coal-fired facilities based on land use at existing coal-fired power plants. Because the existing IP2 and IP3 site includes only 239 ac (97 ha), and much of the area is occupied by plant structures, the NRC staff concludes that there is not sufficient land area at the IP2 and IP3 site to support operations of the alternative. Thus, the coal-fired alternative is analyzed only for an unspecified alternate site. It should be noted that several of the newer coal utilization technologies (e.g., coal-fired integrated gasification combined-cycle systems) could be accommodated on smaller sites than would the conventional pulverized coal concept evaluated here, but likely not a site as small as the IP2 and IP3 site.

The overall impacts of the coal-fired generating facility are discussed in the following sections and summarized in Table 8-3, at the end of Section 8.3.1 of this SEIS. The implications of constructing a new coal-fired plant at an alternate site will depend on the actual location and characteristics of that site. For purposes of this section, the NRC staff assumes that a coal-fired plant located at an alternate site would require the construction of a new transmission line to connect that plant to the regional transmission grid.

Land Use

In the GEIS, the NRC staff estimated that about 0.7 ha (1.7 ac) of land are needed per MW(e) for the construction and operation of a coal-fired power plant. Constructing a 2200-MW(e) coal-fired facility would take approximately 1540 ha (3805 ac). In more recent SEIS documents, the NRC staff indicated that smaller quantities of land may be sufficient to construct coal-fired facilities based on land use at existing coal-fired power plants. A 2200-MW(e) facility may be able to fit on a site with several hundred acres of land rather than the 1540 ha (3805ac) indicated in the GEIS.

Committing land resources to a new coal-fired plant could result in the loss of wildlife habitat or agricultural land. The potential need for new transmission line corridors and ROWs also drive land use effects for the coal-fired facility. As a result of the substantial site area that would be dedicated to and disrupted by coal-fired operations, the NRC staff views this alternative as having potentially MODERATE land use impacts from construction.

Additionally, for the coal-fired alternative, land use changes would occur at an undetermined coal mining area where approximately 75 square miles (sq mi) (19,400 ha) would be affected for mining coal and disposing of mining wastes to support a 2200-MW(e) coal-fired power plant (the GEIS estimates that approximately 34 sq mi (8800 ha) would be disturbed for a 1000-MW(e) coal-fired plant (NRC 1996). Offsite land use for coal mining would partially be offset by the elimination of the need for offsite uranium mining. In the GEIS, the NRC staff estimated that approximately 405 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant (NRC 1996). Therefore the uranium mining offset for a 2200-MW(e) facility would be approximately 890 ha (2,200 ac) of the 19,400 ha required for the coal-fired alternative, resulting in a net requirement of approximately 18,500 ha (45,700 ac). Impacts from the coal fuel cycle would add to the already MODERATE impacts from plant construction.

A coal-fired alternative would likely receive coal and limestone by rail. The coal-fired option would require approximately 10.4 coal unit trains per week (assuming each train has 100 cars with 100 tons of coal per car). For an undeveloped site, a new rail spur would be necessary. For an existing industrial site, a rail spur may exist but could require improvements to handle these deliveries. Impacts from improving an existing rail spur would be small, as the area is already disturbed and used for industrial purposes. Installing a new rail spur could result in relatively minor impacts depending on the length of the rail spur.

Overall, impacts to land use from construction of the coal-fired alternative and its fuel cycle would be MODERATE to LARGE.

Ecology

Siting a coal-fired plant at an alternate site would introduce construction and operating impacts. Converting as much as 1500 ha (3700 ac) of land to industrial use (generating facilities, coal storage, ash and scrubber sludge disposal) could significantly alter terrestrial ecological resources and could affect aquatic ecological resources. Construction and maintenance of a transmission line and rail spur would incrementally add to the terrestrial ecological impacts. Impacts to terrestrial ecology from coal mining also could be substantial, though terrestrial ecology at many coal mining sites has already been disturbed. Therefore, the NRC staff concludes that the impact to terrestrial ecology would be MODERATE to LARGE, depending largely on the ecological sensitivity of the plant and mine sites.

Use of surface water resources to provide makeup water for a closed-cycle cooling system would have some impact on local aquatic resources. Aquatic impacts of a supercritical coal-fired alternative would likely be similar to the impacts of the proposed closed-cycle cooling system proposed for the existing nuclear reactors described in Section 8.1.1 of this SEIS. The supercritical coal-fired power plant's greater thermal efficiency—when compared to the existing IP2 and IP3—would result in smaller impacts, while the coal-fired alternative has greater potential for deposition of pollutants or runoff from coal, ash, or scrubber waste areas. On the whole, the level of impact would be similar. Therefore, the NRC staff concludes that the impact to aquatic ecology would be SMALL.

Due primarily to the potential effects on terrestrial ecology, the NRC staff concludes that the overall impacts of this alternative would be MODERATE to LARGE.

Water Use and Quality

For coal-fired operations at an alternate site, impacts to surface waters would result from withdrawal of water for various operating needs of the facility. These operating needs would include cooling tower makeup and possibly auxiliary cooling for equipment and potable water requirements. Discharges to surface water could result from cooling tower blowdown, coal pile runoff, and runoff from coal ash and scrubber byproduct disposal areas. Both the use of surface waters and discharges to surface waters would be regulated by the State within which the coal-fired facility is located.

The NRC staff expects that any new coal-fired facility would comply with requirements of the discharge permits issued for its operation. Thus, the utility would be obligated to ensure that discharges from the plant conform to applicable water quality standards. Water withdrawals from a small river or cooling pond, however, could lead to potential water use conflicts. Overall, the NRC staff concludes that the potential impacts to surface water resources and water quality would be SMALL to MODERATE for a new coal-fired facility located at an alternate site.

Potential impacts to ground water quality at an alternate site may occur as a result of seepage to ground water from coal storage areas and onsite ash and scrubber sludge disposal areas. However, a coal-fired plant of this size is unlikely to use ground water for cooling tower makeup. In all cases, the NRC staff expects that a coal-fired facility would comply with a ground water use and discharge permit issued by the State having jurisdiction over the plant. Complying with

permit requirements should ensure a small impact. Therefore, the NRC staff concludes that the potential impacts to water resources would be SMALL to MODERATE.

Air Quality

A coal-fired power plant emits a variety of airborne emissions, including SO_x, NO_x, particulate matter, carbon monoxide (CO), hazardous air pollutants (HAPs) (e.g., mercury), and naturally occurring radioactive materials.

A coal-fired alternative built in a nonattainment area (such as exists at the current IP2 and IP3 site) would require a nonattainment area permit and a Title V operating permit under the CAA. A new power plant would also be subject to the new source performance standards for such units in Subpart DA, "Standards of Performance for Electric Utility Steam Generating Units for Which Construction Is Commenced after September 18, 1978," of 40 CFR Part 60, "Standards of Performance for New Stationary Sources." These regulations establish emission limits for particulates, opacity, sulfur dioxide (SO_2), and NO_x. EPA has various regulatory requirements for visibility protection in Subpart P, "Protection of Visibility," of 40 CFR Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," including a specific requirement for review of any new major stationary source in an area designated attainment or unclassified under the CAA.

NRC discussions of SO_x and NO_x emissions include the most recent relevant regulations, because the Clean Air Interstate Rule (CAIR) was vacated by the D.C. Circuit Court in July of 2008. On September 24, 2008, EPA filed for a rehearing of the D.C. Circuit Court decision. Until EPA, Congress, or the courts act, elements of future SO_x and NO_x regulatory approaches remain uncertain.

Emissions of specific pollutants from coal-fired alternatives are as follows:

Sulfur oxides emissions. The NRC staff calculates that a new coal-fired power plant would emit 5236 MT/yr (5767 tons/yr) of SO_x after limestone-based scrubbers remove approximately 99 percent of sulfur compounds from plant exhaust. This plant would be subject to the requirements in Title IV of the CAA. Title IV was enacted to reduce emissions of SO_x and NO_x, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_x emissions and imposes controls on SO_x emissions through a system of marketable allowances. EPA issues one allowance for each ton of SO_x that a unit is allowed to emit.

New units do not receive allowances but are required to have allowances to cover their SO_x emissions. Owners of new units must, therefore, acquire allowances from owners of other power plants or reduce SO_x 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_x emissions, although it might contribute to the local SO_x burden.

Nitrogen oxides emissions. Title IV of the CAA directed EPA to establish technology-based emission limitations for NO_x emissions (see Section 407), rather than a market-based allowance system as is used for SO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants in 40 CFR 60.44a(d)(1). That regulation, issued September 16, 1998 (Volume 63, page 49453 of the *Federal Register* (63 FR 49453)), limits the discharge of any gases that contain nitrogen oxides (expressed as nitrogen dioxide (NO_2)) to 200 nanograms per joule of gross energy output (1.6 pound/megawatt-hour (MW(h)), based on a 30-day rolling average.

As previously discussed, IP2 and IP3 are located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13). All of the States of New Jersey and Connecticut, as well as several counties in Central and Southeastern New York within a 80-km (50-mi) radius of IP2 and IP3, are designated as nonattainment areas for ozone (8-hour standard) (EPA 2008b). Operators or owners of a coal-fired power plant constructed in a nonattainment area would need to purchase offsets for ozone precursor emissions. In this case, NO_x is the major ozone precursor emitted by a coal-fired power plant. In accordance with NYSDEC regulations, "Emission offsets must exceed the net increase in annual actual emissions from the air contamination source project" (NYSDEC, Chapter 3, Parts 231–15). By design, this regulatory requirement should result in a net reduction in ozone emissions in the region.

This new coal-fired plant would likely use a variety of NO_x control technologies, including low-NO_x burners, overfire air, and selective catalytic reduction. EPA notes that when these emissions controls are used in concert, they can reduce NO_x emissions by up to 95 percent (EPA 1998), for total annual emissions of approximately 1230 MT/yr (1355 tons/yr) or 0.14 pounds/MW(h). This is significantly less than the amount allowed by Title IV of the CAA.

Particulate emissions. The NRC staff estimates that the total annual stack emissions would include 175 MT (192 tons) of total suspended particulates and 40 MT (44 tons) of particulate matter having an aerodynamic diameter less than or equal to 10 μm (PM_{10}) (40 CFR 50.6, "National Primary and Secondary Ambient Air Quality Standards for PM_{10}"). Some of this PM_{10} would also be classified as primary $PM_{2.5}$.

As indicated in the IP2 and IP3 ER, fabric filters or electrostatic precipitators would be used for particulate control. EPA notes that filters or precipitators are each capable of removing more than 99 percent of particulate matter, and that SO_2 scrubbers further reduce particulate matter emissions (EPA 1998). In addition to flue emissions, coal-handling equipment would introduce fugitive particulate emissions from coal piles, reclamation equipment, conveyors, and other sources.

Fugitive dust also would be generated during the construction of a coal-fired plant, and construction vehicles and motorized equipment would further contribute to construction-phase air emissions. These emissions would be short lived and intermittent, and construction crews would likely mitigate some impacts through dust control measures.

<u>Carbon monoxide emissions</u>. The NRC staff estimates that the total CO emissions from coal combustion would be approximately 1230 MT/yr (1354 tons/yr) based on EPA-calculated emissions factors for coal-fired power plants.

<u>Hazardous air pollutants including mercury</u>. Following the D.C. Circuit Court's February 8, 2008, ruling that vacated its Clean Air Mercury Rule (CAMR), EPA is working to evaluate how the court's ruling will affect mercury regulation (EPA 2008d). Before CAMR, EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of HAPs (EPA 2000a). EPA determined that coal plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000a). EPA concluded that mercury is the HAP of greatest concern and that (1) a link exists between coal combustion 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 resulting from mercury exposures caused by the consumption of contaminated fish (EPA 2000a). In light of the recent court decision, EPA will revisit mercury regulation, although it is possible that the agency will continue to regulate mercury as a HAP, thus requiring the use of best available control technology to prevent its release to the environment.

<u>Uranium and thorium</u>. Coal contains uranium and thorium, among other naturally occurring elements. According to Alex Gabbard of Oak Ridge National Laboratory, uranium concentrations are generally in the range of 1 to 10 parts per million (ppm), and thorium concentrations are generally about 2.5 times this level (Gabbard 1993). The U.S. Geological Survey (USGS) indicates that Western and Illinois Basin coals contain uranium and thorium at roughly equal concentrations, mostly between 1 and 4 ppm, but also indicates that some coals may contain concentrations of both elements as high as 20 ppm (USGS 1997). Gabbard indicates that a 1000-MW(e) coal-fired plant could release roughly 4.7 MT (5.2 tons) of uranium and 11.6 MT (12.8 tons) of thorium to the atmosphere each year (Gabbard 1993).

Both USGS and Gabbard, however, indicate that almost all of the uranium, thorium, and most decay products remain in solid coal wastes, especially in the fine glass spheres that constitute much of coal's fly ash. Modern emissions controls, such as those included for this coal-fired alternative, allow for recovery of greater than 99 percent of these solid wastes (EPA 1998), thus retaining most of coal's radioactive elements in solid form rather than releasing it to the atmosphere. Even after concentration in coal waste, the level of radioactive elements remains relatively low—typically 10 to 100 ppm—and consistent with levels found in naturally occurring granite rocks, shales, and phosphate rocks (USGS 1997). The levels of uranium and thorium contained in coal wastes and discharged to the environment exceed the levels of uranium and thorium released to the environment by IP2 and IP3.

Carbon dioxide: A coal-fired plant would have unregulated CO_2 emissions that could contribute to global warming. Under the current regulatory framework, a coal-fired plant would have unregulated CO_2 emissions during operations as well as during coal mining and processing, and coal and lime transportation. Burning bituminous coal in the United States emits roughly 93.3 kg (205.3 pounds) of CO_2 per million BTU (DOE/EIA 2008a). The four-unit 2200-MW(e) supercritical coal-fired plant would emit approximately 13.1 million MT (14.4 million tons) of CO_2 per year assuming a heat rate of 8661 BTU/kWh (DOE/EIA 2007b). Section 6.2 of this SEIS contains a discussion of current and likely future relative greenhouse gas (GHG) emissions from several energy alternatives, including coal, natural gas, nuclear, and renewables. In Section 6.2, the NRC staff found that GHG emissions from coal would likely exceed those from other energy alternatives throughout the period of extended operation.

Visibility Regulations: Section 169A of the CAA (42 USC 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from manmade air pollution. EPA issued a new regional haze rule in 1999 (64 FR 35714). The rule specifies that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a coal-fired alternative were located close to a mandatory Class I area, additional air pollution control requirements would be imposed. New York has no Class I areas; of the neighboring States, New Jersey and Vermont each have one—the Brigantine Wilderness Area and the Lye Brook Wilderness, respectively. Brigantine is located about 225 km (140 mi) south of IP2 and IP3, while Lye Brook is roughly 215 km (134 mi) north-northeast. A coal-fired alternative located near these areas or any other Class I area may need additional pollution controls to keep from impairing visibility.

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 CO_2 emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). The NRC staff's analysis shows that emissions of air pollutants, including SO_x, NO_x, and CO, would be significant and would be greater than all other alternatives. Operational emissions of CO_2 are also greater under the coal-fired alternative than under any other alternative.

The NRC analysis for a coal-fired alternative at an alternative site indicates that impacts from the coal-fired alternative would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Thus, the appropriate characterization of air impacts from coal-fired generation would be MODERATE.

Waste

A four-unit, 2220-MW(e) coal-fired plant with a heat rate of 8661 BTU/kWh (DOE/EIA 2007b) would annually consume approximately 5.4 million tons of coal having an ash content of

7.11 percent (Entergy 2007). After combustion, 99.9 percent of this ash, approximately 348,600 MT (384,000 tons) per year, would be collected and disposed of at either an onsite or offsite landfill, or recycled. Based on industry-average recycling rates, approximately 155,610 MT (171,000 tons), or 45 percent, of the ash content would be recycled, leaving a total of approximately 192,290 MT (209,000 tons) for disposal (ACAA 2007). In addition, approximately 300,300 MT (330,000 tons) of scrubber waste would be disposed of or recycled each year. Based on industry-average recycling rates, approximately 237,000 MT (261,000), or 79 percent, of gypsum scrubber waste would be recycled (ACAA 2007). As mentioned in the Air Quality section, this waste also would contain levels of uranium and thorium in concentrations similar to those found in naturally occurring granites, shales, and phosphate rocks (USGS 1997). In addition to coal combustion wastes, a supercritical coal-fired alternative also would produce small amounts of domestic and hazardous wastes.

Disposal of the waste could noticeably affect land use and ground water quality, but 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, EPA issued a “Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels” (EPA 2000b). EPA concluded that some form of national regulation is warranted to address coal combustion waste products because (1) the composition of these wastes could present danger to human health and the environment under certain conditions, (2) EPA has identified 11 documented cases of proven damages to human health and the environment by improper management of these wastes in landfills and surface impoundments, (3) 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 ground water monitoring, and (4) EPA identified gaps in State oversight of coal combustion wastes. Accordingly, EPA announced its intention to issue regulations for disposal of coal combustion waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA). EPA has not yet issued these regulations.

In addition to the waste streams generated during plant operations, considerable debris would be generated during construction of a coal-fired facility. Crews would likely dispose of land-clearing debris on site.

For all of the preceding reasons, the NRC staff considers the impacts of managing waste generated by a coal facility (construction and operating phases) to be MODERATE—the impacts would be clearly noticeable, but would likely not destabilize any important resource.

Human Health

Coal-fired power generation introduces risks to workers at many points in the fuel cycle. These risks include risks from mining coal and limestone, transportation of raw materials, plant construction and operation, and waste management. There also may be public health risks from a coal-fired plant’s operation (routine emissions and coal-pile fires) and fuel cycle (mining and transportation).

During construction activities there would be risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training.

Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices.

In the GEIS, the NRC staff stated that human health impacts (cancer and emphysema) could arise from chronic exposures to coal-fired plant emissions. Emissions contain pollutants such as toxins, particulates, and low levels of naturally occurring radioactive elements. However, Federal and/or State agencies regulate these emissions and enforce emissions standards that are designed to be protective of human health. As a result, power plants install appropriate emission controls to meet regulatory standards.

Coal-fired generation would introduce mechanical sources of noise that would be audible off site. Sources contributing to total noise produced by plant operations are both continuous and intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the coal-handling equipment, solid-waste disposal systems, outside loudspeakers, and commuting activities of plant employees. Noise impacts associated with rail delivery of coal and lime to the generating station site would be most significant for residents living along the new rail spur leading to the plant. Although passing trains significantly raise noise levels near rail corridors, the short duration of the noise tends to minimize impacts.

Based on the cumulative potential impacts of construction activities, emissions, and noise on human health, the NRC staff considers the impact of constructing and operating a new coal-fired facility to be MODERATE.

Socioeconomics

Construction of a coal-fired facility at an alternate site would take approximately 4 years (DOE/EIA 2007b). Based on estimates given in Table 8.1 of the GEIS, the peak workforce is estimated to range from 1.2 to 2.5 additional workers per MW(e) during the construction period. For the 2200-MW(e) plant utilized in this analysis, the peak workforce would range from approximately 2640 to as many as 5500 workers during the 4-year construction period (NRC 1996). During construction, the surrounding communities would experience demands on housing and public services unless some of the workforce is composed of local residents. In the GEIS, the NRC staff stated that socioeconomic impacts would depend on the location of the new plant. For example, at a rural site more of the peak construction workforce would need to relocate (temporarily or permanently) to the area to work. Therefore, socioeconomic impacts could range from SMALL to LARGE depending on whether workers would relocate to be near the site, as well as depending on the size and makeup of the existing community.

At the end of construction, the local population would be affected by the loss of as many as 5000 construction jobs. However, this loss would be partially offset by a postconstruction permanent employment rate of 0.25 workers per MW(e) based on Table 8.2 of the GEIS, or a total of 550 total workers. An additional construction workforce would be needed for the decommissioning of IP2 and IP3 which could temporarily offset the impacts of the lost construction and IP2 and IP3 jobs at the site.

The coal-fired plant would provide new tax revenue to its community. Because this plant would be located in another community, it would have a positive impact on its community while the shutdown of IP2 and IP3 will have a negative impact on the tax base of the IP2 and IP3 community.

The NRC staff concludes that the overall socioeconomic impacts of changes in the local population from the influx of the construction workforce and changes to community tax revenues could be SMALL to LARGE during construction and SMALL to MODERATE during operation, depending on the size and economic structure of the affected communities.

Transportation

During the 4-year construction period of the coal-fired unit, as many as 2640 to 5500 construction workers may be working at the site. During this same time period, trucks and trains would likely be delivering construction materials to the site. The addition of these workers would increase traffic on highways and local roads that lead to the construction site. The impact of this additional traffic could have a MODERATE to LARGE impact on nearby roadways, particularly if the alternate site is in a rural area. Impacts associated with plant operating personnel commuting to work are likely to be SMALL.

For rail transportation of coal and limestone to the alternate site, impacts are likely to range from SMALL to LARGE, depending on local rail characteristics. On average, more than ten 100-car trains per week would deliver coal to the new generating station, and two 10-car trains per week would deliver limestone to the facility. Transportation impacts associated with coal and limestone delivery could range from SMALL to LARGE

Overall, transportation impacts could range from MODERATE to LARGE during construction, and SMALL to LARGE during operation.

Aesthetics

At an alternate site, plant buildings, exhaust stacks, cooling towers, and cooling tower plumes would create aesthetic impacts. The coal-fired alternative's four power plant units would be up to 200 ft (61 m) tall and may be visible off site in daylight hours. The three exhaust stacks could be up to 600 ft (183 m) high (at least 500 ft (152 m) for good engineering practice). If the coal-fired alternative makes use of natural-draft cooling towers, then additional visual impacts will occur from the towers, which may be several hundred feet tall and topped with condensate plumes. Mechanical-draft towers would also generate condensate plumes, but would be markedly shorter than natural-draft towers (or they may use hybrid towers like the alternative described in Section 8.1 of this SEIS). Other buildings on site may also affect aesthetics, as could construction of new transmission lines. Noise and light from plant operations, as well as lighting on plant structures, may be detectable off site.

Aesthetic impacts at the plant site would be minimized if the plant were located in an industrial area adjacent to other power plants or industrial facilities. Development of a new coal-fired facility at an undeveloped alternate site, however, would entail construction of a new transmission line and a new rail spur to bring coal and lime to the plant. The rail spur and transmission line could extend many miles from the site to tie-in points with existing rail and transmission systems. The visual intrusion of these two linear elements, particularly the transmission line, could be significant.

Overall the aesthetic impacts associated with locating at an alternate site would be categorized as MODERATE to LARGE for an undeveloped site, and may be SMALL to MODERATE at a site previously developed for industrial uses.

Historic and Archeological Resources

A cultural resource inventory would be needed for any property that has not been previously surveyed. The survey would include an inventory of field cultural resources, identification and recording of existing historic and archeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site. 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 ROWs).

Historic and archeological resource impacts can generally be effectively managed and, as such, would be considered SMALL to MODERATE at a new undeveloped site, depending on the sensitivity of the site. For a previously developed site, most of which have already been intensively developed, impact on cultural and historic resources would also be SMALL. Previous development would likely have either removed items of archeological interest or may have included a survey for sensitive resources. Any significant resources identified would have to be handled in accordance with the NHPA.

Environmental Justice

As described in Section 8.2 of this SEIS, no environmental impacts were identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if IP2 and IP3 were shut down.

Impacts at the location of the new four-unit coal-fired plant would depend upon the site chosen and the nearby population distribution, but would likely be SMALL to MODERATE for most alternate sites, but could reach LARGE. For previously developed industrial sites, impacts could be larger or smaller, depending on the relative proximity of low-income populations.

8.3.5 Combinations of Alternatives

Even though many individual alternatives to license renewal might not be sufficient on their own to replace the 2158-MW(e) total capacity of the IP2 and IP3 units because of the lack of resource availability, technical maturity, or regulatory barriers, it is conceivable that a combination of alternatives might be sufficient. Such alternatives may also include the continued operation of either IP2 or IP3 combined with other alternatives.

There are many possible combinations of alternatives that could be considered to replace the power generated by IP2 and IP3. In the GEIS, NRC staff indicated that consideration of alternatives would be limited to single, discrete generating options, given the virtually unlimited number of combinations available. In this section, the NRC staff examines two possible combinations of alternatives, considering, among others, the work of Levitan and Associates (2005) and the National Research Council (2006) have all addressed combinations of alternatives. The National Research Council (2006) noted, for example, that ". . . the additional 2 gigawatts (GWs) required if IP2 and IP3 were to be closed could be met by some suitable combination of new generation in the New York City area, efficiency improvements and demand-side management, and new transmission capability from upstate." Information available since the publication of the draft SEIS provides additional insight into renewal energy capability and potential transmission options.

The NRC staff presents two possible combinations based partly on analysis by the National Research Council and in part on comments received on the draft SEIS. In one of these combinations, the NRC has included the continued operation of either IP2 or IP3. The second combination considers several alternatives as a complete replacement of IP2 and IP3. The second combination is based entirely on new generation, efficiency improvements or demand-side management (jointly addressed as conservation), and assumes the availability of transmission capacity to carry power from upstate. These combinations include several alternatives that the NRC staff found to be unsuitable for replacing the entirety of IP2 and IP3 electrical capacity. The NRC staff notes that an infinite number of potential combination alternatives exists, based on varying the amounts or types of power generation employed or varying the extent to which alternatives rely on energy conservation. It is not possible to consider all such combinations. Rather, the NRC staff selected the following alternatives based on available research and input from the draft SEIS comment process. They represent, in the staff's judgment, reasonable examples of combinations based upon comments received, ongoing State-level programs, and resource availability in New York State. The staff notes that none of these combinations are intended to place a limit on available resource capacities, nor are they intended to supplant State or utility level policy decisions about how to generate electricity, reduce or add to loads, set prices, or promote different approaches to generating electricity or managing loads.

<u>Combination Alternative 1</u>

- continued operation of either IP2 or IP3
- obtaining 600 MW(e) from renewable energy sources (primarily wind with smaller amounts of hydropower, biomass, and possibly landfill gas; assumes that sufficient hydropower, biomass, and landfill gas capacity exists to compensate for wind power intermittency)
- implementing 600 MW(e) of conservation programs based on the State's "15x15" energy conservation program and other efforts to improve energy efficiency or increase conservation

<u>Combination Alternative 2</u>

- repowering an existing fossil-powered plant in downstate New York with a new 400-MW(e) to 600 MW(e) combined-cycle power plant (the plant could also be located at the Indian Point site)
- obtaining 600 MW(e) from renewable energy sources (primarily wind, biomass, new hydropower, and landfill gas)
- implementing 1000 to 1200 MW(e) of conservation programs

The following sections analyze the impacts of the two combination alternatives outlined above. In some cases, detailed impact analyses for similar actions are described in previous sections of this Chapter. When this occurs, the impacts of the combined alternatives are discussed in a general manner with reference to other sections of this SEIS. A summary of the impacts from the two combined alternative options is presented in Table 8-5.

8.3.5.1 Impacts of Combination Alternative 1

Each component of the first combination alternative produces different environmental impacts, though several of the options would have impacts similar to—but smaller than—alternatives already addressed in this SEIS. If NYSDEC requires cooling towers, then constructing closed-cycle cooling for one of the existing Indian Point generating units (either IP2 or IP3) would create impacts roughly equal to half of the impacts addressed in 8.1.1 (slightly larger impacts in land use and historical and archaeological resources if IP3 continues to operate as the Algonquin pipeline only needs to be rerouted for the IP3 proposed tower, and Entergy's Phase 1b study identified historic and archaeological resources near the IP3 tower site; potentially larger waste disposal or human health impacts for the IP2 tower as the potential for contaminated blasting spoils and groundwater is greater in that area). Continued operations of either IP2 or IP3 would incur roughly half the impacts of continued operations described in Chapters 3, 4, and 6. (Decommissioning impacts, as described in Chapter 7 of this SEIS, as well as NUREG-0586, would still occur but may occur later than they would if both units retired at the end of their current Operating Licenses.)

The NRC staff has not yet addressed in any depth in this SEIS the impacts of wind power or biomass generation. The New York State Department of Public Service, in late 2009, indicated that renewable generation resources developed under its Renewable Portfolio Standard by 2015 would likely be wind powered (NYSDPS 2009). In the years 2011 through 2015, NYSDPS expects 1076 MW of wind power to come online. Over the same period, it expects 303 MW of biomass (NYSDPS 2009) (including, among other fuel resources, source-separated waste and wood fuel; NYSPSC 2004), 289 MW of hydropower (from upstate New York and Canada), and 95 MW of landfill gas capacity (NYSDPS 2009). These potentials do not indicate an upper bound of the possible resources in the state, but are indicative of the resources most likely to be added based on NYSDPS supply curve projections. By 2015, then, new renewable resource additions could readily supply the 600 MW of renewable capacity considered here with sufficient biomass, hydropower, and landfill gas additions to back up wind power generation.

The wind power portion of this alternative could include onshore or offshore installations, and may include more than one location. Installations have been proposed for many locations around the state, both on- and offshore, and could include wind turbines off Long Island on the Atlantic coast (with easy access to downstate electricity demand), in upstate New York, or on Lake Erie or Lake Ontario. Multiple locations would also allow operators to hedge for poor wind conditions in any one location. A study conducted for NYSERDA (NYSERDA 2005) indicates that unforced capacity – the percentage of installed capacity available at any given time – at New York State wind installations is approximately 10% for onshore installations and 36% at offshore installations (the offshore estimate is based on one location near Long Island). Because wind power installations do not provide full power all the time, the total installed capacity would either need to exceed the capacity stated here or have sufficient backup generation. In this case, NRC staff assumes that other renewables (hydropower, biomass, and landfill gas) could function as a backup.

As noted in Section 8.3.4, under Wood Waste, the biomass alternative would have impacts similar to a coal-fired plant of similar capacity. Unlike a coal-fired plant, however, the biomass plant does not release heavy metals (including mercury, uranium, and thorium) in fly ash.

Biomass plants also tend to be slightly less efficient with slightly lower capacity factors than coal-fired facilities. The types of pollutants would be similar to that shown for the NGCC alternative, but in larger quantities for a given output. New York's RPS does not contemplate direct combustion of municipal solid waste as a qualifying resource (NYSPSC 2004), and thus the more-severe air effects of MSW combustion are not addressed here.

Impacts from conservation measures are likely to be negligible, as the NRC staff indicated in the GEIS (1996) and earlier in this chapter. The primary concerns NRC staff identified in the GEIS related to indoor air quality and waste disposal. In the GEIS, NRC staff indicated that air quality appeared to become an issue when weatherization initiatives exacerbated existing problems, and were expected not to present significant effects. The NRC staff also indicated that waste disposal concerns related to energy-saving measures like fluorescent lighting could be addressed by recycling programs. The NRC staff considers the overall impact from conservation to be SMALL in all resource areas, though measures that provide weatherization assistance to low-income populations may have positive effects on environmental justice.

- **Land Use**

Impacts from this alternative would include the types of impacts discussed for land use in Section 8.1.1.2 and Section 8.3.2.1 of this SEIS. Construction of two hybrid cooling towers would have a SMALL to LARGE impact on land use, depending on where Entergy disposes of excavated material, and construction of one tower would be expected to have approximately half of the impact. If the plant operator constructed only one new cooling tower for the remaining IP unit the land use impacts will also be SMALL to MODERATE, depending on where Entergy disposes of excavated material from the one cooling tower. If no cooling tower was constructed for the remaining unit, the land use impact would be SMALL.

The GEIS notes that gathering fuel for wood-fired plants (a type of biomass plant) can have significant environmental impacts. However, the NRC staff believes that the operation of the 303 MW(e) of biomass-fired generation projected by NYSDPS (NYSDPS 2009) would have minor impacts, especially if the plants were widely distributed and feedstocks were primarily preexisting waste streams. Construction impacts of the biomass plants on land use would be SMALL to MODERATE depending on plant cooling configurations and plant locations. These impacts would be minimized by locating plants on previously disturbed land near other industrial applications, including paper/pulp mills or other forest-product operations where fuels may be readily available. Landfill gas facilities would likely have few new land use impacts as they are typically constructed within or adjacent to existing landfills. New transmission capacity, as discussed in Section 8.3.2 of this SEIS, may be necessary to convey renewables to downstate loads, and could result in additional land use impacts, but staff assumes that adequate transmission will be available.

Impacts from the wind power portion of this alternative would depend largely on whether the wind facility is located onshore or offshore. Onshore wind facilities will incur greater land use impacts than offshore, simply because all towers and supporting infrastructure will be located on land. NRC observations indicate that onshore installations could require several thousand acres, though turbines and infrastructure would actually occupy only a small percentage of that land area. Total land disturbance (temporary and permanent) would be approximately 1 ha (2.5 ac) per MW (NREL 2009). Most of this area (70 percent) is disturbed temporarily during construction. The majority of both temporary and permanent disturbance is a result of roads to support the project (NREL 2009). Land around wind installations could remain in use for activities like agriculture (a practice consistent with wind farm siting throughout the U.S.). For 600 MW of wind capacity, NRC staff estimates a total land disturbance of 600 ha (1482 ac), of which 180 ha (445 ac) would be disturbed for the duration of the project if the entire project were constructed on land. Offshore turbines would have much smaller land use impacts.

Impacts from hydropower contributions to this combination alternative would depend on the location and type of hydropower installation. Hydropower installations that rely on new impoundments may have substantial land use impacts. Hydropower projects that rely on run-of-river or in-stream generator approaches will have markedly lower impacts.

Overall, the NRC staff considers that the land use impacts from the first combination alternative would be SMALL to MODERATE.

- **Ecology**

As described in Section 8.1.1.2 of the SEIS, the construction of two hybrid cooling towers would have a SMALL impact on aquatic ecology and a SMALL impact on terrestrial ecology (Entergy noted in its comments – included in Appendix A of this SEIS – that constructing cooling towers may have an effect on the Indiana Bat; consultation with the U.S. Fish and Wildlife Service may be necessary in the event that one unit continued to operate and NYSDEC required closed-cycle cooling). Because the combined alternative would involve construction and operation of only one cooling tower, the NRC staff considered the resulting impacts from the construction and operation of a single cooling to be SMALL on both the aquatic and terrestrial ecology. (If the remaining IP unit were to continue operating with once-through cooling, the volume of water used would be cut in half, resulting in lower impingement and entrainment impacts, as well as smaller thermal effects. Such effects would not be eliminated, however, and it is reasonable to expect that they would likely be at least MODERATE for some species, though the NRC staff have not analyzed the specific level of impact for this option. Not constructing a cooling tower would mean a smaller terrestrial impact.)

Offsite construction and operation of biomass plants may have a SMALL to MODERATE impact on both aquatic and terrestrial ecology, depending heavily on the location of the plants.

The principal ecological impacts of an offshore wind farm would be to aquatic ecological resources. An onshore wind farm located in upstate New York would primarily affect terrestrial ecology, with up to 180 ha (445 ac) disturbed for the life of the project, though in many cases this land is already in use for agricultural purposes. Neither type of wind farm would be likely to destabilize ecological resources. Accordingly, a wind farm would have SMALL ecological impacts.

NRC staff expects little or no impact to ecology from landfill gas combustion apart from impacts that may be caused by construction on areas outside the landfill confines. Hydropower, however, may trigger additional ecological effects if substantial construction or the creation of new reservoirs are necessary. Some riparian habitats may be inundated along with some upland areas, depending on depth and area of a reservoir. Impoundments could also disrupt migration of fish species, reduce oxygen content, and disrupt water level patters. Run-of-river and in-stream hydropower generation would have relatively minor impacts.

The NRC staff concludes that substantial ecological impacts could occur during the construction phase but could be managed by choice of construction methods (e.g., avoiding particularly sensitive habitats) and by avoiding hydropower options that require reservoirs.

Overall, the NRC staff considers that the ecological impacts, both aquatic and terrestrial, from this combination alternative could range from SMALL to LARGE. Selecting low-impact hydropower approaches and less-sensitive windpower locations would minimize impacts.

- **Water Use and Quality**

The primary water use and quality issues from this alternative would occur from the hydropower portion of this alternative. Impacts, however, depend on the location and type of hydropower facility, with in-stream or run-of-river facilities having lower impacts than facilities that block watercourses. For some installations, impacts would be SMALL, while for others, impacts may be greater.

While construction impacts could occur from a wind farm, particularly if located offshore, these impacts are likely to short lived. An offshore windfarm is unlikely to located immediately adjacent to any water users, though construction may increase turbidity. An onshore wind farm could create additional erosion during construction, as would biomass plants. Landfill gas facilities are likely to trigger little to no additional impacts as they are located on sites that are already developed and typically have controls on water runoff and groundwater infiltration (even if such measures were not working properly at a given landfill, the incremental effect of a landfill gas facility would likely be undetectable compared to the effects of a landfill In general, site management practices keep effects from these components to a small level.

During operations, only the biomass and landfill gas plants would require water for cooling. All of these installations would likely use closed-cycle cooling, however, and this would limit the effects on water resources. As the NRC staff indicated for the NGCC alternative, the landfill gas and wood-fired portions of this alternative are likely to rely on surface water for cooling (or, as is the case in some locations, treated sewage effluent).

Effects from the continued operation of one IP unit with closed-cycle cooling would be SMALL, as would continued operation of one unit with the existing cooling system.

The NRC staff considers impacts on water use and quality to be SMALL to LARGE for this combination alternative. Impacts would be SMALL if low-impact hydropower facilities are selected, and IP2 or IP3 operate with closed-cycle cooling.

- **Air Quality**

The first combined alternative will have some impact on air quality as a result of emissions from the biomass plants and the landfill gas facilities. The impacts are likely to be similar to the NGCC alternative considered in this chapter in terms of the type of emissions, though relatively higher on a per-unit-output basis. Based on DPS projections for renewable generation through 2015, NRC staff projects that roughly 60 percent of backup for the windpower portion of this alternative would come from biomass and landfill gas, and these portions would not operate at all times (combustion units provide support to the windpower power portion of this alternative). Hydropower would supply the remainder of the backup to the wind portion. Hydropower itself produces no direct emissions.

Given the relatively small size of backup combustion generation –less than 400 MW from biomass and landfill gas – the emissions levels are likely to be a fraction of those from the NGCC alternative considered in this chapter. Landfill gas units may require pre-treatment of gas streams in order to avoid emitting toxic gases, though these units also convert methane – a potent greenhouse gas and frequent byproduct of anaerobic decomposition – into carbon dioxide, a less-potent greenhouse gas. Also, these combustion installations are likely to be spread out over several locations in multiple areas. These new facilities would require air permits similar to those discussed for the NGCC alternative, though it is possible that the combustion portions of this alternative may be located outside of non-attainment areas, and thus be subject to less-stringent regulations. Given that a number of areas of New York State are non-attainment areas for ozone, however, it is likely that combustion portions of this alternative would have to offset emissions of NO_x. Overall impacts of these portions of the combination alternative would be SMALL, given the reduced size of this generating source as compared to the NGCC alternative.

Section 8.1.1.2 of this SEIS describes the impacts on air quality from the construction and operation of two hybrid cooling towers to be SMALL to LARGE, depending on CAA compliance. For the construction and operation of a single tower, the impacts would likely be SMALL to MODERATE. The continued operation of one of the nuclear power units without a cooling tower would have SMALL impacts.

Overall, the NRC staff considers that the air quality impacts from the first combination alternative would be SMALL to MODERATE, depending on whether a cooling tower is required at the IP site.

- **Waste**

Constructing a wind farm, biomass generation, and landfill gas generation has the potential to create substantial amounts of waste, as could constructing one cooling tower on the IP site.). Construction impacts could range from SMALL to LARGE during construction depending on site characteristics and the extent to which wastes can be reused, recycled, or readily disposed of.

Operational wastes would come primarily from the biomass power plant. Most of the ash from burned wood waste could be recycled or reused. The waste contribution from the remaining IP2 or IP3 unit would be roughly half of the waste generated by the current plant. Operation of the landfill gas and biomass plants, in addition to generating relatively little waste, would likely reduce or reuse waste streams.

During operations, waste volumes would have only SMALL impacts, while construction stage impacts could range from SMALL to LARGE.

- **Human Health**

The primary health concerns under this option would be occupational health and safety risks during the construction of the new facilities, and excavation for the cooling tower, if necessary. As described in previous sections (NGCC alternative), if the risks are appropriately managed, the human health impacts from these or similar alternatives are SMALL. Impacts from emissions are uncertain, but considered SMALL as the plants would comply with the CAA health-informed standards and other relevant emissions regulations. Continued operation of one IP unit with the existing once-through cooling system would not change this assessment.

Therefore, the NRC staff concludes that the overall human health impact from the first combination alternative would be SMALL.

- **Socioeconomics**

This combination alternative involves the shutdown of either IP2 or IP3. As detailed in Section 8.2 of this SEIS, the socioeconomic impacts of shutting down the plants would be SMALL to MODERATE because of the loss of PILOT payments to local municipalities. Under this option, those payments would be expected to decrease but would not be completely eliminated. Some IP2 or IP3 jobs would be lost with closure of one unit. At the same time, this alternative would create jobs in other locations and also generate new revenues for other municipalities. Overall, the NRC staff concludes that the socioeconomic impacts from the first combined alternative would be SMALL.

- **Socioeconomics (Transportation)**

As described in Section 8.1.1.2 of this SEIS, the construction of two hybrid cooling towers could have up to a LARGE impact on transportation in the area around IP2 and IP3 during construction because of the large volume of rock and debris that would need to be transported off site. Approximately half as much excavated material will need to leave the IP2 and IP3 site under this combination alternative (if the IP unit continued to operate with once-through cooling, no excavated material would need to leave the site and transportation impacts would be eliminated). The other aspects of this alternative will create modest, but noticeable, transportation effects during construction. Given that the biomass facility, hydropower facility, landfill gas installations, and wind farm are likely not be located in the same place, construction-stage impacts are less intense than if they were part of one collocated facility. Construction for the wind-power portion of this alternative may have noticeable impacts while trucks, trains, or ships carry large components to the project sites, but the impacts are limited in duration. The hydropower portion of this alternative is not likely to create transportation impacts unless an impoundment blocked a waterway used for shipping. NRC staff considers this unlikely.

During operation, only the biomass facility is likely to create noticeable impacts on transportation (in gathering materials), and these may not affect any important aspects of local transportation. No other transportation impacts for this alternative are considered to be as severe. Overall, the impact from this combined alternative would likely be MODERATE.

- **Aesthetics**

As described in Section 8.1.1.2 of this SEIS, the construction of two hybrid cooling towers would have a MODERATE impact on aesthetics. Aesthetic impacts from one cooling tower may be slightly smaller, though it would likely still affect the scenic value of the Hudson Valley.

Aesthetic impacts would occur during construction and operation of an offshore wind installation and would depend on its distance from the shore and on its orientation in regard to shoreline communities. The NRC staff estimates that the construction and operational impacts of the facility could be managed, though some may consider the impact to be LARGE, depending on the location of the turbines. An onshore wind facility would also have the potential to create LARGE effects. The aesthetic impacts from new biomass generating plants would likely not have a major effect on visual resources, because the plants are small. Impacts would depend on the plants' locations. Landfill gas facilities would also be unlikely to negative affect aesthetics. Hydropower power facilities would only be likely to have significant effects if they require a large impoundment.

The NRC staff concludes that the overall aesthetic impacts from the first combination alternative could range from SMALL to LARGE, depending primarily on the aesthetic effects of the wind power portion and whether a cooling tower is required for remaining IP unit.

- **Historic and Archeological Resources**

Onsite impacts to historical and cultural resources from the construction of a hybrid cooling tower may range from SMALL to MODERATE. The offsite impacts from the construction of biomass units, wind installations, landfill gas facilities, and hydropower are also expected to be small given the opportunity to evaluate and select the sites in accordance with applicable regulations and the ability to minimize impacts before construction. The impacts from construction of an onshore wind installation or hydropower facility could range from SMALL to MODERATE, depending on whether historical and archaeological resources are present. In that event, proper management of the resources, in conjunction with State historical preservation authorities, would assure that the impacts are not LARGE. Therefore, the NRC staff concludes that the overall impacts on historic and archeological resources from the first combination alternative would be SMALL to MODERATE.

- **Environmental Justice**

No impacts are anticipated in the IP2 and IP3 area that could disproportionately affect minority or low-income communities. Impacts from offsite activities would depend on the location of the activity. Many conservation measures, especially those involving weatherization or efficiency improvements to low-income households, can have disproportionately positive effects for low-income families. Overall, though, impacts to minority and low-income populations from the first combination alternative would depend substantially on the location of the installations and the characteristics of the surrounding communities. Impacts could range from SMALL to LARGE, depending on the location of the facilities relative to minority and low-income communities.

8.3.5.2 Impacts of Combination Alternative 2

The second combination alternative differs from the first in that it completely replaces IP2 and IP3 capacity. In contrast to the first combination alternative, a 400-MW(e) to 600 MW(e) NGCC plant is included as a repowering of an existing facility. NRC staff notes that it could also be located on the IP site. Either modifications to the existing onsite pipeline would be necessary to provide firm year-round service to the site without removing the service rights of other customers in New York and Connecticut served by the pipeline (Levitan and Associates, Inc. 2005) or new gas supplies would have be available from proposed LNG projects or other sources. A repowered NGCC plant at another site may have similar supply restrictions.

Like the first combination alternative, the second combination alternative employs 600 MW(e) from renewable energy sources (wind backed by other renewables). The impacts of these sources are described in the discussion of Combination Alternative 1 in Section 8.3.5.1 of this SEIS, and are not repeated in this section of the SEIS.

Finally, this option requires more aggressive energy conservation programs that would result in an energy savings of 1000 to 1200 MW(e). As described in Section 8.3.4 of this SEIS, these conservation efforts would have overall SMALL impacts, and are not repeated in this section of the SEIS.

- **Land Use**

Siting 400 to 600 MW(e) of NGCC capacity with a closed-cycle cooling system at a repowered facility would require about 18 ha (45 ac) and would likely have SMALL impacts on land use as the existing site as the unit or units could likely be constructed on previously-disturbed land and may be able to reuse substantial portions of onsite infrastructure. These effects would be similar if the NGCC capacity were located at the IP site

Land use impacts from the renewable portion of this alternative are identical to those in Combination Alternative 1.

Overall, the NRC staff considers that the land use impacts from this combination alternative would be SMALL to MODERATE.

- **Ecology**

As described in Section 8.3.1 of this SEIS, the impacts from the construction of five NGCC units at a repowered site or at IP2 and IP3 would have a SMALL impact on aquatic and terrestrial ecology.

Impacts from the renewable portion are SMALL to LARGE, as was the case in Combination Alternative 1.

Overall, the NRC staff considers that the ecological impacts from the second combination alternative would be SMALL to LARGE, depending on locations selected for each alternative.

- **Water Use and Quality**

Impacts from the renewable portions of this alternative are SMALL to LARGE, as were those considered in Combination Alternative 1.

The NGCC repowering portion of this alternative would create water demands, but would minimize them by relying on closed-cycle cooling. Impacts would be significantly smaller than those considered for the stand-alone NGCC alternative, which were SMALL at the IP site or a repowered site .

The overall effects on water use and quality of the second combination alternative would range from SMALL to LARGE, depending on locations of the alternatives and the type of hydroelectric facility constructed.

- **Air Quality**

The second combination alternative will have some impact on air quality as a result of emissions from the combustion alternatives. The impact from renewable portions would be the same as those described in Combination Alternative 1, which was SMALL to MODERATE. The NGCC, repowered facility would have emissions that range from 20 to 30 percent of those of the stand-alone NGCC alternative (which also had SMALL to MODERATE impacts). Nonetheless, the NRC staff concludes that the overall impacts from all of the new plants would range from SMALL to MODERATE.

- **Waste**

Impacts from renewable portions of this alternative would be the same as those in Combination Alternative 1, which were SMALL to LARGE. Wastes from the NGCC portion of this alternative would be similar in type to those in the stand-alone NGCC alternative, which had SMALL impacts. Overall, the NRC staff concludes that the impacts will be SMALL to LARGE.

- **Human Health**

The primary health concerns under this option would be occupational health and safety risks during construction As described in previous sections (for combination alternative 1 and the NGCC alternatives), if the risks are appropriately managed, the human health impacts from these or similar alternatives are SMALL.

The NRC staff concludes that the overall human health impact from the second combination alternative would be SMALL.

- **Socioeconomics**

The second combination alternative involves the complete shutdown of IP2 and IP3. As detailed in Section 8.2 of this SEIS, the socioeconomic impacts of shutting down the plant would be SMALL to MODERATE because of the loss of PILOT payments. (Constructing the NGCC portion of this alternative at the IP site could replace some of the PILOT payments. Levitan and Associates (2005) indicated that a smaller gas-fired plant may replace a significant portion of the PILOT payments currently provided by IP2 and IP3.) Some IP2 and IP3 jobs would be lost but replaced with decommissioning jobs and jobs associated with the construction and operation of the gas turbine plant. Other jobs would be generated by the construction of the offsite alternatives. While many of these jobs would cease at the end of construction, a fraction would remain during operation. Overall, the NRC staff concludes that the socioeconomic impacts from the second combination alternative would likely be SMALL to MODERATE, primarily because of the significant loss in revenues from the PILOT payments and the loss of IP2 and IP3 jobs.

- **Socioeconomics (Transportation)**

The aspects of this alternative will create modest transportation effects during construction. The renewable portions of this alternative will have the same impacts as in combination alternative 1, which were MODERATE. Also, construction of this NGCC facility will require fewer workers than the NGCC alternative considered in Section 8.3.1 of this SEIS because it is much smaller.

The NGCC unit may create noticeable impacts on gas transmission, but improvements to gas transmission or new LNG capacity may offset these impacts. Because winter heating customers take priority over utility generation customer, the plant is unlikely to have noticeable effects for other gas users, though it may need to burn fuel oil during peak demand periods.

Transportation impacts for this alternative would be moderated because the construction and operation workforce would be spread over multiple locations. No single project would have a significant long-term impact. Overall, the NRC staff concludes that the impact would likely be MODERATE.

- **Aesthetics**

Aesthetic impacts would occur primarily as a result of the wind power portion of this alternative, and may range from SMALL to LARGE from wind power alone. Other aspects of this alternative are unlikely to have noticeable effects. Particularly, NGCC repowering will have little, if any effect on the repowered site.

As a result, the NRC staff concludes that the overall aesthetic impacts from the second combination alternative would be SMALL to LARGE, depending on the degree to which wind power installations affect areas where aesthetics are an important value.

- **Historic and Archeological Resources**

Onsite impacts to historical and cultural resources from the construction of a single gas turbine plant are expected to be SMALL. The offsite impacts from the construction of renewable installations are expected to be SMALL to MODERATE, as in Combination Alternative 1, given the opportunity to evaluate and select the sites in accordance with applicable regulations and the ability to minimize impacts before construction. The NGCC portion of this alternative will be constructed on an existing site, using existing infrastructure to the extent possible. Even if constructed on the IP2 and IP3 site, it is likely that the NGCC portion of this alternative could avoid sensitive areas. Therefore, the NRC staff concludes that the overall impacts on historic and archeological resources from the second combination alternative would be SMALL to MODERATE.

- **Environmental Justice**

Impacts from construction and operations would depend on the locations of the activities. Many conservation measures, especially those involving weatherization or efficiency improvements to low-income households, can have disproportionately positive effects for low-income families. Overall, though, impacts to minority and low-income populations from the second combination alternative would depend substantially on the location of the installations and the characteristics of the surrounding communities. Impacts could range from SMALL to LARGE, depending on the location of the facilities relative to minority and low-income communities .

1

2 **Table 8-4. Summary of Environmental Impacts of Combination Alternatives**

Impact Category	Combination 1		Combination 2	
	Impact	Comments	Impact	Comments
Land Use	SMALL to MODERATE	Impacts would depend on location of wind farm, type of hydro facilities, the site selection for the biomass plants, as well as land-disposal of wastes	SMALL to MODERATE	Impacts would depend on location of wind farm, type of hydro facilities, the site selection for the biomass plants.
Ecology	SMALL to LARGE	Impacts substantially depend on the type and location of facilities.	SMALL to LARGE	Impacts substantially depend on the type and location of facilities.
Water Use and Quality	SMALL to LARGE	Impacts depend largely on type and location of hydropower facilities.	SMALL to LARGE	Impacts depend largely on the type and location of hydropower facilities.
Air Quality	SMALL to MODERATE	Air emissions from biomass and landfill gas facilities would be minor given their size and possible multiple locations. One cooling tower could have an effect on air quality.	SMALL to MODERATE	Air emissions of the small biomass and landfill gas facilities would be minor considering their size and possible multiple locations; NGCC facility 20-30 percent of output of alternative in 8.3.1.
Waste	SMALL to LARGE	Construction waste impacts could range from SMALL to LARGE. Operational wastes are SMALL.	SMALL to LARGE	Construction waste impacts could range from SMALL to LARGE. Operational wastes are SMALL.

3

Table 8-4 (continued)

Impact Category	Combination 1		Combination 2	
	Impact	Comments	Impact	Comments
Human Health	SMALL	Emissions and occupational risks would be managed in accordance with applicable regulations.	SMALL	Emissions and occupational risks would be managed in accordance with applicable regulations.
Socioeconomics	SMALL	Some PILOT payments and jobs may be lost.	SMALL to MODERATE	IP2 and IP3 jobs and PILOT payments lost; some new jobs and taxes; minimum impacts from other power alternatives.
Socioeconomics (Transportation)	MODERATE	Construction impacts may be significant but short-lived.	MODERATE	Transportation effects may be noticeable during construction..
Aesthetics	SMALL to LARGE	Visual impacts from new wind turbines, depend on locations selected. Impacts also from cooling tower, if constructed.	SMALL to LARGE	Visual impacts from new wind turbines depend on the location chosen. Limited impact from combustion facilities.
Historic and Archeological Resources	SMALL to MODERATE	Cultural resources inventories would be needed to identify, evaluate, and mitigate potential impacts from construction.	SMALL to MODERATE	Cultural resources inventories would be needed to identify, evaluate, and mitigate potential impacts from construction.
Environmental Justice	SMALL to LARGE	Impacts would depend on plant locations.	SMALL to LARGE	Impacts would depend on plant locations.

8.4 Summary of Alternatives Considered

In this SEIS, the NRC staff has considered alternative actions to license renewal of IP2 and IP3 including the no-action alternative (discussed in Section 8.2), new generation or energy conservation alternatives (natural gas and conservation alternatives discussed in Sections 8.3.1 through 8.3.2), purchased electrical power (discussed in Section 8.3.3), alternative power-generating technologies that staff dismissed from detailed consideration (including supercritical coal-fired power; discussed in Section 8.3.4), and two combinations of alternatives (discussed in Section 8.3.5).

As established in the GEIS, the need for power from IP2 and IP3 is assumed by the NRC in the license renewal process. Should the NRC not renew the IP2 and/or IP3 operating licenses, their generating capacity or load reduction (e.g., by conservation) would have to come from an alternative to license renewal (which may include some of the alternatives considered here).

Furthermore, even if the NRC renews the operating licenses, Entergy could elect not to operate either IP2 or IP3 for the full terms of the renewed licenses. Decisions about which alternative to implement, regardless of whether or not the NRC renews the IP2 and IP3 operating licenses, are outside the NRC's authority and are subject to consideration by Entergy, other power producers, and State-level decision makers (or non-NRC Federal-level decision makers where applicable).

Impacts from the conservation alternative are generally lower than those from other alternatives, including the proposed action. Impacts from the NGCC alternative at a repowered site or the IP site has the potential for larger air quality impacts, but smaller aquatic ecology impacts. Impacts from combination alternatives (with or without continued operation of one IP unit) that do not rely on conventional hydropower are likely to have smaller aquatic impacts than continued operation of IP2 and IP3, while they have potentially larger impacts in other areas, including air quality, aesthetics, and land use. Continued operation of one IP unit with closed-cycle cooling as part of a combination alternative would increase impacts to aesthetics, land use, waste, and air quality while reducing aquatic impacts. A NGCC alternative at a new site is likely to have a variety of more-significant impacts than continued operations of IP2 and IP3.

For most impact areas – land use, air quality, waste, transportation, aesthetics, historic and archaeological resources, for example – the closed-cycle cooling alternative has larger impacts that continued operation of IP2 and IP3 with its current cooling system. Its impact to aquatic ecology, however, is smaller than continued operation with the existing once-through cooling system. The NRC staff notes that this evaluation is not intended to preempt or prejudice NYSDEC SPDES proceedings in any way, and resolution of cooling system requirements for IP2 and IP3 remains and issue for resolution in these proceedings.

8.5 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."

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."

40 CFR Part 122. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 122, "EPA Administered Permit Programs: National Pollutant Discharge Elimination System."

40 CFR Part 125. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 125, "Criteria and Standards for the National Pollutant Discharge Elimination System."

42 U.S.C. 7491. United Stated Code, Title 42: *The Public Health and Welfare*, Part 7491, "Visibility Protection for Federal Class I Areas."

63 FR 49453. Environmental Protection Agency. "Revision of Standards of Performance for Nitrogen Oxide Emissions from New Fossil-Fuel Fired Steam Generating Units; Revisions to Reporting Requirements for Standards of Performance for New Fossil-Fuel Fired Steam Generating Units." Final rule. September 16, 1998.

64 FR 35714. Environmental Protection Agency. "Regional Haze Regulations." Final rule. July 1, 1999.

6 NYCRR Part 231. Compilation of the Rules and Regulations of the State of New York, Title 6, *Environmental Conservation*, Part 231. "New Source Review in Nonattainment Areas and Ozone Transport Regions."

American Coal Ash Association (ACAA). 2007. "ACAA Releases 2006 CCP Production and Use Survey." August 24, 2007. Available at URL: http://www.acaa-usa.org/associations/8003/files/2006_CCP_Survey (Final-8-24-07).pdf. Accessed April 15, 2008.

American Council for an Energy-Efficient Economy (ACEEE). 2006. "The State Energy Efficiency Scorecard for 2006." Report Number E075. June 2006.

Blake, Michael E. 2008. "U.S. capacity factors: Another small gain, another new peak." *Nuclear News*. Volume 51, Number 6. Page 21. May 2008.

Cape Wind Associates, LLC. 2007. Cape Wind Energy Project Final Environmental Impact Statement. February 15, 2007. Available at URL: http://www.capewind.org/article137.htm.

Champlain Hudson Power Express, Inc. (CHPEI). "Project Development Portal." August 11, 2010. Available URL: https://www.chpexpress.com/.

Clean Air Act of 1970, as amended (CAA). 42 USC 7401, et seq.

Clean Water Act of 1977 (CWA). 33 USC 1326 et seq. (common name of the Federal Water Pollution Control Act of 1977).

Coastal Zone Management Act of 1972 (CZMA). 16 USC. 1451–1465.

Department of Energy (DOE). 1986. "Wind Energy Resource Atlas of the United States." DOE/CH 10093-4, DE86004442. October 1986. Available at URL: http://rredc.nrel.gov/wind/pubs/atlas/. Accessed March 3, 2008.

Department of Energy (DOE). 2002. Energy Information Administration, "Electric Power Annual 2000, Volume II," DOE/EIA-0348(00)/2, November 2002. Available at URL: http://tonto.eia.doe.gov/FTPROOT/electricity/0348002.pdf. Accessed November 22, 2005.

Department of Energy (DOE). 2006. "National Electric Transmission Congestion Study." August.

Department of Energy (DOE). 2008. "U.S. Atlas of Renewable Resources." National Renewable Energy Laboratory. Available at URL: http://www.nrel.gov/gis/maps.html#resource_atlas. Accessed June 9, 2008.

Department of Energy, Energy Information Administration (DOE/EIA). 2001. "Cost and Quality of Fuels for Electric Utility Plants 2000 Tables." DOE/EIA-0191(00). August 2001. Available at URL: http://tonto.eia.doe.gov/FTPROOT/electricity/019100.pdf.

Department of Energy, Energy Information Administration (DOE/EIA). 2006 "Assumptions to the Annual Energy Outlook 2006 with Projections to 2030." DOE/EIA-0554(2006). Washington, DC. Available at URL: http://tonto.eia.doe.gov/FTPROOT/forecasting/0554(2006).pdf.

Department of Energy, Energy Information Administration (DOE/EIA). 2007a. "Annual Energy Outlook 2007 with Projections to 2030." Energy Information Administration, Office of Integrated Analysis and Forecasting, U.S. Department of Energy, Washington, DC. DOE/EIA-0383(2007). February.

Department of Energy, Energy Information Administration (DOE/EIA). 2007b. "Assumptions to the Annual Energy Outlook 2007, Electricity Market Module." DOE/EIA-0554(2007). April 2007.

Department of Energy, Energy Information Administration (DOE/EIA). 2008. "New York Renewable Electricity Profile: 2006 Edition." Release date: May 2008b. Available at URL: www.eia.doe.gov/cneaf/solar.renewables/page/state profiles/new york.html. Accessed June 13, 2008.

Department of Energy, Energy Information Administration (DOE/EIA). 2009. "New York Renewable Electricity Profile: 2007 Edition." Release date: June 2009. Available at URL: www.eia.doe.gov/cneaf/solar.renewables/page/state profiles/new york.html. Accessed August 11, 2010.

Department of Energy, Energy Information Administration (DOE/EIA). 2008a. "Voluntary Reporting of Greenhouse Gases Program (Emission Coefficients)." Available at URL: http://www.eia.doe.gov/oiaf/1650/factors.html. Accessed March 26, 2008.

Department of Energy, Energy Information Administration (DOE/EIA). 2008b. "Short-Term Energy Outlook." December 9, 2008. Available at URL: http://www.eia.doe.gov/emeu/steo/pub/contents.html. Accessed December 9, 2008.

Department of Energy, Energy Information Administration (DOE/EIA). 20010. "Annual Energy Outlook 2010 with Projections to 2035." Energy Information Administration, Office of Integrated Analysis and Forecasting, U.S. Department of Energy, Washington, DC. DOE/EIA-0383(2010). May 11, 2010.

Enercon Services, Inc. (Enercon). 2003. "Economic and Environmental Impacts Associated with Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration."

Enercon Services, Inc. (Enercon). 2010. "Engineering Feasibility and Costs of Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration." Available at URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/convclosloop.pdf. Accessed: August 9, 2010.

Entergy Nuclear Northeast (ENN). 2007. "Supplement to License Renewal Application (LRA) Environmental Report References." November 14, 2007. ADAMS Accession No. ML073330590

Entergy Nuclear Northeast (ENN). 2009. "Documents Related to License Renewal Application – Environmental Report." December 17, 2009. ADAMS Accession No. ML100290495.

Entergy Nuclear Northeast (ENN). 2010. "Correction to License Renewal Application (TAC Nos. MD5407 and MD5408)." May 27, 2010. ADAMS Accession No. ML101590515.

Entergy Nuclear Operations, Inc. (Entergy) 2007. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application). April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210530.

Environmental Protection Agency (EPA). 1998. "Compilation of Air Pollutant Emission Factors," Volume 1, "Stationary Point and Area Sources: AP 42," Fifth Edition. Section 1.1, "Bituminous and Subbituminous Coal Combustion: Final Section, Supplement E." Available at URL: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s01.pdf.

Environmental Protection Agency (EPA). 2000a. "Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units." *Federal Register*. Volume 65, Number 245, pp. 79825–79831. Washington, DC., December 20, 2000.

Environmental Protection Agency (EPA). 2000b. "Environmental Fact Sheet: Regulatory Determination for Wastes from the Combustion of Fossil Fuels." EPA530-F-00-025. May 2000.

Environmental Protection Agency (EPA). 2004. "National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities." *Federal Register*, Volume 69, Number 131, pp. 41576–41693. Washington, DC. July 9, 2004.

Environmental Protection Agency (EPA). 2007. "National Pollutant Discharge Elimination System—Suspension of Regulations Establishing Requirements for Cooling Water Intake Structures at Phase II Existing Facilities." *Federal Register*, Volume 72, Number 130, pp. 37107–37109. Washington, DC. July 9, 2007.

Environmental Protection Agency (EPA). 2008a. Safe Drinking Water Information System (SDWIS) database. Available at URL: http://www.epa.gov/enviro/html/sdwis/sdwis_query.html. Accessed March 26, 2008.

Environmental Protection Agency (EPA). 2008b. "Green Book." Available at URL: http://www.epa.gov/air/oaqps/greenbk/. Accessed March 26, 2008.

Environmental Protection Agency (EPA). 2008c. "National Estuary Program—Comprehensive Conservation and Management Plans." Available at URL: http://www.epa.gov/owow/estuaries/ccmp/. Accessed February 1, 2008.

Environmental Protection Agency (EPA). 2008d. "Clean Air Mercury Rule." Available at URL: http://222.epa.gov/air/ercuryrule/. Accessed April 7, 2008.

Gabbard, Alex. 1993. "Coal combustion: Nuclear resource or danger," *Oak Ridge National Laboratory Review*. Oak Ridge National Laboratory: Oak Ridge, Tennessee. Summer/Fall 1993. Available at URL: http://www.ornl.gov/ORNLReview/rev26-34/text/colmain.html. Accessed September 29, 2006.

General Electric Energy. 2005. "H System: World's Most Advanced Combined Cycle Technology Brochure." Publication GEA 13585C. November. Available at URL: http://www.gepower.com/prod_serv/products/gas_turbines_cc/en/h_system/index.htm. Accessed June 6, 2008.

GreatSchools. 2008. Available at URL: http://www.greatschools.net/cgi-bin/ny/district_profile/278#students. Accessed February 13, 2008.

Hudson River Foundation (HRF). 2008a. "About HRF." Available at URL: http://www.hudsonriver.org. Accessed March 3, 2008.

Hudson River Foundation (HRF). 2008b. "Striped Bass Tagging Program." Available at URL: http://www.hudsonriver.org. Accessed March 3, 2008.

Idaho National Energy and Environmental Laboratory (INEEL). 1998. "U.S. Hydropower Resource Assessment for New York." DOE/ID-10430(NY). Idaho Falls, Idaho. December 1988.

Integrated Waste Services Association (IWSA). 2007. "Waste to Energy and the Production Tax Credit." Fact Sheet. Washington, DC. Available at URL: http://www.wte.org/docs/FactSheetPTC.pdf.

IWSA. 2008. "Renewable Energy." Available at URL: http://www.wte.org/energy. Accessed June 13, 2008.

Laidlaw Energy Group. 2008. "NY Biomass Project." Available at URL: http://www.laidlawwnwery.com/ny-biomass-project.html. Accessed June 13, 2008.

Levitan and Associates, Inc. 2005. "Indian Point Retirement Options, Replacement Generation, Decommissioning/Spent Fuel Issues, and Local Economic / Rate Impacts." Prepared for the County of Westchester and the County of Westchester Public Utility Service Agencies.

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

National Oceanic and Atmospheric Administration (NOAA). 2003. "Resource Agency Views of Technology Employed to Prevent Fish Mortality at Cooling Water Intakes." Presented by Richard Wantuck, NOAA Fisheries, Southwest Region. Cooling Water Intake Symposium, Arlington, VA. May 6–7. Available at URL: http://www.epa.gov/waterscience/presentations/wantuck.pdf. Accessed March 3, 2008.

National Renewable Energy Laboratory (NREL). 2009. *Land Use Requirements of Modern Wind Power Plants in the United States.* Golden, CO. August, 2009. Available URL: http://www.nrel.gov/docs/fy09osti/45834.pdf. Accessed: August 12, 2010.

National Research Council. 2006. "Alternatives to the Indian Point Energy Center for Meeting New York Electric Power Needs." Committee on Alternatives to Indian Point for Meeting Energy Needs. National Academy of Sciences. ISBN: 0-309-10172-7, p. 376.

New York Independent System Operator (NYISO). 2010. "Power Trends 2010: New York's Emerging Energy Crossroads." Available URL: http://www.nyiso.com/public/webdocs/newsroom/power_trends/powertrends2010_FINAL_04012010.pdf. Accessed on August 17, 2010.

New York-New Jersey Harbor Estuary Program (NY-NJ HEP). Undated-a. "New York-New Jersey Harbor Estuary Program." Available at URL: http://www.harborestuary.org/. Accessed December 9, 2008.

New York-New Jersey Harbor Estuary Program (NY-NJ HEP). Undated-b. "About the Estuary." Available at URL: http://www.harborestuary.org/aboutestuary.htm. Accessed December 9, 2008.

New York Regional Interconnect (NYRI). 2008. Matter of the Application (Supplement). State of New York Public Service Commission Case No. 06-T-0650. Exhibit 4. Available at URL: http://www.nyri.us/filing.html. Accessed June 9, 2008.

New York Regional Interconnect (NYRI). 2010. "New York Regional Interconnect." Available URL: http://www.nyri.us. Accessed: August 10, 2010.

New York State Department of Environmental Conservation (NYSDEC). 2003a. "Draft State Pollution Discharge Elimination System (SPDES) Discharge Permit." 2003. Available at URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointSPDES.pdf. Accessed July 12, 2007.

New York State Department of Environmental Conservation (NYSDEC). 2003b. Entergy Nuclear Indian Point 2 and 3—Ruling. In the Matter of a Renewal and Modification of a State Pollutant Discharge Elimination System (SPDES) Discharge Permit Pursuant to Environmental Conservation Law (ECL) Article 17 and Title 6 of the Official Compilation of Codes, Rules, and Regulations of the State of New York (6 NYCRR) Parts 704 and 750 et seq. by Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC, Permittees. February 3, 2003.

New York State Department of Environmental Conservation (NYSDEC). 2003c. Fact Sheet. "New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal with Modification, IP2 and IP3 Electric Generating Station, Buchanan, NY." November 2003. Available at URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf. Accessed July 12, 2007.

New York State Department of Environmental Conservation (NYSDEC). 2003d. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2, Bowline 1 and 2, and Indian Point 2 and 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties. Hudson River Power Plants FEIS." June 25, 2003.

New York State Department of Environmental Conservation (NYSDEC). 2004. "DRAFT State Pollutant Discharge Elimination System (SPDES) DISCHARGE PERMIT." Available URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/reviseddft4103.pdf. Accessed August 17, 2010.

New York State Department of Environmental Conservation (NYSDEC). 2007. "Checklist of the Amphibians, Reptiles, Birds, and Mammals of New York, Including Their Legal Status." Eighth Revision.

New York State Department of Environmental Conservation (NYSDEC). 2008a. "Herp Atlas Interim Data (1990–1998)." Available at URL: http://www.dec.ny.gov/animals/7140.html. Accessed March 26, 2008.

New York State Department of Environmental Conservation (NYSDEC). 2008b. "Habitat Protection Programs—Steam Electric Generation." Available at URL: http://www.dec.ny.gov/animals/32847.html. Accessed March 3, 2008.

New York State Department of Environmental Conservation (NYSDEC). 2010a. "Indian Point Nuclear Facility Units 2 and 3 - SPDES Permit: NYS DEC's Administrative Proceeding for the Modification of the SPDES Permit." Available at URL: http://www.dec.ny.gov/permits/57609.html. Accessed August 17, 2010.

New York State Department of Environmental Conservation (NYSDEC). 2010b. "Joint Application for CWA § 401 Water Quality Certification, NRC License Renewal – Entergy Nuclear Indian Point Units 2 and 3, DEC Nos.: 3-5522-00011/00030 (IP2) and 3-5522-00105/00031 (IP3), *Notice of Denial*." April 2, 2010. Available at URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/ipdenial4210.pdf. Accessed August 17, 2010.

New York State Department of Environmental Conservation (NYSDEC). 2010c. "CP-nn / Best Technology Available (BTA) for Cooling Water Intake Structures." March 4, 2010. Available URL: http://www.dec.ny.gov/docs/fish_marine_pdf/drbtapolicy1.pdf. Accessed August 2, 2010.

New York State Department of Public Service (NYSDPS). 2009. "The Renewable Portfolio Standard: Mid Course Report." October 26, 2009. Available URL: http://documents.dps.state.ny.us/public/Common/ViewDoc.aspx?DocRefId=%7B230CE88F-60A5-475B-A24A-6FC9B2780DEF%7D. Accessed: August 9, 2010.

New York State Energy Research and Development Authority (NYSERDA). 2003. "Energy Efficiency and Renewable Energy Resource Development Potential in New York State." December 2003.

New York State Energy Research and Development Authority (NYSERDA). 2007. "Leading the Way in Energy Innovation, A Three-Year Strategic Outlook 2007–2010."

New York State Energy Research and Development Authority (NYSERDA). 2005. "The Effects of Integrating Wind Power on Transmission Planning, Reliability, and Operations. Report on Phase 2: System Performance Evaluation." March 4, 2005. Available URL: http://www.nyserda.org/publications/wind_integration_report.pdf. Accessed: August 12, 2010.

New York State Office of Parks, Recreation and Historic Preservation (NYSHPO). 2009. "RE: NRC, Energy Indian Point Units 2 and 3 Operating License Renewal, 450 Broadway, Town of Buchanan, Westchester County, 06PR06720." ADAMS Accession No. ML103060210.

New York State Public Service Commission (NYSPSC). 2004. Case 03-E-0188 – Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard, Order Regarding Retail Renewable Portfolio Standard. Issued and Effective September 24, 2004. Available URL: http://www3.dps.state.ny.us/pscweb/WebFileRoom.nsf/Web/85D8CCC6A42DB86F85256F1900533518/$File/301.03e0188.RPS.pdf?OpenElement. Accessed: August 12, 2010.

New York State Public Service Commission (NYSPSC). 2010. "07-M-0548: Energy Efficiency Portfolio Standard." Available URL: http://www3.dps.state.ny.us/W/PSCWeb.nsf/All/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument. Accessed: August 11, 2010.

New York Times. 1986. "As Striped Bass Run Up Hudson the Pace Quickens at Hatchery." By Susan Dechillo. June 8.

Nuclear Regulatory Commission (NRC). 1979. "Final Environmental Statement Related to Selection of the Preferred Closed Cycle Cooling System at Indian Point Units Number 3, Consolidated Edison Company of New York, Inc., Power Authority of the State of New York." NUREG-0574, Office of Nuclear Reactor Regulation, Washington, DC.

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

Nuclear Regulatory Commission (NRC). 2001. "Policy Issue Information. Subject: Future Licensing and Inspection Readiness Assessment." SECY 01-0188. October 12, 2001.

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." NUREG-1437, Volume 1, Addendum 1, Washington, DC.

Nuclear Regulatory Commission (NRC). 2002. "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities." NUREG-0586, Supplement 1, Volume 1. Appendix J, "Socioeconomic and Environmental Justice Impacts Related to the Decision to Permanently Cease Operations." November 2002.

Nuclear Regulatory Commission (NRC). 2004a. NUREG-1437, Supplement 15, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants—Virgil C. Summer Nuclear Station." Office of Nuclear Reactor Regulations, Washington, DC.

Nuclear Regulatory Commission (NRC). 2004b. "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions." *Federal Register*, Volume 69, pp. 52040–52048. August 24, 2004.

Nuclear Regulatory Commission (NRC). 2006. NUREG-1437, Supplement 28, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants Regarding Oyster Creek Nuclear Generating Station," Washington, DC.

Riverkeeper. 2008. "History of Power Plants on the Hudson: Hudson River Settlement Agreement." Available at URL: http://riverkeeper.org/champaign.php/biodiversity/the_facts/565-hisotry-of-power-plants-on-the. Accessed February 1, 2008.

TRC Environmental Corp (TRC). 2002. "Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC, Emissions Avoidance Study," revised August 2002.

U.S. Census Bureau. 2000. Available at URL: http://factfinder.census.gov/servlet/SAFFFacts?_event=&geo_id=16000US3610341&_geoContext=01000US%7C04000US36%7C16000US3610341&_street=&_county=Buchanan&_cityTown=Buchanan&_state=04000US36&_zip=&_lang=en&_sse=on&ActiveGeoDiv=geoSelect&_useEV=&pctxt=fph&pgsl=160&_submenuId=factsheet_1&ds_name=null&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=&show_2003_tab=&redirect=Y. Accessed February 13, 2008.

U.S. Geological Survey (USGS). 1997. "Radioactive Elements in Coal and Fly Ash: Abundance, Forms, and Environmental Significance; USGS Fact Sheet FS-163-97." Available at URL: http://greenwood.cr.usgs.gov/enerfy/factshts/163-97/FS-163-97.pdf.

U.S. Second Circuit Court of Appeals. 2004. *Riverkeeper, Inc. v. U.S. E.P.A.* (*Riverkeeper I*). 358 F.3d 174. (February 2, 2004).

U.S. Second Circuit Court of Appeals. 2007. *Riverkeeper, Inc. v. U.S. E.P.A.* (*Riverkeeper II*). 475 F.3d 83. (January 25, 2007)

University of Liege. 2007. "Deep Sounds Scare Fish Away From Turbines That Could Kill Them." *ScienceDaily*, 16 May 2007. Available at URL: http://www.sciencedaily.com/releases/2007/05/070514154055.htm. Accessed February 28, 2008.

Walsh et al. 1999. "Biomass Feedstock Availability in the United States: 1999 State Level Analysis." April 30, 1999.

WINS. 2008. "Plans for Wind Farm Off Long Island Triples in Size." April 17, 2008. Available at URL: http://www.1010wins.com/pages/2021612.php?. Accessed June 9, 2008.

9.0 SUMMARY AND CONCLUSIONS

Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2 (IP2), LLC, and Entergy Nuclear Indian Point 3 (IP3), LLC, are joint applicants for the renewal of the IP2 and IP3 operating licenses (joint applicants will be referred to as Entergy). On April 23, 2007, Entergy submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the IP2 and IP3 operating licenses for an additional 20 years each under Title 10, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," of the *Code of Federal Regulations* (10 CFR Part 54) (Entergy 2007a). If the operating licenses are renewed, State and Federal (other than NRC) regulatory agencies and Entergy would ultimately decide whether the plant will continue to operate based on factors such as the need for power, power availability from other sources, regulatory mandates, or other matters within the agencies' jurisdictions or the purview of the owners. If the NRC decides not to renew the operating licenses, then the units must be shut down upon the expiration of the current operating licenses, subject to the conclusion of the license renewal process. If the license renewal review is ongoing at the time of license expiration, the units will be allowed to continue operating until the NRC makes a determination. The IP2 operating license will expire on September 28, 2013; the IP3 operating license will expire on December 12, 2015.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA), requires an environmental impact statement (EIS) for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." As identified in 10 CFR Part 51, certain licensing and regulatory actions require an EIS. In 10 CFR 51.20(b)(2), the NRC requires preparation of an EIS or a supplement to an EIS for renewal of a reactor operating license. Furthermore, 10 CFR 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[1]

Upon acceptance of the license renewal application for docketing, the NRC began the environmental review process described in 10 CFR Part 51 by publishing, on August 10, 2007, a Notice of Intent to prepare an EIS and conduct scoping (Volume 72, page 45075, of the *Federal Register* (72 FR 45075)). The NRC staff held two public scoping meetings on September 19, 2007, and visited the IP2 and IP3 site to conduct site audits on September 10–14, 2007, and September 24–27, 2007. The NRC staff reviewed the Entergy environmental report (ER) (Entergy 2007b) and compared it to the GEIS, consulted with other agencies, and conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal" (NRC 2000). The NRC staff also considered the public comments received during the scoping process for preparation of the draft supplemental environmental impact statement (SEIS) for IP2 and IP3. Public comments and NRC staff responses are available in the Scoping Summary Report prepared by the NRC staff (ADAMS Accession Number ML083360115).

The NRC staff issued a draft SEIS in December 2008. Thereafter, the staff held public meetings

(1) 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.

in Cortlandt Manor, New York, on February 12, 2009 and presented the preliminary results of the NRC environmental review, answered questions from the public, and received comments on the draft SEIS. The NRC staff considered and addressed all of the comments received. The comments are reflected in this SEIS and/or addressed in Part 2 of Appendix A to this final SEIS.

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 effects. 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 the following:

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

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

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 thescope of the generic determination in 10 CFR 51.23(a) and in accordance with 10 CFR 51.23(b).[2]

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(2) The title of 10 CFR 51.23 is "Temporary storage of spent fuel after cessation of reactor operation—generic determination of no significant environmental impact."

The GEIS contains the results of a systematic evaluation of the consequences of renewing an operating license 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 (CEQ) guidelines. The following definitions of the three significance levels are set forth in the footnotes to Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51:

> 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 environmental 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 likely not to be sufficiently beneficial to warrant implementation.

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

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 SEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized.

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 operating licenses for IP2 and IP3), continued operation of either IP2 or IP3, alternative methods of power generation, and conservation. The NRC staff also considered an alternative that included continued operation of IP2 and IP3 with a closed-cycle cooling system.

9.1 Environmental Impacts of the Proposed Action—License Renewal

The NRC staff has established an independent process for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. The NRC staff has not identified any information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. In the IP2 and IP3 ER, Entergy identified leakage from onsite spent fuel pools as potentially new and significant information (Entergy 2007b). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this SEIS. Based on the NRC staff's review of Entergy's analysis, the NRC staff's adoption of the NRC inspection report findings in this SEIS, and Entergy's subsequent statements (all discussed in Section 2.2.7), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant). Therefore, the NRC staff relied upon the conclusions of the GEIS for all Category 1 issues that are applicable to IP2 and IP3.

Entergy's license renewal application contains an analysis of the Category 2 issues that are applicable to IP2 and IP3, plus environmental justice and chronic effects from electromagnetic fields for a total of 23 issues. The NRC staff has reviewed the Entergy analysis and has conducted an independent review of each issue. Six of the Category 2 issues are not applicable because they are related to cooling systems, water use conflicts, and ground water use not found at IP2 and IP3.

As discussed in Chapter 3, scoping comments revealed—and Entergy indicated—that Entergy may replace reactor vessel heads and control rod drive mechanisms (CRDMs) in both units. As a result, the NRC staff addressed the impacts of these replacement activities in Chapter 3. This includes three Category 2 issues that apply only to refurbishment, six Category 2 issues that apply to refurbishment and continued operation, and one uncategorized issue, environmental justice, that applies to both refurbishment and continued operations. The NRC staff determined that all effects from refurbishment activities are of SMALL significance.

The NRC staff addresses twelve Category 2 issues related to impacts from continued operations and postulated accidents during the renewal term, as well as environmental justice and chronic effects of electromagnetic fields. Research is continuing in the area of chronic effects on electromagnetic fields, and a scientific consensus has not been reached. Therefore, no further evaluation of this issue is required. The NRC staff concludes that the potential environmental effects for 9 of the 12 categorized issues are of SMALL significance in the context of the standards set forth in the GEIS. The NRC staff concludes that the combined impacts from impingement and entrainment (each a separate issue) are MODERATE. Impacts from heat shock could range from SMALL to LARGE, based on the large uncertainties discussed in Chapter 4. Based on corrected data received since the completion of the draft SEIS, the NRC staff concludes that impacts to the endangered shortnose sturgeon which ranged from SMALL to LARGE in the draft SEIS are likely to be SMALL.

For severe accident mitigation alternatives (SAMAs), the NRC staff concludes that a reasonable, comprehensive effort was made by Entergy to identify and evaluate SAMAs. Based on its review of the SAMAs for IP2 and IP3, and the plant improvements already made, the NRC staff concludes that several candidate SAMAs may be cost-beneficial. However, these SAMAs do not relate 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.

For all issues of SMALL significance, current measures to mitigate the environmental impacts of plant operation were found to be adequate. For issues of MODERATE or LARGE significance (i.e., issues related to aquatic ecology), mitigation measures are addressed both in Chapter 4 and in Chapter 8 as alternatives based on determinations in the draft New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) permit proceeding, Clean Water Act Section 401 proceeding, and in draft policy statements published by the State. In Chapter 8, the NRC staff considers the impacts that may result if the plant converts from once-through cooling to a closed-cycle cooling system (Section 8.1.1).

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. The NRC staff concludes that the cumulative impacts to the environment around IP2 and IP3 license renewal would be LARGE for some affected resources, given historical environmental impacts, current actions, and likely future actions. With the exception of aquatic resources, the contribution of IP2 and IP3 to cumulative impacts is SMALL.

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 or operating license 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 and operation have already occurred, have been mitigated, or have been avoided. The environmental impacts to be evaluated for license renewal are those associated with refurbishment and continued operation during the renewal term.

Adverse impacts of continued operation from (a) heat shock and (b) the combined effects of entrainment and impingement of fish and shellfish are considered to be potentially SMALL to LARGE, and MODERATE, respectively. Other adverse impacts are considered to be of SMALL significance.

Adverse impacts of likely alternatives to the operation of IP2 and IP3 vary greatly. Many have smaller impacts to aquatic resources than the proposed renewal of IP2 and IP3, though all have larger impacts than the proposed renewal of IP2 and IP3 in at least one other resource area.

9.1.2 Irreversible or Irretrievable Resource Commitments

The commitment of resources related to construction and operation of IP2 and IP3 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, operation, and refurbishment; the nuclear fuel used by the reactors; and ultimately, permanent offsite storage space for the spent fuel assemblies.

Entergy may be required to commit additional resources should the final NYSDEC SPDES permit require closed-cycle cooling (as required in the draft revised SPDES permit) and Entergy decides to (1) build and operate a closed-cycle cooling system to meet the permit's required reductions in impacts to aquatic ecology, or (2) make other modifications that meet the terms of the SPDES permit without retrofitting to closed-cycle cooling. However, regardless of the future status of the SPDES permit, significant resource commitments will be required during the renewal term for additional fuel and the permanent spent fuel storage space. IP2 and IP3 replace a portion of their fuel assemblies during every refueling outage, which typically occurs on a 24-month cycle (Entergy 2007a). Additional resources would also be committed to constructing and installing new reactor vessel heads and CRDMs.

The likely energy alternatives would also require a commitment of resources for construction of the replacement facilities, implementation of conservation measures, and in some cases, fuel to run plants. Significant resource commitments would also be required for development of transmission capacity. These resource commitments, however, would not necessarily come from Entergy as Entergy currently has no obligation to support power production in the New York area should IP2 and IP3 permanently shut down.

9.1.3 Short-Term Use Versus Long-Term Productivity

An initial balance between local short-term uses of the environment and maintenance and enhancement of long-term productivity at IP2 and IP3 was set when the plant was approved and construction began. Renewal of the operating licenses for IP2 and IP3 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 operating licenses would lead to a shutdown of the plant that will alter the balance in a manner that depends on subsequent uses of the site. Furthermore, new replacement energy sources or conservation options will establish new balances at their respective locations.

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives

The proposed action is renewal of the operating licenses for IP2 and IP3. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 through 7 discuss environmental issues associated with renewal of the operating licenses. Environmental issues associated with the no-action alternative and alternatives such as new power generation, purchased power, conservation, and cooling system modifications are discussed in Chapter 8.

The significance of the environmental impacts from the proposed action (approval of the application for renewal of the operating licenses), the no-action alternative (denial of the application), an alternative involving altering plant operations to comply with the NYSDEC draft SPDES discharge permit, construction of gas-fired generating capacity at alternate sites, gas-fired generation of power at IP2 and IP3, and two combinations of alternatives are compared in Table 9-1. All new fossil-fueled alternatives presented in Table 9-1 are assumed to use closed-cycle cooling systems given current New York State regulations for new power plants.

Table 9-1 shows the significance of the plant-specific environmental effects of the proposed action (renewal of IP2 and IP3 operating licenses) as well as the environmental effects of alternatives to the proposed action. Impacts from license renewal would be SMALL for all impact categories except aquatic ecology, which includes the impacts of heat shock, entrainment, and impingement. Chapter 4 of this SEIS describes the MODERATE impacts of plant operation on aquatic ecology through impingement and entrainment (impact levels vary by species), and the potentially SMALL to LARGE impacts from thermal shock. Overall, impacts to aquatic ecology from continued operation of IP2 and IP3 without cooling system modifications or restoration actions are SMALL to LARGE. A single significance level was not assigned for the collective offsite radiological impacts from the fuel cycle and from high-level radioactive waste spent fuel disposal (see Chapter 6) or for the impacts of greenhouse gases (GHG).

The NRC staff is analysis indicates that the no-action alternative has the smallest effect, but it would necessitate additional actions to replace generation capacity (whether with newly-constructed power plants or purchased power) and/or to institute conservation programs. Impacts of the likely consequences of the no-action alternative would be similar to those of the energy alternatives that the NRC staff considered. All other alternative actions have impacts in at least four resource areas that reach SMALL to MODERATE or higher significance. Often, these impacts are the result of constructing new facilities or infrastructure.

9.3 Conclusions and Recommendations

Based on (1) the analysis and findings in the GEIS, (2) the ER and other information submitted by Entergy, (3) consultation with Federal, State, Tribal, and local agencies, (4) the NRC staff's consideration of public scoping comments received, and comments on the draft SEIS, and (5) the NRC staff's independent review, the recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable.

1 **Table 9-1. Summary of Environmental Significance of License Renewal and Alternatives**

Impact Category	Proposed Action License Renewal	No-Action Alternative[b] Plant Shutdown	License Renewal with New Closed-Cycle Cooling	NGCC At the IP Site or a Repowered Site	NGCC At a New Site
Land Use	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	MODERATE to LARGE
Ecology—Aquatic	MODERATE and SMALL to LARGE[a]	SMALL	SMALL	SMALL	SMALL
Ecology—Terrestrial	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE
Water Use and Quality	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Air Quality	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE
Waste	SMALL	SMALL	SMALL to LARGE	SMALL	SMALL
Human Health	SMALL [c]	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE
Aesthetics	SMALL	SMALL	MODERATE to LARGE	SMALL	SMALL to LARGE
Historical and Archeological Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Environmental Justice	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE

2
3

Table 9-1 (continued)

Impact Category	Conservation/Energy Efficiency	Combination of Alternatives Option 1: One IP unit, onsite gas, offsite renewables, and conservation	Combination of Alternatives Option 2: Gas, offsite renewables, additional imported power, and conservation
Land Use	SMALL	SMALL to MODERATE	SMALL to MODERATE
Ecology – Aquatic	SMALL	SMALL to LARGE	SMALL to LARGE
Ecology – Terrestrial	SMALL	SMALL to LARGE	SMALL to LARGE
Water Use and Quality	SMALL	SMALL to LARGE	SMALL to LARGE
Air Quality	SMALL	SMALL to MODERATE	SMALL to MODERATE
Waste	SMALL	SMALL to LARGE	SMALL to LARGE
Human Health	SMALL	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL	SMALL to MODERATE
Transportation	SMALL	MODERATE	MODERATE
Aesthetics	SMALL	SMALL to LARGE	SMALL to LARGE
Historical and Archeological Resources	SMALL	SMALL to MODERATE	SMALL to MODERATE
Environmental Justice	SMALL	SMALL to LARGE	SMALL to LARGE

(a) NRC staff analysis indicates that impingement and entrainment impacts are MODERATE, but that thermal shock effects could potentially range from SMALL to LARGE.
(b) The no-action alternative does not, on its own, meet the purpose and need of the GEIS. No action would necessitate other generation or conservation actions which may include—but are not limited to—the alternatives addressed in this table.
(c) For the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, a specific significance level was not assigned. See Chapter 6 for details.
(d) Analysis was based on use of a closed-cycle cooling system.

9.4 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."

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

72 FR 45705. "Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 and 3; Notice of Intent To Prepare an Environmental Impact Statement and Conduct Scoping Process." August 10, 2007

Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Indian Point, Units 2 & 3, License Renewal Application." April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210512.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application). April 23, 2007. ADAMS Accession No. ML071210530.

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

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

Nuclear Regulatory Commission (NRC). 1999. NUREG-1437, Volume 1, Addendum 1, "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." Washington, DC.

Nuclear Regulatory Commission (NRC). 2000. NUREG-1555, Supplement 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal." Washington, DC.

in Cortlandt Manor, New York, on February 12, 2009 and presented the preliminary results of the NRC environmental review, answered questions from the public, and received comments on the draft SEIS. The NRC staff considered and addressed all of the comments received. The comments are reflected in this SEIS and/or addressed in Part 2 of Appendix A to this final SEIS.

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 effects. 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 the following:

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

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

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 thescope of the generic determination in 10 CFR 51.23(a) and in accordance with 10 CFR 51.23(b).[2]

(2) The title of 10 CFR 51.23 is "Temporary storage of spent fuel after cessation of reactor operation—generic determination of no significant environmental impact."

The GEIS contains the results of a systematic evaluation of the consequences of renewing an operating license 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 (CEQ) guidelines. The following definitions of the three significance levels are set forth in the footnotes to Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51:

> 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 environmental 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 likely not to be sufficiently beneficial to warrant implementation.

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

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 SEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized.

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 operating licenses for IP2 and IP3), continued operation of either IP2 or IP3, alternative methods of power generation, and conservation. The NRC staff also considered an alternative that included continued operation of IP2 and IP3 with a closed-cycle cooling system.

9.1 Environmental Impacts of the Proposed Action—License Renewal

The NRC staff has established an independent process for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. The NRC staff has not identified any information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. In the IP2 and IP3 ER, Entergy identified leakage from onsite spent fuel pools as potentially new and significant information (Entergy 2007b). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this SEIS. Based on the NRC staff's review of Entergy's analysis, the NRC staff's adoption of the NRC inspection report findings in this SEIS, and Entergy's subsequent statements (all discussed in Section 2.2.7), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant). Therefore, the NRC staff relied upon the conclusions of the GEIS for all Category 1 issues that are applicable to IP2 and IP3.

Entergy's license renewal application contains an analysis of the Category 2 issues that are applicable to IP2 and IP3, plus environmental justice and chronic effects from electromagnetic fields for a total of 23 issues. The NRC staff has reviewed the Entergy analysis and has conducted an independent review of each issue. Six of the Category 2 issues are not applicable because they are related to cooling systems, water use conflicts, and ground water use not found at IP2 and IP3.

As discussed in Chapter 3, scoping comments revealed—and Entergy indicated—that Entergy may replace reactor vessel heads and control rod drive mechanisms (CRDMs) in both units. As a result, the NRC staff addressed the impacts of these replacement activities in Chapter 3. This includes three Category 2 issues that apply only to refurbishment, six Category 2 issues that apply to refurbishment and continued operation, and one uncategorized issue, environmental justice, that applies to both refurbishment and continued operations. The NRC staff determined that all effects from refurbishment activities are of SMALL significance.

The NRC staff addresses twelve Category 2 issues related to impacts from continued operations and postulated accidents during the renewal term, as well as environmental justice and chronic effects of electromagnetic fields. Research is continuing in the area of chronic effects on electromagnetic fields, and a scientific consensus has not been reached. Therefore, no further evaluation of this issue is required. The NRC staff concludes that the potential environmental effects for 9 of the 12 categorized issues are of SMALL significance in the context of the standards set forth in the GEIS. The NRC staff concludes that the combined impacts from impingement and entrainment (each a separate issue) are MODERATE. Impacts from heat shock could range from SMALL to LARGE, based on the large uncertainties discussed in Chapter 4. Based on corrected data received since the completion of the draft SEIS, the NRC staff concludes that impacts to the endangered shortnose sturgeon which ranged from SMALL to LARGE in the draft SEIS are likely to be SMALL.

For severe accident mitigation alternatives (SAMAs), the NRC staff concludes that a reasonable, comprehensive effort was made by Entergy to identify and evaluate SAMAs. Based on its review of the SAMAs for IP2 and IP3, and the plant improvements already made, the NRC staff concludes that several candidate SAMAs may be cost-beneficial. However, these SAMAs do not relate 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.

For all issues of SMALL significance, current measures to mitigate the environmental impacts of plant operation were found to be adequate. For issues of MODERATE or LARGE significance (i.e., issues related to aquatic ecology), mitigation measures are addressed both in Chapter 4 and in Chapter 8 as alternatives based on determinations in the draft New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) permit proceeding, Clean Water Act Section 401 proceeding, and in draft policy statements published by the State. In Chapter 8, the NRC staff considers the impacts that may result if the plant converts from once-through cooling to a closed-cycle cooling system (Section 8.1.1).

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. The NRC staff concludes that the cumulative impacts to the environment around IP2 and IP3 license renewal would be LARGE for some affected resources, given historical environmental impacts, current actions, and likely future actions. With the exception of aquatic resources, the contribution of IP2 and IP3 to cumulative impacts is SMALL.

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 or operating license 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 and operation have already occurred, have been mitigated, or have been avoided. The environmental impacts to be evaluated for license renewal are those associated with refurbishment and continued operation during the renewal term.

Adverse impacts of continued operation from (a) heat shock and (b) the combined effects of entrainment and impingement of fish and shellfish are considered to be potentially SMALL to LARGE, and MODERATE, respectively. Other adverse impacts are considered to be of SMALL significance.

Adverse impacts of likely alternatives to the operation of IP2 and IP3 vary greatly. Many have smaller impacts to aquatic resources than the proposed renewal of IP2 and IP3, though all have larger impacts than the proposed renewal of IP2 and IP3 in at least one other resource area.

9.1.2 Irreversible or Irretrievable Resource Commitments

The commitment of resources related to construction and operation of IP2 and IP3 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, operation, and refurbishment; the nuclear fuel used by the reactors; and ultimately, permanent offsite storage space for the spent fuel assemblies.

Entergy may be required to commit additional resources should the final NYSDEC SPDES permit require closed-cycle cooling (as required in the draft revised SPDES permit) and Entergy decides to (1) build and operate a closed-cycle cooling system to meet the permit's required reductions in impacts to aquatic ecology, or (2) make other modifications that meet the terms of the SPDES permit without retrofitting to closed-cycle cooling. However, regardless of the future status of the SPDES permit, significant resource commitments will be required during the renewal term for additional fuel and the permanent spent fuel storage space. IP2 and IP3 replace a portion of their fuel assemblies during every refueling outage, which typically occurs on a 24-month cycle (Entergy 2007a). Additional resources would also be committed to constructing and installing new reactor vessel heads and CRDMs.

The likely energy alternatives would also require a commitment of resources for construction of the replacement facilities, implementation of conservation measures, and in some cases, fuel to run plants. Significant resource commitments would also be required for development of transmission capacity. These resource commitments, however, would not necessarily come from Entergy as Entergy currently has no obligation to support power production in the New York area should IP2 and IP3 permanently shut down.

9.1.3 Short-Term Use Versus Long-Term Productivity

An initial balance between local short-term uses of the environment and maintenance and enhancement of long-term productivity at IP2 and IP3 was set when the plant was approved and construction began. Renewal of the operating licenses for IP2 and IP3 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 operating licenses would lead to a shutdown of the plant that will alter the balance in a manner that depends on subsequent uses of the site. Furthermore, new replacement energy sources or conservation options will establish new balances at their respective locations.

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives

The proposed action is renewal of the operating licenses for IP2 and IP3. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 through 7 discuss environmental issues associated with renewal of the operating licenses. Environmental issues associated with the no-action alternative and alternatives such as new power generation, purchased power, conservation, and cooling system modifications are discussed in Chapter 8.

The significance of the environmental impacts from the proposed action (approval of the application for renewal of the operating licenses), the no-action alternative (denial of the application), an alternative involving altering plant operations to comply with the NYSDEC draft SPDES discharge permit, construction of gas-fired generating capacity at alternate sites, gas-fired generation of power at IP2 and IP3, and two combinations of alternatives are compared in Table 9-1. All new fossil-fueled alternatives presented in Table 9-1 are assumed to use closed-cycle cooling systems given current New York State regulations for new power plants.

Table 9-1 shows the significance of the plant-specific environmental effects of the proposed action (renewal of IP2 and IP3 operating licenses) as well as the environmental effects of alternatives to the proposed action. Impacts from license renewal would be SMALL for all impact categories except aquatic ecology, which includes the impacts of heat shock, entrainment, and impingement. Chapter 4 of this SEIS describes the MODERATE impacts of plant operation on aquatic ecology through impingement and entrainment (impact levels vary by species), and the potentially SMALL to LARGE impacts from thermal shock. Overall, impacts to aquatic ecology from continued operation of IP2 and IP3 without cooling system modifications or restoration actions are SMALL to LARGE. A single significance level was not assigned for the collective offsite radiological impacts from the fuel cycle and from high-level radioactive waste spent fuel disposal (see Chapter 6) or for the impacts of greenhouse gases (GHG).

The NRC staff is analysis indicates that the no-action alternative has the smallest effect, but it would necessitate additional actions to replace generation capacity (whether with newly-constructed power plants or purchased power) and/or to institute conservation programs. Impacts of the likely consequences of the no-action alternative would be similar to those of the energy alternatives that the NRC staff considered. All other alternative actions have impacts in at least four resource areas that reach SMALL to MODERATE or higher significance. Often, these impacts are the result of constructing new facilities or infrastructure.

9.3 Conclusions and Recommendations

Based on (1) the analysis and findings in the GEIS, (2) the ER and other information submitted by Entergy, (3) consultation with Federal, State, Tribal, and local agencies, (4) the NRC staff's consideration of public scoping comments received, and comments on the draft SEIS, and (5) the NRC staff's independent review, the recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable.

1 **Table 9-1. Summary of Environmental Significance of License Renewal and Alternatives**

	Proposed Action	No-Action Alternative[b]	License Renewal with	NGCC	
Impact Category	**License Renewal**	**Plant Shutdown**	**New Closed-Cycle Cooling**	**At the IP Site or a Repowered Site**	**At a New Site**
Land Use	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	MODERATE to LARGE
Ecology—Aquatic	MODERATE and SMALL to LARGE[a]	SMALL	SMALL	SMALL	SMALL
Ecology—Terrestrial	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE
Water Use and Quality	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Air Quality	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE
Waste	SMALL	SMALL	SMALL to LARGE	SMALL	SMALL
Human Health	SMALL [c]	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE
Aesthetics	SMALL	SMALL	MODERATE to LARGE	SMALL	SMALL to LARGE
Historical and Archeological Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Environmental Justice	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE

2
3

Table 9-1 (continued)

Impact Category	Conservation/Energy Efficiency	Combination of Alternatives	
		Option 1: One IP unit, onsite gas, offsite renewables, and conservation	**Option 2: Gas, offsite renewables, additional imported power, and conservation**
Land Use	SMALL	SMALL to MODERATE	SMALL to MODERATE
Ecology – Aquatic	SMALL	SMALL to LARGE	SMALL to LARGE
Ecology – Terrestrial	SMALL	SMALL to LARGE	SMALL to LARGE
Water Use and Quality	SMALL	SMALL to LARGE	SMALL to LARGE
Air Quality	SMALL	SMALL to MODERATE	SMALL to MODERATE
Waste	SMALL	SMALL to LARGE	SMALL to LARGE
Human Health	SMALL	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL	SMALL to MODERATE
Transportation	SMALL	MODERATE	MODERATE
Aesthetics	SMALL	SMALL to LARGE	SMALL to LARGE
Historical and Archeological Resources	SMALL	SMALL to MODERATE	SMALL to MODERATE
Environmental Justice	SMALL	SMALL to LARGE	SMALL to LARGE

(a) NRC staff analysis indicates that impingement and entrainment impacts are MODERATE, but that thermal shock effects could potentially range from SMALL to LARGE.
(b) The no-action alternative does not, on its own, meet the purpose and need of the GEIS. No action would necessitate other generation or conservation actions which may include—but are not limited to—the alternatives addressed in this table.
(c) For the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, a specific significance level was not assigned. See Chapter 6 for details.
(d) Analysis was based on use of a closed-cycle cooling system.

9.4 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."

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

72 FR 45705. "Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 and 3; Notice of Intent To Prepare an Environmental Impact Statement and Conduct Scoping Process." August 10, 2007

Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Indian Point, Units 2 & 3, License Renewal Application." April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210512.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application). April 23, 2007. ADAMS Accession No. ML071210530.

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

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

Nuclear Regulatory Commission (NRC). 1999. NUREG-1437, Volume 1, Addendum 1, "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." Washington, DC.

Nuclear Regulatory Commission (NRC). 2000. NUREG-1555, Supplement 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal." Washington, DC.

Appendix A

Comments Received on the Environmental Review

Appendix A

Comments Received on the Environmental Review

Comments Received During Scoping and Scoping Summary Adoption

In this appendix, the NRC staff adopts the Scoping Summary Report for Indian Point Nuclear Generating Unit Nos. 2 and 3 as prepared by the NRC staff in response to comments received on the scope of the environmental review. The NRC staff issued the scoping summary report on December 19, 2008. The Scoping Summary Report is available for public inspection in the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland, 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS).

The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams/web-based.html. The scoping summary report is listed under Accession No. ML083360115.

Persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr@nrc.gov.

On August 10, 2007, the NRC published a Notice of Intent in the Federal Register (72 FR 45075) to notify the public of the Staff's intent to prepare a plant-specific supplement to the GEIS (SEIS) regarding the renewal application for the IP2 and IP3 operating license. As outlined by NEPA, the NRC initiated the scoping process with the issuance of the Federal Register Notice. The NRC invited the applicant, federal, state, local, and tribal government agencies, local organizations, and individuals to participate in the scoping process by providing oral comments at scheduled public meetings and/or submitting written suggestions and comments no later than October 12, 2007.

The scoping process included two public scoping meetings, which were both held on September 19, 2007, at Colonial Terrace, 119 Oregon Road, Cortlandt Manor, New York. The NRC issued press releases and distributed flyers locally. Both sessions began with NRC staff members providing a brief overview of the license renewal process and the NEPA process. Following the NRC's prepared statements, the meetings were open for public comments. Approximately 50 attendees provided oral comments that were recorded and transcribed by a certified court reporter.

The meeting summary, which was issued on October 24, 2007, and the associated transcripts can be found in the NRC PDR or in ADAMS at Accession No. ML072851079. The transcripts of the meetings can be found in ADAMS at Accession Numbers ML072830682 and ML072890209.

The scoping summary contains all comments received on the review, as well as the NRC staff's responses to those comments. Comments received on the draft SEIS will be included in this Appendix of the final SEIS.

A.1 Comments Received on the Draft SEIS

Pursuant to 10 CFR Part 51, the staff transmitted the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Units 2 and 3, Draft Report for Comment* (NUREG-1437, Supplement 38, referred to as the draft SEIS) to Federal, State, Native American Tribal, and local government agencies as well as interested members of the public. As part of the process to solicit public comments on the DSEIS, the staff:

• placed a copy of the DSEIS in the NRC's electronic Public Document Room, its license renewal website, White Plains Public Library(White Plains, NY), Hendrick Hudson Free Library (Montrose, NY) and the Field Library(Peekskill, NY),

• sent copies of the DSEIS to the applicant, members of the public who requested copies, and certain Federal, State, Native American Tribal, and local agencies,

• published a notice of availability of the DSEIS in the *Federal Register* on December 31, 2008, (71 FR 75280),

• issued press releases and public announcements such as advertisements in local newspapers and postings in public places announcing the issuance of the DSEIS, the public meetings, and instructions on how to comment on the DSEIS,

• held public meetings in Cortlandt Manor, New York, on February 12, 2009, to describe the results of the environmental review and answer related questions,

• established an e-mail address to receive comments on the DSEIS through the Internet.

During the DSEIS comment period, the staff received comments from 183 individuals or groups. Eighty-eight commenters spoke during the public meetings. The staff reviewed the public meeting transcripts and the comment letters that are part of the docket file for the application, all of which are available in the NRC's Agencywide Documents Access Management System (ADAMS). ADAMS is accessible at http://www.nrc.gov/reading-rm/adams.html. Appendix A, Part II, Section A.2, contains a summary of the comments and the staff's responses. Appendix A, Part II, Section A.3, contains the comment letters and commenters excerpts from the transcripts. The comment period closed on March 18, 2009.

No individuals or groups requested an extension of the comment period. Several groups, however, submitted comments months after the close of the comment period, most recently on November 5, 2010. The NRC staff found it impracticable to address these comments, and those late-filed comments are not included in this appendix.

Each comment identified by the staff was assigned a specific commenter identifier (marker). That identifier is typed in the letter's margin at the beginning of the comment discussion.

Table A-1. Individuals and/or Groups Providing Comments on the DSEIS.
Commenters appear in alphabetical order, and each commenter has been given a unique commenter identification number.

Commenter	Affiliation (if stated)	Commenter ID Number
Adams, Kenneth	Business Council of New York State	1

Commenter	Affiliation (if stated)	Commenter ID Number
Allen, Judy	Resident, Putnam Valley	2
American Citizen	American Citizens	3
Anders, Fred	NYS Office of Coastal, Local Government and Community Sustainability	4
Anthony, Rev. Dr. Cheryl	Jude International Christian Center	5
Argintar, Herbert		6
Ball, Gregory	New York State Assembly	7
Banfield, William	Empire State Regional Council of Carpenters	8
Bard Center for Environmental Policy	Auropriya A. Reddy, Emily B. Fischer, Katherine C. Galbraith, Kristine E. Pierce, Shaylah C. Reagan, Michel N. Wahome, Matthew A. Guenther, Kaleena S. Miller, Taryn L. Morris, Joshua Z. Jacobson, Jaclyn Harrison, Lindsay Chapman, Anne E. Kline, Than H. Phoo, Daniel Smith	9
Barthelme, Margaret	Student, Ramapo College	10
Bartholomew, Alice		11
Bassi, Laura		12
Berasi, Pete		13
Bigby, Derry	African American Environmentalist Association	14
Bittermann, Sister Rosemarie	St. Patrick Villa	15
Blades, Adam	Student, Ramapo College	16
Blumenthal, Richard	Connecticut, Attorney General	17
Boorman, Lindsay		18
Bowman, Reginald	NYC Housing Authority’s Resident Council	19
Brancato, Deborah	Riverkeeper	20
Brennan, Chris		21
Bron, Gary		22
Burruss, Melvin	African American Men of Westchester	23
Burton, Nancy	Mothers Milk Project	24
Butler, Elizabeth		25
Byrd, Ricardo	National Association of Neighborhoods	26
Calvani, Dorothy		27
Campbell, Joanne	Albany Houses Tenants Association of Brooklyn	28
Capurso, Tom	Local 3	29
Carmody, Greg	Student, Ramapo College	30
Castro, Maria	Hispanic Energy Coalition	31

Commenter	Affiliation (if stated)	Commenter ID Number
Chernoff, Patricia		32
Clark, Pamela	Hudson River Club	33
Clegg, Thomas		34
Cohen, Lisa		35
Connolly, Jerry	Coalition of Labor for Energy and Jobs	36
Cooper, Loraine		37
Cypser, Betty	Raging Grannies	38
Cypser, Rudy		39
Dacimo, Fred	Entergy	40
Daly, Mary Ann		41
Davis, Darwin	Greater Harlem Chamber of Commerce	42
Davis, Jill	Hendrick Hudson Free Library	43
DeAngelo, Carol		44
Degraff, Rev. Jacques	100 Black Men	45
Digby, Derry	African American Environmental Association	46
DiRocco, Steve		47
Donahue, Mayor Al	Mayor, Town of Buchanan	48
Durett, Dan	African American Environmentalists Association	49
Edelstein, Michael	Ramapo College	50
Evans, Laurie	Westchester SAFE	51
Falciano, Patrick		52
Federspiel, John	Hudson Valley Hospital System	53
Feinberg, Janie		54
Filippelli, John	United States Environmental Protection Agency	55
Fitzpatrick, Brian		56
Forehand, Ron	Hudson Valley Gateway Chamber of Commerce	57
Form Letter		58
Foster, Mary	Mayor, Peekskill	59
Fraiser, Andrew	NextGen Network	60
Friedman, Carolyn	Resident, Nyack	61
Frye, Glen	Brooklyn Anti-Violence Coalition	62
Funck, John		63
Furgatch, Lisa		64
Garcia, Frank	Bronx Hispanic Chamber of Commerce	65

Commenter	Affiliation (if stated)	Commenter ID Number
Garisto, Mary Ann		66
Gordon, Marsha	Business Council of Westchester	67
Grady, Peter		68
Raging Grannies		69
Gould, Ross	Attorney (Working with HRSC)	70
Gray, Jennifer		71
Green, George		72
Greene, Manna	Hudson River Sloop Clearwater	73
Hassman, Howard		74
Hawkins, Gerard	Resident, Croton on Hudson	75
Helman, Lucille		76
Hirsh, Seth		77
Hohlfeld, Bill	Local 46 Labor Management Cooperative Trust	78
Hudson River Sloop Clearwater, Inc.	Manna Jo Greene, Ross Gould, Esq.	79
Imoberdorf, Olivia		80
Indusi, Joan		81
Jacobs, Mark		82
Johnson, Tom	Buchanan Firefighter	83
Karamaty, Valery	Raging Grannies	84
Karas, Joe	Carpenters Union Local 11	85
Kardos, Terry	Resident, Cortlandt Manor	86
Kardos, Theresa	Resident, Cortlandt Manor	87
Kearney, Gail		88
Keenan, Jennifer	Student, Ramapo College	89
Kelly, John	Entergy (retired Director of Licensing)	90
Ketchum, Arleen		91
Klein, Tom	Boilermakers Local 5	92
Knolmayer, Liz	Student, Ramapo College	93
Knubel, James	New York AREA	94
Koldewyn, Kennis		95
Kopec, Eileen	Student, Ramapo College	96
Kopshaw, Kaitlin	Student, Ramapo College	97
Kourie, Kathleen	Resident, Garrison	98
Kremer, Arthur	NY AREA (Affordable Reliable Energy Alliance)	99

Commenter	Affiliation (if stated)	Commenter ID Number
Lapido, Helen	Resident, Cortlandt Manor	100
Ledwith, Robert	Metallic Lathers Union and Reinforcing Ironworkers Local 46	101
Lee, Michel	Council on Intelligent Energy and Conservation Policy	102
Leifer, Susan	Sierra Club	103
Likes, Philip		104
Ludwigson, Steve	Boilermakers Local 5	105
Mallon, Sister Florence		106
Mangano, Joe	Radiation and Public Health Project	107
Marzullo, Dominic	Indian Point	108
Mattis, John	Resident, Cortlandt	109
Maturo, Michael	Orangetown Councilman	110
McCann, Dr. Daniel	Superintendent, Hendrick Hudson School District	111
McCormick, John	(enter for Environment Commerce and Energy)	112
McDonald, Norris	(enter for Environment Commerce and Energy)	113
McGrath, John	Easter Seals, New York	114
Miranda, George	New York Teamsters Joint Council 16	115
Miranda, Rick	Brooklyn Hispanic Chamber of Commerce	116
Mitchell, Grace	Resident, Lower Hudson Valley	117
Montague, Virginia	NY Coalition of 100 Black Women	118
Mooney, William	Westchester County Association	119
Moore, Dr. Patrick	Greenspirit Strategies, LLC	120
Murdock, Chad		121
Murphy, Regina		122
Musegaas, Phillip	Riverkeeper	123
Myslinski, Melissa		124
Nemeczek, Jessica	Student, Ramapo College	125
Newman, Janet	West Branch Conservation Association	126
Nicklas, Donald	Local 7	127
NYSDEC	Joan Leary Matthews, John L. Parker	128
NYSO of the Attorney General	Janice A. Dean, John Sipos, Lisa Feiner	129
Oros, George	Westchester County Board of Legislators	130
Otis, Mike	Professor, University	131
Parker, John	NYSDEC Attorney, Region 3	132
Perry, Sharonee	Former Brooklyn Community Board	133

Commenter	Affiliation (if stated)	Commenter ID Number
Perry, Donzella	Resident, Brooklyn	134
Pilder, Leslie		135
Pockriss, Peter	Director of Development for Historic Hudson Valley	136
Puglisi, Linda	Supervisor, Town of Cortlandt	137
Race, Kira	Student, Ramapo College	138
Raddant, Andrew	U.S. Department of the Interior, Regional Environment Officer	139
Riverkeeper, Inc.	Phillip Musegaas, Victor Tafur, Deborah Brancato	140
ROAR		141
Rogers, Sister Mary Christine		142
Rosenfeld, Alice	Resident, Westchester County	143
Ryan, Thomas	Boilermakers Local 5	144
Ryan, Martyn	Resident, Rockland County	145
Safian, Keith	Phelps Memorial Hospital	146
Sambrook, Andrea	Resident, Mamaroneck	147
Samuels, Al	Rockland Business Association	148
Scarola, Julianne	Student, Ramapo College	149
Seeger, Bob	Millwright and Machinery Erectors Local Union No. 740	150
Seeman, Laurie		151
Shapiro, Susan	Sierra Club	152
Shaw, Gary		153
Shepard, Margo	Westchester Citizens Awareness Network	154
Sherman, Andrea	Resident, White Plains	155
Skanes, Brian	Westchester Community Association	156
Slevin, James	Utility Workers Local 1-2	157
Smith, Rev. George Robeson	Mother AME Mount Zion Church in Harlem	158
Smith, Carol	Orange County Chamber of Commerce	159
Sorbello, Dino		160
Starke, Alexis	Resident, Hudson Valley	161
Sullivan, John		162
Swertfager, Diane	Hendrick Hudson H.S.	163
Taormino, Michelle	Student, Ramapo College	164
Tompkins, Dana	Green Infrastructure LLC	165
Tracey, Michael	International Association of Heat & Frost Insulators &	166

Commenter	Affiliation (if stated)	Commenter ID Number
	Allied Workers Local Union 91	
Unknown (Sister Anne ?)		167
Various Authors		168
Vitale, Paul	Business Council of Westchester	169
Walsh, Marion		170
Waltzer, Rosemary		171
Wanshel, Jeff		172
Warren, Roxanne		173
Weininger, Ellen	Resident, White Plains	174
Weininger, Annette		175
Weinstein, Dava		176
Wilson, Craig	SHARE	177
Withrow, Leigh		178
Wolf, Peter		179
Wood, Patti	Grassroots Environmental Education	180
Yanofsky, John	Paramount Center for the Arts	181
Yarme, Judith		182
Yaroscak-Lanzotti, Helen	Resident, Yorktown Heights	183

Table A-2. Technical Issue Categories. Comments were divided into one of the 28 categories below, each of which has a unique abbreviation code.

Abbreviation Code	Technical Issue	Abbreviation Code	Technical Issue
AE	Aquatic Ecology	OM	Operational Maintenance
AL	Alternatives	ON	Opposition to Nuclear
AM	Aging Management	OP	Operational Safety
AS	Aesthetics	OR	Opposition to Relicensing
AQ	Air Quality	OS	Out of Scope
CI	Cumulative Impacts	PA	Postulated Accidents
CR	Cultural Resources	PS	Psycho-Social Effects
DC	Decommissioning/Deregulation	RE	Remediation
DE	Demographics	RG	Regulatory
EC	Energy Costs/Energy Needs	RI	Radiological Impacts
ED	Editorial	RF	Refurbishment
EJ	Environmental Justice	RW	Radiological Waste Management
EP	Emergency Preparedness	SA	Safety
GE	GEIS	SE	Support for Entergy
GI	General Environmental Impacts	SF	Spent Fuel Pool
GL	Global Warming	SM	SAMA
GW	Ground Water	SO	Socioeconomics
HH	Human Health Issues	SR	Support for Relicense
LE	Leaks	ST	Security & Terrorism
LR	License Renewal and its Process	TE	Terrestrial Ecology
LU	Land Use	TL	Transmission Lines
MP	Monitoring Programs	TS	Threatened and Endangered Species
NE	NEPA	UF	Uranium Fuel Cycle
		WA	Water Use and Quality

Table A-3. Comments Received during Scoping Period. Comments are listed alphabetically by commenter, and each comment has a unique comment identification code.

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
1-a-EC/SO/SR	Adams, K.	transcript	176	ML091410355
1-b-EC/SE	Adams, K.	transcript	176	ML091410355
1-c-EC/SO	Adams, K.	transcript	178	ML091410355
1-d-AQ/EC	Adams, K.	transcript	178	ML091410355
1-e-SR	Adams, K.	transcript	180	ML091410355
2-a-AL/RI	Allen, J.	transcript	181	ML091410354
2-b-HH/RI	Allen, J.	transcript	181	ML091410354
2-c-HH	Allen, J.	e-mail	184	ML090640367
3-a-AE/LE/LR	American Citizen	e-mail	186	ML090650458
4-a-AE/LR	Anders, F.	e-mail	187	ML090771329
4-b-AL/LR	Anders, F.	e-mail	188	ML090771329
4-c-LR/SF	Anders, F.	e-mail	189	ML090771329
4-d-CI/LR/SO	Anders, F.	e-mail	189	ML090771329
4-e-LR	Anders, F.	e-mail	190	ML090771329
5-a-AQ/SR	Anthony, Rev. Dr. C.	transcript	191	ML091410354
5-b-AQ/SR	Anthony, Rev. Dr. C.	transcript	192	ML091410354
5-c-AQ/SR	Anthony, Rev. Dr. C.	transcript	192	ML091410354
6-a-EP/OR	Argintar, H.	e-mail	193	ML090700173
7-a-SE/SL	Ball, G.	e-mail	194	ML090640373
7-b-AL	Ball, G.	e-mail	194	ML090640373
7-c-SO	Ball, G.	e-mail	194	ML090640373
7-d-AQ/EC/SR	Ball, G.	e-mail	194	ML090640373
7-e-SR	Ball, G.	e-mail	194	ML090640373
8-a-SR	Banfield, W.	e-mail	196	ML090700180
8-b-SO	Banfield, W.	e-mail	196	ML090700180
8-c-AQ/HH/SO	Banfield, W.	e-mail	196	ML090700180
8-d-SE/SR	Banfield, W.	e-mail	196	ML090700180
9-a-GI	Bard Center for Environmental Policy	e-mail	197	ML090771343
9-b-OR/SA	Bard Center for Environmental Policy	e-mail	198	ML090771343
9-c-LE/PA/RW	Bard Center for Environmental Policy	e-mail	198	ML090771343
9-d-EP	Bard Center for Environmental Policy	e-mail	198	ML090771343
9-e-AE/AL	Bard Center for Environmental Policy	e-mail	198	ML090771343
9-f-AL	Bard Center for Environmental Policy	e-mail	198	ML090771343
9-g-AL/SO	Bard Center for Environmental Policy	e-mail	199	ML090771343
9-h-AE/AL/AQ	Bard Center for	e-mail	199	ML090771343

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
	Environmental Policy			
9-i-AL/ED	Bard Center for Environmental Policy	e-mail	200	ML090771343
9-j-AL/ED	Bard Center for Environmental Policy	e-mail	202	ML090771343
10-a-PA	Barthelme, M.	transcript	204	ML091410355
10-b-AL	Barthelme, M.	transcript	204	ML091410355
10-c-GL	Barthelme, M.	transcript	204	ML091410355
10-d-PA	Barthelme, M.	e-mail	205	ML090720661
11-a-OR	Bartholomew, A.	e-mail	207	ML090650248
11-b-AE	Bartholomew, A.	e-mail	207	ML090650248
11-c-AE	Bartholomew, A.	e-mail	207	ML090650248
11-d-LE	Bartholomew, A.	e-mail	207	ML090650248
11-e-RW/ST	Bartholomew, A.	e-mail	207	ML090650248
11-f-AL/OR	Bartholomew, A.	e-mail	207	ML090650248
12-a-OR	Bassi, L.	e-mail	208	ML090700181
12-b-AE	Bassi, L.	e-mail	208	ML090700181
12-c-AE	Bassi, L.	e-mail	208	ML090700181
12-d-LE	Bassi, L.	e-mail	208	ML090700181
12-e-RW/ST	Bassi, L.	e-mail	208	ML090700181
12-f-AL	Bassi, L.	e-mail	208	ML090700181
13-a-OR	Berasi, P.	e-mail	209	ML090720667
13-b-AE	Berasi, P.	e-mail	209	ML090720667
13-c-PA/SF/ST	Berasi, P.	e-mail	209	ML090720667
13-d-PA/SF	Berasi, P.	e-mail	209	ML090720667
13-e-RW/UF	Berasi, P.	e-mail	209	ML090720667
13-f-AM/GE/OM	Berasi, P.	e-mail	209	ML090720667
13-g-DE/EP	Berasi, P.	e-mail	209	ML090720667
13-h-OR	Berasi, P.	e-mail	210	ML090720667
13-i-OR	Berasi, P.	e-mail	210	ML090720667
14-a-AQ/EJ/SR	Bigby, D.	hand-in	212	ML091740490
14-b-AQ/EJ/SR	Bigby, D.	hand-in	213	ML091740490
14-c-AL/AQ	Bigby, D.	hand-in	214	ML091740490
14-d-AL/EJ/GL	Bigby, D.	hand-in	214	ML091740490
14-e-SR	Bigby, D.	hand-in	216	ML091740490
15-a-OR	Bittermann, Sister R.	letter	217	ML090860661
16-a-DE/PA	Blades, A.	e-mail	218	ML090720679
16-b-PS/ST	Blades, A.	e-mail	218	ML090720679
16-c-EP/PA/PS	Blades, A.	e-mail	218	ML090720679
16-d-LR	Blades, A.	e-mail	219	ML090720679
17-a-NE/SF	Blumenthal, R.	e-mail	221	ML090720677

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
				ML090820081
17-b-EP/ST	Blumenthal, R.	e-mail	221	ML090720677 ML090820081
17-c-NE	Blumenthal, R.	e-mail	222	ML090720677 ML090820081
17-d-DE	Blumenthal, R.	e-mail	224	ML090720677 ML090820081
17-e-NE/PA	Blumenthal, R.	e-mail	225	ML090720677 ML090820081
17-f-PA	Blumenthal, R.	e-mail	225	ML090720677 ML090820081
17-g-ST	Blumenthal, R.	e-mail	226	ML090720677 ML090820081
17-h-SF	Blumenthal, R.	e-mail	227	ML090720677 ML090820081
17-i-SF/ST	Blumenthal, R.	e-mail	227	ML090720677 ML090820081
17-j-SF	Blumenthal, R.	e-mail	227	ML090720677 ML090820081
17-k-SF/ST	Blumenthal, R.	e-mail	228	ML090720677 ML090820081
17-l-SF/ST	Blumenthal, R.	e-mail	229	ML090720677 ML090820081
17-m-EP	Blumenthal, R.	e-mail	230	ML090720677 ML090820081
17-n-EP/PA/ST	Blumenthal, R.	e-mail	230	ML090720677 ML090820081
17-o-AE/NE	Blumenthal, R.	e-mail	231	ML090720677 ML090820081
17-p-EP/PA/RI	Blumenthal, R.	e-mail	232	ML090720677 ML090820081
17-q-AE/NE	Blumenthal, R.	e-mail	233	ML090720677 ML090820081
17-r-EP/GI/RI	Blumenthal, R.	e-mail	234	ML090720677 ML090820081
18-a-LE/OR	Boorman, L.	e-mail	235	ML090720666
18-b-DE/ST	Boorman, L.	e-mail	235	ML090720666
18-c-AE	Boorman, L.	e-mail	235	ML090720666
18-d-OR	Boorman, L.	e-mail	235	ML090720666
19-a-EC/SR	Bowman, R.	transcript	236	ML091410354
19-b-EC/SO/SR	Bowman, R.	transcript	237	ML091410354
19-c-EC/SO/SR	Bowman, R.	transcript	238	ML091410354

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
20-a-PA/SF/ST	Brancato, D.	transcript	239	ML091410354
20-b-HH	Brancato, D.	transcript	239	ML091410354
20-c-AE/OR	Brancato, D.	transcript	240	ML091410354
21-a-AE/OR/SF	Brennan, C.	e-mail	242	ML090640369
21-b-GI/OR	Brennan, C.	e-mail	242	ML090640369
22-a-HH/OR/PA	Bron, G.	e-mail	243	ML090700171
23-a-SE/SR	Burruss, M.	transcript	244	ML091410355
23-b-SO	Burruss, M.	transcript	244	ML091410355
23-c-AL/AQ	Burruss, M.	transcript	244	ML091410355
23-d-EC	Burruss, M.	transcript	244	ML091410355
23-e-AQ	Burruss, M.	transcript	245	ML091410355
23-f-EC/SO	Burruss, M.	transcript	245	ML091410355
23-g-SR	Burruss, M.	transcript	246	ML091410355
23-h-AL/AQ	Burruss, M.	hand-in	247	ML091740490
23-i-EC/SO/SR	Burruss, M.	hand-in	247	ML091740490
24-a-HH/OR/RI	Burton, N.	transcript	248	ML091410354
24-b-HH/OR/RI	Burton, N.	hand-in	251	ML091740490
25-a-OR	Butler, E.	e-mail	255	ML090720676
26-a-EC/LR	Byrd, R.	transcript	256	ML091410354
26-b-OP	Byrd, R.	transcript	257	ML091410354
26-c-EC/SO/SR	Byrd, R.	transcript	258	ML091410354
27-a-OR	Calvani, D.	e-mail	259	ML090700183
27-b-AE	Calvani, D.	e-mail	259	ML090700183
27-c-AE	Calvani, D.	e-mail	259	ML090700183
27-d-LE	Calvani, D.	e-mail	259	ML090700183
27-e-SF/ST	Calvani, D.	e-mail	259	ML090700183
27-f-OR	Calvani, D.	e-mail	259	ML090700183
28-a-EC/SR	Campbell, J.	transcript	260	ML091410354
28-b-EC/SO	Campbell, J.	transcript	260	ML091410354
29-a-SO/SR	Capurso, T.	transcript	262	ML091410355
29-b-OP	Capurso, T.	transcript	262	ML091410355
29-c-EC/SA	Capurso, T.	transcript	262	ML091410355
30-a-AL/AQ/AS/ EJ/GE	Carmody, G.	e-mail	265	ML090700187
31-a-EJ/SR	Castro, M.	transcript	266	ML091410355
31-b-EC/EJ/HH	Castro, M.	transcript	266	ML091410355
31-c-AQ/SR	Castro, M.	transcript	266	ML091410355
32-a-AM/OP/PA	Chernoff, P.	e-mail	268	ML090640374
33-a-AE/GL/LE	Clark, P.	e-mail	269	ML090640400
34-a-AL/EC	Clegg, T.	transcript	270	ML091410355
34-b-AL/EC	Clegg, T.	transcript	270	ML091410355
35-a-LE/OM	Cohen, L.	e-mail	272	ML909640370

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
35-b-EP	Cohen, L.	e-mail	272	ML909640370
35-c-AM/RW	Cohen, L.	e-mail	272	ML909640370
35-d-OR	Cohen, L.	e-mail	272	ML909640370
35-e-OR/RE	Cohen, L.	e-mail	272	ML909640370
36-a-SR	Connolly, J.	transcript	273	ML091410355
36-b-OP	Connolly, J.	transcript	273	ML091410355
36-c-AL/AQ/EC	Connolly, J.	transcript	274	ML091410355
36-d-OP/SO	Connolly, J.	transcript	274	ML091410355
36-e-OP/SO	Connolly, J.	transcript	275	ML091410355
37-a-AE/OR	Cooper, L.	letter	276	ML091100401
37-b-LE/SF/ST	Cooper, L.	letter	276	ML091100401
38-a-ON	Cypser, B.	transcript	277	ML091410354
38-b-PA/RW/ST	Cypser, B.	e-mail	278	ML090640364
38-c-RW/SF/ST	Cypser, B.	e-mail	278	ML090640364
38-d-AL	Cypser, B.	e-mail	278	ML090640364
38-e-RW/SF	Cypser, B.	e-mail	278	ML090640364
38-f-RW/SF	Cypser, B.	hand-in	279	ML091740490
38-g-RW	Cypser, B.	hand-in	279	ML091740490
38-h-ST	Cypser, B.	hand-in	279	ML091740490
38-i-RW	Cypser, B.	hand-in	279	ML091740490
39-a-RW/SF	Cypser, R.	transcript	280	ML091410355
39-b-LE	Cypser, R.	transcript	280	ML091410355
39-c-PA/ST	Cypser, R.	transcript	280	ML091410355
39-d-PA/ST	Cypser, R.	transcript	281	ML091410355
40-a-SR	Dacimo, F.	transcript	282	ML091410355
40-b-AE	Dacimo, F.	transcript	282	ML091410355
40-c-AE	Dacimo, F.	transcript	283	ML091410355
40-d-AE	Dacimo, F.	transcript	284	ML091410355
40-e-AE	Dacimo, F.	transcript	284	ML091410355
40-f-AE	Dacimo, F.	transcript	284	ML091410355
40-g-EC	Dacimo, F.	transcript	285	ML091410355
40-h-SR	Dacimo, F.	email	286	ML091040133
40-i-OS	Dacimo, F.	email	287	ML091040133
40-j-AE/AL	Dacimo, F.	email	287	ML091040133
40-k-AE	Dacimo, F.	email	292	ML091040133
40-l-ED	Dacimo, F.	email	292	ML091040133
40-m-ED	Dacimo, F.	email	292	ML091040133
40-n-AE/ED	Dacimo, F.	email	292	ML091040133
40-o-ED/RG	Dacimo, F.	email	292	ML091040133
40-p-AE	Dacimo, F.	email	293	ML091040133
40-q-AE	Dacimo, F.	email	293	ML091040133
40-r-AE	Dacimo, F.	email	294	ML091040133

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
40-s-AE	Dacimo, F.	email	294	ML091040133
40-t-AE/ED	Dacimo, F.	email	295	ML091040133
40-u-ED/TS	Dacimo, F.	email	295	ML091040133
40-v-AL/TS	Dacimo, F.	email	295	ML091040133
40-x-ED	Dacimo, F.	email	296	ML091040133
40-y-AE	Dacimo, F.	email	296	ML091040133
40-z-AE	Dacimo, F.	email	296	ML091040133
40-aa-ED	Dacimo, F.	email	296	ML091040133
40-bb-AE/ED	Dacimo, F.	email	296	ML091040133
40-cc-AE/ED	Dacimo, F.	email	298	ML091040133
40-dd-AE/AL	Dacimo, F.	email	298	ML091040133
40-ee-AE	Dacimo, F.	email	299	ML091040133
40-ff-AE/ED	Dacimo, F.	email	299	ML091040133
40-gg-AE	Dacimo, F.	email	299	ML091040133
40-hh-AE	Dacimo, F.	email	300	ML091040133
40-ii-AE/AL/TS	Dacimo, F.	email	300	ML091040133
40-jj-AE	Dacimo, F.	email	301	ML091040133
40-kk-AE/ED	Dacimo, F.	email	301	ML091040133
40-ll-AE	Dacimo, F.	email	301	ML091040133
40-mm-AE/ED	Dacimo, F.	email	302	ML091040133
40-nn-AE	Dacimo, F.	email	302	ML091040133
40-oo-AE	Dacimo, F.	email	303	ML091040133
40-pp-AL	Dacimo, F.	email	303	ML091040133
40-qq-AE/ED	Dacimo, F.	email	303	ML091040133
40-rr-AE/ED/TL	Dacimo, F.	email	303	ML091040133
40-ss-ED	Dacimo, F.	email	304	ML091040133
40-tt-AE	Dacimo, F.	email	304	ML091040133
40-uu-AE	Dacimo, F.	email	305	ML091040133
40-vv-ED	Dacimo, F.	email	305	ML091040133
40-ww-ED/SM	Dacimo, F.	email	305	ML091040133
40-xx-AL/AQ	Dacimo, F.	email	306	ML091040133
40-yy-ED	Dacimo, F.	email	306	ML091040133
40-zz-AL	Dacimo, F.	email	307	ML091040133
40-aaa-AE/AL	Dacimo, F.	email	309	ML091040133
40-bbb-AL	Dacimo, F.	email	310	ML091040133
40-ccc-AL/TE	Dacimo, F.	email	311	ML091040133
40-ddd-AL/TS	Dacimo, F.	email	312	ML091040133
40-eee-AL/AQ	Dacimo, F.	email	312	ML091040133
40-fff-AL/AQ	Dacimo, F.	email	313	ML091040133
40-ggg-AL	Dacimo, F.	email	313	ML091040133
40-hhh-AL/ED	Dacimo, F.	email	315	ML091040133
40-iii-ED	Dacimo, F.	email	316	ML091040133
40-jjj- AE	Dacimo, F.	email	318	ML091040133

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
40-kkk-AL	Dacimo, F.	email	318	ML091040133
40-lll-ED/SM	Dacimo, F.	email	318	ML091040133
40-mmm-AE	Dacimo, F.	email	320	ML091040133
40-nnn-AE	Dacimo, F.	email	324	ML091040133
40-ooo-AE/ED	Dacimo, F.	email	324	ML091040133
40-ppp-AE/CE	Dacimo, F.	email	325	ML091040133
40-qqq-AE	Dacimo, F.	email	328	ML091040133
40-rrr-AL	Dacimo, F.	email	341	ML091040133
40-sss-AL	Dacimo, F.	email	344	ML091040133
40-ttt-AE	Dacimo, F.	email	347	ML091040133
40-uuu-AE	Dacimo, F.	email	348	ML091040133
40-vvv-AE	Dacimo, F.	email	348	ML091040133
40-www-AL	Dacimo, F.	email	348	ML091040133
40-xxx-AE/ED	Dacimo, F.	email	349	ML091040133
40-yyy-AE	Dacimo, F.	email	349	ML091040133
40-zzz-AE	Dacimo, F.	email	350	ML091040133
40-aaaa-TS	Dacimo, F.	email	350	ML091040133
40-bbbb-TS	Dacimo, F.	email	351	ML091040133
40-cccc-TS	Dacimo, F.	email	352	ML091040133
40-dddd-TS	Dacimo, F.	email	352	ML091040133
40-eeee-AE	Dacimo, F.	email	353	ML091040133
40-ffff-AE	Dacimo, F.	email	353	ML091040133
40-gggg-AL	Dacimo, F.	email	367	ML091040133
40-hhhh-AL	Dacimo, F.	email	370	ML091040133
40-iiii-AL	Dacimo, F.	email	374	ML091040133
40-jjjj-AL	Dacimo, F.	email	377	ML091040133
40-kkkk-AL	Dacimo, F.	email	382	ML091040133
40-llll-AL	Dacimo, F.	email	384	ML091040133
40-mmmm-AL	Dacimo, F.	email	387	ML091040133
40-nnnn-AL	Dacimo, F.	email	390	ML091040133
40-oooo-AL	Dacimo, F.	email	428	ML091040133
40-pppp-AL	Dacimo, F.	email	435	ML091040133
40-qqqq-AE	Dacimo, F.	email	442	ML091040133
40-rrrr-AE	Dacimo, F.	email	457	ML091040133
40-ssss-AE	Dacimo, F.	email	459	ML091040133
40-tttt-AE	Dacimo, F.	email	461	ML091040133
40-uuuu-AE	Dacimo, F.	email	463	ML091040133
40-vvvv-AE	Dacimo, F.	email	471	ML091040133
40-wwww-AE	Dacimo, F.	email	472	ML091040133
40-xxxx-AE	Dacimo, F.	email	475	ML091040133
40-yyyy-AE	Dacimo, F.	email	476	ML091040133
40-zzzz-AE	Dacimo, F.	email	479	ML091040133
40-aaaaa-AE	Dacimo, F.	email	480	ML091040133

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40-bbbbb-AE	Dacimo, F.	email	480	ML091040133
40-ccccc-AE	Dacimo, F.	email	480	ML091040133
40-ddddd-AE	Dacimo, F.	email	482	ML091040133
40-eeeee-AE	Dacimo, F.	email	482	ML091040133
40-fffff-AE	Dacimo, F.	email	483	ML091040133
40-ggggg-AE	Dacimo, F.	email	483	ML091040133
40-hhhhh-AE	Dacimo, F.	email	483	ML091040133
40-iiiii-AE	Dacimo, F.	email	485	ML091040133
40-jjjjj-AE	Dacimo, F.	email	487	ML091040133
40-kkkkk-AE	Dacimo, F.	email	489	ML091040133
40-lllll-AE	Dacimo, F.	email	495	ML091040133
40-mmmmm-AE	Dacimo, F.	email	513	ML091040133
40-nnnnn-TS	Dacimo, F.	email	513	ML091040133
40-ooooo-TS	Dacimo, F.	email	515	ML091040133
40-ppppp-AE	Dacimo, F.	email	523	ML091040133
40-qqqqq-AE	Dacimo, F.	email	525	ML091040133
40-rrrrr-AE	Dacimo, F.	email	533	ML091040133
40-sssss-AE	Dacimo, F.	email	538	ML091040133
40-ttttt-AE	Dacimo, F.	email	553	ML091040133
40-uuuuu-AE	Dacimo, F.	email	574	ML091040133
40-vvvvv-AE	Dacimo, F.	email	577	ML091040133
40-wwwww-GE/LR	Dacimo, F.	hand-in	595	ML091740490
40-xxxxx-SE	Dacimo, F.	hand-in	596	ML091740490
40-yyyyy-AE	Dacimo, F.	hand-in	596	ML091740490
40-zzzzz-AE	Dacimo, F.	hand-in	596	ML091740490
40-aaaaaa-AE	Dacimo, F.	hand-in	597	ML091740490
40-bbbbbb-AE	Dacimo, F.	hand-in	600	ML091740490
40-cccccc-AL/RG	Dacimo, F.	hand-in	601	ML091740490
41-a-OR	Daly, Mary A.	letter	604	ML090860664
41-b-AM/SF	Daly, Mary A.	letter	604	ML090860664
41-c-AE/LE	Daly, Mary A.	letter	604	ML090860664
41-d-AL	Daly, Mary A.	letter	604	ML090860664
42-a-EC/SR	Davis, D.	transcript	605	ML091410354
42-b-EC/SO	Davis, D.	transcript	605	ML091410354
42-c-HH	Davis, D.	transcript	605	ML091410354
42-d-SE/SR	Davis, D.	transcript	605	ML091410354
42-e-SR	Davis, D.	hand-in	607	ML091740490
42-f-EC/SO	Davis, D.	hand-in	607	ML091740490
42-g-AL/AQ	Davis, D.	hand-in	607	ML091740490
42-h-SE/SL	Davis, D.	hand-in	607	ML091740490
43-a-SE/SO	Davis, J.	hand-in	608	ML091740490
44-a-OR	DeAngelo, C.	e-mail	610	ML090771348

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44-b-AM/DE/SF	DeAngelo, C.	e-mail	610	ML090771348 ML090860663
44-c-AE/LE	DeAngelo, C.	e-mail	610	ML090771348 ML090860663
44-d-OR	DeAngelo, C.	e-mail	610	ML090771348 ML090860663
45-a-AQ/EJ	Degraff, Rev. Jacques	transcript	611	ML091410354
45-b-AL/EC/EJ	Degraff, Rev. Jacques	transcript	612	ML091410354
45-c-LR	Degraff, Rev. Jacques	transcript	612	ML091410354
46-a-EC/SR	Digby, D.	transcript	614	ML091410355
46-b-AQ/EJ	Digby, D.	transcript	614	ML091410355
46-c-AL/EJ/SR	Digby, D.	transcript	615	ML091410355
47-a-SF	DiRocco, S.	e-mail	616	ML090771334
47-b- LE/EP/SF	DiRocco, S.	e-mail	616	ML090771334
47-c-RW	DiRocco, S.	e-mail	616	ML090771334
48-a-OP	Donahue, Mayor A.	transcript	617	ML091410354
48-b-EC/SO	Donahue, Mayor A.	transcript	617	ML091410354
48-c-SE/SO	Donahue, Mayor A.	transcript	618	ML091410354
48-d-AQ/SO	Donahue, Mayor A.	transcript	618	ML091410354
48-e-OP/SR	Donahue, Mayor A.	transcript	619 59	ML091410354
48-f-SE	Donahue, Mayor A.	transcript	619	ML091410354
48-g-AQ/SO	Donahue, Mayor A.	transcript	620	ML091410354
49-a-SR	Durett, D.	transcript	621 59	ML091410354
49-b-AQ/EJ	Durett, D.	transcript	622	ML091410354
49-c-LR/SR	Durett, D.	transcript	622 54/60	ML091410354
49-d-AQ/EJ/SR	Durett, D.	hand-in	625 59	ML091740490
49-e-AL/EJ	Durett, D.	hand-in	626	ML091740490
49-f-AQ/EJ	Durett, D.	hand-in	628	ML091740490
49-g-AL/AQ/EJ	Durett, D.	hand-in	630	ML091740490
49-h-AQ/EC	Durett, D.	hand-in	632	ML091740490
49-i-SR	Durett, D.	hand-in	633	ML091740490
50-a-LR	Edelstein, M.	transcript	634	ML091410355
50-b-DE/PA	Edelstein, M.	transcript	635	ML091410355

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
50-c-PA	Edelstein, M.	transcript	636	ML091410355
50-d-EP/HH	Edelstein, M.	transcript	636	ML091410355
50-e-NE	Edelstein, M.	transcript	637	ML091410355
50-f-NE	Edelstein, M.	e-mail	639	ML090700188
50-g-GE/SF	Edelstein, M.	e-mail	639	ML090700188
50-h-DE/PA	Edelstein, M.	e-mail	639	ML090700188
50-i-EJ/LE	Edelstein, M.	e-mail	640	ML090700188
50-j-EJ/PA	Edelstein, M.	e-mail	640	ML090700188
50-k-PA	Edelstein, M.	e-mail	640	ML090700188
50-l-HH/PA	Edelstein, M.	e-mail	641	ML090700188
50-m-PA/ST	Edelstein, M.	e-mail	641	ML090700188
50-n-RW/SF	Edelstein, M.	e-mail	641	ML090700188
50-o-HH/LE/PA	Edelstein, M.	e-mail	641	ML090700188
50-p-DE/EP/NE	Edelstein, M.	e-mail	642	ML090700188
50-q-DE/EP	Edelstein, M.	e-mail	642	ML090700188
50-r-EP/PS	Edelstein, M.	e-mail	643	ML090700188
50-s-SO	Edelstein, M.	e-mail	643	ML090700188
50-t-EJ	Edelstein, M.	e-mail	643	ML090700188
50-u-GL/UF	Edelstein, M.	e-mail	644	ML090700188
51-a-HH/PA/UF	Evans, L.	transcript	645	ML091410355
51-b-AL	Evans, L.	transcript	645	ML091410355
51-c-AL	Evans, L.	transcript	645	ML091410355
52-a-SA	Falciano, P.	transcript	647	ML091410355
52-b-ST	Falciano, P.	transcript	647	ML091410355
52-c-AL/AQ/EC	Falciano, P.	transcript	648	ML091410355
52-d-AL	Falciano, P.	transcript	648	ML091410355
52-e-SR	Falciano, P.	transcript	649	ML091410355
53-a-SE/SR	Federspiel, J.	transcript	650	ML091410354
54-a-LE/OR/RW/SF	Feinberg, J.	e-mail	652	ML090720670
54-b-DE/ST	Feinberg, J.	e-mail	652	ML090720670
54-c-AE	Feinberg, J.	e-mail	652	ML090720670
54-d-OR	Feinberg, J.	e-mail	652	ML090720670
55-a-OS	Filippelli, J.	letter	653	ML090860878
55-b-AE/RG	Filippelli, J.	letter	654	ML090860878
55-c-RW	Filippelli, J.	letter	654	ML090860878
55-d-SM	Filippelli, J.	letter	654	ML090860878
55-e-PA	Filippelli, J.	letter	654	ML090860878
55-f-AE/PA/RW	Filippelli, J.	letter	655	ML090860878
56-a-AL/AQ/EC	Fitzpatrick, B.	e-mail	656	ML090700182
56-b-SO	Fitzpatrick, B.	e-mail	656	ML090700182
56-c-HH	Fitzpatrick, B.	e-mail	657	ML090700182
56-d-EP	Fitzpatrick, B.	e-mail	657	ML090700182

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56-e-SE	Fitzpatrick, B.	e-mail	657	ML090700182
56-f-AL/SA	Fitzpatrick, B.	e-mail	657	ML090700182
57-a-SA	Forehand, R.	transcript	658	ML091410355
57-b-AQ/EC/SO	Forehand, R.	transcript	658	ML091410355
57-c-SA/SE/SO	Forehand, R.	transcript	659	ML091410355
57-d-SL	Forehand, R.	letter	660	ML090700172
57-e-EC/OP/SO	Forehand, R.	letter	660	ML091680295
57-f-AL/AQ	Forehand, R.	letter	660	ML091680295
57-g-SR	Forehand, R.	letter	660	ML091680295
57-h-SE/SR	Forehand, R.	letter	660	ML091680295
58-a-SR	Form Letter	letter	661	ML091100591
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Comment ID	Commenter	Comment Source[a]	Comment Page No(s).	ADAMS Accession Number
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58-b-AL/AQ/EJ	Form Letter	letter	661	ML091100591
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58-c-AQ/EC/SO	Form Letter	letter	661	ML091100591
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Comment ID	Commenter	Comment Source(a)	Comment Page No(s).	ADAMS Accession Number
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58-d-SR	Form Letter	letter	661	ML091100591
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				ML091100750
				ML091100751
				ML091100752
				ML091100753
				ML091100755
59-a-LR	Foster, Mary	transcript	662	ML091410355
60-a-SE	Fraiser, A.	transcript	665	ML091410354
60-b-AQ/SE	Fraiser, A.	transcript	666	ML091410354
61-a-AE/AL/OR	Friedman, C.	e-mail	668	ML090640398
61-b-LE/RW/ST	Friedman, C.	e-mail	668	ML090640398
62-a-EJ/SR	Frye, G.	transcript	669	ML091410355
62-b-EJ/SR	Frye, G.	transcript	669	ML091410355
63-a-OR	Funck, J.	e-mail, letter	671	ML090640355
				ML090711021
63-b-RW	Funck, J.	e-mail, letter	671	ML090640355
				ML090711021
63-c-AE	Funck, J.	e-mail, letter	671	ML090640355
				ML090711021
63-d-LE	Funck, J.	e-mail, letter	671	ML090640355
				ML090711021
63-e-AM	Funck, J.	e-mail, letter	671	ML090640355
				ML090711021
63-f-RW/ST	Funck, J.	e-mail, letter	671	ML090640355
				ML090711021
63-g-OR	Funck, J.	e-mail, letter	672	ML090640355
				ML090711021
64-a-LE/OM/OR/RW	Furgatch, L.	e-mail	673	ML090640376
65-a-SO/SR	Garcia, F.	transcript	674	ML091410354
65-b-EC/SR	Garcia, F.	transcript	674	ML091410354
65-c-EC/SO/SR	Garcia, F.	transcript	674	ML091410354
66-a-GI/OR	Garisto, M.	e-mail	676	ML090720675
66-b-OE	Garisto, M.	e-mail	676	ML090720675
66-c-RG	Garisto, M.	e-mail	676	ML090720675
67-a-SR	Gordon, M.	e-mail, letter	677	ML090700176
				ML091680298

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
67-b-EC/SO	Gordon, M.	e-mail, letter	677	ML090700176 ML091680298
67-c-EC	Gordon, M.	e-mail, letter	677	ML090700176 ML091680298
67-d-AL	Gordon, M.	e-mail, letter	677	ML090700176 ML091680298
67-e-SE/SO	Gordon, M.	e-mail, letter	677	ML090700176 ML091680298
67-f-SR	Gordon, M.	e-mail, letter	677	ML090700176 ML091680298
68-a-AL/NE	Gould, R.	hand-in	678	ML091740490
68-b-DE/EF/NE	Gould, R.	hand-in	678	ML091740490
68-c-DE/EJ/NE	Gould, R.	hand-in	679	ML091740490
68-d-AL	Gould, R.	hand-in	680	ML091740490
69-a-HH/LE/OR/PA	Grady, P.	e-mail	682	ML090700185
70-a-ON	Raging Grannies	transcript, hand-in	683	ML091410355 ML091740490
70-b-UF	Raging Grannies	transcript, hand-in	685	ML091410355 ML091740490
70-c-OR	Raging Grannies	transcript, hand-in	685	ML091410355 ML091740490
70-d-OR	Raging Grannies	transcript, hand-in	687	ML091410355 ML091740490
71-a-OE	Gray, J.	e-mail	691	ML090720680
71-b-PA	Gray, J.	e-mail	691	ML090720680
71-c-LE/RW	Gray, J.	e-mail	691	ML090720680
71-d-RW	Gray, J.	e-mail	691	ML090720680
72-a-EP/LE/OR/RW	Green, G.	e-mail	693	ML090640378
73-a-HH	Greene, M.	transcript	694	ML091410354
73-b-EJ/LE	Greene, M.	transcript	694	ML091410354
73-c-EJ/HH/LE	Greene, M.	transcript	695	ML091410354
73-d-EP	Greene, M.	transcript	695	ML091410354
73-e-EJ/HH	Greene, M.	hand-in	697	ML091740490
73-f-AL/AQ/WA	Greene, M.	hand-in	698	ML091740490
73-g-AE	Greene, M.	hand-in	698	ML091740490
73-h-AM/LR/ST	Greene, M.	hand-in	698	ML091740490
74-a-LE	Hassman, H.	e-mail	699	ML090640394
74-b-SA	Hassman, H.	e-mail	699	ML090640394
75-a-OR	Hawkins, G.	e-mail	700	ML090640393
75-b-EP/LE/OP/ST	Hawkins, G.	e-mail	700	ML090640393

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
75-c-EC/SA	Hawkins, G.	e-mail	700	ML090640393
76-a-AE/LE/OR	Helman, L.	e-mail	701	ML090640363
76-b-OR/PA	Helman, L.	e-mail	701	ML090640363
77-a-AE/OR	Hirsh, S.	e-mail	702	ML090640395
78-a-SR	Hohlfeld, B.	transcript	703	ML091410354
78-b-EC/GI/ST	Hohlfeld, B.	transcript	703	ML091410354
78-c-SO/SR	Hohlfeld, B.	transcript	703	ML091410354
79-a-HH	Hudson River Sloop Clearwater, Inc.	hand-in	705	ML091740490
79-b-EJ/HH	Hudson River Sloop Clearwater, Inc.	hand-in	706	ML091740490
79-c-AL	Hudson River Sloop Clearwater, Inc.	hand-in	706	ML091740490
79-d-LR/NE	Hudson River Sloop Clearwater, Inc.	hand-in	706	ML091740490
79-e-HH/SO	Hudson River Sloop Clearwater, Inc.	hand-in	709	ML091740490
79-f-HH	Hudson River Sloop Clearwater, Inc.	hand-in	711	ML091740490
79-g-SO	Hudson River Sloop Clearwater, Inc.	hand-in	711	ML091740490
79-h-EJ	Hudson River Sloop Clearwater, Inc.	hand-in	711	ML091740490
79-i-HH/SO	Hudson River Sloop Clearwater, Inc.	hand-in	711	ML090780770
79-j-HH	Hudson River Sloop Clearwater, Inc.	hand-in	711	ML090780770
79-k-SF	Hudson River Sloop Clearwater, Inc.	hand-in	712	ML090780770
79-l-AE	Hudson River Sloop Clearwater, Inc.	hand-in	712	ML090780770
79-m-AL	Hudson River Sloop Clearwater, Inc.	hand-in	713	ML090780770
79-n-EJ	Hudson River Sloop Clearwater, Inc.	hand-in	714	ML090780770
79-o-EJ	Hudson River Sloop Clearwater, Inc.	hand-in	716	ML090780770
79-p-EJ	Hudson River Sloop Clearwater, Inc.	hand-in	716	ML090780770
79-q-EJ	Hudson River Sloop Clearwater, Inc.	hand-in	718	ML090780770
79-r-EJ	Hudson River Sloop Clearwater, Inc.	hand-in	720	ML090780770
79-s-EJ/HH	Hudson River Sloop Clearwater, Inc.	hand-in	720	ML090780770
79-t-EJ	Hudson River Sloop Clearwater, Inc.	hand-in	721	ML090780770
79-u-EJ/SM	Hudson River Sloop Clearwater, Inc.	hand-in	724	ML090780770
79-v-EJ/EP/SM	Hudson River Sloop Clearwater, Inc.	hand-in	724	ML090780770
79-w-EJ	Hudson River Sloop	hand-in	727	ML090780770

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
	Clearwater, Inc.			
79-x-AL/EJ	Hudson River Sloop Clearwater, Inc.	hand-in	728	ML090780770
79-y-EJ/UF	Hudson River Sloop Clearwater, Inc.	hand-in	730	ML090780770
79-z-AL	Hudson River Sloop Clearwater, Inc.	hand-in	731	ML090780770
79-aa-LR	Hudson River Sloop Clearwater, Inc.	hand-in	734	ML090780770
80-a-EP/OR/RW/ST	Imoberdorf, O.	e-mail	736	ML090640366
80-b-LE/RW/SF/ST	Imoberdorf, O.	e-mail	736	ML090640366
80-c-OR	Imoberdorf, O.	e-mail	736	ML090640366
81-a-UF	Indusi, J.	transcript	737	ML091410355
81-b-EC	Indusi, J.	transcript	737	ML091410355
81-c-AL	Indusi, J.	transcript	737	ML091410355
81-d-OR	Indusi, J.	transcript	738	ML091410355
82-a-OR	Jacobs, M.	transcript	739	ML091410354
82-b-GI/LR	Jacobs, M.	transcript	739	ML091410354
82-c-LR	Jacobs, M.	transcript	740	ML091410354
83-a-OS	Johnson, T.	transcript	743	ML091410355
84-a-RW	Karamaty, V.	transcript	744	ML091410354
84-b-OS	Karamaty, V.	transcript	744	ML091410354
84-c-ON	Karamaty, V.	transcript	744	ML091410354
85-a-EC/SO/SR	Karas, J.	transcript	747	ML091410355
85-b-AQ/HH	Karas, J.	transcript	747	ML091410355
85-c-EC/SO/SR	Karas, J.	transcript	747	ML091410355
86-a-OR	Kardos, T.	transcript	749	ML091410354
86-b-AQ	Kardos, T.	transcript	749	ML091410354
86-c-AL	Kardos, T.	transcript	749	ML091410354
86-d-AE/AL/GL	Kardos, T.	transcript	750	ML091410354
86-e-OR	Kardos, T.	transcript	750	ML091410354
87-a-DE/EP	Kardos, Th.	e-mail	751	ML090771342
87-b-HH/PA/RW/ST	Kardos, Th.	e-mail	751	ML090771342
87-c-AM/HH/OM	Kardos, Th.	e-mail	751	ML090771342
87-d-AE	Kardos, Th.	e-mail	751	ML090771342
87-e-GL	Kardos, Th.	e-mail	752	ML090771342
87-f-AL	Kardos, Th.	e-mail	752	ML090771342
88-a-AQ	Kearrey, G.	transcript	753	ML091410355
88-b-EC/SR	Kearney, G.	transcript	753	ML091410355
88-c-EC/SR	Kearney, G.	transcript	753	ML091410355
89-a-HH/PA/SF	Keenan, J.	e-mail	755	ML090720664
90-a-SA	Kelly, J.	transcript	756	ML091410354

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
90-b-AQ	Kelly, J.	transcript	756	ML091410354
90-c-AL/AQ/HH	Kelly, J.	transcript	756	ML091410354
90-d-AL/EC/SO	Kelly, J.	transcript	757	ML091410354
90-e-AL/AQ	Kelly, J.	hand-in	759	ML091740490
91-a-OR	Ketchum, A.	e-mail	831	ML090720672
91-b-AE	Ketchum, A.	e-mail	831	ML090720672
91-c-AE	Ketchum, A.	e-mail	831	ML090720672
91-d-LE	Ketchum, A.	e-mail	831	ML090720672
91-e-OR/RW/ST	Ketchum, A.	e-mail	831	ML090720672
92-a-EC/SO/SR	Klein, T.	transcript	832	ML091410355
92-b-EC/SO	Klein, T.	transcript	832	ML091410355
92-c-AL/AQ	Klein, T.	transcript	833	ML091410355
92-d-SO/SR	Klein, T.	transcript	833	ML091410355
92-e-SO/SR	Klein, T.	letter	834	ML091682097
92-f-AL/EC	Klein, T.	letter	834	ML091682097
92-g-SO/SR	Klein, T.	letter	834	ML091682097
93-a-OE	Knolmeter, L.	e-mail	835	ML090720681
93-b-RI/TE	Knolmeter, L.	e-mail	835	ML090720681
93-c-AL/EC	Knolmayer, L.	e-mail	835	ML090720681
93-d-AE/MP/RG	Knolmayer, L.	e-mail	835	ML090720681
93-e-AE/RG	Knolmayer, L.	e-mail	836	ML090720681
93-f-AE	Knolmayer, L.	e-mail	836	ML090720681
93-g-EJ/HH	Knolmayer, L.	e-mail	836	ML090720681
94-a-LR	Knubel, J.	transcript	838	ML091410355
94-b-AE	Knubel, J.	transcript	838	ML091410355
94-c-AL/EC	Knubel, J.	transcript	838	ML091410355
95-a-AL	Koldewyn, K.	e-mail	840	ML090720671
96-a-GE/LR	Kopec, E.	e-mail	842	ML090700186
96-b-LR/NE	Kopec, E.	e-mail	842	ML090700186
96-c-AM/LE/OM	Kopec, E.	e-mail	842	ML090700186
96-d-HH/LE/RI	Kopec, E.	e-mail	843	ML090700186
96-e-HH/LE/WA	Kopec, E.	e-mail	843	ML090700186
96-f-DC/LE/WA	Kopec, E.	e-mail	843	ML090700186
96-g-EJ/HH/LE	Kopec, E.	e-mail	843	ML090700186
96-h-EP	Kopec, E.	e-mail	844	ML090700186
96-i-EJ/UF	Kopec, E.	e-mail	844	ML090700186
96-j-LR/PA/RW	Kopec, E.	e-mail	844 5 1	ML090700186
96-k-AE/TS	Kopec, E.	e-mail	844	ML090700186
96-l-AE/AL/RG	Kopec, E.	e-mail	845	ML090700186
96-m-AE	Kopec, E.	e-mail	845	ML090700186
96-n-AM/LE	Kopec, E.	e-mail	845	ML090700186
96-o-AL	Kopec, E.	e-mail	845	ML090700186

Comment ID	Commenter	Comment Source(a)	Comment Page No(s).	ADAMS Accession Number
96-p-OR	Kopec, E.	e-mail	846	ML090700186
97-a-EJ/HH	Kopshaw, K.	transcript	847	ML091410355
97-b-TS	Kopshaw, K.	transcript	847	ML091410355
97-c-AQ/WA	Kopshaw, K.	transcript	848	ML091410355
97-d-AE	Kopshaw, K.	transcript	849	ML091410355
97-e-PA	Kopshaw, K.	transcript	849	ML091410355
97-f-DE/PA	Kopshaw, K.	e-mail	851	ML090720652
97-g-EP/PA	Kopshaw, K.	e-mail	851	ML090720652
97-h-AE/AL	Kopshaw, K.	e-mail	851	ML090720652
97-i-AE/OL	Kopshaw, K.	e-mail	851	ML090720652
97-j-TS	Kopshaw, K.	e-mail	851	ML090720652
97-k-EJ/HH/LE	Kopshaw, K.	e-mail	852	ML090720652
98-a-EP/OR/PA	Kourie, K.	e-mail	853	ML090640375
98-b-AL/SA	Kourie, K.	e-mail	853	ML090640375
98-c-HH/LE/RI	Kourie, K.	e-mail	853	ML090640375
98-d-OR/RE	Kourie, K.	e-mail	853	ML090640375
99-a-SR	Kremer, A.	transcript	854 5 9	ML091410354
99-b-AQ/HH	Kremer, A.	transcript	854	ML091410354
99-c-AL/EC	Kremer, A.	transcript	855	ML091410354
99-d-AL/AQ	Kremer, A.	transcript	856	ML091410354
100-a-OR	Lapido, H.	e-mail	857	ML090640399
101-a-SR	Ledwith, R.	letter	858 5 9	ML091680292
101-b-EC	Ledwith, R.	letter	858	ML091680292
101-c-SO/SR	Ledwith, R.	letter	858 5 9	ML091680292
102-a-AL	Lee, M.	transcript	859	ML091410354
102-b-AE/GI	Lee, M.	transcript	859	ML091410354
102-c-RW/SF	Lee, M.	transcript	860	ML091410354
102-d-OW/PA/ST	Lee, M.	transcript	860	ML091410354
102-e-OE	Lee, M.	e-mail	861	ML090641135
102-f-AL	Lee, M.	e-mail	861	ML090641135
102-g-AE	Lee, M.	e-mail	861	ML090641135
102-h-HH/RI	Lee, M.	e-mail	861	ML090641135
102-i-AM/GL	Lee, M.	e-mail	861	ML090641135
102-j-PA	Lee, M.	e-mail	861	ML090641135
102-k-RW	Lee, M.	e-mail	861	ML090641135
102-l-NE/PA	Lee, M.	e-mail	862	ML090641135
102-m-GE/OM	Lee, M.	e-mail	862	ML090641135
102-n-AM	Lee, M.	e-mail	862	ML090641135
102-o-OM	Lee, M.	e-mail	862	ML090641135
102-p-OE	Lee, M.	e-mail	862	ML090641135

Comment ID	Commenter	Comment Source(a)	Comment Page No(s).	ADAMS Accession Number
103-a-AL/UF	Leifer, S.	transcript	863	ML091410355
103-b-RW/SF	Leifer, S.	transcript	863	ML091410355
103-c-AL/UF	Leifer, S.	transcript	863	ML091410355
104-a-LR	Likes, P.	hand-in	865	ML091740490
105-a-SO/SR	Ludwigson, S.	transcript	866	ML091410355
105-b-AL/EC	Ludwigson, S.	transcript	866	ML091410355
105-c-EC/SR	Ludwigson, S.	transcript	867	ML091410355
106-a-AE/LE/RW/SF	Mallon, Sister F.	letter	868	ML090860660
107-a-HH/RI	Mangano, J.	e-mail, hand-in	869	ML090640401 ML091740490 ML090540443
108-a-EC/SO/SR	Marzullo, D.	transcript	877	ML091410355
108-b-AL/GI/SR	Marzullo, D.	transcript	877	ML091410355
109-a-SO	Mattis, J.	transcript	879	ML091410354
109-b-EC/EP	Mattis, J.	transcript	879	ML091410354
109-c-SE/SO	Mattis, J.	transcript	879	ML091410354
109-d-SO/SR	Mattis, J.	transcript	880	ML091410354
110-a-OP/OR	Maturo, M.	e-mail	881	ML090771333
110-b-LE/WA	Maturo, M.	e-mail	881	ML090771333
110-c-AL/OP/ST	Maturo, M.	e-mail	881	ML090771333
111-a-SO	McCann, Dr. D	transcript	882	ML091410354
111-b-SO/SR	McCann, Dr. D	transcript	882	ML091410354
111-c-EC/SO	McCann, Dr. D	transcript	883	ML091410354
111-d-SO	McCann, Dr. D	transcript	883	ML091410354
112-a-AL/AQ/EC	McCormick, J.	transcript	885	ML091410354
112-b-AL/AQ/EC	McCormick, J.	transcript	886	ML091410354
112-c-AL	McCormick, J.	hand-in	889	ML091740490
112-d-AL/AQ	McCormick, J.	hand-in	889	ML091740490
112-e-AL/AQ	McCormick, J.	hand-in	892	ML091740490
112-f-AL/AQ	McCormick, J.	hand-in	892	ML091740490
112-g-AL/AQ/EC	McCormick, J.	hand-in	893	ML091740490
112-h-AL/RG	McCormick, J.	hand-in	894	ML091740490
112-i-SR	McCormick, J.	hand-in	894	ML091740490
113-a-SR	McDonald, N.	transcript	895	ML091410355
113-b-AE/AL/EJ	McDonald, N.	transcript	895	ML091410355
113-c-EJ/GE	McDonald, N.	transcript	896	ML091410355
113-d-AQ/GL/SR	McDonald, N.	transcript	896	ML091410355
113-e-SR	McDonald, N.	hand-in	899	ML091740490
113-f-AL/AQ	McDonald, N.	hand-in	899	ML091740490
113-g-AE/AL/AQ	McDonald, N.	hand-in	900	ML091740490
113-h-AE/GL	McDonald, N.	hand-in	901	ML091740490
113-i-AL/AQ	McDonald, N.	hand-in	902	ML091740490

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
113-j-EC	McDonald, N.	hand-in	905	ML091740490
113-k-AL/AQ/RG	McDonald, N.	hand-in	905	ML091740490
113-l-SR	McDonald, N.	hand-in	907	ML091740490
114-a-SE	McGrath, J.	transcript	908	ML091410355
115-a-SA/SE/SO	Miranda, G.	transcript, hand-in	910	ML091410354 ML091740490
115-b-SO	Miranda, G.	transcript, hand-in	910	ML091410354 ML091740490
116-a-SO/SR	Miranda, R.	transcript	915	ML091410354
116-b-EC/SO	Miranda, R.	transcript	915	ML091410354
116-c-LR/SR	Miranda, R.	transcript	916	ML091410354
117-a-AM/LE/OR	Mitchell, G.	letter	917	ML090711022
117-b-AM/LE	Mitchell, G.	letter	917	ML090711022
117-c-DE/ST	Mitchell, G.	letter	917	ML090711022
118-a-AQ/EJ/SR	Montague, V.	transcript	918	ML091410354
118-b-EC/EJ/SR	Montague, V.	transcript	919	ML091410354
119-a-SR	Mooney, W.	e-mail, letter	921	ML090680019 ML091680294 ML090680022
119-b-EC/SO	Mooney, W.	e-mail, letter	921	ML090680019 ML091680294 ML090680022
119-c-AQ/EC/SO	Mooney, W.	e-mail, letter	921	ML090680019 ML091680294 ML090680022
119-d-AQ/SE	Mooney, W.	e-mail, letter	921	ML090680019 ML091680294 ML090680022
119-e-EC/GI/SO	Mooney, W.	e-mail, letter	921	ML090680019 ML091680294 ML090680022
119-f-SR	Mooney, W.	e-mail, letter	921	ML090680019 ML091680294 ML090680022
119-g-EC/SO/SR	Mooney, W.	transcript	922	ML091410354
119-h-AQ	Mooney, W.	transcript	922	ML091410354
119-i-SO	Mooney, W.	transcript	922	ML091410354
119-j-SE/SR	Mooney, W.	transcript	922	ML091410354
120-a-EC/SA	Moore, Dr. P.	transcript	924	ML091410355
120-b-HH	Moore, Dr. P.	transcript	924	ML091410355

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
120-c-AL/AQ/EC	Moore, Dr. P.	transcript	925	ML091410355
120-d-OS	Moore, Dr. P.	transcript	926	ML091410355
120-e-AE	Moore, Dr. P.	transcript	926	ML091410355
120-f-AE	Moore, Dr. P.	transcript	926	ML091410355
120-g-EC	Moore, Dr. P.	hand-in	928	ML091740490
120-h-OP/HH	Moore, Dr. P.	hand-in	928	ML091740490
120-i-AL/AQ/GI	Moore, Dr. P.	hand-in	929	ML091740490
120-j-AL/AQ	Moore, Dr. P.	hand-in	929	ML091740490
120-k-AE	Moore, Dr. P.	hand-in	930	ML091740490
120-l-LE	Moore, Dr. P.	hand-in	931	ML091740490
120-m-RW/SF	Moore, Dr. P.	hand-in	931	ML091740490
120-n-ST	Moore, Dr. P.	hand-in	931	ML091740490
120-o-LE	Moore, Dr. P.	hand-in	931	ML091740490
120-p-SR	Moore, Dr. P.	hand-in	932	ML091740490
121-a-DE/OR	Murdock, C.	e-mail	933	ML090771332
121-b-AM/LE	Murdock, C.	e-mail	933	ML090771332
121-c-OR/PA	Murdock, C.	e-mail	933	ML090771332
122-a-DE/PA/ST	Murphy, R.	e-mail	934	ML090640396
122-b-LE	Murphy, R.	e-mail	934	ML090640396
122-c-AE	Murphy, R.	e-mail	934	ML090640396
122-d-AL	Murphy, R.	e-mail	934	ML090640396
123-a-AE	Musegaas, P.	transcript	935	ML091410355
123-b-AE	Musegaas, P.	transcript	935	ML091410355
123-c-AE	Musegaas, P.	transcript	936	ML091410355
123-d-GE/SF	Musegaas, P.	transcript	936	ML091410355
123-e-RW/SF	Musegaas, P.	transcript	937	ML091410355
123-f-GE	Musegaas, P.	transcript	937	ML091410355
123-g-AL	Musegaas, P.	transcript	937	ML091410355
124-a-AL/RW/SF	Myslinski, M.	e-mail	939	ML090720655
124-b-EJ/EP/HH/PA	Myslinski, M.	e-mail	939	ML090720655
125-a-DE/EP	Nemeczek, J.	e-mail	940	ML090720648
125-b-EP	Nemeczek, J.	e-mail	940	ML090720648
126-a-DE/RW/SF/ST	Newman, J.	e-mail	941	ML090650457
126-b-AE	Newman, J.	e-mail	941	ML090650457
126-c-LE	Newman, J.	e-mail	941	ML090650457
126-d-LE/RI	Newman, J.	e-mail	941	ML090650457
127-a-SA/SR	Nicklas, D.	transcript	942	ML091410355
127-b-EC/SO	Nicklas, D.	transcript	942	ML091410355
127-c-AL/SR	Nicklas, D.	transcript	942	ML091410355
128-a-LR	NYSDEC	e-mail	948	ML090780782
128-b-AE/EP/TS	NYSDEC	e-mail	948	ML090780782

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
128-c-GE/LR	NYSDEC	e-mail	949	ML090780782
128-d-GE/LR	NYSDEC	e-mail	949	ML090780782
128-e-AE	NYSDEC	e-mail	950	ML090780782
128-f-AE	NYSDEC	e-mail	951	ML090780782
128-g-AE	NYSDEC	e-mail	952	ML090780782
128-h-AE/AL	NYSDEC	e-mail	954	ML090780782
128-i-AL	NYSDEC	e-mail	956	ML090780782
128-j-AE	NYSDEC	e-mail	961	ML090780782
128-k-AE	NYSDEC	e-mail	962	ML090780782
128-l-AE	NYSDEC	e-mail	962	ML090780782
128-m-AE	NYSDEC	e-mail	963	ML090780782
128-n-AE	NYSDEC	e-mail	963	ML090780782
128-o-TS	NYSDEC	e-mail	963	ML090780782
128-p-TS	NYSDEC	e-mail	964	ML090780782
128-q-AE	NYSDEC	e-mail	966	ML090780782
128-r-SM/UF	NYSDEC	e-mail	967	ML090780782
128-s-EP	NYSDEC	e-mail	975	ML090780782
129-a-LR	NYSO of the Attorney General	hand-in	986	ML090771328
129-b-UF	NYSO of the Attorney General	hand-in	990	ML090771328
129-c-RW	NYSO of the Attorney General	hand-in	994	ML090771328
129-d-AL/LU	NYSO of the Attorney General	hand-in	997	ML090771328
129-e-SM	NYSO of the Attorney General	hand-in	1002	ML090771328
129-f-AL	NYSO of the Attorney General	hand-in	1006	ML090771328
129-g-AL	NYSO of the Attorney General	hand-in	1008	ML090771328
129-h-AL	NYSO of the Attorney General	hand-in	1014	ML090771328
129-i-AL	NYSO of the Attorney General	hand-in	1016	ML090771328
129-j-AL	NYSO of the Attorney General	hand-in	1017	ML090771328
129-k-AL/LR	NYSO of the Attorney General	hand-in	1018	ML090771328
129-l-AL	NYSO of the Attorney General	hand-in	1018	ML090771328
129-m-SM	NYSO of the Attorney General	hand-in	1022	ML090771328
129-n-SM	NYSO of the Attorney General	hand-in	1028	ML090771328
129-o-SM	NYSO of the Attorney General	hand-in	1032	ML090771328
130-a-AQ/SR	Oros, G.	transcript	1044	ML091410354
130-b-OP/SO/SR	Oros, G.	transcript	1045	ML091410354

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
131-a-OS	Otis, M.	transcript	1046	ML091410355
131-b-SE	Otis, M.	transcript	1046	ML091410355
131-c-SE/SR	Otis, M.	transcript	1047	ML091410355
131-d-SE	Otis, M.	hand-in	1048	ML091740490
131-e-AQ/EC/SR	Otis, M.	hand-in	1049	ML091740490
132-a-AL	Parker, J.	transcript	1051	ML091410354
132-b-NE	Parker, J.	transcript	1051	ML091410354
132-c-AE	Parker, J.	transcript	1052	ML091410354
132-d-GI/LR	Parker, J.	transcript	1052	ML091410354
132-e-GI/LR	Parker, J.	transcript	1052	ML091410354
132-f-AE	Parker, J.	transcript	1053	ML091410354
132-g-GI/LR	Parker, J.	transcript	1053	ML091410354
133-a-EC/SO/SR	Perry, S.	transcript	1055	ML091410354
133-b-EC	Perry, S.	transcript	1055	ML091410354
133-c-AQ	Perry, S.	transcript	1055	ML091410354
133-d-AL/AQ/SR	Perry, S.	transcript	1056	ML091410354
134-a-AL/AQ/GI	Perry, D.	transcript	1057	ML091410355
134-b-AL/AQ/EJ	Perry, D.	transcript	1057	ML091410355
135-a-LE/OR	Pilder, L.	e-mail	1059	ML090640206
135-b-LE	Pilder, L.	e-mail	1059	ML090640206
135-c-RW/SF/ST	Pilder, L.	e-mail	1059	ML090640206
136-a-CR/SO/SR	Pockriss, P.	transcript	1060	ML091410354
136-b-SO/SR	Pockriss, P.	transcript	1060	ML091410354
136-c-SE	Pockriss, P.	transcript	1061	ML091410354
137-a-SA/SR	Puglisi, L.	transcript	1062	ML091410355
137-b-GW/RW/PA/SF	Puglisi, L.	transcript	1063	ML091410355
137-c-NE	Puglisi, L.	transcript	1063	ML091410355
137-d-LR/ST	Puglisi, L.	transcript	1063	ML091410355
137-e-LR	Puglisi, L.	hand-in	1066	ML091740490
137-f-AL/LE/PA/RF/SF	Puglisi, L.	hand-in	1067	ML091740490
137-g-NE/RW	Puglisi, L.	hand-in	1067	ML091740490
137-h-AL	Puglisi, L.	hand-in	1068	ML091740490
137-i-PA	Puglisi, L.	hand-in	1068	ML091740490
137-j-RI	Puglisi, L.	hand-in	1068	ML091740490
137-k-RF	Puglisi, L.	hand-in	1069	ML091740490
137-l-DC/RW	Puglisi, L.	hand-in	1069	ML091740490
137-m-LR	Puglisi, L.	hand-in	1071	ML091740490
137-n-LR	Puglisi, L.	hand-in	1071	ML091740490
137-o-SO	Puglisi, L.	hand-in	1071	ML091740490
137-p-ST	Puglisi, L.	hand-in	1071	ML091740490
137-q-EP	Puglisi, L.	hand-in	1071	ML091740490

Comment ID	Commenter	Comment Source[a]	Comment Page No(s).	ADAMS Accession Number
137-r-LR	Puglisi, L.	hand-in	1073	ML091740490
138-a-EJ/HH/LE	Race, K.	e-mail	1074	ML090720659
139-a-TS	Raddant, A.	e-mail	1077	ML090771341
139-b-TS	Raddant, A.	e-mail	1077	ML090771341
139-c-AE	Raddant, A.	e-mail	1078	ML090771341
139-d-AE	Raddant, A.	e-mail	1078	ML090771341
139-e-AE	Raddant, A.	e-mail	1079	ML090771341
139-f-AL/LR	Raddant, A.	e-mail	1079	ML090771341
139-g-LR	Raddant, A.	e-mail	1080	ML090771341
140-a-AE	Riverkeeper, Inc.	e-mail	1082	ML090860983
140-b-EP	Riverkeeper, Inc.	e-mail	1083	ML090860983
140-c-AE	Riverkeeper, Inc.	e-mail	1085	ML090860983
140-d-AE	Riverkeeper, Inc.	e-mail	1087	ML090860983
140-e-AE	Riverkeeper, Inc.	e-mail	1088	ML090860983
140-f-AE	Riverkeeper, Inc.	e-mail	1089	ML090860983
140-g-AE	Riverkeeper, Inc.	e-mail	1089	ML090860983
140-h-AE	Riverkeeper, Inc.	e-mail	1090	ML090860983
140-i-AE	Riverkeeper, Inc.	e-mail	1091	ML090860983
140-j-AE	Riverkeeper, Inc.	e-mail	1091	ML090860983
140-k-AE	Riverkeeper, Inc.	e-mail	1092	ML090860983
140-l-AE	Riverkeeper, Inc.	e-mail	1092	ML090860983
140-m-TS	Riverkeeper, Inc.	e-mail	1092	ML090860983
140-n-TS	Riverkeeper, Inc.	e-mail	1093	ML090860983
140-o-TS	Riverkeeper, Inc.	e-mail	1094	ML090860983
140-p-TS	Riverkeeper, Inc.	e-mail	1094	ML090860983
140-q-TS	Riverkeeper, Inc.	e-mail	1094	ML090860983
140-r-TS	Riverkeeper, Inc.	e-mail	1096	ML090860983
140-s-TS	Riverkeeper, Inc.	e-mail	1096	ML090860983
140-t-TS	Riverkeeper, Inc.	e-mail	1097	ML090860983
140-u-GW/SA	Riverkeeper, Inc.	e-mail	1097	ML090860983
140-v-GW/HH/RI	Riverkeeper, Inc.	e-mail	1099	ML090860983
140-w-GW/HH/RI	Riverkeeper, Inc.	e-mail	1100	ML090860983
140-x-HH	Riverkeeper, Inc.	e-mail	1102	ML090860983
140-y-AE/CI	Riverkeeper, Inc.	e-mail	1105	ML090860983
140-z-AE/CI	Riverkeeper, Inc.	e-mail	1105	ML090860983
140-aa-SM	Riverkeeper, Inc.	e-mail	1106	ML090860983
140-bb-SM	Riverkeeper, Inc.	e-mail	1106	ML090860983
140-cc-SM	Riverkeeper, Inc.	e-mail	1110	ML090860983
140-dd-SM	Riverkeeper, Inc.	e-mail	1114	ML090860983
140-ee-SM	Riverkeeper, Inc.	e-mail	1115	ML090860983
140-ff-SM	Riverkeeper, Inc.	e-mail	1115	ML090860983
140-gg-UF	Riverkeeper, Inc.	e-mail	1117	ML090860983

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
140-hh-SM	Riverkeeper, Inc.	e-mail	1119	ML090860983
140-ii-SM/UF	Riverkeeper, Inc.	e-mail	1119	ML090860983
140-jj-SM	Riverkeeper, Inc.	e-mail	1120	ML090860983
140-kk-AL	Riverkeeper, Inc.	e-mail	1122	ML090860983
140-ll-AL	Riverkeeper, Inc.	e-mail	1122	ML090860983
140-mm-AL	Riverkeeper, Inc.	e-mail	1123	ML090860983
140-nn-AL	Riverkeeper, Inc.	e-mail	1124	ML090860983
140-oo-AL	Riverkeeper, Inc.	e-mail	1124	ML090860983
140-pp-AL	Riverkeeper, Inc.	e-mail	1125	ML090860983
140-qq-AL	Riverkeeper, Inc.	e-mail	1126	ML090860983
140-rr-AL	Riverkeeper, Inc.	e-mail	1126	ML090860983
140-ss-LR	Riverkeeper, Inc.	e-mail	1127	ML090860983
140-tt-AE	Riverkeeper, Inc.	e-mail	1133	ML090860983
140-uu-TS	Riverkeeper, Inc.	e-mail	1142	ML090860983
140-vv-AE	Riverkeeper, Inc.	e-mail	1142	ML090860983
140-ww-AE/CI	Riverkeeper, Inc.	e-mail	1142	ML090860983
140-xx-AE	Riverkeeper, Inc.	e-mail	1142	ML090860983
140-yy-AE	Riverkeeper, Inc.	e-mail	1143	ML090860983
141-a-OR	ROAR	letter	1151	ML090860662
141-b-AM/DE/PA/RW	ROAR	letter	1151	ML090860662
141-c-AE/LE/RI	ROAR	letter	1151	ML090860662
141-d-AL/OR	ROAR	letter	1151	ML090860662
142-a-LE/OR	Rogers, Sister Mary Christine	letter	1152	ML091680291
143-a-GI/OR/RW	Rosenfeld, A.	e-mail	1153	ML090700174
144-a-EC/SA/SR	Ryan, T.	transcript	1154	ML091410355
144-b-EC/SO	Ryan, T.	transcript	1154	ML091410355
144-c-ST	Ryan, T.	transcript	1155	ML091410355
144-d-AL/OS	Ryan, T.	transcript	1155	ML091410355
145-a-AM/PA	Ryan, M.	e-mail	1157	ML090771330
145-b-RW/SF/ST	Ryan, M.	e-mail	1157	ML090771330
145-c-HH/LE	Ryan, M.	e-mail	1157	ML090771330
145-d-LE/OM/WA	Ryan, M.	e-mail	1157	ML090771330
145-e-AE	Ryan, M.	e-mail	1157	ML090771330
145-f-DE/OR	Ryan, M.	e-mail	1157	ML090771330
145-g-OE	Ryan, M.	transcript	1158	ML091410355
146-a-EP/SE	Safian, K.	transcript	1159	ML091410355
146-b-EC	Safian, K.	transcript	1160	ML091410355
146-c-AQ/SR	Safian, K.	transcript	1160	ML091410355
146-d-EC/SO	Safian, K.	transcript	1161	ML091410355
147-a-GL/LE	Sambrook, A.	e-mail	1162	ML090700175
147-b-NE/PA	Sambrook, A.	e-mail	1162	ML090700175

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
147-c-AM	Sambrook, A.	e-mail	1162	ML090700175
147-d-OR	Sambrook, A.	e-mail	1162	ML090700175
148-a-AL/SO	Samuels, A.	transcript	1163	ML091410354
148-b-AL/SO	Samuels, A.	e-mail	1166	ML090700184
148-c-AL/SO	Samuels, A.	hand-in	1167	ML091740490
149-a-AE	Scarola, J.	e-mail	1172	ML090720657
149-b-EJ/HH	Scarola, J.	e-mail	1172	ML090720657
149-c-HH/LE	Scarola, J.	e-mail	1172	ML090720657
149-d-EP/HH/RI	Scarola, J.	e-mail	1173	ML090720657
149-e-TS	Scarola, J.	e-mail	1173	ML090720657
150-a-SA/SE	Seeger, B.	transcript	1174	ML091410355
150-b-SA/SO	Seeger, B.	transcript	1174	ML091410355
150-c-SA/SE	Seeger, B.	transcript	1175	ML091410355
150-d-EC/SR	Seeger, B.	letter	1177	ML091680296
150-e-AQ/OP/SO	Seeger, B.	letter	1177	ML091680296
150-f-SO/SR	Seeger, B.	letter	1177	ML091680296
151-a-OR	Seeman, L.	transcript	1178	ML091410355
151-b-OS	Seeman, L.	transcript	1178	ML091410355
151-c-SA	Seeman, L.	transcript	1179	ML091410355
151-d-EP	Seeman, L.	transcript	1180	ML091410355
151-e-OR	Seeman, L.	transcript	1181	ML091410355
152-a-GE/PA	Shapiro, S.	transcript	1182	ML091410354
152-b-AM/SA	Shapiro, S.	transcript	1183	ML091410354
152-c-LE/OP	Shapiro, S.	transcript	1183	ML091410354
152-d-AM/OP	Shapiro, S.	transcript	1184	ML091410354
152-e-NE	Shapiro, S.	transcript	1185	ML091410354
153-a-LE	Shaw, G.	transcript	1186	ML091410355
153-b-LE	Shaw, G.	transcript	1186	ML091410355
153-c-OM	Shaw, G.	transcript	1187	ML091410355
153-d-AM/LE/OM	Shaw, G.	transcript	1187	ML091410355
153-e-AM/DE	Shaw, G.	transcript	1188	ML091410355
154-a-HH/LE/MP	Shepard, M.	transcript	1189	ML091410355
154-b-AL	Shepard, M.	transcript	1191	ML091410355
155-a-EC/SO	Sherman, A.	transcript, hand-in	1192	ML091410354ML091 740490
155-b-PA	Sherman, A.	transcript, hand-in	1192	ML091410354ML091 740490
155-c-AL/SA	Sherman, A.	transcript, hand-in	1193	ML091410354 ML091740490
155-d-OR	Sherman, A.	transcript, hand-in	1193	ML091410354 ML091740490
156-a-SE/SR	Skanes, B.	transcript	1194	ML091410354

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
157-a-OP	Slevin, J.	transcript	1196	ML091410354
157-b-AL/EC/SO	Slevin, J.	transcript	1196	ML091410354
157-c-AQ/EC	Slevin, J.	transcript	1197	ML091410354
157-d-EC/SR	Slevin, J.	transcript	1197	ML091410354
157-e-OP	Slevin, J.	letter	1199	ML090711019
157-f-AL/EC/SO	Slevin, J.	letter	1199	ML090711019
158-a-EJ/SR	Smith, Rev. G. R.	transcript	1201	ML091410354
158-b-AL/AQ/EC	Smith, Rev. G. R.	transcript	1202	ML091410354
159-a-EC/GL	Smith, C.	transcript	1204	ML091410354
159-b-AL/SA/SR	Smith, C.	transcript	1204	ML091410354
159-c-EC/SR	Smith, C.	transcript	1205	ML091410354
159-d-EC	Smith, C.	transcript	1205	ML091410354
159-e-AL/AQ/SR	Smith, C.	transcript	1205	ML091410354
160-a-AL/OR/SA	Sorbello, D.	e-mail	1206	ML090640372
161-a-GI	Starke, A.	transcript	1207	ML091410355
161-b-GI/LE/WA	Starke, A.	transcript	1207	ML091410355
161-c-RW/ST	Starke, A.	transcript	1207	ML091410355
161-d-GI/OR	Starke, A.	e-mail	1209	ML090771338
161-e-AE	Starke, A.	e-mail	1209	ML090771338
161-f-LE/WA	Starke, A.	e-mail	1209	ML090771338
161-g-ST/UF	Starke, A.	e-mail	1209	ML090771338
161-h-DE/ST	Starke, A.	e-mail	1209	ML090771338
161-i-AL/OR	Starke, A.	e-mail	1209	ML090771338
162-a-OR/RW	Sullivan, J.	transcript	1211	ML091410354
162-b-AL/SF/ST	Sullivan, J.	transcript	1211	ML091410354
162-c-OR	Sullivan, J.	e-mail	1212	ML090771345
162-d-GW/LE/PA	Sullivan, J.	e-mail	1212	ML090771345
162-e-AM/RW	Sullivan, J.	e-mail	1212	ML090771345
162-f-OR	Sullivan, J.	e-mail	1212	ML090771345
163-a-SE/SO/SR	Swertfager, D.	e-mail	1213	ML090640368
164-a-PA/ST	Taormino, M.	transcript	1216	ML091410355
164-b-EP	Taormino, M.	transcript	1216	ML091410355
164-c-LE/TE	Taormino, M.	transcript	1216	ML091410355
164-d-LR/OM	Taormino, M.	transcript	1217	ML091410355
164-e-EP	Taormino, M.	transcript	1217	ML091410355
164-f-EJ/EP	Taormino, M.	e-mail	1219	ML090720660
164-g-LE/MP	Taormino, M.	e-mail	1219	ML090720660
164-h-UF	Taormino, M.	e-mail	1220	ML090720660
164-i-GL	Taormino, M.	e-mail	1220	ML090720660
165-a-OR/PA	Tompkins, D.	e-mail	1221	ML090640357
166-a-AE	Tracey, M.	letter	1222	ML091680293
166-b-AL/EC/SO	Tracey, M.	letter	1222	ML091680293

Comment ID	Commenter	Comment Source(a)	Comment Page No(s).	ADAMS Accession Number
166-c-AL/HH	Tracey, M.	letter	1222	ML091680293
166-d-SO/SR	Tracey, M.	letter	1222	ML091680293
166-e-SO/SR	Tracey, M.	hand-in	1223	ML091740490
166-f-AL/EC	Tracey, M.	hand-in	1223	ML091740490
166-g-AE/SO	Tracey, M.	hand-in	1224	ML091740490
167-a-AE	Unknown (Sister A.?)	letter	1225	ML090860665
167-b-OR/RW/SF	Unknown (Sister A.?)	letter	1225	ML090860665
168-a-OS	Various Authors	hand-in	1226	ML091740490
169-a-AL/EC/SO	Vitale, P.	transcript	1289	ML091410354
169-b-AL/AQ/EC	Vitale, P.	transcript	1289	ML091410354
170-a-OR	Walsh, M.	e-mail	1291	ML090780761
170-b-HH	Walsh, M.	e-mail	1291	ML090780761
170-c-DE/PA	Walsh, M.	e-mail	1291	ML090780761
170-d-PA/SM	Walsh, M.	e-mail	1291	ML090780761
170-e-LE/WA	Walsh, M.	e-mail	1293	ML090780761
170-f-HH/PA/UF	Walsh, M.	e-mail	1293	ML090780761
170-g-AL	Walsh, M.	e-mail	1293	ML090780761
170-h-HH/OR	Walsh, M.	e-mail	1293	ML090780761
171-a-SO	Waltzer, R.	transcript	1295	ML091410355
171-b-PA/ST	Waltzer, R.	transcript	1295	ML091410355
172-a-HH/RI	Wanshel, J.	e-mail	1296	ML090771331 Ml090820080
172-b-DE/EP	Wanshel, J.	e-mail	1296	ML090771331 Ml090820080
172-c-ST	Wanshel, J.	e-mail	1296	ML090771331 Ml090820080
172-d-LR	Wanshel, J.	e-mail	1296	ML090771331 Ml090820080
173-a-AE/EP/ST	Warren, R.	e-mail	1297	ML090640387
173-b-AL/OR	Warren, R.	e-mail	1297	ML090640387
174-a-HH/RI	Weininger, E.	e-mail	1298	ML090700177
174-b-RI	Weininger, E.	e-mail	1298	ML090700177
174-c-HH	Weininger, E.	e-mail	1298	ML090700177
174-d-PA	Weininger, E.	e-mail	1298	ML090700177
174-e-NE/PA	Weininger, E.	e-mail	1298	ML090700177
174-f-GI/OM	Weininger, E.	e-mail	1298	ML090700177
174-g-AM	Weininger, E.	e-mail	1298	ML090700177
174-h-SA	Weininger, E.	e-mail	1298	ML090700177
174-i-AL	Weininger, E.	e-mail	1298	ML090700177
174-j-OR	Weininger, E.	e-mail	1298	ML090700177
175-a-OP/OR/PA	Weininger, A.	e-mail	1299	ML090720672
176-a-OR	Weinstein, D.	e-mail	1300	ML090700183

Comment ID	Commenter	Comment Source[(a)]	Comment Page No(s).	ADAMS Accession Number
176-b-AE	Weinstein, D.	e-mail	1300	ML090700183
176-c-AE	Weinstein, D.	e-mail	1300	ML090700183
176-d-LE	Weinstein, D.	e-mail	1300	ML090700183
176-e-RW/SF/ST	Weinstein, D.	e-mail	1300	ML090700183
176-f-OR	Weinstein, D.	e-mail	1300	ML090700183
177-a-AQ/EC/SO	Wilson, C.	transcript, hand-in	1301	ML091410355 ML091740490
177-b-EC	Wilson, C.	transcript, hand-in	1301	ML091410355 ML091740490
177-c-AQ	Wilson, C.	transcript, hand-in	1302	ML091410355 ML091740490
177-d-AQ/EJ/SR	Wilson, C.	transcript, hand-in	1302	ML091410355 ML091740490
178-a-LE/OR/RW	Withrow, L.	e-mail	1304	ML090640359
179-a-SA/SF/RW	Wolf, P.	transcript	1305	ML091410354
179-b-LE/OP/SA	Wolf, P.	transcript	1306	ML091410354
179-c-PA	Wolf, P.	transcript	1306	ML091410354
179-d-DE	Wolf, P.	transcript	1307	ML091410354
179-e-LE/WA	Wolf, P.	transcript	1307	ML091410354
179-f-RW/SF/ST	Wolf, P.	transcript	1307	ML091410354
179-g-AM	Wolf, P.	transcript	1307	ML091410354
179-h-OR/SA	Wolf, P.	transcript	1307	ML091410354
179-i-OE	Wolf, P.	e-mail	1309	ML090771340
180-a-HH/LE/RI	Wood, P.	e-mail	1310	ML090700178
180-b-AL	Wood, P.	e-mail	1310	ML090700178
180-c-AE	Wood, P.	e-mail	1310	ML090700178
180-d-AM/GL	Wood, P.	e-mail	1310	ML090700178
180-e-PA	Wood, P.	e-mail	1310	ML090700178
180-f-RW	Wood, P.	e-mail	1310	ML090700178
180-g-PA	Wood, P.	e-mail	1310	ML090700178
180-h-GI/OM	Wood, P.	e-mail	1311	ML090700178
180-i-AM	Wood, P.	e-mail	1311	ML090700178
180-j-OM	Wood, P.	e-mail	1311	ML090700178
181-a-SE/SR	Yanofsky, J.	transcript	1312	ML091410354
182-a-LE/OR	Yarme, J.	e-mail	1315	ML090720678
182-b-AE/HH/RW/SF	Yarme, J.	e-mail	1315	ML090720678
182-c-EP/ST	Yarme, J.	e-mail	1315	ML090720678
182-d-AL/EJ/OR	Yarme, J.	e-mail	1315	ML090720678
183-a-EP/HH/PA	Yaroscak-Lanzotti, H.	e-mail	1316	ML090771344
183-b-AM/OM	Yaroscak-Lanzotti, H.	e-mail	1316	ML090771344
183-c-EP/HH/PA	Yaroscak-Lanzotti, H.	e-mail	1316	ML090771344

Comment ID	Commenter	Comment Source(a)	Comment Page No(s).	ADAMS Accession Number
183-d-ST	Yaroscak-Lanzotti, H.	e-mail	1316	ML090771344

(a) Transcript comments were received orally during one of two dSEIS comment meetings held on February 12, 2009, and transcribed by a certified court reporter.

A.2 Comments and Responses

Comments and responses in this section are grouped in the following categories:

A.2.1 Comments Concerning the License Renewal Process A-48

A.2.1.1 NEPA A-54

A.2.1.2 GEIS A-56

A.2.2 Comments in Support of License Renewal at Indian Point Nuclear Generating Units 2 and 3 A-58

A.2.3 Comments in Opposition of License Renewal at Indian Point Nuclear Generating Units 2 and 3 A-60

A.2.4 Comments Concerning Surface-Water Quality, Hydrology, Groundwater, and Water Use Issues A-60

A.2.5 Comments Concerning Aquatic Ecology, Terrestrial Ecology, General Ecology, and Threatened and Endangered Species A-62

A.2.6 Comments Concerning Human Health Issues A-92

A.2.7 Comments Concerning Socioeconomic Issues A-101

A.2.7.1 Demographics A-106

A.2.7.2 Aesthetics A-108

A.2.7.3 Psycho-Social Effects A-109

A.2.7.4 Environmental Justice A-110

A.2.8 Comments Concerning Land Use Issues A-121

A.2.9 Comments Concerning Postulated Accidents A-123

A.2.10 Comments Concerning Severe Accident Mitigation Alternatives (SAMAs) A-127

A.2.11 Comments Concerning Uranium Fuel Cycle and Waste Management Issues A-134

A.2.12 Comments Concerning Radiological Impact A-142

A.2.13 Comments Concerning Spent Fuel A-144

A.2.14 Comments Concerning Alternatives A-150

A.2.15 Comments Concerning Decommissioning Issues A-160

A.2.16 Comments Concerning Greenhouse Gases A-162

A.2.17 Comments Concerning Editorial Issues A-164

A.2.18 Comments Concerning Refurbishment A-166

A.2.19 Comments Outside the Scope of the Environmental Review for License Renewal: Safeguards and Security; Operational Safety; Aging Management; Need for Power; Energy Costs, etc. A-167

A.2.1 Comments Concerning the License Renewal Process

The following comments offer general opposition to the NRC's method of regulation:

3-a-AE/LE/LR; 82-b-GI/LR; 82-c-LR; 104-a-LR; 125-a-LR; 128-a-LR; 132-d-GI/LR

Response: *The NRC welcomes public participation in the rulemaking process. There are several ways for the public to participate in the rulemaking:*

- *The public may provide comments in response to a Federal Register notice. The NRC publishes notices of rulemaking activities in the Federal Register to solicit public comments, and may also publish a notice of a meeting or workshop to be held regarding a rule. The Federal Register notice contains information on how to provide specific comments on a proposed rule to the NRC.*

- *The public may provide comments on the NRC's Rule Forum website. The NRC's Rule Forum is a web-based computer forum that was developed to provide an easy means for a member of the public to access and comment on NRC rulemaking activities. The Rule Forum contains proposed rulemakings that have been published by the NRC in the Federal Register, petitions for rulemakings that have been received and docketed by the NRC, and other types of documents related to rulemaking.*

- *Members of the public can provide comments on the NRC's Technical Conference Forum website. The Technical Conference Forum is a web-based forum that facilitates public participation on NRC issues related to the development of draft rulemakings, draft guidance documents, and other initiatives.*

- *Members of the public may petition the NRC to develop, change or rescind a rule by filing a petition for rulemaking in accordance with the regulations in 10 CFR 2.802.*

Before filing a petition for rulemaking, a member of the public may consult with the NRC concerning questions about NRC regulations by calling the Rules and Directives Branch at 301-415-7163 or toll-free at 800-368-5642, or by writing the following address;

Chief

Rule and Directives Branch

Division of Administrative Services

Office of Administration

U.S. Nuclear Regulatory Commission

Washington, DC 20555-0001

The information that members of the public can receive when consulting with the NRC about a petition for rulemaking includes a description of the procedures and process for filing and responding to a petition for rulemaking, clarification of an existing NRC regulation and the basis for the regulation, or assistance in clarifying their potential petition so that the Commission is better able to understand the nature of the issues that are concern.

Petitions should be submitted to the following address:

Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Attn: Rulemakings and Adjudications Staff
E-mail: secy@nrc.gov
Fax: 301-415-1101

The petitions must, as a minimum, outline a general solution to a problem, or present the substance or text of any proposed regulations or amendment or specify the regulation that the petitioner proposes to be rescinded or amended. In writing a petition, a member of the public should state clearly and concisely his or her grounds for, and interest in the proposal, and also include a statement in support of the petition that outlines the specific issues involved: the views or arguments regarding those issues; the relevant technical, scientific or other data that is reasonably available; and any other pertinent information to support the proposal.

The following comment states that the NRC cannot issue a renewed operating license until New York State concurs with Entergy's application for consistency certification:

4-a-AE/LR

Response: *The NRC's process for making a decision to grant or deny a license renewal application is based on whether there is reasonable assurance that the requirements in the NRC's regulations for license renewal can be met. If the applicant meets the requirements in the regulations, the NRC may approve renewal of the license.*

Under the authority granted to New York State by the Federal Coastal Zone Management Act and codified in 15 CFR Part 930, the State must determine whether a Federal action is consistent with the State's Coastal Management Plan. The NRC recognizes that the New York State Department of State will review Entergy's application for consistency with the State's Coastal Management Plan, and also recognizes that continued operation of IP2 and IP3 will require a positive consistency determination by the State. Objections by the Department of State may be appealed to the U.S. Commerce Secretary.

The NRC will continue to monitor the actions of New York State regarding Entergy's consistency certification relating to IPEC's license renewal application.

The following comments state that the views of local agencies regarding the preparation of the Environmental Impact Statement should be considered:

59-a-LR; 137-d-LR/ST

Response: *Governmental agencies other than the NRC are invited through the environmental scoping process to assess whether or not they should be considered cooperating agencies under the regulatory structure afforded by the President's Council on Environmental Quality (CEQ). It also invites them to identify whether or not they have a particular expertise on an issue that may be invaluable to the NRC, or have consultation roles under other statues that may have a bearing on site-specific issues.*

A notice of the receipt of the license renewal application is posted in the Federal Register shortly after it is received by the NRC. The notice indicates where copies are available and how they can be obtained. Other Federal, State, and local governmental agencies that are interested in reviewing the application can obtain a copy and provide comments to the NRC during the scoping process or after publication of the draft site-specific supplement to the generic environmental impact statement. The NRC considers those comments during its review of the license renewal application and its development of the draft and final environmental impact statement.

The following are general comments indicating the NRC is required to comply with NEPA:

79-d-LR/NE; 128-d-GE/LR; 140-ss-LR

Response: *The NRC fully supports the principles of NEPA which establishes a national policy that:*

• encourages productive and enjoyable harmony between man and his environment,

• promotes efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man, and

• enriches the understanding of the ecological systems and natural resources important to the Nation.

The NEPA regulations adopted by the Council on Environmental Quality (CEQ) direct Federal agencies on matters related to environmental policy, including the public scoping process, use of lead agencies, and selection of alternatives. The NRC is an independent regulatory agency. As an independent agency, the NRC has established its own regulations to implement NEPA. The Commission's policy is to take account of the CEQ's regulations voluntarily. The NRC's requirements for compliance with NEPA is contained in 10 CFR Part 51, Subpart A; National Environmental Policy Act – Regulations Implementing Section 102(2).

The Commission recognizes a continuing obligation to conduct its domestic licensing and related regulatory functions in a manner that is both receptive to environmental concerns and consistent with the Commission's responsibility as an independent regulatory agency for protecting the health and safety of the public.

The following comment suggests that the determination of impacts in the SEIS should be based on more recent and comprehensive studies:

79-aa-LR

Response: *The Comment suggests that in order to adequately assess the impacts of license renewal, the NRC staff must obtain more recent and comprehensive studies related to radiological impacts on human health, aquatic resources, and environmental justice.*

The impact on each of these resource areas have been evaluated and documented in the draft SEIS, and additional information related to these resource areas were also considered during the NRC staff's review of comments on the draft SEIS.

With respect to radiological impacts on human health impacts, which is a Category 1 issue, the staff considered new information to determine whether it would indicate that the impacts are beyond those described in the GEIS. The staff's finding, as documented in Section 4.3, did not change for radiological impacts on human health.

With respect to impacts on aquatic resources, the staff has considered and performed an evaluation of additional information from several sources as part of preparing the final SEIS. Its findings are documented in Section 4.1. Similarly, additional information on environmental justice was also considered and evaluated in Section 4.4.6.

The following comments are opposed to comments brought up in public meetings being classified as out of scope or not being addressed:

73-h-AM/LR/ST; 96-b-LR/NE; 96-j-LR/PA/RW; 132-e-GI/LR; 137-e-LR; 164-d-LR/OM; 172-d-LR

Response: *The comments are opposed to the scoping criteria used by the NRC for the environmental review process. The NRC staff's review of license renewal applications addresses safety and environmental matters relevant to license renewal. The comments are general in nature and provide no new information related to the IPEC review. No change to the SEIS will be made as a result of these comments.*

The following comment is opposed to the time and money spent on the license renewal process for Indian Point:

117-c-LR/SR

Response: *The comments are opposed to the time and money spent on the license renewal process for IPEC. The NRC is responsible, in accordance with the Atomic Energy Act of 1954, as amended, to review operating license renewal applications such as the IP2 and IP3 LRA. The comments are general in nature and provide no new information. No change to the SEIS will be made as a result of these comments.*

The following comment states that the draft environmental impact statement did not adequately analyze the potential visual impact of cooling towers in the context of the Scenic Areas of State Significance (SASS) documentation:

4-b-AL/LR

Response: *The topic of cooling towers is considered an alternative which is discussed in chapter 8.1.1 under "Close Cycle Cooling Alternatives" of NUREG-1437, Supplement 38. The NRC's environmental review regulations implementing NEPA, in 10 CFR Part 51, require that the NRC consider reasonable alternatives to a proposed action before acting on a proposal, including consideration of the no-action alternative.*

IP2 and IP3 currently use a once-through cooling-water system that withdraws water from and discharges water to the Hudson River. The type of cooling system currently used by Indian Point is known to have a more adverse effect on the aquatic environment than cooling towers. On April 8, 2003, the New York State Department of Environmental Conservation – which holds authority under the Federal Clean Water Act to regulate pollutant discharge – proposed to modify the SPDES permit to require IP2 and IP3 reduce the impacts to aquatic organisms caused by the once-through cooling system. Accordingly, the alternative of a closed-cycle cooling system is considered in this SEIS.

Aesthetics was one of the impacts considered in the environmental review and as seen in Table 8.1 of NUREG-1437, Supplement 38 it is addressed. As stated in Table 8.1, construction of two towers that could stand 150-165 feet tall is considered to have a moderate impact. The height of these towers would have noticeable impact on the aesthetics of the site, while the existing once-through cooling system is considered to have a small impact on the aesthetics of the site.

A final decision has not been made by the State of New York on the building of cooling towers at IPEC. If a decision is made to build cooling towers at IPEC, construction and operation of those towers could require an NRC licensing action and a separate environmental evaluation.

The following comment is a general statement that the fuel storage disposal and groundwater contamination must conform to state standards:

4-c-LR/UF

Response: *The NRC's process for the license renewal of nuclear power facilities does involve substantial participation of state and local government agencies. The following requirements are contained in 10 CFR 51.71 (d):*

"Consideration will be given to compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection, including applicable zoning and land-use regulations and water pollution limitations or requirements issued or imposed under the Federal Water Pollution Control Act. The environmental impact of the proposed action will be considered in the analysis with respect to matters covered by environmental quality standards and requirements irrespective of whether a certification or license from the appropriate authority has been obtained. While satisfaction of Commission standards and criteria pertaining to radiological effects will be necessary to meet the licensing requirements of the Atomic Energy Act, the analysis will, for the purposes of NEPA, consider the radiological effects of the proposed action and alternatives."

Additional information about spent fuel is discussed in the Spent Fuel comment response section.

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments request the SEIS to provide detailed analysis supported by data as to how the proposed licensing would impact coastal land and water uses:

4-d-CI/LR/SO; 4-e-LR

Response: *Information on land and water use can be found in section 2.2 "Plant Interaction with the Environment." Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near IPEC, and detailed descriptions where needed to support the analysis of potential environmental impacts of refurbishment and operations during the renewal term. Land use is a one of many issues considered in the NRC environmental review.*

IPEC is located within the State's Coastal Zone which is regulated by the New York Coastal Management Program (CMP), and authorized by the Coastal Zone Management Act of 1972. The CMP includes a total of 44 policies which are applicable to development and use proposals within or affecting the State's coastal area. Activities related to the seeking of permits, licenses, *waivers, certification or similar types of approval from a Federal agency (such as relicensing of IPEC) within or affecting such areas are subject to reviews for consistency with these policies. The New York Department of State will conduct a separate consistency review for that process.*

Section 2.2.5 of the draft SEIS, Aquatic Resources, describes the physical, chemical and biological characteristics of the Hudson River estuary as well as major anthropogenic events that have influenced the estuary and the history of regulatory action over the past 50 years. This section is sufficient for NRC decision-making purposes and provides a detailed discussion of how the current licenses have impacted coastal lands and water use.

The following comment consists of general statements questioning the NRC's role in development of the Environmental Impact statement:

16-d-LR

Response: *The Atomic Energy Act of 1954 (as amended) allows the U.S. Nuclear Regulatory Commission (NRC) to issue licenses for commercial power reactors to operate for up to 40 years. NRC regulations allow for the renewal of these licenses for up to an additional 20 years beyond the initial licensing period depending on the outcome of an assessment to determine whether the reactor can continue to operate safely during the 20-year period of extended operation. The license renewal process includes reviewing the license renewal application, conducting a thorough assessment of the safety and environmental impacts of the proposed action, and if appropriate, renewing the license. The NRC's review of a license renewal application proceeds along two tracks: one for safety issues and another for environmental issues. The license renewal process is defined by a clear set of regulations that are designed to ensure safe operation and protection of the environment during the period of extended operation.*

The following comments are general statements expressing support for proceeding with the license renewal process:

26-a-EC/LR; 40-wwwww-GE/LR; 45-c-LR; 49-c-LR/SR; 94-a-LR; 116-c-LR/SR

Response: *The comments are supportive of the license renewal process. The comments are general in nature, provide no new information and, therefore will not be evaluated further.*

The following comment is opposed to the 60-day period in 2007 during which NRC provided an opportunity for interested parties to request an adjudicatory hearing:

137-n-LR

Response: *On October 1, 2007, the Commission extended the period in which interested parties could file requests for adjudicatory hearings through November 30, 2007. The Commission has acted to address this concern, and the time period for filing a timely petition to intervene has expired. The comments provide no new information and will not be evaluated further.*

The following comments request the relicensing to be contingent upon or postponed until all environmental issues and problems have been addressed:

137-m-LR; 139-g-LR

Response: *Many environmental issues are not within the NRC's regulatory authority to resolve. For example, environmental issues related to the facility's once-through cooling system are regulated, monitored, and permitted by the New York State Department of Environmental Conservation through the power delegated to the State under the Clean Water Act. While the NRC coordinates with other regulatory authorities, the NRC cannot address issues that are not under its jurisdiction. The NRC's responsibilities in the license renewal review include assessing and comparing environmental impacts from license renewal and other alternatives that meet the SEIS's applicable purpose and need.*

In cases where environmental issues are under the NRC's jurisdiction – such as those relating to radiation and radioactive materials – the NRC takes action to regulate those issues under the facility's current operating license separately from a license renewal review.

The following comments request a Blue Ribbon Commission/task force by the Governor of New York to address Indian Point concerns:

137-r-LR

Response: *This suggestion relates to requested action by New York's Governor and does not directly relate to the NRC's license renewal SEIS.*

The following comment requests an expedited timeline for the final license review:

166-a-LR/SR

Response: *The NRC staff's standard review timeline is 22 months for a review without an adjudicatory hearing, and 30 months for a review with an adjudicatory hearing. In the Indian Point review, however, the NRC staff has extended the schedule on several occasions to address review-related issues. The staff's acceptance letter included a 26 month schedule because Entergy needed to address an issue related to the facility's current licensing basis before NRC staff could continue its review. Since that time, an Atomic Safety and Licensing Board Panel has admitted numerous contentions for hearing, and the staff has extended its review schedule in order to address new information and the large numbers of scoping and draft SEIS comments. The NRC staff will continue to act in a deliberate and timely fashion.*

A.2.1.1 NEPA

The following comments state that the NRC has not taken the "hard look" as required by NEPA:

17-a-NE/SF; 17-q-AE/NE; 50-e-NE; 50-p-DE/EP/NE; 68-a-AL/NE; 79-d-LR/NE; 96-b-LR/NE; 137-c-NE

The following comments state that NEPA requires the reviewing agency to consider the impact on the environment resulting from the total effects of the contemplated action and other past, present and reasonable foreseeable future actions:

17-c-NE; 17-e-NE/PA; 17-n-NE; 17-o-AE/NE; 50-p-DE/EP/NE; 147-b-NE/PA; 152-e-NE; 174-e-NE/PA

The following are general comments stating that the EIS does not meet the minimum requirements of NEPA:

68-c-DE/EF/NE; 102-I-NE/PA; 132-b-NE; 180-g-NE/PA

Response: *The Atomic Energy Act of 1954 (as amended) allows the NRC to issue licenses for commercial power reactors to operate for up to 40 years. NRC regulations allow for the renewal of these licenses for up to an additional 20 years beyond the initial licensing period depending on the outcome of an assessment to determine whether the reactor can continue to operate safely during the 20-year period of extended operation. The license renewal process includes reviewing the license renewal application, conducting a thorough assessment of the safety and environmental impacts of the proposed action, and if appropriate, renewing the license. The NRC's review of a license renewal application proceeds along two tracks: one for safety issues and another for environmental issues. The license renewal process is defined by a clear set of regulations that are designed to ensure safe operation and protection of the environment during the period of extended operation.*

The NRC fully supports the principles of NEPA, which establishes a national policy that:

• encourages productive and enjoyable harmony between man and his environment,

• promotes efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man, and

• enriches the understanding of the ecological systems and natural resources important to the Nation.

The NEPA regulations adopted by the CEQ direct Federal agencies on matters related to environmental policy, including the public scoping process, use of lead agencies, and selection of alternatives. The NRC is an independent regulatory agency. As an independent agency, the NRC has established its own regulations to implement NEPA. The Commission's policy is to take account of the CEQ's regulations voluntarily. The NRC's requirements for compliance with NEPA are contained in 10 CFR Part 51, Subpart A; National Environmental Policy Act – Regulations Implementing Section 102(2).

NEPA does not require that a Federal agency choose the alternative with the least impact. Rather, NEPA requires that it discloses all potential impacts so that the decision the agency makes can be fully informed. NEPA does not require the review or analysis of actions other than the action being considered. For example, the NEPA review for license renewal would not include an environmental review of the existing operating license, a review of an independent spent fuel storage installation, or an analysis of a waste repository, each of which has its own separate NEPA review.

An EIS is a written analysis of the reasonably foreseeable effects of an activity on the environment, including the air, water, human health, animal life, vegetation, natural resources, aesthetics, and any resources of historic, archaeological, or architectural significance. The review also evaluates cumulative, socio-economic (including environmental justice), cultural, and other impacts.

Cumulative impacts on the environment result when impacts of an action are added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually small impacts that become significant when taken collectively over a geographic area or a period of time. Any agency (Federal or non-Federal) or non-governmental entities can contribute through their actions or approvals to cumulative effects. These combined impacts are defined as "cumulative" and include individually minor but collectively significant actions taking place over a geographic area or a period of time.

The NRC evaluates cumulative effects during the site visit and scoping process by identifying the impacts that have affected the environment surrounding the facility. For example, the close proximity of another nuclear reactor facility or another industrial facility that also discharges warm water into the same river may have a cumulative impact on aquatic ecology that is greater than the impact of just one facility. The NRC staff would take into consideration the potential for cumulative impacts from such facilities.

The NRC recognizes a continuing obligation to conduct its domestic licensing and related regulatory functions in a manner which is both receptive to environmental concerns and consistent with the Commission's responsibility as an independent regulatory agency for protecting the public and the environment.

No changes have been made to the SEIS based on these comments.

A.2.1.2 GEIS

The following comments are opposed to the use of the GEIS due to the age of the document:

50-a-LR; 50-g-GE/SF; 96-a-GE/LR; 123-d-GE/SF; 123-f-GE; 128-c-GE/LR; 129-a-LR; 140-a-GE/LR;13-f-AM/GE/OM

Response: *The GEIS has been adopted by the NRC through the rulemaking process and continues to apply to IP2 and IP3 as well as other nuclear power plants undergoing license renewal review. The NRC will continue to evaluate new applications under the existing regulatory framework using the GEIS as previously published and codified in NRC's regulations. However, insights and information gained during the GEIS update process and from experience with completed license renewal reviews using the GEIS will be considered during the review of ongoing and upcoming applications until the update of the GEIS and appropriate revisions to 10 CFR Part 51 are completed.*

If a new issue emerges, it is first analyzed to determine whether it is within the scope of the license renewal evaluation. If a new environmental issue is determined to be within the scope of license renewal and it was not addressed in the GEIS or codified in the NRC license renewal environmental protection rule, the NRC evaluates the significance of the information by calling upon experts from within the NRC, its contractors or other recognized institutions. If the new issue is relevant only to a particular site, the NRC staff performs a site-specific analysis and includes its conclusion in the site-specific supplement to the generic environmental impact statement on license renewal (SEIS). If the new and significant information appears to be relevant to other sites, the NRC staff will consider the issue in future SEISs and include it as a candidate for evaluation in the periodic update of the GEIS and possible amendment to the rule.

The NRC has anticipated the need to revisit the GEIS and its implementing regulations. The Commission declared its intent to revisit the GEIS on a 10-year cycle to determine whether the technical bases or conclusions need to be updated. The GEIS represents a snapshot in time. Therefore, it is appropriate to periodically determine whether changes have occurred that should be included in an update to the GEIS. Science and conditions in the natural environment evolve, and the scientific community's understanding of issues, methods, and assumptions may need to be revisited. Experience gained in using the regulatory framework may identify situations in which new approaches or conclusions are appropriate. Changes in statutes, regulations, policies, and practices may have a cascading impact on the NRC licensing framework.

Currently, the GEIS for license renewal, which was originally issued in 1996, is being updated. The NRC is considering the public comments received on the draft GEIS and is considering the appropriate changes to the document. The final GEIS is scheduled to be issued in the first quarter of 2011.

The following comment states that there is a lack of Environmental Justice information within the GEIS:

113-c-EJ/GE

Response: *Environmental justice was not evaluated on a generic basis, because guidance for implementing Executive Order 12898 was not available prior to completion of the 1996 GEIS. Environmental justice impacts are addressed in plant-specific environmental reviews, and are discussed in Section 4.4.6 of this SEIS.*

The NRC staff is guided in its consideration of environmental justice in plant-specific environmental reviews by Office of Nuclear Reactor Regulation (NRR), Office Instruction LIC-203, Appendix C "Environmental Justice in NRR NEPA Documents." The environmental justice review involves identifying minority and low-income populations in the vicinity of the plant that may be affected by license renewal, including their geographic locations, any concerns and potential environmental impacts that may affect these populations, the significance of such concerns and effects, whether they would be disproportionately high and adverse when compared to the general population, and if so, the mitigation measures available to reduce and/or eliminate these impacts. The NRC staff performs the environmental justice review and reports the results of this review in the SEIS. This comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment states that the GEIS is defective in determining the environmental impacts associated with components that cannot be fully inspected:

102-m-GE/OM

Response: *The NRC staff performs a safety review to determine whether there is reasonable assurance that activities authorized by the renewed license will continue to be conducted in accordance with the current licensing basis.*

The intent of the NRC staff's safety review is to determine if the applicant has adequately demonstrated that the effects of aging will not adversely affect any systems, structures, or components, as identified in 10 CFR 54.4. When the plant was designed, certain assumptions were made about the length of time the plant would be operated. During the license renewal process, the applicant must also confirm whether these design assumptions will continue to be valid throughout the period of extended operation and whether aging effects will be adequately managed. The applicant must demonstrate that the effects of aging will be managed in such a way that the intended functions of "passive" or "long-lived" structures and components will be maintained during extended operation. For active components, surveillance and maintenance programs will continue throughout the period of extended operation.

If additional aging management activities are needed, the applicant may be required to establish new monitoring programs or increase inspections. For instance, applicants should specify activities that need to be performed (such as water chemistry and inspections) to prevent and mitigate age-related degradation. These activities increase the likelihood that the program is *effective in minimizing degradation and that the component is replaced if specified thresholds are exceeded.*

The regulations in 10 CFR Part 54 provide the basis for the NRC staff's safety review. Detailed guidance on the NRC staff's safety review for license renewal is provided in the Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants (NUREG-1800). The purpose of the Standard Review Plan is to ensure quality and uniformity in the staff's review and to present a well-defined basis upon which to evaluate the applicant's programs and activities for the period of extended operation. The Standard Review Plan was developed based on information in the Generic Aging Lessons Learned (GALL) Report (NUREG-1801), which was developed by the NRC with input from interested stake holders. The GALL Report documents the basis that is used for determining if existing programs are adequate or if they should be augmented for license renewal.

The focus of the license renewal safety review is on managing the detrimental effects of aging. The review provides reasonable assurance that the effects of aging will be managed for the period of extended operation such that systems, structure, and components (SSCs) will continue to perform their intended functions in accordance with the plant's current licensing basis. Many of the existing programs and regulatory requirements that already provide adequate aging management will continue to be applicable after renewal. The license renewal review focuses on the SSCs for which current activities and requirements may not be sufficient to manage aging in the period of extended operation.

These comments are specific to the GEIS and do not provide new information that would cause a change to the SEIS.

The following comment offers general support for the findings of the GEIS:

40-wwwww-GE/LR

Response: *This comment is in support of the findings of the GEIS and is general in nature. The comment provides no new information and, therefore will not be evaluated further. No change is the SEIS will be made as a result of this comment.*

A.2.2 Comments in Support of License Renewal for Indian Point Nuclear Generating Units 2 and 3

The following comments provide general support for license renewal:

8-a-SR; 36-e-OP/SO; 40-h-SR; 42-e-SR; 46-a-EC/SR; 48-e-OP/SR; 48-f-SE; 49-a-SR; 49-d-EJ/SR; 49-i-SR; 52-e-SR; 57-d-SL; 57-h-SE/SR; 58-a-SR; 65-a-SO/SR; 67-a-SR; 67-f-SR; 78-a-SR; 92-d-SO/SR; 92-g-SO/SR; 99-a-SR; 101-a-SR; 101-c-SO/SR; 105-a-SO/SR; 105-c-EC/SR; 108-b-AL/GI/SR; 111-b-SO/SR; 113-a-SR; 113-e-SR; 116-a-SO/SR; 116-c-LR/SR; 119-a-SR; 119-f-SR; 120-p-SR; 127-a-SA/SR; 127-c-AL/SR; 137-a-SA/SR; 144-a-EC/SA/SR; 148-b-AL/SO; 148-c-AL/SO; 150-d-EC/SR; 159-b-AL/SA/SR; 159-c-EC/SR; 159-e-AL/AQ/SR; 163-a-SE/SO/SR; 166-a-LR/SR; 166-d-SO/SR; 166-e-SO/SR; 168-a-OS

Response: *The comments support license renewal of Indian Point and are general in nature. The comments provide no new and significant information; therefore, no changes were made to the SEIS in response to these comments.*

The following comments support the license renewal due to the cumulative impacts of denial of the license renewal application:

7-d-AQ/EC/SR; 14-a-AQ/EJ/SR; 23-i-EC/SO/SR; 31-a-EJ/SR; 40-a-SR; 46-c-AL/EJ/SR; 62-a-EJ/SR; 78-c-SO/SR; 92-a-EC/SO/SR; 92-e-SO/SR; 108-a-EC/SO/SR; 109-d-SO/SR; 113-d-AQ/GL/SR; 131-c-SE/SR; 158-a-EJ/SR

Response: *The comments support license renewal of IP2 and IP3 due to the adverse potential effects of the denial of license renewal. Responses to the cited impacts are addressed in their respective comment response category. The comments provide no new and significant information; therefore, no changes were made to the SEIS in response to these comments.*

The following comments express support for license renewal due to the air quality associated with nuclear power plants versus alternative energy sources:

5-a-AQ/SR; 5-b-AQ/SR; 5-c-AQ/SR; 14-a-AQ/EJ/SR; 36-a-SR; 62-b-EJ/SR; 112-i-SR; 113-d-AL/AQ/SR; 113-I-SR; 118-a-AQ/EJ/SR; 119-j-SE/SR; 133-d-AL/AQ/SR; 146-c-AQ/SR; 177-d-AQ/EJ/SR

Response: *The comments support license renewal of IP2 and IP3 due to the positive effects on air quality. Responses to the cited impacts are addressed in the Air Quality section. The comments provide no new and significant information; therefore, no changes were made to the SEIS in response to these comments.*

The following comments are supportive of relicensing due to the availability of power from IPEC and the potential costs associated with alternatives:

8-b-SO; 19-a-EC/SR; 19-b-EC/SO/SR; 19-c-EC/SO/SR; 26-c-EC/SO/SR; 28-a-EC/SR; 31-c-AQ/SR; 49-c-LR/SR; 58-d-SR; 65-b-EC/SR; 65-c-EC/SO/SR; 85-a-EC/SO/SR; 88-b-EC/SR; 88-c-EC/SR; 118-b-EC/EJ/SR; 119-g-EC/SO/SR; 131-e-AQ/EC/SR; 133-a-EC/SO/SR; 157-d-EC/SR

Response: *The comments support license renewal of Indian Point due to the adverse potential utility costs of alternative energy. Responses to the cited impacts are addressed in the Energy Costs and/or Socioeconomic section. The comments provide no new and significant information; therefore, no changes were made to the SEIS in response to these comments.*

The following comments are supportive of license renewal due to the plants' positive impact on the community:

1-a-EC/SO/SR; 1-e-SR; 8-d-SE/SR; 23-a-SR; 23-g-SR; 29-a-SO/SR; 42-a-EC/SR; 42-d-SE/SR; 53-a-SE/SR; 57-g-SR; 85-c-EC/SO/SR; 130-b-OP/SO/SR; 131-d-SE; 131-e-AQ/EC/SR; 136-a-CR/SO/SR; 136-b-SO/SR; 148-a-AL/SO; 150-f-SO/SR; 156-a-SE/SR; 181-a-SE/SR

Response: The comments support license renewal of Indian Point based on the positive impact Entergy has on the community. Responses to the cited impacts are addressed in the socioeconomic section. The comments provide no new and significant information; therefore, no changes were made to the SEIS in response to these comments.

A.2.3 Comments in Opposition to License Renewal for Indian Point Nuclear Generating Units 2 and 3

The following comments express opposition to license renewal:

6-a-EP/OR/OS; 9-b-OE/OR/SA; 11-a-OR; 11-f-AL/OR; 12-a-OR; 13-a-OR; 13-h-OR; 15-a-OR; 18-a-LE/OR; 18-d-OR; 21-a-AE/LI/OR/SF; 21-b-GI/OR; 22-a-HH/OR/OS/PA; 24-a-HH/OR/RI; 24-b-HH/OR; 25-a-OR; 27-a-OR; 27-f-OR; 35-d-OR; 35-e-OR/RE; 37-a-AE/OR; 41-a-OR; 44-a-OR; 44-d-OR; 50-f-NE/OR; 54-a-LE/OR/RW; 54-d-OR; 61-a-AE/AL/OR; 63-a-OR; 63-g-OR; 66-a-GI/OR; 69-a-HH/LE/OR/PA; 70-c-OR; 70-d-OR; 72-a-EP/LE/OR/RW; 75-a-OR; 76-a-AE/LE/OR; 76-b-OR/PA; 77-a-AE/OR; 80-a-EP/OR/RW/ST; 80-c-OR/OS; 81-d-OR; 82-a-OR; 86-a-OR; 86-e-OR; 91-a-OR; 91-e-OR/RW/ST; 96-p-OR; 98-a-EP/OR/PA; 98-d-OR/RE; 100-a-OR; 110-a-OP/OR; 121-a-DE/OR; 121-c-OR/PA; 135-a-LE/OR; 143-a-GI/OR/RW; 141-a-OR; 141-d-AL/OR; 142-a-LE/OR; 145-f-DE/OR;147-d-OE/OR; 151-a-OR; 151-e-OR; 155-d-OR; 161-d-GI/OR; 161-i-AL/OR; 162-c-OE/OR; 162-f-OE/OR; 165-a-OR/PA; 167-b-OR/RW/SF; 170-a-OE/OR; 170-h-HH/OE/OR; 173-b-AL/OR; 174-j-OR; 175-a-OP/OR/PA; 182-a-LE/OR; 182-d-AL/EJ/OR; 176-a-OR; 176-f-OR; 179-h-OR/SA

Response: Portions of these comments that express general opposition to renewing the licenses for IP2 and IP3 provide no new and significant information and have not resulted in any changes to this SEIS. Portions of these comments that address particular technical issues are addressed in the respective technical sections of this appendix.

The following comments are opposed to nuclear energy:

38-a-ON; 70-a-ON; 84-c-ON

Response: The comments oppose license renewal of Indian Point and are general in nature. The comments provide no new and significant information; therefore, no changes were made to the SEIS in response to these comments.

A.2.4 Comments Concerning Surface-Water Quality, Hydrology, Groundwater, and Use Issues

The following comments indicate opposition to license renewal because of the continuing leaks of radioactive water into the groundwater and the Hudson River and the residual contamination of Cs-137 and Sr-90 into the Hudson River.

3-a-AE/LE/LR; 11-d-LE; 12-d-LE; 35-a-LE/OM; 37-b-LE/SF/ST; 41-c-AE/LE; 44-c-AE/LE; 47-b-LE/EP/SF; 61-b-LE/RW/ST; 63-d-LE; 69-a-HH/LE/OR/PA; 72-a-EP/LE/OR/RW; 74-a-LE; 75-b-EP/LE/OP/ST; 76-a-AE/LE/OR; 80-b-LE/RW/SF/ST; 91-d-LE; 106-a-AE/LE/RW/SF; 110-b-LE/WA; 121-b-AM/LE; 122-b-LE; 126-c-LE; 126-d-LE/RI

Response: *The dSEIS, in chapters 2 and 4, addressed the impacts of the radioactive material leaks. The NRC staff concluded that the calculated maximum dose to a member of the public exposed to all sources of radioactive material from IPEC was below NRC and EPA radiation dose limits. Additional information on the impacts from the leaks is contained in the Human Health response section.*

The following comment indicates that radioactive tritium released from IPEC is also found in nature and does not have a significant impact.

33-a-AE/GL/LE

Response: *It is true that tritium is a naturally occurring radioactive form of hydrogen. It is produced in the atmosphere when cosmic rays collide with air molecules. As a result, tritium is found in very small or trace amounts in groundwater throughout the world. It is also a byproduct of the production of electricity by nuclear power plants.*

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment indicates that leaking radioactive material from IPEC, including Sr-90; are causing cancer and contaminating mother's milk.

39-b-LE; 73-b-EJ/LE; 96-d-HH/LE/RI

Response: *The comments are addressed in the Human Health section.*

The following comments indicate that the EIS does not adequately discuss the long term health impacts from the radionuclides leaking from the spent fuel pool into the groundwater and the Hudson River, including eating fish from the Hudson River.

73-c-EJ/HH/LE; 96-e-HH/LE/WA; 96-f-DC/LE/WA; 97-k-EJ/HH/LE; 98-c-HH/LE/RI

Response: *The NRC staff performed a site specific evaluation of the leaks of radioactive material at IPEC. The evaluation is contained in Chapters 2 and 4 of the dSEIS. The comments are addressed in the Human Health section.*

The following comments indicate that plant aging will cause an increase in the number of leaks.

71-c-LE/RW; 96-c-AM/LE/OM; 96-n-AM/LE

Response: *The NRC staff reviewed the issue of radioactive effluent releases from normal routine pathways and of the abnormal leaks from the spent fuel pools. There is a thorough discussion of these issues in Chapters 2 and 4 of the dSEIS that address the impacts to human health from routine and abnormal radioactive releases.*

As part of its review, the NRC staff reviewed five years of historical radioactive and radiological environmental monitoring data. Based on the data, the Staff concluded that the calculated doses to a member of the public from the normal and abnormal radioactive releases were within NRC's radiation dose standards. The environmental data showed some radionuclides associated with the operation of IPEC; however, residual radioactivity from atmospheric weapons tests and naturally occurring radioactivity were the predominant sources of radioactivity in the samples collected. The Staff concluded that IPEC operations did not result in an adverse impact to the public greater than environmental background levels.

The NRC staff also evaluated the impacts from the leaking radioactive material into the groundwater and into the Hudson River in Chapter 2. For the evaluation contained in the dSEIS, the NRC staff used information from an Inspection conducted by personnel from NRC's Region I office and NRC's Headquarters office. The NRC thoroughly inspected this issue at IPEC, starting with initial notification of the leaks in September 2005 and followed the issue until the inspection closed in May, 2008. The NRC Inspection Report (ADAMS Accession number ML081340425) made the following summary statement; "Our inspection determined that public health and safety has not been, nor is likely to be, adversely affected, and the dose consequences to the public that can be attributed to current on-site conditions associated with *groundwater contamination is negligible." In the body of the Inspection Report there are two key conclusions relevant to the potential human health impacts from the leaks. They are presented in Chapter 2 of the SEIS:*

The NRC has already fully considered and addressed the issue in the SEIS and the comments do not present any significant new information or arguments that would warrant a change to the final SEIS.

The comment indicates that Indian Point took corrective action to identify and mitigate the leaks of Sr-90 and tritium, including installation of monitoring wells and continued inspection of the spent fuel pool for indications of leakage.

120-o-LE

Response: *The comment is noted. The comment does not present any significant new and significant information that would warrant a change to the final SEIS.*

A.2.5 Comments Concerning Aquatic Ecology, Terrestrial Ecology, General Ecology, and Threatened and Endangered Species

The following comments indicate that data on impingement and entrainment were collected at IP2 and IP3 between 1981 and 1990 and thus may be too old to be reliable, especially because differences in the fish populations been the 1990s and the present are great. The comments also indicate that no impingement or entrainment monitoring has been conducted since the installation of Ristroph screens.

17-q-AE/NE/OE; 21-a-AE/UF/OR/SF; 79-I-AE; 96-k-AE/OE/TS; 96-I-AE/AL/RG; 140-c-AE; 140-f-AE; 140-tt-AE; 140-uu-TS

Response: *The responsibility for requiring monitoring of entrainment, impingement, and thermal effects at IP2 and IP3 lies with New York State and not the NRC. In describing the available data and in its analysis, NRC staff described the age of the data from each of these in-plant monitoring programs and acknowledged the shortcomings of relying on such old data. The weight of evidence approach employed by the NRC included two primary lines of evidence: assessment of aquatic population trends in the Hudson River and an evaluation of strength of connection (i.e., relationship of the aquatic resources to power plant operations). NRC staff used population trend data available from 1974 or 1975, depending on the sampling program, through 2005 in its assessment. The staff also used impingement and entrainment data available from 1975 through 1990 to determine the strength of connection. Although entrainment and impingement monitoring was not conducted at IP2 and IP3 after 1990, NRC staff believes that sufficient information is available to determine the strength of connection between plant operations and aquatic resources in the Hudson River. These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment suggests a change in the description of the fish return system discharge in SEIS Chapter 2.

40-k-AE

Response: *The text has been modified.*

The following comments indicate that NRC does not have sufficient data to assess thermal impact on aquatic resources.

128-n-AE; 140-g-AE; 140-uu-TS

Response: *The NRC staff agrees that limited data are not available to address potential thermal impacts to the aquatic resources in the Hudson River. The staff acknowledged the uncertainties related to thermal effects in Section 4.1.4 and recommended that a thermal study be conducted. In the final SEIS, the NRC expressed the uncertainty arising from the lack of both studies and data as a range of impact levels from Small to Large and observed that the level of impact level could be refined when more data become available. The responsibility insuring that thermal discharges from IP2 and IP3 meet New York State water quality criteria for protection of aquatic life lies with New York State and not the NRC*

The following comments indicate that sufficient data are not available to limit thermal impacts to small to moderate.

128-k-AE; 140-xx-AE; 140-c-AE

Response: *NYSDEC has the regulatory authority for thermal discharges, has stated that the applicant has exceeded thermal limits in the past, and has concluded that thermal impacts could be large, The NRC staff has concluded that thermal impacts could range from small to large for selected species and has revised the final SEIS to reflect this conclusion.*

The following comments indicate that the NRC staff's approach to assessing impact to fish populations differs from the NYSDEC's, which focuses on fish mortality rather than fish populations and finds significant adverse impact.

128-f-AE; 128-g-AE; 140-c-AE; 140-d-AE; 140-h-AE; 140-k-AE

Response: *NRC staff acknowledges that its approach to assessing aquatic impacts differs from DEC's. The difference is associated with the regulatory frameworks followed by each agency. The NRC staff assessed impacts with respect to resource stability. To address resource stability, it is appropriate to assess population trends of representative, important species that occur near the site. The staff assessed population trends using appropriate statistical techniques and explained the methods and results in technical appendices accompanying the draft SEIS and Chapter 4. This methodology used by the staff produces results that are directly applicable to the NRC categories of small, moderate, and large levels of impact.*

The following comments indicate that trend analyses for aquatic resources assume a normal distribution of abundance, whereas population abundance is often not normally distributed and is often log-normally distributed. The NRC staff model operates about equally for normal and lognormal distributions.

140-tt-AE; 40-qqqqq-AE

Response: *NRC staff acknowledges that fish population data from the Hudson River are not normally distributed and that these data often contain large numbers of zero abundance observations and a few observations of high abundance. To develop a measure of abundance to assess trends through time, the staff chose to analyze the 75th percentile of the weekly catches for each year. The advantage of this approach over the use of a mean of untransformed or log-transformed data is that the 75th percentile allows each observation to* *influence the result equally. In contrast, the use of the mean (average) of untransformed or log-transformed data can result in small (or large) catches having unequal or arbitrary influences on the result. The staff explains and discusses its rationale for the choice of the 75th percentile and the advantage of using this approach in a dynamic system influenced by multiple stressors in Appendix I, Section I.2.1 Assessment of Population Trends. NRC staff added text to clarify the approach and rationale to the final SEIS in Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment.*

The following comments indicated that, in assessing population trends, the NRC staff 's test that 40 percent of observations lie outside the standardized mean abundance level observed over the first 5 years of the long-term study make it harder to score a large potential impact if unusually great variability occurred within those first 5 years.

140-d-AE; 140-tt-AE

Response: *Appendix I of the SEIS, Section I.2.1, Assessment of Population Trends, provides a description of the process used to develop standardized data. The NRC staff standardized abundance data by subtracting the first five year mean of the 75th percentiles of the weekly abundance data within each year and dividing this number by the standard deviation based on all years. This standardization allows comparisons of all fish species across years on the same scale. Staff chose the first five years for the mean to represent a short period of time closest to the start of operation of IP2 and IP3.*

The decision rule in the draft SEIS was intended to incorporate a population-level response with respect to the variance (noise) present in the system. In response to comments received and further investigation, the NRC Staff refined the population trend weight of evidence assessment by altering the decision rules in the final SEIS. The rationale for using increased population fluctuations was based on several sources. For example, Pimm et al. (1988) found that the risk of extinction for populations on islands correlated with temporal variability of the populations: populations most likely to become extinct had high variability, and Anderson et al. (2008) reported that fish populations stressed by fishing fluctuate more than unharvested stocks. The increased population fluctuations arise from the unstable population dynamics brought about by changing demographic parameters such as intrinsic growth rates. The presence of extreme population fluctuations is one of several criteria used by IUCN (2000) to assess vulnerability to extinction when considering candidate species for the Red List. For these reasons, the staff selected increased population fluctuations as a measure of ecological instability in the draft SEIS.

Some observations, however, suggest that using increased population fluctuations adds little to the use of trend alone. In discussing reddened spectra of biological population fluctuations, Pimm (1992, page 95) observes: "Any process that creates a trend in density will cause the population's variability to increase." Because of this, increasing population fluctuations may indicate a recovering population rather than an unstable one. In the general case where population variance increases as the mean, as the mean of a recovering population increases, the variance will also increase. Increasing variance accompanying an increasing trend could then signal a recovering population, not an unstable population. O'Grady et al. (2004) compared 16 measures frequently used to predict extinction risk in vertebrate populations and found that population size and trend were the best correlates of extinction risk and that variability in population size contributed little more to prediction. NRC staff interprets extinction risk as an indicator of ecological instability and a large level of impact.

The observations of Pimm (1992) and O'Grady et al. (2004) suggest to NRC staff that use of increased population fluctuations in addition to population trend adds little to determining if Hudson River fish populations are unstable and could be removed from the analysis. Removal would satisfy the commenters' objections, result in only a small change in sensitivity, and simplify the analysis. Therefore, NRC staff modified the decision rule in the final SEIS and removed the criterion that 40 percent of observations lie outside the standardized mean abundance level observed over the first 5 years of the long-term study. The revised method appears in the final SEIS in Appendix H, Section H.1.3 Combined Effects of Impingement and Entrainment.

Literature Cited in Response

Anderson, C.N.K., C.H. Hsieh, S.A. Sandin, R. Hewitt, A. Hollowed, J. Beddington, R.M. May, and G. Sugihara. 2008. Why fishing magnifies fluctuations in fish abundance. Nature 452(17):835-839.

IUCN (International Union for Conservation of Nature). 2000. IUCN Red List Categories and Criteria, Version 3.1. Species Survival Commission, IUCN, Gland, Switzerland. Available URL http://intranet.iucn.org/webfiles/doc/SSC/RedList/redlistcatsenglish.pdf

O'Grady, J.J., D.H. Reed, B.W. Brook, and R. Frankham. 2004. What are the best correlates of predicted extinction risk? Biological Conservation 118:513-520.

Pimm, S.L. 1992. The Balance of Nature? Ecological Issues in the Conservation of Species and Communities. University of Chicago Press, Illinois.

Pimm, S.L., H. L. Jones, and J. Diamond. 1988. On the risk of extinction. The American Naturalist 132(6):757-785.

The following comments observe that NRC assesses river-wide, river segment 4, and coastal trends of abundance in their weight-of-evidence score, while indicating that some species do not complete their life cycle in river segment 4; therefore, the comments indicate that there is no justification for including that geographic region in the analysis. Riverwide abundance trends are more relevant than Region 4 trends and marine species are not susceptible to impacts from IP2 and IP3.

140-d-AE; 140-tt-AE

Response: *The RIS include fish that are resident, migratory within the estuary and migratory along the coast. In the draft SEIS, NRC staff used river segment 4, river-wide, and coastal trends as valid measures of changes in fish populations at different scales and distances from IP2 and IP3 and weighted the three measures as to biological relevancy for assessing impacts of IP2 and IP3. NRC staff believes that impacts to fish species closest to the plant are the most biologically relevant, because as distance from the plant increases, the effects associated with the plant are more difficult to discern. NRC staff also recognizes that coastal trends are fundamentally different than the other two trends, however. River-wide and River Segment 4 populations are young-of-the-year (YOY) fish sampled with the same Hudson River fish survey programs. The coastal populations represent both the progenitors of the YOY and, typically, the YOY fish themselves years later as adults. Coastal population trends are based on commercial and recreational landings and subject to a wide variety of influences. NRC staff therefore accepted the comments, removed coastal population trends as an equal measure with river-*

wide and River Segment 4 trends, and used the coastal trends as ancillary information in interpreting impact. The revised method appears in the final SEIS in Appendix H, Section H.1.3 Combined Effects of Impingement and Entrainment.

The following comments indicate that NRC staff's use of a 3-year moving average prior to analysis in the methodology used to classify aquatic impacts into small, moderate, and large results in the classification process being less able to distinguish moderate from small impact levels when the methodology is tested using one hypothetical population model in a Monte Carlo simulation.

40-ccccc-AE; 40-qqqqq-AE

Response: *Changes to the decision rules associated with population trend line of evidence discussed in earlier comment responses reduce the probability of misclassification. These changes are discussed in Chapter 4 and Appendix H of the final SEIS. NRC did not change the three-year moving average in the final SEIS because it does not affect the probability of misclassification using the new decision rules.*

The following comments indicate that testing the methodology used to by NRC staff to classify aquatic impacts into small, moderate, and large using one hypothetical population model in a Monte Carlo simulation showed that different sets of rules produced different classifications with the same data. No classification scheme should be used without testing its performance on data with known characteristics.

40-ccccc-AE; 40-qqqqq-AE

Changes to the decision rules associated with population trend line of evidence discussed in an earlier comment response reduce the probability of misclassification.

The following comment indicates that the near-field (River Segment 4) and river-wide analyses that NRC staff conducted using densities, catch per unit effort, and abundance indices are not independent because some of the same data are involved in these analyses. All of the data are subject to sampling errors and other sources of variability. Performing different statistical analyses on data sets that are underlain by some of the same data increases the likelihood that at least one index, purely by chance, will suggest a moderate or large impact level.

40-aaaaa-AE

Response: *River-wide indices are weighted by the volume (FSS) or area (BSS) sampled within each river segment. River Segment 4 is one of the smaller weighted segments, and its contribution to the population trends is greatly diluted in the river-wide analysis. So although River Segment 4 data are included in the river-wide analysis, the two analyses are uncorrelated. This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment indicates that NRC staff used statistical criteria to define instability for classifying impact levels as small, moderate, or large. Defining instability in a different way could change the conclusions.

40-bbbbb-AE

Response: *Changes to the decision rules associated with population trend line of evidence discussed in an earlier comment response.*

The following comment indicates that NRC provided no rationale for truncating all Hudson River data sets used in its analysis to a common length of 27 years.

40-ddddd-AE

Response: *Decisions concerning the truncation of the Hudson River data sets were based on the sampling design. The intent was to create a standardized set of information that could be used to compare across years. No change.*

The following comment indicates that NRC staff used a visual inspection of pre- and post 1985 Fall Shoals Survey (FSS) data and relative agreement between FSS and Beach Seine Survey (BSS) data to determine whether to analyze the FSS data set as a single or separate time periods. The differences in patterns were not apparent.

40-eeeee-AE

Response: *To address this comment, the NRC staff has employed a nonparametric sign test to test for differences in abundance patterns with respect to the gear change that occurred during the FSS. In addition, figure symbols associated with Appendix I, Section I.2.1 have been modified to improve clarity.*

The following comment indicates that, when NRC staff's regression analysis did not converge, NRC sometimes attempted to achieve convergence by eliminating outliers, even though there the staff had no independent reason to suspect that the data point was not a valid observation of abundance. Discarding an outlier point may help the algorithm converge to a solution that appears to be statistically significant even though in reality a significant trend is not present.

40-fffff-AE

Response: *NRC Staff presented the analyses in the draft SEIS with and without the outliers and found no differences in the conclusions. This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment indicates that the analytical software NRC staff used to estimate trend lines apparently provides little opportunity to adjust the solution of the algorithm by changing initial values, search methods, step sizes, or convergence criteria. Using software that allows the statistician to fine-tune the algorithm would have been preferable to discarding outlier data points in order to achieve convergence.

40-ggggg-AE

Response: *The software chosen by the NRC Staff (PRISM Version 4) is specifically designed to perform nonlinear estimations. The Staff believes the choice of this software is appropriate for its intended use. NRC Staff has provided a table of initial values in the FSEIS so others can reproduce the information contained therein.*

The following comment indicates that trend estimates, mean square error (MSE), and statistical probabilities for the segmented regression used by NRC staff are not necessarily unique. The comments attempt to duplicate the analyses that NRC staff used on the abundance index data set and produced the same results as NRC staff achieved for some data sets but not others. The differences suggest that NRC's selection of either the linear or segmented regression based on which method achieved the lowest MSE

may not always have been correct. It is not clear that this would lead to different impact classifications for any of the data sets, but a potential for different results exists.

40-hhhhh-AE

Response: *NRC staff has provided a table of initial values in the FSEIS so others can reproduce the information contained therein. The NRC staff has evaluated the sensitivity of the initial values to the results and presented the information in the final SEIS, Appendix I, Section I.2.1.*

The following comments indicate that the effect of using a proportional rank abundance in the strength-of-connection analysis is to reduce the assigned level of impact on abundant, commonly-caught fish.

140-c-AE; 140-tt-AE

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the DSEIS, the NRC Staff developed an alternative approach to assessing strength-of-connection that does not rely on proportional rank abundance. Information of this alternative analysis is found in the final SEIS, Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4.*

The following comments indicate that another effect of using a proportional rank abundance in the strength-of-connection analysis is that each species in not fairly assessed on its own merits.

40-nnn-AE; 128-h-AE/AL; 140-c-AE; 140-d-AE; 140-e-AE; 140-tt-AE

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, NRC staff developed an alternative approach to assessing strength-of-connection that does not rely on proportional rank abundance. Information concerning this alternative analysis is found in the final SEIS, Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4.*

The following comment indicates that the effect of using a proportional rank abundance in the strength-of-connection analysis when tested with a Monte Carlo simulation is to increase the probability that at least one species would erroneously be assigned a large strength of connection level.

40-iiiii-AE; 40-rrrrr-AE

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, NRC staff developed an alternative approach to assessing strength-of-connection that does not rely on proportional rank abundance. Information concerning this alternative analysis is found in the final SEIS, Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4*.

The following comments indicate that NRC staff used two comparisons of fish densities in the strength-of-connection analysis: impingement density vs. river density in river region 4 and entrainment density vs. river density in river region 4. Data used to make such comparisons must be consistent, and NRC staff used inconsistent or inappropriate data. An alternative method that resolves the inconsistencies results in all species having a moderate strength of connection (where adequate data allow calculation).

40-iiiii-AE; 40-sssss-AE

Response: *NRC Staff addressed these inconsistencies based on new information provided by Entergy in its comments on the DSEIS. The staff revised the final SEIS, Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4 to reflect the incorporation of this new information.*

The following comments indicate that the strength-of-connection analysis relies on an unsubstantiated and unproven assumption that the cooling water system has no impact on invertebrate species that are prey to fish. This assumption affects analyses of impingement, entrainment, and heated discharge water and makes low to moderate levels of impacts for most species almost inevitable.

140-e-AE; 140-tt-AE; 140-yy-AE

Response: *The GEIS addresses impacts to invertebrates from nuclear plant operations and concludes that the level of impact is small. No site-specific information was available for Indian Points Units 2 and 3. Based on comments on the DSEIS, the NRC Staff developed an alternative approach to assessing strength-of-connection that does not rely on the indirect effects of the loss of prey on predator species. Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4 have been revised in the final SEIS to reflect these changes.*

The following comment indicates that the strength-of-connection line of evidence used by NRC staff includes measures relating to the impingement and entrainment of fish species that are prey of the Representative Important Species. The NRC staff supports the claim using literature citations. The literature supports a conclusion that such indirect effects are possible but not certain. Because of high uncertainty concerning indirect effects of prey entrainment, NRC should assign the measure a lower weight.

40-uuuuu-AE

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC Staff developed an alternative approach to assessing strength-of-connection that does not weight the indirect effects of prey entrainment or impingement. Information concerning this alternative analysis is found in the final SEIS, Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4.*

The following comment indicates that NRC staff asserts that the loss of prey can have a large impact on predator species, while papers cited by NRC do not substantiate this assumption.

40-n-AE/ED; 40-mmm-AE; 40-uuu-AE; 40-uuuuu-AE

Response: The NRC staff cited papers in the final SEIS Section 4 and Section H.1.3 that show that loss of prey can affect predators.

The following comment indicates that the NRC staff calculated entrainment and impingement density metrics as the number of organisms divided by the number of samples instead of by water volume withdrawn. The metrics are confounded by interannual variation in sampling effort independent of the volume withdrawn.

40-sssss-AE

Response: *Based on new information provided by Entergy in its comments on the DSEIS, the NRC Staff developed an alternative approach to calculating the density of entrainment or impingement that removes the confounding of interannual variation in the volume of water withdrawn and sampling effort. Information concerning this alternative approach is found in the final SEIS Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Appendix I, Section I.2.2, Analysis of Strength of Connection.*

The following comment indicates that the draft SEIS treats impingement and entrainment as equally likely to affect aquatic resources, but available information demonstrates that impingement impacts are relatively insignificant. Conflating the assessments of entrainment and impingement substantially overstates the impacts of impingement on the Hudson River fish community. Impingement and entrainment should be analyzed separately because impingement impacts are Small for all representative and important species post screen installation. Both NYSDEC and USEPA accepted screens as the best technology available in 1993. An agreement was drafted to include verification monitoring, but River Keeper did not sign it, and thus, the owners were under no obligation to perform the verification monitoring.

40-ee-AE/OE; 40-wwww-AE

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC Staff developed an alternative approach to assessing strength-of-connection that does not weight the effects of entrainment or impingement. Information concerning this alternative analysis is found in Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4.*

The following comment indicates that NRC has confused mortality and survival rates of fish impinged on the Ristroph screens.

128-h-AE/AL

Response: *The text of the final SEIS has been corrected.*

The following comment asks about the origins of bluefish impingement mortality rate data.

128-h-AI/AL

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC staff revised the strength of connection analysis in the final SEIS, and the estimates of CIMR used in revised analysis account for impingement survival. Information of this alternative analysis is found in Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4.*

The following comment indicates that ConEd and NYPA (1992) reported mortality rates for rainbow smelt impinged on Ristroph screens.

128-h-AE/AL

Response: *Impingement survival (96 h) for rainbow smelt was estimated in 1978 from 2 fish collected at IP1 as 0% survival (Texas Instrument Inc. 1979) and again in 1985 from 135 fish collected at IP2 as 85.7% survival (Consolidated Edison Co. 1985). The reference in the comment (NYPA 1992) was not complete and the NRC staff could not locate it. The NRC staff* *revised the strength of connection analysis in the final SEIS, and the estimates of CIMR used in revised analysis account for impingement survival. See the final SEIS, Appendix I, Section I.2.2, Analysis of Strength of Connection for further details.*

Literature Cited in Response

Consolidated Edison Company of New York, Inc. 1985. Biological Evaluation of a Ristroph Screen at Indian Point Unit 2. Prepared by Consolidated Edison Company of New York, Inc., New York, New York.

Texas Instruments, Inc. 1979. Collection Efficiency and Survival Estimates of Fish Impinged on a Fine Mesh Continuously Operating Traveling Screen at the Indian Point Generating Station for the Period 8 August to 10 November 1978. Prepared for Consolidated Edison Company of New York, Inc., New York, New York. Prepared by Texas Instruments, Inc., Science Services Division, Dallas, Texas.

The following comment indicates that the draft SEIS accurately characterizes the methods used to monitor impingement losses at IP2 and IP3 but does not fairly characterize the efforts made at IP2 and IP3 to develop, demonstrate, and install effective technologies for minimizing impingement losses.

40-d-AE; 40-ll-AE/ED; 40-wwww-AE

Response: The *NRC staff's intent is to provide an overview of the efforts made at IP2 and IP3 to minimize impingement losses, not to describe in detail the entire process or its history. Because the information provided in this comment is available in the Final SEIS, it will be publicly available and assessable. No changes were made in response to this comment.*

The following comments indicate that the NRC staff reviewed but did not apply Fletcher's survival estimates for Ristroph screens and fish return system to adjust impingement loss totals based on the rationale that no verification modeling or validation of the installed system had been performed. Application of those survival estimates to estimated impingement losses would reduce the estimated impingement losses.

40-cc-AE/ED/OE; 40-yyy-AE; 40-zzz-AE; 40-xxxx-AE

Response: *The NRC Staff did not use the Fletcher's preliminary estimates in the draft SEIS because they were not validated through full-scale field tests. Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC staff developed an alternative approach that incorporates Fletcher's preliminary estimates as part of conditional mortality rates in the strength of connection. Information of this alternative analysis is found in Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4.*

The following comment indicates that, because entrainment sampling was inconsistent over years, only weeks 18-32 should be used.

40-vvvvv-AE

Response: *Some taxa were mainly caught during weeks 1-16 and, to maintain that information, the staff used all entrainment sampling weeks in the final SEIS analysis.*

The following comment indicates that the Representative and Important Species (RIS) analyzed in the draft SEIS appear to be those whose abundance and distribution were detailed in the 1999 DEIS prepared by the Hudson River utilities (CHGEC et al. 1999). That list is broader than the original “Resident Important Species” [no reference given]. Expansion of the analysis to include additional species that are not typically subject to impingement and entrainment at IP2 and IP3 increases the chances of false positive instances of large impact levels.

40-p-AE; 40-zzzz-AE

Response: *These comments are correct that the NRC staff used the list of RIS from the 1999 DEIS. NRC staff believes that the RIS should include a broad range of physiologies, trophic relationships, body sizes, migratory behaviors, commercial values, recreational interests, ecological services, and other characteristics in order to best represent the aquatic resources of the Hudson River. No changes have been made as a result of this comment.*

The following comments indicate that Appendix D of Entergy’s Biology Team Report contains an extensive and complicated analysis based on the NRC staff’s weight-of-evidence analysis with eight major changes to assumptions and methodology.

40-q-AE/OE; 40-ff-AE; 40-mmm-AE; 40-ppp-AE/CE; 40-vvvv-AE; 40-jjjjj-AE; 40-kkkkk-AE; 40-ttttt-AE

Response: *The eight major changes suggested in the comment are presented below along with the the NRC staff’s response:*

1. Elimination of inconsistencies in the trends analysis and in analysis of diet preferences for some RIS.

> *The NRC Staff believes this comment refers to the strength of connection analysis, not the trend analysis. Based on new information provided by Entergy in its comments (and the comments of others) on the draft SEIS, the NRC Staff developed an alternative approach that uses impingement and entrainment data to provide ancillary information concerning the strength of connection*

2. Reweighting of the lines of evidence used in the population trends analysis to account for the fact that river-wide abundance trends are more relevant measures of population status than are abundance trends in the immediate vicinity of IP2 and IP3.

> *This comment refers to providing more weight to the river-wide population trend data and less to the River Segment 4 data. The NRC staff believes that impacts to fish species closest to the plant are the most biologically relevant, because as distance from the plant increases, the effects associated with the plant are more difficult to discern. The staff modified the analysis to remove coastal commercial and recreational trends from the population trend analysis and to use those data as ancillary trend information. See final SEIS Appendix H, Section 1.3 Combined Effects of Impingement and Entrainment and in Chapter 4.*

3. Adjustment of the population trends WOE scores for marine species to account for the fact that many or most members of these populations never enter the Hudson River and are not susceptible to entrainment or impingement at IP and IP3.

Juvenile forms of marine migratory species are part of the Hudson River ecosystem and were the primary focus of the trend analysis. No changes were made to the FSEIS.

4. Reweighting of the lines of evidence used in the strength of connection (SOC) analysis to account for the low impact of impingement relative to entrainment (section 2 of this report) and the high uncertainty associated with predictions concerning the importance of indirect effects.

Based on new information provided by Entergy in its comments (and the comments of others) on the DSEIS, the NRC staff developed an alternative approach that uses impingement and entrainment data to provide ancillary information concerning the strength of connection. Information concerning this alternative analysis is found in Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment and in Chapter 4.

5. Inclusion of the attribute scaling factors developed by Menzie et al. (1996) to accord more weight to attributes that are closely related to determination of causation.

Menzie et al. (1996) suggested that attributes may or may not be scaled: "The 11 attributes can either be assigned equal importance or they can be scaled to reflect their relative importance in weighting measurement endpoints." No changes were made to the FSEIS.

6. Inclusion of the "availability of objective measures" attribute from Menzie et al. (1996) to accord more weight to attributes that directly measure quantities of interest for impact assessment.

As noted in the technical information provided with the comment, this attribute would be scored equally for each measurement and would not alter the final weights. No changes were made to the FSEIS.

7. Modification of the impact category assignment scheme to eliminate a bias inherent in the scheme used in the DSEIS.

The NRC staff set up the 1, 2, 4 weighting and decision rules to give more weight to a large impact (if it occurred). No changes were made to the FSEIS.

8. Addition of two additional lines of evidence to the SOC analysis, to more directly address direct and indirect impacts of entrainment and impingement on Hudson River fish populations.

Based on new information provided by Entergy in its comments (and the comments of others) on the DSEIS, the NRC staff developed an alternative approach that uses impingement and entrainment data to provide ancillary information concerning the strength of connection. This approach incorporated elements of conditional entrainment mortality rate (CEMR) and conditional impingement mortality rate (CIMR) in the assessment.

The following comments indicate that the approach used by Entergy's consultants in their Adverse Environmental Impact (AEI) Report is more scientifically rigorous and defensible and provides a stronger foundation for environmental decision-making than the NRC staff's weight of evidence (WOE) approach.

40-z-AE; 40-bb-AE/ED; 40-uu-AE; 40-kkkkk-AE; 40-lllll-AE

Response: *Entergy's consultants' AEI Report (Barnthouse et al. 2008) used an approach with multiple lines of evidence and population trend analyses. In their comments on the draft SEIS, Entergy's consultants (Barnthouse et al 2009) compared their AEI approach with the NRC staff's WOE approach showed similarities and differences, and presented an alternative WOE approach to that used by the NRC staff. Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC revised the Weight of Evidence approach in the final SEIS to include improved data and an improved WOE approach that addresses comments submitted by Entergy's consultants and others. The NRC staff believes that its WOE approach provides an independent, strong, and scientifically rigorous and defensible analysis that fulfills the needs of NEPA and NRC's regulations.*

Literature Cited in Response

Barnthouse, L.W., D.G. Heimbuch, W.V. Winkle, and J. Young. 2008. Entrainment and Impingement at IP2 and IP3: A Biological Impact Assessment. Prepared for Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 and 3. January 2008. ADAMS Accession No. ML083360704.

Barnthouse, L.W., D.G. Heimbuch, M. Mattson, and J.R. Young. 2009. Review of NRC's Impingement and Entrainment Impact Assessment for IP2 and IP3. March 2009. ADAMS Accession No. ML080390059.

The following comment indicates that only 7 of the 11 attributes defined by Menzie (1996) were used in WOE analysis and all had equal weight.

40-vvvv-AE

Response: *The strengths of the WOE analysis proposed by Menzie et al. (1996) include flexibility and adaptability, and those authors discuss use of alternate attributes and equal weighting. NRC explains its use of attributes, weighting, and rational for weighting in Appendix H.*

The following comment indicates that an alternative WOE approach including a CMR based determination of causation would be preferable.

40-vvvv-AE

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC revised the Weight of Evidence approach in the final SEIS to now include CMR.*

The following comments indicate that Indian Point must do as little damage as possible to an already stressed system, and thus minimize cumulative impacts.

140-z-AE/CI; 140-vv-AE; 140-ww-AE/CI

Response: *The cumulative impacts analysis in the final SEIS describes the impacts of IP2 and IP3 when added to or interacting with other effects in the Hudson River over the period of license renewal.*

The following comment indicates that the Pisces (2007) report on entrainment, impingement, and thermal impacts shows that Indian Point's operation caused temperature increases that have had significant effects on aquatic life.

140-I-AE

Response: *The NRC staff's conclusion in the final SEIS includes this possibility in the range of impact levels.*

The following comment indicates that the applicant failed to demonstrate that it meets New York State's water quality standard for thermal impacts or that it has received a waiver pursuant to Clean Water Act 316(a).

128-j-AE

Response: *Permitting and enforcement of these matters are under the jurisdiction of New York State. This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment indicates that the NRC staff has no basis to reach different conclusions than the State of New York on thermal impacts from the discharges of Indian Point.

128-j-AE; 128-l-AE

Response: *The NRC staff's analysis and conclusions are presented for the purposes of satisfying NEPA with regard to the NRC decision regarding whether to renew the Indian Point operating licenses. The State of New York holds permitting power for the facility with regard to regulating facility discharges under the Clean Water Act. NRC assessments for NEPA purposes do not supersede judgments by the State of New York. The NRC staff notes that Indian Point continues to operate under a SPDES permit originally issued in 1987, and that New York State has yet to issue a new permit that reflects its expressed concerns regarding impact levels. The NRC staff has re-examined the data used to limit the range of impact levels and expanded the range of possible thermal impact levels to include large, which is the conclusion reached by New York State and DOI in their comments. For details, see final SEIS, Section 4.1.4.5, NRC Staff Assessment of Thermal Impacts.*

The following comment indicates that the NRC staff has reported the conclusory misstatements of the applicant in regard to thermal impacts.

128-m-AE

Response: *In the section referred to by this comment, the staff describes the history of thermal effluent compliance, not assessing impact Impacts are assessed elsewhere in the SEIS. This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment indicates that language in the draft SEIS at page 2-35 regarding tidal conditions and thermal plume should be changed.

40-rrrr-AE

Response: *This comment refers to Section 2.2.5.1, the Hudson River Estuary, which is a general description of the estuary. The change would add more detail, but would not* *substantively change the description. This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment indicates that language in the draft SEIS or biological assessment concerning shortnose sturgeon and CORMIX modeling of Indian Point's thermal plume should be changed.

40-mm-AE; 40-jjj-AE; 40-ssss-AE

***Response**: These comments refer to a review of historical studies in Section 4.1.4.3, Thermal Studies and Conclusions, and suggest a re-analysis of historical study results. The purpose of this section is to present a historical perspective and not to reanalyze the original authors' work. These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment indicates that draft SEIS language at page 4-25 regarding application of CORMIX modeling to the thermal plume should be changed. This would change the conclusion on level of impact for thermal impacts from "small to moderate" to "small."

40-e-AE; 40-y-AE; 40-nn-AE; 40-eeee-AE; 40-ffff-AE; 40-tttt-AE; 40-uuuu-AE; 40-bbbbbb-AE

***Response:** In its comments on the DSEIS, New York State DEC, the agency that permits thermal effluents in New York, stated that insufficient information is presently available to limit the range of thermal impact levels to small to moderate and concluded that a large level of impact could not be excluded. The NRC staff agrees that large impacts cannot be excluded and has modified its conclusions in Section 4.1.4.3, Thermal Studies and Conclusions to account for a range of small to large impact levels. The staff notes that the inclusion of a reference to New York State's thermal study requirement, which Entergy indicates applies to other power plants as well as Indian Point, was not intended to indicate that the Indian Point facility is not in compliance with the conditions of its SPDES permit.*

The following comment indicates that, because shortnose sturgeon, which is listed under the Endangered Species Preservation Act, has a slow maturation process and females do not spawn every year, any impacts to the population will be noticeable.

140-m-TS

***Response:** In general, NRC staff agrees that long time periods are required to detect population-level impacts to long-lived and slowly-maturing species. The staff believes it based its analysis on the best data available at this time.*

The following comment indicates that the NRC staff should use the best available scientific and commercial data to assess impacts to the endangered shortnose sturgeon. Data to assess impacts are in fact limited. The conclusion of Small to Large for shortnose sturgeon is not adequate. The staff needs to estimate the effects of impingement.

140-n-TS; 128-p-TS; 140-q-TS

***Response:** The NRC staff found inconsistencies in the shortnose sturgeon impingement data submitted to it by Entergy prior to publishing the draft SEIS. As a result, NRC staff requested* *that Entergy provide improved data (lacking the errors in earlier Entergy data) to NRC. Those data, which are the best available and more closely match the NMFS data, are included in Section 4, Appendices H and I, and a revised biological assessment.*

The following comment indicates that the NRC staff had conflicting data from Entergy and NMFS on impingement of the endangered shortnose sturgeon.

40-qq-AE/ED; 140-o-TS

Response: *NRC found inconsistencies in the shortnose sturgeon impingement data sent to it by Entergy. Those data appear in the draft SEIS exactly as NRC received them from Entergy. As a result, NRC requested that Entergy send improved data (lacking the errors in earlier Entergy data) to NRC. Those data, which more closely match the NMFS data, are included in the final SEIS as the best available data.*

The following comment indicates that NRC simply noted that it had insufficient data to assess the effects of Indian Point operation on the endangered shortnose sturgeon instead of gathering data support a decision.

140-q-TS

Response: *New York State DEC, not NRC, is responsible for impingement and entrainment sampling as part of SPDES permitting. The NYSDEC may require additional entrainment and impingement monitoring, should it deem such sampling necessary. In addition, NMFS, not NRC, can require monitoring of endangered species under Section 7 of the Endangered Species Act if it finds such monitoring necessary.*

The following comment indicates that Indian Point Units 2 and 3 require an incidental take statement to comply with the Endangered Species Act.

140-r-TS

Response: *As summarized by the NRC staff in its biological assessment for shortnose sturgeon, the latest biological opinion for IP2 and IP3, conducted in 1979 by NMFS, did not require an incidental take statement. NMFS retains the authority to impose additional conditions as a result of ongoing consultation should it deem them necessary.*

The following comment indicates that NRC lacks the data to provide sufficient support for conclusions regarding the Atlantic sturgeon, which is a candidate species for listing under the Endangered Species Act, and other species.

128-p-TS; 140-t-TS

Response: *NRC found inconsistencies in the sturgeon impingement data it received from Entergy prior to the publication of the draft SEIS. After the NRC published the draft SEIS, Entergy submitted updated data to the NRC, and those data, which are the best available and more closely match the NMFS data, are included in Chapter 4, as well as Appendices H and I.*

The following comments indicate that the SEIS should contain summaries of life cycles of shortnose and Atlantic sturgeon in the Hudson River, as well as detailed explanations of impingement sampling of shortnose and Atlantic sturgeon at Indian Point from 1975 through 1990.

40-mmmmm-AE, 40-yyyy-AE

Response: *The SEIS and biological assessment contain this information.*

The following comments indicate that the correct number of sturgeon impinged from 1981 through 1990 equals the number counted in sampling each year as presented in the 1999 DEIS.

40-gg-AE; 40-nnnnn-TS, 40-ooooo-TS, 40-yyyy-AE

Response: *The NRC staff in the draft SEIS presented sturgeon impingement data exactly as Entergy provided them in response to the staff's requests. After NRC published the draft SEIS, Entergy supplied NRC revised data, which NRC presents in the final SEIS.*

The following comments express concern with the data on shortnose sturgeon impingement and indicate that it appears odd that nearly all impingement of shortnose sturgeon occurred in two years. There are several years that have no reported data at all. The data are self-conflicting and do not present a complete, accurate, and current illustration of the status of impinged sturgeon.

40-nnnnnn-TS;
140-n-TS; 140-o-TS; 140-p-TS; 140-q-TS

Response: *The NRC staff found inconsistencies in the shortnose sturgeon impingement data that was submitted by Entergy. After NRC published the draft SEIS, NRC staff requested improved data from Entergy. Those data, which are the best available and more closely match the NMFS data, are included in the final SEIS Chapter 4, Appendices H and I, and the revised biological assessment.*

The following comments indicate that the biological assessment for the endangered shortnose sturgeon is incomplete and therefore the draft SEIS is incomplete.

128-o-TS, 128-p-TS

Response: *The biological assessment submitted to NMFS with the draft SEIS reflected the best available data at that time. A revised biological assessment is being sent to NMFS along with the NRC's final SEIS. Consultation under the Endangered Species Act may continue.*

The following comment indicates that the essential fish habitat assessment is incomplete and therefore the DSEIS is incomplete.

128-q-AE

Response: *The essential fish habitat assessment has been completed and sent to NMFS.*

The following comments indicate that the NRC staff ignored New York State's findings on aquatic impacts, that the NRC should defer to the responsible permitting authority, and that the NRC's assessment is a direct contradiction to the State's assessment.

128-e-AE; 128-f-AE; 132-f-AE; 140–h-AE; 140-i-AE; 140-j-AE

Response: *The NRC staff assesses environmental impact levels in relation to NEPA and the NRC's regulations, which may have different purposes and requirements than New York State's regulations. The assessments and conclusions made by NRC staff in fulfilling the requirements of NRC and NEPA regulations do not supersede any regulatory decisions made by the State of New York.*

The following comment indicates that the NRC staff's assessment of a large impact on Hudson river bluefish is contrary to observations that very few adult bluefish are impinged, few if any bluefish eggs and larvae have ever been entrained, and survival of adult bluefish of the intake screens in likely very high.

40-c-AE; 40-hh-AE; 128-h-AE/AL

Response: *Based on comments on the draft SEIS and new and revised information provided by Entergy, the NRC Staff developed an alternative approach to assessing strength-of-connection. Information of this alternative analysis is found in Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and in Chapter 4*. The NRC staff revised the levels of impact for bluefish and other Hudson River species in the final SEIS based on the revised methodology.

The following comment indicates that NYSDEC believes that the impact level from continued operation of Indian Point's cooling water system should be large for striped bass, white perch, and Atlantic tomcod based on population trends, likelihood of impinging young-of-the-year, likelihood of reducing a food resource, and historical impingement and entrainment data collected at IP2 and IP3.

128-h-AE/AL

Response: *NRC staff assesses environmental impact levels in relation to NRC's regulations, which may have different requirements than New York State's regulations. The aquatic resources impact assessment in the final SEIS uses the best available data and a weight of evidence approach that encompasses two lines of evidence, each made up of several measures. The NRC staff's assessment and conclusions do not supersede the State of New York's authority to implement and enforce standards under the Clean Water Act.*

The following comment indicates that impacts to fish populations should cause the NRC staff to propose closed cycle cooling at Indian Point.

128-h-AE/AL

Response: *New York State DEC is responsible for insuring that intake and discharge structures comply with requirements of the Clean Water Act. New York State has indicated that closed-cycle cooling would be preferable, but has not required that Indian Point convert to closed-cycle cooling.*

The following comment indicates that New York State has been collecting and analyzing data for decades, and the NRC staff's recent analysis of aquatic impacts cannot supplant NYSDEC's analysis.

128-g-AE

Response: *The NRC staff assesses environmental impacts in relation to NEPA and NRC's regulations, which may have different purposes and requirements than New York State's regulations. The NRC staff's analysis does not supplant NYSDEC's analysis.*

The following comments assert that the SEIS does not assess the effects of radionuclides released from IP2 and IP3 in groundwater and food web accumulation on aquatic biota, including the shortnose sturgeon:

140-s-TS; 140-z-AE/CI

Response: *As part of NRC's operating reactor oversight program, the NRC staff performed independent sampling and analysis of environmental media related to the leaks of radioactive water from the spent fuel pools 2008. The NRC conducted an independent analysis of groundwater, Hudson River water, and fish during its inspection of IPEC's actions in response to the leaks. The following two key findings related to human health are also presented in the Chapter 2 of the SEIS. The first specifically addresses radiation levels identified in fish sampling, and the second addresses human exposures through fish consumption.*

1) "Currently, there is no drinking water exposure pathway to humans that is affected by the contaminated groundwater conditions at Indian Point Energy Center. Potable water sources in the area of concern are not presently derived from groundwater sources or the Hudson River, a fact confirmed by the New York State Department of Health. The principal exposure pathway to humans is from the assumed consumption of aquatic foods (i.e., fish or invertebrates) taken from the Hudson River in the vicinity of Indian Point, that has the potential to be affected by radiological effluent releases. Notwithstanding, no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations."

2) "The annual calculated exposure to the maximum exposed hypothetical individual, based on application of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Release of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I," relative to the liquid effluent aquatic food exposure pathway is currently, and expected to remain, less than 0.1% of the NRC's "As Low As is Reasonably Achievable (ALARA)" guidelines of Appendix I of Part 50 (3 mrem/yr total body and 10 mrem/yr maximum organ), which is considered to be negligible with respect to public health and safety, and the environment."

The complete discussion of NRC actions and its inspection are contained in the NRC inspection report dated May 13, 2008. The full report is available to the public through the ADAMS electronic reading room on the NRC's website (www.NRC.gov). The ADAMS accession number for the inspection report is ML081340425.

In addition to the 2008 inspection report, IP2 and IP3 conduct a radiological environmental monitoring program (REMP) in which radiological impacts to the environment and the public are monitored, documented, and compared to NRC standards. Entergy summarizes the results of its REMP in an Annual Radiological Environmental Operating Report, and NRC reviews these reports. The reports are publicly available on the NRC's public website. The IP2 and IP3 REMP enables the identification and quantification of changes in the radioactivity of the area and to measure radionuclide concentrations in the environment attributable to operations at the IP2 and IP3 site.

The REMP samples environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. Within the REMP, the waterborne pathway consists of measurements of Hudson River surface water, fish and invertebrates, aquatic vegetation, bottom sediment, and shoreline soil.

While neither the 2008 inspection report process nor the REMP specifically sampled the shortnose sturgeon – an endangered and thus protected species – the inspection report *examined – and the REMP continues to examine – radionuclide levels in other fish and aquatic species.*

The comment does not present any significant new information and no change has been made to the final SEIS.

The following comment indicates that the NRC staff did not include data or assess impacts associated with operation of Indian Point Unit 1.

140-q-TS

Response: *Indian Point Unit 1 (IP1) no longer operates and is in a condition known as SAFSTOR. The subject of this SEIS is Entergy's application to renew the operating licenses of IP2 and IP3 for an additional 20 years of operation beyond the term of the original licenses. IP1 operated from September 1962 through October 1974, and so affected the Hudson River aquatic resources before the start of the long-term ecological sampling programs used to assess environmental impacts in this SEIS.*

The following comment indicates that some aspects of the methodology used by the NRC staff for assessing impact to aquatic resources were unclear in the draft SEIS and were clarified only during a conference call with NRC staff and consultants.

40-ppppp-AE

Response: *In the draft SEIS, the NRC staff presented methods, sources of data, assumptions, and conclusions in Appendices H and I, and summarized them in Chapter 4. Based on new information provided by Entergy in its comments and the comments of others on the DSEIS, the NRC Staff modified its approach for assessing the aquatic population trends and strength-of-connection lines of evidence. The revised methods are shown in Chapter 4 and Appendices H and I of this final SEIS.*

The following comments indicate that two types of errors could occur in the methodology used by NRC to classify aquatic impacts into small, moderate, and large: identifying a potential impact when none actually exists and failure to identify a potential impact when in fact it does exist. The DSEIS provides no discussion of these types of errors or the relative degree of protection the classification process provides against each type.

40-qqqqq-AE; 40-ccccc-AE

Response: *Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC revised the Weight of Evidence approach in the final SEIS and taken the decision rule process used in the draft out of the probabilistic-testing scenario, which makes this question less relevant.*

The following comment indicates that the US Fish and Wildlife Service is unable to concur with the determination that continued operation of IP2 and IP3 are not likely to adversely affect Indiana bats as NRC staff has not provided information on how the project may indirectly affect Indiana bats and their forage area.

139-a-TS

Response: *The NRC staff has added information to Section 4.6.2, Terrestrial Threatened or Endangered Species.*

The following comments indicate that studies should be done to confirm whether endangered Indian bats or threatened bog turtles live on the site and what impacts continued operation of IP2 and IP3 would have on these protected species.

97-b-TS; 97-j-OE/TS; 149-e-TS

Response: *The applicant has stated that no expansion of existing facilities or disturbance of forest or other land on the site would occur during the renewal period. The NRC staff believes that the lack of planned changes suggests that no new impacts would occur. In addition, site area does not have suitable habitat for the bog turtle, and bog turtles have not been reported in the region of Westchester County near the IP2 and IP3 site. The NRC staff concluded that bog turtles were not likely to occur on the site. These conclusions are stated in Section 4.2.2 of the draft SEIS, and so NRC staff made no change to that text in the final SEIS.*

The following comments indicate disagreement with the criteria used by NRC to assess impacts to aquatic resources. The levels of impact "small," "moderate," and "large" are subjectively defined and lack metrics. Because these criteria are subjectively defined, it is difficult to objectively evaluate cumulative impacts for any alternative, and it is difficult to objectively evaluate dissimilar impact categories (e.g., air quality, terrestrial ecology) in order to compare alternatives.

40-mmm-AE; 139-c-AE; 139-f-AL/AR

Response: *These impact levels are currently part of the NRC's environmental regulations, promulgated through a public rulemaking process. In the rulemaking process, NRC staff solicited public and agency comments. The impact levels cannot be changed by NRC staff within this proceeding.*

The following comment indicates that the NRC staff's weight-of-evidence approach is insufficiently protective of fishery resources and underestimates the potential effect of Indian Point on these fish. Although population level impacts are an appropriate measure of ecological effects, populations are difficult to sample and population trends may be difficult to measure

139-d-AE

Response: *The NRC staff believes that fishery resources are adequately addressed because the RIS it examined include a broad range of physiologies, trophic links, body sizes, migratory behaviors, commercial values, recreational interests, ecological services, and other characteristics in order to best represent the aquatic resources of the Hudson River. In its draft and final SEIS, NRC staff conducted a thorough weight-of-evidence analysis of impact levels on the RIS in relation to definitions of impact in NRC regulations. The NRC regulations define impact in terms of resource stability, not just numbers affected. Based on new information provided by Entergy in its comments and on the comments of others on the draft SEIS, the NRC Staff modified both the population trend and strength-of-connection lines of evidence. Information concerning this alternative analysis can be found in Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4 of the Final SEIS.*

The following comment indicates that NRC staff used no pre-Indian Point data, which clouds data interpretation.

139-d-AE

Response: *NRC staff recognizes that comparing attributes of aquatic resources before and after operation of IP2 and IP3 could provide additional information, if such data were available. Intensive sampling of the Hudson River began only after operation of IP2 and IP3 began, however, no data for the period before the operation of IP2 and IP3 are available.*

The following comment indicates that the NRC staff concluded that adverse heat related impacts to aquatic species may be small to moderate because it did not find evidence that adverse effects were "clearly noticeable and sufficient to destabilize important attributes of an aquatic resource." DOI disagrees with this conclusion because it is based on an absence of data and is not supported by scientific evidence such as on-site studies to objectively assess plant-related thermal stress on aquatic organisms.

139-e-AE

Response: *New York State, under the Clean Water Act, sets and enforces limits for thermal discharge from IP2 and IP3. The facility currently holds a SPDES permit issued by the State of New York, and that permit is the subject of ongoing adjudicatory proceedings before the NYSDEC. The NRC staff lacks authority to require Entergy to sample for compliance with the State's SPDES permit requirements. The State sets SPDES permit requirements based in part on potential impacts to aquatic life. The NRC staff has expanded the range of possible thermal impact levels to include large, the conclusion reached by New York State and DOI in their comments. See final SEIS, Section 4.1.4.5, NRC Staff Assessment of Thermal Impacts.*

The following comment indicates that certain cold water fish species may be particularly vulnerable to temperature changes caused by thermal discharges from electrical plants like Indian Point. Atlantic tomcod and rainbow smelt are such species.

139-e-AE

Response: *This observation has been added to Section 4.1.4.5 NRC Staff Assessment of Thermal Impacts.*

The following comments object to the numbers of Hudson River fish of all life stages killed by entrainment and impingement due to operation of the once-through cooling water systems at IP2 and IP3.

3-a-AE/LE/LR; 11-b-AE; 12-b-AE; 13-b-AE; 18-c-AE; 20-c-AE/OE; 27-b-AE; 37-a-AE/OR; 40-ccc-AL/TE; 54-c-AE; 61-a-AE/AL/OR; 63-c-AE; 73-g-AE; 87-d-AE/AL; 91-b-AE; 96-I-AE/AL/RG; 97-i-AE/OL; 106-a-AE/LE/RW/SF; 122-c-AE, 123-b-AE, 126-b-AE, 132-c-AE, 141-c-AE/LE/RI, 145-e-AE/AL, 149-a-AE, 161-e-AE, 166-a-AE, 1667-a-AE; 176-b-AE; 182-b-AE/HH/RW/SF; 183-a-AE/RW/SF

Response: *The responsibility for regulating the location, design, construction and capacity of cooling water intake structures to minimize adverse environment impact at IP2 and IP3 lies with New York State and not the NRC. The NRC staff has assessed and disclosed the impacts of extending the operation of IP2 and IP3 for an additional 20 years beyond their present license terms in accordance with the National Environmental Policy Act (NEPA) and NRC's regulations. These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment contends that the majority of fish killed by entrainment and impingement are in the egg stage, so that looking just at numbers killed is misleading.

120-e-AE

Response: *In its draft and final SEIS, NRC staff conducted a thorough weight-of-evidence analysis of impact levels in relation to definitions of impact in NRC regulations. NRC regulations define impact in terms of resource stability, not just numbers affected. This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comments object to environmental effects of thermal discharges into the Hudson River due to operation of the once-through cooling water systems at IP2 and IP3.

13-b-AE; 87-d-AE; 96-I-AE/AL/RG; 96-m-AE; 97-d-AE; 97-h-AE/AL; 182-b-AE/HH/RW/SF

Response: *The responsibility insuring that thermal discharges from IP2 and IP3 meet New York State water quality criteria for protection of aquatic life lies with New York State and not the NRC. The NRC staff has assessed and disclosed the impacts of extending the operation of IP2 and IP3 for an additional 20 years beyond their present license terms in accordance with the National Environmental Policy Act (NEPA) and NRC's regulations. These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment contends that NRC addressed ecological impacts inadequately.

9-e-AE/AL

Response: *In its draft and final SEIS, the NRC staff conducted a thorough weight-of-evidence analysis of impact levels in relation to definitions of impact in NRC regulations. NRC regulations define impact in terms of resource stability. The NRC staff modified its analysis in response to comments on the draft SEIS. This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comments state that the data do not support a finding other than large for ecological impacts to aquatic resources in the Hudson River.

20-c-AE; 21-a-AE/OR/SF; 40-qqq-AE; 123-a-AE

Response: *Because NYSDEC has the regulatory authority for thermal discharges, has stated that the applicant has exceeded thermal limits in the past, and has concluded that thermal impacts could be large, the NRC staff concludes that thermal impacts could range from small to large for selected species and has revised the final SEIS to reflect this conclusion. The responsibility for requiring monitoring of entrainment and impingement at IP2 and IP3 lies with New York State and not the NRC. In describing the available data and in its analysis, NRC staff described the age of the data from each of these in-plant monitoring programs and acknowledged the shortcomings of relying on such old data. The weight of evidence approach employed by the NRC staff included two primary lines of evidence: assessment of aquatic population trends in the Hudson River and an evaluation of strength of connection (i.e., relationship of the aquatic resources to power plant operations). NRC staff used population trend data available from 1974 or 1975, depending on the sampling program, through 2005 in its assessment. It also used impingement and entrainment data available from 1975 through 1990 to determine the strength of connection. Although entrainment and impingement monitoring* *was not conducted at IP2 and IP3 after 1990, NRC staff believes that sufficient information is available to determine the strength of connection between plant operations and aquatic resources in the Hudson River These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comments indicate that other environmental impacts on Hudson River aquatic resources are more detrimental than impacts due to Indian Point or that positive impacts from Indian Point outweigh negative ones, so that negative aquatic impacts from Indian Point are comparatively insignificant.

33-a-AE/GL/LE; 113-b-AE/AL/EJ; 166-g-AE/SO

Response: *In accordance with NEPA, the NRC staff assessed the environmental impacts of license renewal for IP2 and IP3. The effects of other environmental impacts on Hudson River aquatic resources are discussed under Cumulative Impacts in the final SEIS.*

The following comments concern effects of global climate change on impacts to aquatic resources or the effects of Indian Point on climate change:

97-d-AE; 102-a-AL/OE; 102-b-AE/GL/OE; 113-h-AE/GL; 180-d-AE/AL/GL;

Response: *The NRC Staff addressed the effects of climate change on impacts to aquatic resources as part of cumulative impact assessment in Section 4.8.1.*

The following comments indicate concern about eutrophication or lack of monitoring for it.

40-w-AE/ED; 93-d-AE/MP/RG; 97-c-AE/WA

Response: *Eutrophication is commonly associated with lakes and ponds, although it may occur in rivers, particularly slow-moving rivers such as the Hudson River. Elevated temperatures from thermal discharges can exacerbate eutrophication. The responsibility for insuring that thermal discharges from IP2 and IP3 meet New York State water quality criteria for protection of aquatic life lies with New York State and not the NRC. The NRC staff has assessed and disclosed the impacts of extending the operation of IP2 and IP3 for an additional 20 years beyond their present license terms in accordance with the National Environmental Policy Act (NEPA) and NRC's implementing regulations. These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment concerns the sufficiency of thermal studies conducted in the vicinity of Indian Point to provide the data necessary to assess aquatic impact levels.

93-e-AE/RG

Response: *The responsibility insuring that thermal discharges from IP2 and IP3 meet New York State water quality criteria for protection of aquatic life lies with New York State and not the NRC. The NRC staff has assessed and disclosed the impacts of extending the operation of IP2 and IP3 for an additional 20 years beyond their present license terms in accordance with the National Environmental Policy Act (NEPA) and NRC's implementing regulations This comment does not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comments concern the impacts of Indian Point's cooling water system on or propagating through aquatic food webs or habitats.

93-f-AE; 97-c-AE/WA; 97-d-AE; 173-a-AE/EP/ST; 180-c-AE/OE

Response: *The NRC staff recognizes the importance of considering indirect effects through food webs and habitat change. The staff chose RIS that include a broad range of physiologies, trophic links, body sizes, migratory behaviors, commercial values, recreational interests, ecological services, and other characteristics in order to best represent the aquatic resources of the Hudson River. Some of these species have trophic interactions with other RIS. In addition, the analysis of cumulative impacts considers trophic interactions. These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment contends that increased predation by the increasing striped bass population in the Hudson River caused the decreases in other fish populations.

120-f-AE

Response: *The effects of environmental stressors other than operation of IP2 and IP3, including the increased striped bass population, on Hudson River aquatic resources are discussed under Cumulative Impacts in Chapter 4.*

The following comment indicates that New York State and Entergy do not have unresolved, competing views of Indian Point's impacts on aquatic resources as summarized by the NRC staff in the draft SEIS.

40-ttt-AE

Response: *Comments received by NRC staff from New York State agencies and Entergy on the draft SEIS indicate that the State and Entergy appear to have different views of Indian Point's impacts on aquatic resources.*

The following comments indicate that Entergy's analysis of aquatic impacts is based on more recent and complete data than New York State's FEIS and that NRC should afford Entergy's analysis more weight in its analysis.

40-ttt-AE; 40-uuu-AE; 40-vvv-AE

Response: *The NRC staff conducted an independent impact analysis of aquatic impacts as required by NEPA. The NRC staff's analysis is based on the most recent data as supplied by Entergy to the NRC. These comments do not present the kind of new and significant information that would warrant a change in the final SEIS.*

The following comment indicates that the NRC should have classified the impact on blue crab as small rather than unknown due to lack of data.

40-qqqq-AE

Response: *Based on new information provided by Entergy in its comments and the comments of others on the draft SEIS, the NRC staff modified the approach to assessing population trends and strength-of-connection lines of evidence. In the final SEIS, the level of impact for blue crabs is small. Information regarding this alternative analysis is found in the final SEIS, Appendix H, Section H.1.3, Combined Effects of Impingement and Entrainment, and Chapter 4.*

The following comment indicates that NRC analysis should include a listing of assumptions and analytical decisions that contribute to uncertainty and the implications of alternative assumptions.

40-qqqq-AE

Response: *The final SEIS includes a discussion of the various sources of uncertainty in the analysis.*

The following comment indicates that the data set collected by the Hudson River utilities is one of the largest ever collected on estuarine biology. The NRC staff's conclusions are not fully reflective of the available and relative information and are therefore in error.

40-aaaaaa-AE

Response*: The NRC staff recognizes that the data set collected by the Hudson River utilities is one of the largest collected on estuarine biology—particularly fish species. For this reason NRC staff elected to use an ecological risk assessment weight-of-evidence approach that examined multiple lines of evidence for a large number of representative and important species potentially affected by operation of IP2 and IP3. NRC staff also examined direct and indirect effects and cumulative effects of license renewal. NRC staff believes that the resulting analysis is sufficiently thorough and far reaching to assess impacts based on these data.*

These comments express concern about the classification of impact on bluefish as large.

40-b-AE; 40-c-AE; 40-aaaaaa-AE

Response*: As a result of updated and additional data submitted to NRC by Entergy after publication of the draft SEIS and modifications to methodology in response to technical comments on the draft SEIS, the impact of operation of IP2 and IP3 on bluefish has been revised in the final SEIS.*

The following comments indicate concern about killing shortnose and Atlantic sturgeon by entrainment and impingement due to operation of the once-through cooling water systems or concern about the lack of monitoring to determine the actual numbers of sturgeon entrained or impinged.

11-b-AE; 11-c-AE; 12-b-AE; 12-c-AE; 13-b-AE; 20-c-AE/OR; 27-c-AE; 37-a-AE/OR; 41-c-AE/LE; 44-c-AE/LE; 61-a-AE/AL/OR; 63-c-AE; 86-d-AE/AL/GL; 87-d-AE; 91-c-AE; 93-d-AE/MP/RG; 93-e-AE/RG; 93-f-AE; 97-d-AE; 97-i-AE/OL; 106-a-AE/LE/RW/SF; 126-b-AE; 141-c-AE/LE/RI; 161-e-AE; 167-a-AE; 176-c-AE; 182-b-AE/HH/RW/SF

Response: *New York State DEC, not NRC, is responsible for impingement and entrainment sampling as part of SPDES permitting. In addition, NMFS, not NRC, can require monitoring of endangered species under Section 7 of the Endangered Species Act. In the draft SEIS, the NRC staff presented sturgeon impingement data exactly as Entergy provided them. After the draft SEIS was published, Entergy submitted revised data, which the staff presents in the final SEIS and in a revised biological assessment prepared under the Endangered Species Act.*

The following comments indicate concern about assigning a small to large impact to shortnose sturgeon when the population appears to be increasing.

94-b-AE/OE; 40-ii-AE/AL/OE//TS

Response: *In the draft SEIS, the NRC staff presented sturgeon impingement data exactly as Entergy provided them. After the draft SEIS was published, Entergy submitted revised data, which the staff presents in the final SEIS, Chapter 4 and Appendices H and I and in a revised biological assessment prepared under the Endangered Species Act. Based on the revised data and methods, the NRC staff determined that the level of impact for shortnose sturgeon is small.*

The following comments indicate concern with one of several issues related to the shortnose sturgeon: (1) the problems of assessing impact or threats to endangered species when monitoring programs had been discontinued or never initiated and data sets are therefore incomplete, (2) the NRC staff's lack of definite conclusions on impacts from incomplete data, or (3) how the NRC staff expressed the uncertainties associated with impact levels for which underlying data were incomplete.

20-c-AE; 40-nnn-AE; 96-k-AE/TS; 97-d-AE; 97-i-AE; 140-a-AE

Response: *New York State DEC, not NRC, is responsible for impingement and entrainment sampling as part of SPDES permitting. NMFS, not NRC, can require monitoring of endangered species under Section 7 of the Endangered Species Act. In the draft SEIS, the NRC staff presented sturgeon impingement data exactly as Entergy had provided them. After the draft SEIS was published, Entergy submitted revised data, which the staff presents in the final SEIS and in a revised biological assessment prepared under the Endangered Species Act.*

The following comments indicate that NMFS, in 1979, concluded that the effect of entrainment and impingement of shortnose sturgeon by Indian Point would have a negligible effect on the population. Subsequently, IP installed devices to reduce impingement mortality. The Hudson River population of shortnose sturgeon appears to be growing. The observations indicate that impingement and entrainment are not adversely affecting the Hudson River population of shortnose sturgeon.

40-jj-AE; 40-bbbb-TS; 40-cccc-TS; 40-qqqq-AE

Response: *The NRC staff discusses the historical mitigation efforts at IP2 and IP3 and uses the best available data in its assessment. In the draft SEIS, the NRC staff presented sturgeon impingement data exactly as Entergy had provided them. After the draft SEIS was published, Entergy submitted revised data, which the staff presents in the final SEIS, Chapter 4 and Appendices H and I and in a revised biological assessment prepared under the Endangered Species Act. Based on the revised data and comments it received, the staff has revised the level of impact for shortnose sturgeon to small.*

The following comment indicates that NRC included among protected species the Atlantic sturgeon, which is a candidate for listing under the Endangered Species Act, and bald eagle, which was recently delisted.

40-aaaa-TS

Response: *The NRC staff has changed the pertinent section headings to 4.6.1, Aquatic Special Status Species, and 4.6.2, Terrestrial Special Status Species.*

The following comments are general statements that the NRC staff has not provided a thorough and accurate analysis of all relevant potential impacts.

17-r-EP/GI/RI; 40-zzzzzz-AE; 132-a-AL/OE; 132-e-GI/LR; 132-g-GI/LR; 164-i-GL; 174-f-GI/OM; 180-C-AE/OE; 180-h-GI/OM

Response: *The Generic Environmental Impact statement for license renewal (GEIS) evaluated 92 environmental issues and, of these, 69 were found to be generic (Category 1) while 23 issues were found to require a site-specific review and analysis. Twenty-one of the site specific issues are considered to be Category 2 issues. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized and are addressed by site-specific analysis.*

Category 1 issues are termed "generic" issues because the conclusions related to their environmental impacts were found to be common to all plants. For Category 1 issues, a single level of significance was common to all plants, mitigation was considered, and the NRC determined that it was not likely to be beneficial. Issues that were resolved generically are not reevaluated in the site-specific supplement to the generic environmental impact statement on license renewal (SEIS) because the conclusions reached would be the same as in the GEIS, unless new and significant information was identified that would lead the NRC staff to reevaluate the GEIS's conclusions.

Site-specific issues (Category 2 issues) were analyzed by the applicant as part of its environmental report. The NRC staff evaluated site-specific data provided by the applicant, other Federal agencies, state agencies, Tribal and local governments, as well as information from the open literature and members of the public. From this information, the staff made a site-specific assessment of the particular issues. Its analyses and conclusions are included in the SEIS.

The following comment states that the NRC level of impact to American shad from operation of IP2 and IP3 should be small and that the NRC staff's analysis should include qualitative estimates of conditional entrainment and impingement mortality rates (CEMR and CIMR) from CHGEC (1999).

40-q-AE/OE

Response: *Based on new information provided by Entergy and others in their comments on the DSEIS, the NRC Staff developed an alternative approach that uses impingement and entrainment data to provide ancillary information concerning the strength of connection. This assessment approach incorporates elements of CEMR and CIMR.*

The following comment states because the draft SEIS does not describe the basis of the health advisory for eating flesh of white catfish from the Hudson River, the final SEIS should say that "there is no relation between the health advisory and Indian Point."

40-r-AE/OE

Response: The *NRC staff reported the health advisory and did not state or imply any relation between the health advisory and the operation of IP2 and IP3. No change has been made to the SEIS.*

The following comment states that the FSEIS should cite Bath and O'Connor's (1985, New York Fish and Game Journal) paper on food selection of Hudson River white perch and say that "no evidence has been found that white perch consume other fish."

40-s-AE/OE

Response: *The U.S. Fish and Wildlife Services (Stanley and Danie 1983) finds that after white perch are 22 cm (9 inches) long, they eat fish almost exclusively. No change.*

Literature Cited in Response

Stanley, J.G., and D.S. Danie. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic -- white perch). U.S. Fish and Wild1ife Service, Division of Biological Services, FWS/OBS-82/11.7. U.S. Army Corps of Engineers, TR EL-82-4. 12 pp.

The following comment indicates the commenter's view that the NRC staff did not consider the magnitude of population effects in its analyses.

40-gg-AE

Response: The *NRC staff did consider the magnitude of population effects in its analyses. Further, based on new information provided by Entergy and others in their comments on the draft SEIS, the NRC staff revised the analysis of combined effects of entrainment and impingement to look more quantitatively at population effects.*

The following comments assert that the impact of IP2 and IP3 on the entire coastal stock of Atlantic menhaden from Florida to Maine should be small. Likewise, where the NRC staff found available site-specific data inadequate to draw firm conclusions on levels of impact, the NRC staff could use other (unspecified) sources of data or reasoning.

40-jj-AE, 40-kk-AE/ED

Response: The *NRC staff defined the two areas of interest for assessing impacts of IP2 and IP3: The lower Hudson River and the Hudson River Segment 4 near Indian Point. Based on new information provided by Entergy and others in their comments on the draft SEIS, the NRC staff revised its analysis of combined effects of entrainment and impingement and found an overall impact level of moderate for aquatic resources.*

The following comments express the opinion that Entergy has had a long-standing commitment to assess the health of the Hudson River and that the Hudson River is healthy with IP2 and IP3 operating.

40-yyyyy-AE, 120-k-AE

Response: The *NRC staff has independently assessed levels of impact to the Hudson River due to operation of IP2 and IP3 as part of the license renewal application process according to its own regulations in 10 CFR Part 51. The staff presents its conclusions in the final SEIS in terms of NRC-defined levels of impact (small, moderate, or large) rather than terms of "health of the Hudson River."*

The following comment indicates that the NRC's impact levels on aquatic life do not provide a meaningful indication of the actual impacts to aquatic life.

123-c-AE/OE

Response:* *The *NRC staff conducted a detailed, independent assessment of impacts of the operation of IP2 and IP3 on aquatic resources of the Hudson River. For a few species, the draft SEIS found that the available data were insufficient to support a firm conclusion in terms of the NRC's definitions of levels of impact and expressed the uncertainty due to insufficient data by providing a range of impact levels. In Section 4.1.3.5 of the draft SEIS, the NRC staff used the maximum and minimum over all species examined to represent the overall impingement and entrainment impact level, which was a range from small to large. Based on new information provided by Entergy and others in their comments on the draft SEIS, the NRC Staff modified the analysis in the final SEIS and represented impact levels more precisely. In Section 4.1.3.5 of the final SEIS, the staff expressed the weight-of-evidence scores numerically and used an average score over all species examined to represent the overall impingement and entrainment impact level, which the staff found to be "moderate."*

The following comment indicates that both the range of zebra mussels in the Hudson River and the NRC staff's trend analyses used in the DSEIS to assess potential effects of zebra mussels were limited to freshwater (River Segment 12), and so the conclusions should apply only to River Section 12 and not to the Indian Point segment of the River.

40-tt-AE; 40-ooo-AD/ED/OE

Response: *In assessing the impact of entrainment and impingement from IP2 and IP3, Entergy's consultants (Barnthouse et al. 2008, page 23), examined "…expected effects of CWIS [Cooling Water Intake Structure] and four other stressors that are widely regarded as potentially having affected Hudson River fish populations: fishing, invasion of the Hudson River by zebra mussels (*Dresseina polymorpha*), temperature (Atlantic tomcod only), and predation by striped bass." Previously, Strayer et al. (2004) had indicated that the invasion of zebra mussels may have affected fish populations, including number of adult American shad and striped bass as well as other species, by acting through the food web. The NRC staff therefore included zebra mussels when it independently assessed cumulative impacts to Hudson River aquatic resources due to operation of IP2 and IP3 and other stressors.*

Literature Cited in Response

Barnthouse, L.W., D.G. Heimbuch, W. van Winkle, and J. Young. 2008. Entrainment and Impingement at IP2 and IP3: A Biological Impact Assessment. Prepared for Entergy Nuclear Operations, Inc. January 2008. ADAMS Accession No. ML080390059.

*Strayer, D.L., K.A. Hattala, and A.W. Kahnle. 2004. Effects of an invasive bivalve (*Dreissena polymorpha*) on fish in the Hudson River estuary. Canadian Journal of Fisheries and Aquatic Sciences 61:924-941*

This comment indicates that although NRC staff could not develop an index of abundance for shortnose sturgeon, Woodland and Secor (2005) developed "a reliable index of abundance based on the Fall Juvenile Fish Survey."

40-nnn-AE.

Response: *NRC staff selected young-of-the-year fish from the Fall Shoals Survey (FSS) for developing its index of shortnose sturgeon abundance so that each index value is a measure of* *the single year class of young-of-the-year fish. Because each index of abundance represented a distinct year class, NRC staff could assess trends in abundance of YOY fish not only for shortnose sturgeon, but for all Hudson River RIS. Woodland and Secor (2005) used the largest size class in the FSS, which the utilities' data sets designate as LC4 and which would include fish from previous year classes, in their index of abundance. For the purposes assessing population trends in its analysis of RIS, NRC staff's index of abundance of YOY fish is the appropriate approach. Because the density of shortnose sturgeon is low, however, in some years the FSS captured no YOY and the index value is zero.*

The following comments request revisions to the text on page 2-50 to indicate that no additional mortality studies were performed following installation of Ristroph screens at IP2 and IP3 because NYSDEC did not require additional studies:

40-o-ED/RG

Response: Text has been changed to reflect the comment.

The following comments assert that the NYSDEC SPDES permits contain reasonable measures to quantify and minimize impacts to the Hudson River:

55-b-AE/RG; 93-d-AE/MP/RG; 66-c-RG;113-k-AL/AQ/RG; 112-h-AL/RG; 96-I-AE/AL/RG; 93-e-AE/RG

Response: Under the authority created by the Clean Water Act Amendments of 1972, granted to the U.S. Environmental Protection Agency (EPA), and then delegated to the New York State Department of Environmental Conservation (NYSDEC), the State of New York is responsible for matters related to compliance with Clean Water Act provisions and under them, the provisions of the State Pollution Discharge Elimination System (SPDES) permits that are currently subject to adjudication before NYSDEC. NRC staff has no jurisdiction over SPDES standards, requirements, or challenges.

One commenter in this section indicated that NRC staff ought should collect additional data related to impingement, entrainment, and thermal shock. In conducting its analysis for this SEIS, the NRC staff has relied on the best available information on impacts from IP2 and IP3.

A.2.6 Comments Concerning Human Health Issues

The following comments primarily concern the human health impacts related to the operation of the Indian Point Energy Center (IPEC). The comments assert that the use of inadequate dose calculation methodology, the inappropriate use of "reference man" with its outdated physical assumptions, underestimates the risks to women and children, and in particular, that the dSEIS does not contain adequate evidence that the radioactive emissions from IPEC are within Federal limits. The comments also assert that the radioactive emissions from IPEC are responsible for increased cancer rates in the region. To support their position, the commenter's cite a report authored by Mr. Mangano (included in the transcript) which claims that the increased incidence of leukemia rates in the area around the plant site are the result of the radioactive emissions from IPEC. Finally, the commenters recommend that the NRC's public dose limit should be reduced from an annual dose of 100 mrem (1 mSv) to 25 mrem (0.25 mSv):

2-b-HH/RI; 2-c-HH; 22-a-HH/OR/OS/PA; 50-d-EP/HH; 50-o-HH/LE/PA; 73-a-HH; 73-e-EJ/HH; 79-a-HH; 79-s-EJ/HH; 87-b-HH/PA/RW/ST; 87-c-AM/HH/OM; 96-d-HH/LE/RI; 107-a HH/RA; 124-b-EJ/EP/HH/PA; 153-a-LE; 154-a-HH/LE/MP; 170-b-HH

Response: *The NRC's mission is to protect the public health and safety and the environment from the effects of radiation from nuclear reactors, materials, and waste facilities. The NRC's regulatory limits for radiological protection are set to protect workers and the public from the harmful health effects of radiation on humans. The limits are based on the recommendations of standards-setting organizations. Radiation standards reflect extensive scientific study by national and international organizations. The NRC actively participates and monitors the work of these organizations to keep current on the latest information concerning radiation protection. If the NRC determines that there is a need to revise its radiation protection regulations, it will initiate a rulemaking. The models recognized by the NRC for use by nuclear power reactors to calculate dose incorporate conservative assumptions and account for differences in gender and age to ensure that workers and members of the public are adequately protected from radiation.*

Although radiation may cause cancers at high doses , currently there are no reputable scientifically conclusive data that unequivocally establish the occurrence of cancer following exposure to low doses and dose rates, below about 10 rem (0.1 Sv). However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably over-estimates those risks. Based on this theory, the NRC conservatively establishes limits for radioactive effluents and radiation exposures for workers and members of the public. While the public dose limit in 10 CFR Part 20 is 100 mrem (1 mSv) for all facilities licensed by the NRC, the NRC has imposed additional constraints on nuclear power reactors. Each nuclear power reactor, including IPEC, has enforceable license conditions that limit the total annual whole body dose to a member of the public outside the facility to 25 mrem (0.25 mSv). In addition, there are license conditions to limit the dose to a member of the public from radioactive material in gaseous effluents to an annual dose of 15 mrem (0.15 mSv) to any organ and for radioactive liquid effluents, a dose of 3 mrem (0.03 mSv) to the whole body and 10 mrem (0.1 mSv) to any organ. The NRC staff reviewed five years of radiation dose data from IP2 and IP3 and found the annual doses to members of the public to be well within the requirements discussed above.

The amount of radioactive material released from nuclear power facilities is monitored, and known to be very small. The doses of radiation that are received by members of the public as a result of exposure to nuclear power facilities are low (i.e., less than a few millirem) that resulting cancers attributed to the radiation have not been observed and would not be expected. To put this in perspective, each person in this country receives an average total annual dose of about 300 millirems (3 mSv) from natural sources of radiation (i.e., radon, 200 mrem; cosmic rays, 27 mrem; terrestrial [soil and rocks], 28 mrem; radiation within our body, 39 mrem) and about 63 mrem (0.63 mSv) from man-made sources (i.e., medical x-rays, 39 mrem; nuclear medicine, 14 mrem; consumer products, 10 mrem; occupational, 0.9 mrem; nuclear fuel cycle, <1 mrem; and fallout, <1 mrem).

Radiation from natural and man-made sources is not different in its properties or effect. Although a number of studies of cancer incidence in the vicinity of nuclear power facilities have *been conducted, there are no studies to date that are accepted by the scientific community that show a correlation between radiation dose from nuclear power facilities and cancer incidence in the general public. The information submitted by Mr. Mangano concerning the increase in child leukemia summarizes data published by the New York State Cancer Registry. While the data is a compilation of the cases and types of cancer recorded in New York State, it does not provide a basis for linking the cancer cases to the operation of IP2 and IP3 . The Mangano report asserts that the cancers are the result of radiation released from IPEC. The NRC staff reviewed the report cited by Mr. Mangano and found that it did not determine the cause for the cancer.*

To ensure that U.S. nuclear power plants are operated safely, the NRC licenses the plants , licenses the plant operators, and establishes license conditions for the safe operation of each plant. The NRC provides continuous oversight of the plants through its Reactor Oversight Process (ROP) to verify that they are being operated in accordance with NRC regulations. The NRC has authority to take action to protect public health and safety and the environment, and may require immediate licensee actions, up to and including a plant shutdown.

The NRC has considered and addressed this issue in the SEIS. The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that Indian Point provides clean electric power in a manner that is good for our air and water, lowers the rates of childhood asthma and other ailments, and fights global warming by reducing greenhouse gases:

8-c-AQ/HH/SO; 31-b-EC/EJ/HH; 42-c-HH; 85-b-AQ/HH; 99-b-AQ/HH

Response: *The comments are acknowledged. The comments do not present any significant new information that would warrant a change to the final SEIS.*

The following comments assert that the EIS does not adequately discuss the long term impacts from routine radioactive releases and radionuclides leaking from the spent fuel pool into the groundwater and drinking water, including the potential Rockland County desalination plant's use of Hudson River water, and the impacts from eating fish from the Hudson River:

20-b-HH; 27-d-LE; 51-a-HH/PA/UF; 69-a-HH/LE/OR/PA; 73-c-EJ/HH/LE; 79-e-HH/SO; 79-s-EJ/HH; 96-d-HH/LE/RI; 96-e-HH/LE/WA; 96-g-EJ/HH/LE; 97-a-EJ/HH; 97-k-EJ/HH/LE; 98-c-HH/LE/RI; 102-h-HH/RI; 135-b-LE; 137-j-RI; 140-v-GW/HH/RI; 140-w-GW/HH/RI; 140-x-HH; 140-y-AE/CI; 140-aa-SM; 145-c-HH/LE; 149-c-HH/LE; 153-a-LE; 153-b-LE; 164-c-LE; 164-g-LE/MP; 170-e-LE/WA; 172-a-HH/RI; 174-a-HH/RI; 176-d-LE; 178-a-LE/OR/RW; 179-e-LE/WA; 180-a-HH/LE/RI

Response: *The NRC staff does not agree with this comment. There is a thorough discussion in Chapters 2 and 4 that addresses impacts to human health from routine and abnormal radioactive releases. The NRC staff reviewed five years of historical radioactive and radiological environmental monitoring data. Based on the data, the Staff concluded that the calculated doses to a member of the public from the radioactive releases were within NRC's radiation dose standards. The environmental data showed some radionuclides associated with the operation of IP2 and IP3; however, residual radioactivity from atmospheric weapons tests and naturally occurring radioactivity were the predominant sources of radioactivity in the samples collected. The Staff concluded that IPEC operations did not result in an adverse impact to the public greater than environmental background levels.*

The NRC staff also evaluated the impacts from the leaking radioactive material into the groundwater and into the Hudson River in Chapters 2 and 4. The dSEIS used information from an Inspection conducted by personnel from NRC's Region I office and NRC's Headquarters office. The NRC thoroughly inspected this issue at IPEC, starting with initial notification of the leaks in September 2005 until the inspection closed in May 2008. The NRC Inspection Report (ADAMS Accession number ML081340425) reached the following conclusion: "Our inspection determined that public health and safety has not been, nor is likely to be, adversely affected, and the dose consequences to the public that can be attributed to current on-site conditions associated with groundwater contamination is negligible." In the text of the Inspection Report there are two key conclusions relevant to the potential human health impacts from the leaks. They are presented here and in Chapter 2 of the dSEIS:

1) "Currently, there is no drinking water exposure pathway to humans that is affected by the contaminated groundwater conditions at Indian Point Energy Center. Potable water sources in the area of concern are not presently derived from groundwater sources or the Hudson River, a fact confirmed by the New York State Department of Health. The principal exposure pathway to humans is from the assumed consumption of aquatic foods (i.e., fish or invertebrates) taken from the Hudson River in the vicinity of Indian Point, that has the potential to be affected by radiological effluent releases. Notwithstanding, no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations."

2) "The annual calculated exposure to the maximum exposed hypothetical individual, based on application of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Release of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I," relative to the liquid effluent aquatic food exposure pathway is currently, and expected to remain, less than 0.1% of the NRC's "As Low As is Reasonably Achievable (ALARA)" guidelines of Appendix I of Part 50 (3 mrem/yr total body and 10 mrem/yr maximum organ), which is considered to be negligible with respect to public health and safety, and the environment."

To ensure that the nuclear power plants are operated safely and maintain radioactive emissions within regulatory limits, the NRC licenses the plants , licenses the plant operators, and establishes license conditions for the safe operation of each plant. The NRC provides continuous oversight of plants through its Reactor Oversight Process (ROP) to verify that they are being operated in accordance with NRC regulations. The NRC has authority to take actions as necessary to protect public health and safety, and may require immediate licensee actions, up to and including a plant shutdown.

Regarding the potential operation of a Rockland County desalination plant, the NRC staff addressed potential future cumulative radiological impacts in Chapter 4, section 4.8.3, "Cumulative Radiological Impacts." The NRC staff discussed the applicable radiation protection limits set by the NRC and the EPA to protect members of the public from the cumulative impacts of radiation. The NRC staff noted that the NRC and the State of New York would regulate any future actions in the vicinity of IP2 and IP3 that could contribute to cumulative radiological impacts. Therefore, if plans for the proposed Rockland County desalination plant advance to the licensing phase, the facility would be required to have the means to monitor the source water and, if necessary, have a treatment system to meet applicable drinking water standards for radioactive and nonradioactive contaminants.

The NRC has considered and addressed this issue in the SEIS. The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments indicate that Indian Point's radiological environmental monitoring program (REMP) does not collect milk samples. The Mother's Milk Project asserts that goat's milk was collected and was analyzed and found to contain Sr-89 and Sr-90, which it asserts is from radioactive emissions from IPEC. In addition, the comments cite a concern that the NRC, New York State, and Connecticut do not independently collect and analyze milk samples:

24-a-HH/OR/RI; 24-b-HH/OR/RI; 79-f-HH; 149-c-HH/LE; 153-a-LE; 154-a-HH/LE/MP; 172-a-HH/RI

Response: *It is correct that the IPEC's REMP does not collect and analyze milk samples. This is because the last nearby dairy farm closed in 1992. The closure of the dairy farm was also reported by the State of New York in its 1994 report (the last publicly available state report) on the results of their independent REMP conducted in the environs around IPEC.*

The NRC's guidance on environmental monitoring allows for the substitution of an alternate environmental medium if a particular environmental medium is unavailable. In this case, IPEC collects samples of broadleaf vegetation because there is no local dairy farm where it can obtain milk samples. The dSEIS, in Chapter 2, discussed IPEC's 2006 REMP data for Sr-90 as being attributable to past atmospheric weapons testing. The levels detected were consistent with the historical levels of radionuclides resulting from weapons testing as measured over the years. Additionally, the calculated maximum organ dose in 2006 to an offsite member of the public from gaseous iodine, tritium, and particulate effluents from IP1 and IP2 was 1.19 x10^{-2} mrem (1.19x10^{-4} mSv) to the child thyroid. For IP3, the calculated maximum organ dose in 2006 to an offsite member of the public from gaseous iodine, tritium, and particulate effluents for the maximally exposed organ (child liver) was 1.07x10^{-3} mrem (1.07x10^{-5} mSv). These doses are well within the NRC's dose design objective of 15 mrem (0.15 mSv) in Appendix I to 10 CFR Part 50. Thus, the NRC staff concluded in Chapter 4 of the dSEIS that the impacts to members of the public and the environment were bounded by the evaluations in the GEIS, which assessed the impacts as SMALL.

The NRC does not conduct an independent REMP around nuclear power plants. The NRC licenses the nuclear plants , licenses the plant operators, and establishes regulations and license conditions for the safe operation of each plant. The NRC provides continuous oversight of plants through its Reactor Oversight Process (ROP) to verify that the plants perform all required monitoring and are being operated in accordance with NRC rules and regulations. The NRC has authority to take action as necessary to protect public health and safety and may demand immediate licensee actions, up to and including a plant shutdown. At IPEC, the NRC staff performed independent sampling and analysis of environmental media related to the leaks of radioactive water from the spent fuel pools. The NRC conducted an independent analysis of groundwater, Hudson River water, and fish during its inspection of IPEC's actions in response to the leaks. In the text of the Inspection Report there are two key conclusions relevant to the potential human health impacts from the leaks. They are presented here and in the dSEIS:

1) "Currently, there is no drinking water exposure pathway to humans that is affected by the contaminated groundwater conditions at Indian Point Energy Center. Potable water sources in the area of concern are not presently derived from groundwater sources or the Hudson River, a fact confirmed by the New York State Department of Health. The principal exposure pathway to humans is from the assumed consumption of aquatic foods (i.e., fish or invertebrates) taken *from the Hudson River in the vicinity of Indian Point, that has the potential to be affected by radiological effluent releases. Notwithstanding, no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations."*

2) "The annual calculated exposure to the maximum exposed hypothetical individual, based on application of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Release of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I," relative to the liquid effluent aquatic food exposure pathway is currently, and expected to remain, less than 0.1% of the NRC's "As Low As is Reasonably Achievable (ALARA)" guidelines of Appendix I of Part 50 (3 mrem/yr total body and 10 mrem/yr maximum organ), which is considered to be negligible with respect to public health and safety, and the environment."

The complete discussion of NRC actions and its inspection are contained in the NRC inspection report dated May 13, 2008. The full report is available to the public through the ADAMS electronic reading room on the NRC's website (www.NRC.gov). The ADAMS accession number for the inspection report is ML081340425.

The NRC has no authority to require the States of New York or Connecticut to perform independent collection and analysis of environmental media around IPEC.

The NRC has considered and addressed this issue in the SEIS. The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that the SEIS does not adequately discuss the information on samples of mother's milk (human and animal) that was tested and found to have detectable levels of radioactive Sr-89 and Sr-90:

24-a-HH/OR/RI; 50-o-HH/LE/PA

Response: *The NRC does not require the sampling and analysis of human mother's milk, nor does it have the authority to require such sampling. The issue of the sampling and analysis of animal milk and the radiation doses to members of the public and impact to the environment was discussed in the preceding comment response. Regarding the purported detection of radionuclides attributed to the operation of IPEC in milk samples collected and analyzed by the Mother's Milk Project, the NRC staff found that the report contained very limited radiological information, and lacked documentation on the authenticity, precision and accuracy of the data from a competent analytical laboratory.*

The NRC staff considered and addressed this issue in the draft SEIS. The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that the SEIS does not adequately address the air quality deterioration and negative human health effects that would result from the shutdown of Indian Point:

90-c-AL/AQ/HH

Response: *This comment was responded to in the Air Quality comment resolution section.*

The following comment asserts that the human health consequences of an accident need to be more thoroughly discussed in the SAMA section of the SEIS:

50-I-HH/PA; 17-p-EP/PA/RI

Response: *The severe accident mitigation alternatives (SAMA) review provides an evaluation of potential alternatives to mitigate the effects of severe accidents. Severe nuclear accidents are more severe than design basis accidents, and could result in substantial damage to the reactor core, regardless of offsite consequences. In the GEIS , the NRC 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. Based on information in the GEIS, the Commission found the following:*

"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. Chapter 5 in the dSEIS contains the NRC staff's evaluation of IPEC's mitigation of severe accidents.

The NRC staff reviewed and evaluated SAMAs for IPEC to ensure that the range of changes (i.e., hardware modifications, changes to plant procedures, and changes to the training program) that could improve severe accident safety performance were identified and evaluated. While the SAMA evaluation contains population radiation dose information in Table 5-4 in chapter 5, the values are used to show the relative percent of the dose resulting from the various containment failure modes that were evaluated. The purpose of the SAMA is not to evaluate the human health impacts, but rather to evaluate a range of mitigation actions that may reduce the risk of a severe accident and are cost-effective.

The NRC has considered and addressed this issue in the SEIS and the comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that the SEIS should evaluate the health consequences of a spent fuel fire:

89-a-HH/PA/SF

Response: *The environmental and health impacts of design basis accidents (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 an operating license. The results of these evaluations are contained in licensing documentation such as the applicant's final safety analysis report, the NRC staff's safety evaluation report, the final environmental statement (FES) and Section 5.1 of the draft SEIS.*

In the GEIS, the Commission determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. As part of the license renewal process, the NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 environmental report, the site visit, the scoping process, or evaluation of other available information.

Therefore, the NRC staff concludes that there are no impacts related to DBAs beyond those discussed in the GEIS.

In addition, the issue of a spent fuel fire was specifically addressed by the NRC in two Petitions for Rulemaking (PRM) (PRM 51-10 and PRM 51-12) submitted by the Attorney General of the Commonwealth of Massachusetts and the Attorney General of the State of California. The details of the petitions and the NRC's evaluation are available to the public through the ADAMS electronic reading room on the NRC website (www.NRC.gov) and in the Federal e-Rulemaking Portal: Go to http://www.regulations.gov and search for documents filed under Docket ID [NRC–2006–0022] (PRM–51–10), and [NRC–2007–0019] (PRM–51–12).

The Massachusetts and California Petitioners requested that the NRC initiate a rulemaking concerning the environmental impacts of the high density storage of spent nuclear fuel in spent fuel pools (SFPs). The Petitioners asserted that ''new and significant information'' shows that the NRC incorrectly characterized the environmental impacts of high-density spent fuel storage as ''insignificant'' in its GEIS for the renewal of nuclear power plant licenses. Specifically, the Petitioners asserted that spent fuel stored in high-density SFPs is more vulnerable to a zirconium fire than the NRC concluded in its NEPA analysis.

The Commission denied the petition for rulemaking, concluding as follows:

"Based upon its review of the petitions, the NRC has determined that the studies upon which the Petitioners rely do not constitute new and significant information. The NRC has further determined that its findings related to the storage of spent nuclear fuel in pools, as set forth in NUREG–1437 and in Table B–1, of Appendix B to Subpart A of 10 CFR Part 51, remain valid. Thus, the NRC has met and continues to meet its obligations under NEPA. For the reasons discussed previously, the Commission denies PRM–51–10 and PRM–51–12."

The NRC has considered and addressed the issue raised in this comment in the SEIS. The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that the average level of Sr-90 in baby teeth in the Indian Point area is among the highest in the U.S and rose sharply after the 1980s:

107-a-HH/RI

Response: *The NRC staff does not agree with this comment. In 2000, a report entitled "Strontium-90 in Deciduous Teeth as a Factor in Early Childhood Cancer" was published by the Radiation and Public Health Project. The report alleges that there has been an increase in cancer incidence due to strontium-90 released from nuclear power facilities. Elevated levels of strontium-90 in deciduous (baby) teeth were claimed in the report as the evidence for the increase in childhood cancer.*

There are three sources of strontium-90 in the environment: fallout from nuclear weapons testing, releases from the Chernobyl accident in the Ukraine, and releases from nuclear power reactors. The largest source of strontium-90 is from weapons testing fallout as a result of above-ground explosions of nuclear weapons (approximately 16.9 million curies of strontium-90). The Chernobyl accident released 216,000 curies of strontium-90. The total annual release of strontium-90 into the atmosphere from all U.S. nuclear power plants is typically 1/1,000th of 1 curie, which is so low that the only chance of detecting strontium-90 is sampling the nuclear power plant effluents themselves. The NRC regulatory limits on radioactive effluent releases *and doses to the public are based on the radiation protection recommendations of international and national organizations such as the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP). Gaseous effluent releases are monitored at IPEC, and the results of the monitoring are reported annually to the NRC and are publicly available on the NRC's website. The radiological effluent release program and the radiological environmental monitoring program at IPEC were reviewed by the NRC staff as part of the license renewal process and found to be acceptable.*

Additionally, in a report published in 2001, the American Cancer Society concluded that although reports about cancer case clusters in communities surrounding nuclear power plants have raised public concern, studies show that clusters do not occur more often near nuclear plants than they do by chance elsewhere in the population. The NCRP has observed no statistically significant data which supports that there is an increased incidence of biological effects due to strontium-90 exposures at levels typical of worldwide fallout, which is the greatest source of strontium-90 in the environment. Likewise, there is no new evidence that links strontium-90 with increases in breast cancer, prostate cancer, or childhood cancer rates. The American Cancer Society recognizes that public concern about environmental cancer risks often focuses on risks for which no carcinogenicity has been proven or on situations where known exposures to carcinogens are at such low levels that risks are negligible. The report states that "ionizing radiation emissions from nuclear facilities are closely controlled and involve negligible levels of exposure for communities near such plants."

Radioactive releases of gaseous and liquid effluents, including releases from the IP2 spent fuel pool into the groundwater, are discussed in Chapter 2 of the SEIS and found to be within NRC dose limits.

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that the radioactive emissions from Indian Point are among the highest in the U.S:

107-a-HH/RI; 172-a-HH/RI

Response: *All nuclear plants were licensed with the expectation that they would release some radioactive material to both the air and water during normal operation. NRC regulations require that radioactive gaseous and liquid releases from nuclear power plants meet radiation dose-based limits specified in 10 CFR Part 20, the "as low as is reasonably achievable" (ALARA) dose criteria in Appendix I to 10 CFR Part 50, and the EPA's regulations in 40 CFR Part 190. Regulatory limits are placed on the radiation dose that members of the public might receive from radioactive material released by nuclear plants. The NRC regulations are dose based, such that the dose resulting from the radioactive effluent is the value used by the NRC to determine compliance with regulatory limits. Nuclear power plants are required to report their radioactive gaseous, liquid, and solid effluent releases as well as the results of their radiological environmental monitoring program annually to the NRC. The annual effluent release and radiological environmental monitoring reports submitted to the NRC are available to the public through the ADAMS electronic reading room on the NRC website (www.NRC.gov).*

As part of the license renewal process, the NRC staff reviewed the radiological effluent release program and the radiological environmental monitoring program at IPEC and found them to be acceptable. The Staff's radiological evaluation of IPEC is in Chapter 2 and 4 of the dSEIS.

The NRC has considered and addressed this issue in the SEIS. The comments do not present any significant new information or arguments that would warrant a change to the final SEIS.

The following comments assert that a 2004 study by Columbia University on 54,000 nuclear power plant workers showed that they have fewer cancers and live longer than their counterparts in the general population.

120-b-HH; 120-h-OP/HH

Response: *The NRC staff is aware of the study. The comment does not does not present any significant new information that would warrant a change to the final SEIS.*

The following comment asserts that the EIS must include an evaluation of the impacts to poor people who rely on fishing for their diet who are being indirectly exposed to radiation from eating contaminated fish:

124-b-EJ/EP/HH/PA

Response: *The NRC staff performed a thorough evaluation of this issue in chapter 4 of the dSEIS. As indicated, the staff reviewed the results of IPEC's radiological environmental monitoring program (REMP), which show that concentrations of radioactive contaminants in native leafy vegetation, soils and sediments, Hudson River surface water and fish from the vicinity of IPEC are very low (at or near the threshold of the survey instrument's detection capability) and seldom above background levels. Based on these data, the NRC staff concluded that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife*

The NRC has considered and addressed this issue in the SEIS. The comment does not present any significant new information that would warrant a change to the final SEIS.

A.2.7 Comments Concerning Socioeconomic Issues

The following comments express concern about the reliability and cost of energy and electric power. Several comments stated that the continued operation of Indian Point is a key component to the region's economic stability because of its ability to provide jobs and reliable electricity at a low cost. Those comments stressed that, if Indian Point was to cease operation, the area would experience a rise in electricity costs and interrupted service (including blackouts) over the next twenty years. Several comments expressed concerns about potential air quality impacts from alternative energy fossil-fueled power plants if Indian Point were to be shut down. The comments also wanted to make known the benefits of Indian Point as an emissions-free electricity provider.

1-a-EC/SO/SR; 1-c-EC/SO; 8-b-SO; 8-c-AQ/HH/SO; 19-b-EC/SO/SR; 19-c-EC/SO/SR; 26-c-EC/SO/SR; 28-b-EC/SO; 42-b-EC/SO; 42-f-EC/SO; 48-b-EC/SO; 48-d-AQ/SO; 57-e-EC/OP/SO; 58-c-AQ/EC/SO; 78-c-SO/SR; 85-a-EC/SO/SR; 92-a-EC/SO/SR; 101-c-SO/SR; 108-a-EC/SO/SR; 115-b-SO; 119-b-EC/SO; 119-c-AQ/EC/SO; 119-e-EC/GI/SO; 119-g-EC/SO/SR; 133-a-EC/SO/SR; 146-d-EC/SO; 150-e-AQ/OP/SO; 157-b-AL/EC/SO; 157-f-AL/EC/SO; 166-b-AL/EC/SO; 177-a-AQ/EC/SO

Response: *Nuclear power plants, like various other electrical generating plants, generate a significant amount of employment and income in the local economies. The local communities provide the people, goods, and services needed to operate the power plant. Power plant* *operations, in turn, provide wages and benefits for people, and payments for goods and services.*

Any impact on electricity costs and service impacts from the loss of IP2 and IP3 electrical generating capacity is speculative. Due to the deregulation of the energy market in the State of New York, competition for the sale of electricity may keep electricity costs and services under control.

These comments are generally supportive of license renewal for IP2 and IP3 and nuclear power. The NRC is responsible for licensing and regulating the operation of nuclear power plants to ensure the protection of public health and safety and the environment. Air quality impacts from alternative energy power generation including environmental justice concerns are discussed in Chapter 8 in the SEIS. These comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments pertain to contributions to the local economy in the form of high-paying jobs and tax revenue:

7-c-SO; 23-b-SO; 23-f-EC/SO; 23-i-EC/SO/SR; 29-a-SO/SR; 36-d-OP/SO; 57-b-AQ/EC/SO; 65-a-SO/SR; 65-c-EC/SO/SR; 67-b-EC/SO; 90-f-EC/SO; 92-b-EC-SO; 92-d-SO/SR; 92-e-SO/SR; 92-g-SO/SR; 105-a-SO/SR; 109-a-SO; 115-a-SA/SE/SO; 116-a-SO/SR; 116-b-EC/SO; 119-i-SO; 130-a-AQ/SO; 130-b-OP/SO/SR; 137-o-SO; 144-b-EC/SO; 150-b-SA/SO; 155-a-EC/SO; 166-d-SO/SR; 166-e-SO/SR; 166-g-AE/SO; 169-a-AL/EC/SO

Response: *Nuclear power plants, like various other electrical generating plants, generate a significant amount of employment and income in the local economies. The local communities provide the people, goods, and services needed to operate the power plant. Power plant operations, in turn, provide wages and benefits for people, and payments for goods and services.*

Terminating nuclear plant operations and reducing plant staff would have an impact on regional employment and income, and may affect the quality and availability of community services. Income from plant wages and salaries as well as expenditures for goods and services would decrease. Indirect employment and income created as a result of nuclear power plant operations would also disappear or be reduced. Demand for services and housing would substantially decline as plant workers and their families leave the area in search of jobs elsewhere, creating a decline in demand for housing, depressing housing prices and values. Conversely, housing markets in the vicinity of metropolitan areas generally experience more rapid, housing turnover, higher prices, and lower vacancy rates. While the loss of plant employment in urban regions may mean some out-migration of workers, many plant employees would be able to find other opportunities for employment. In addition, the socioeconomic impact on small businesses could be offset by economic growth in other parts of the regional economy.

These comments are generally supportive of license renewal for IP2 and IP3. These comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments pertain to Entergy's involvement in the local community:

43-a-SE/SO; 48-a-SE/SO; 57-c-SA/SE/SO; 67-e-SE/SO; 85-c-EC/SO/SR; 109-c-SE/SO; 111-a-SO; 111-b-SO/SR; 111-c-EC/SO; 111-d-SO; 136-a-CR/SO/SR; 136-b-SO/SR; 150-f-SO/SR; 163-a-SE/SO/SR

Response: *These comments are generally supportive of Entergy's involvement in the local community and for the license renewal of IP2 and IP3. These comments do not present any significant new information that would warrant a change to the final SEIS.*

The following comments indicate that the DSEIS inadequately addresses socioeconomic impacts:

4-d-CI/LR/SO; 79-g-SO

Response: *The environmental review considers the potential socioeconomic impacts of license renewal on the communities and people living in the region surrounding IP2 and IP3. The discussion of impacts in this SEIS focuses on environmental issues of license renewal in proportion to their significance.*

As discussed in Section 2.2.8 of the SEIS, the nuclear plant and the people and communities that support it can be described as a dynamic socioeconomic system. The local communities provide the people, goods, and services needed to operate the nuclear power plant. Power plant operations, in turn, provide wages and benefits for people, and payments for goods and services. The measure of a communities' ability to support IP2 and IP3 operations depends on the ability of the community to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomics region of influence (ROI) is defined by the area where IP2 and IP3 employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The IP2 and IP3 ROI consists of Dutchess, Orange, Putnam, and Westchester Counties, where approximately 84 percent of IP2 and IP3 employees reside. Riverfront communities in these counties were included in the assessment of socioeconomic impacts. Since Entergy has no plans to add non-outage employees during the license renewal period, employment levels at IP2 and IP3 would not change. Based on this information, there would be no socioeconomic impacts in the ROI during the license renewal term beyond those already being experienced. Cumulative socioeconomic impacts of license renewal are discussed in SEIS Section 4.8.4.

In addition, the safe operation of nuclear power plants is not limited to license renewal but is and will be dealt with on a daily basis as a part of the current and renewed operating license. Safety issues and concerns are addressed by the NRC on an ongoing basis at every nuclear power plant. Safety inspections are and will be conducted throughout the operating life of the plant, whether during the original or renewed operating license. If safety issues are discovered at a nuclear power plant, they are addressed immediately, and any necessary changes are incorporated under the current operating license. As such, the regulatory safety oversight of IP2 and IP 3 are ongoing and outside the regulatory scope of license renewal. This comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments express concern that the Draft SEIS does not adequately consider the socioeconomic effects under the no action alternative, Section 8.2, and does not accurately address the negative impacts that denying the request for license renewal would have on local communities.

9-g-AL/SO; 90-d-AL/EC/SO

Response: *The socioeconomic consequences of terminating operations and the shutdown of IP2 and IP3 on the communities and people living in the region around the power plants under* *the no action alternative is addressed in Chapter 8 of the SEIS. Any impact on electricity costs from the loss of IP2 and IP3 electrical generating capacity is speculative. Due to the deregulation of the energy market in the State of New York, competition may keep electricity costs under control.*

Terminating nuclear plant operations was considered under the no action alternative, including the effects that reducing plant staff would have on regional employment and income and the quality and availability of community services. Nuclear power plants generate a significant amount of employment and income in the local economies, which would be reduced with the cessation of plant operations. Income from plant wages and salaries as well as expenditures for goods and services would decrease. Demand for services and housing would substantially decline. Indirect employment and income created as a result of nuclear power plant operations would also be reduced.

The termination of plant operations would also have an impact on population and housing. Loss of plant employment in rural communities would likely mean plant workers and their families would leave the area in search of jobs elsewhere, creating a decline in demand for housing, depressing housing prices and values. Conversely, housing markets in the vicinity of metropolitan areas generally experience more rapid, housing turnover, higher prices, and lower vacancy rates. While the loss of plant employment in urban regions may mean some out-migration of workers, many plant employees would be able to find other opportunities for employment. In addition, the socioeconomic impact on local communities from the termination of power plant operations could be offset by economic growth in other parts of the regional economy. These comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments express concern that the strongest opposition to the renewal of the Indian Point operating license is coming from outside of the affected region:

56-b-SO; 109-d-SO/SR

Response: *These comments are generally supportive of Entergy and the license renewal of IP2 and IP3. These comments do not present any significant new information that would warrant a change to the final SEIS.*

The following comments assert that the socioeconomic effects from the shutdown of IP2 and IP3 would not be as severe as expected:

50-s-SO; 171-a-SO

Response: *Terminating nuclear plant operations and reducing plant staff would have an impact on regional employment and income and the quality and availability of community services. Nuclear power plants generate a significant amount of employment and income in the local economies, which would no longer occur with the cessation of plant operations. Income from plant wages and salaries as well as expenditures for goods and services would decrease. Demand for services and housing would be reduced. Indirect employment and income created as a result of nuclear power plant operations would also be reduced.*

The termination of plant operations would also have an impact on population and housing. Loss of plant employment in smaller communities would likely mean plant workers and their families would leave the area in search of jobs elsewhere, creating a decline in demand for housing, depressing housing prices and values. Conversely, housing markets in the vicinity of *metropolitan areas generally experience more rapid, housing turnover, higher prices, and lower vacancy rates. While the loss of plant employment in urban regions may mean some out-migration of workers, many plant employees would be able to find other opportunities for employment. In addition, any socioeconomic impact could be offset by economic growth in other parts of the regional economy.*

Should the licenses not be renewed, the owner of the Indian Point property would continue to make property tax payments to the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District. Depending on the commencement of decommissioning activities, some workers would continue to be employed at Indian Point for an extended period of time after the termination of power plant operations. The majority of the impacts associated with plant operations would cease with reactor shutdown; however, some impacts would remain unchanged, while others would continue at reduced or altered levels. Terminating nuclear power plant operations would not immediately lead to the dismantlement (decommissioning) of the reactor and infrastructure. Some socioeconomic impacts resulting from terminating nuclear plant operations could be mitigated through new uses of the land. Impacts from the decommissioning of IP2 and IP3 in the future would be similar to what would occur now if the licenses were not renewed. Other economic values (e.g., property values and eco-tourism) could have been diminished by the presence of Indian Point. These values might flourish after plant shutdown, decommissioning, and removal and could make up for some economic loss; however this issue along with Indian Point workers ability to change jobs is speculative.

These comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment describes the economic connection between Indian Point and Rockland County and expresses concern that the loss of jobs and local tax revenue from the closure of Indian Point would have a financial impact on Rockland County. The comment also expressed concern about the potential negative effects that a shutdown of Indian Point would have on local and small businesses in the area.

148-a-AL/SO; 148-b-AL/SO; 148-c-AL/SO

Response: *Nuclear power plants, like various other electrical generating plants, generate a significant amount of employment and income in the economies of local counties. The local communities provide the people, goods, and services needed to operate the power plant. Power plant operations, in turn, provide wages and benefits for people, and payments for goods and services.*

Terminating nuclear plant operations and reducing plant staff would have an impact on regional employment and income and may affect the quality and availability of community services. Income from plant wages and salaries as well as expenditures would decrease. Demand for services and housing would substantially decline. Indirect employment and income created as a result of nuclear power plant operations would also be reduced.

The termination of plant operations would also have an impact on population and housing. Loss of plant employment in smaller communities would likely mean plant workers and their families would leave the area in search of jobs elsewhere, creating a decline in demand for housing, depressing housing prices and values. Conversely, housing markets in the vicinity of metropolitan areas generally experience more rapid, housing turnover, higher prices, and lower vacancy rates. While the loss of plant employment in urban regions may mean some out-

migration of workers, many plant employees would be able to find other opportunities for employment. In addition, any socioeconomic impact on small businesses in Rockland County could be offset by economic growth in other parts of the regional economy.

These comments are generally supportive of the license renewal of IP2 and IP3. These comments do not present any significant new information that would warrant a change to the final SEIS.

A.2.7.1 Demographics

The following comments express concern that Indian Point is located in one of the most densely populated regions of the United States, and it should not have been sited there. Comments indicate that it is irresponsible to have a nuclear power plant located so close to a major city, and that Indian Point could not get siting approval today because of the population density around the plant.

17-d-DE; 97-f-DE/PA; 121-a-DE/OR; 145-f-DE/OR; 153-e-AM/DE; 179-d-DE

Response: *As discussed in Section 2.2.8.5 in the SEIS, IP2 and IP3 are located in a high-population area. The NRC is responsible for licensing and regulating the operation of nuclear power plants to ensure the protection of public health and safety and the environment. The safe operation of nuclear power plants is not limited to license renewal but is dealt with on an ongoing basis as a part of the current operating licenses. Safety issues and concerns are addressed by the NRC on an ongoing basis at every nuclear power plant. Safety inspections are and will be conducted throughout the operating life of the plant, whether during the original or renewed operating license term. If safety issues are discovered at a nuclear power plant, they are addressed immediately, and any necessary changes are incorporated into the current operating license. As such, the regulatory safety oversight of IP2 and IP 3 is ongoing and outside the regulatory scope of license renewal. These comments do not present any significant new information that would warrant a change to the final SEIS.*

The following comments indicate concern that the Indian Point evacuation plan is unlikely to be effective, including evacuating children from schools, and that evacuation plans have not kept up with changing demographics or potential traffic issues.

13-g-DE/EP; 50-p-DE/EP/NE; 87-a-DE/EP; 125-a-DE/EP; 172-b-DE/EP

Response: *Before a plant is licensed to operate, the NRC must have "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." The NRC's decision of reasonable assurance is based on licensees complying with NRC regulations and guidance. The emergency plans for nuclear power plants cover preparations for evacuation, sheltering, and other actions to protect residents near plants in the event of a serious incident. Nuclear power plant owners, government agencies, and State and local officials work together to create a system for emergency preparedness and response that will serve the public in the unlikely event of an emergency. Federal oversight of emergency preparedness for licensed nuclear power plants is shared by the NRC and Federal Emergency Management Agency (FEMA).*

As part of the reactor oversight process, the NRC reviews licensees' emergency planning procedures and training. These reviews include regular drills and exercises that assist licensees in identifying areas for improvement, such as in the interface of security operations and emergency preparedness. These reviews are used by the NRC to make radiological health *and safety decisions before issuing new licenses and in the continuing oversight of operating reactors. The NRC also has the authority to take action, including shutting down any reactor deemed not to provide reasonable assurance of the protection of public health and safety.*

The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR Part 54, which included public notice and comment. As discussed in the statement of consideration for rulemaking (56 FR 64966), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. Requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR Part 50. These requirements apply to all operating licenses and will continue to apply to facilities with renewed licenses. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing age, race, and ethnographic demographics and other site-related factors.

The Commission has determined that there is no need for a special review of emergency planning issues in the context of an environmental review for license renewal. Therefore, decisions and recommendations concerning emergency preparedness at nuclear plants are ongoing and outside the regulatory scope of license renewal. These comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments indicate concern that spent fuel at Indian Point is vulnerable to terrorist attack or an accident in the spent fuel pools. The comments indicate that an attack on spent fuel stored at the Indian Point site would be disastrous given the size of the surrounding population.

18-b-DE/ST; 54-b-DE/ST; 117-c-DE/ST; 122-a-DE/PA/ST; 126-a-DE/RW/SF/ST; 161-h-DE/ST

Response: *As discussed in Section 2.2.8.5 in the SEIS, IP2 and IP3 are located in a high-population area. The NRC requires that nuclear power plants be both safe and secure. Safety refers to operating the plant in a manner that protects the public and the environment. Security refers to protecting the plant (i.e., using people, equipment, and fortifications) from intruders who wish to damage or destroy it in order to harm people and the environment.*

Security issues such as safeguards planning are not tied to a license renewal action but are considered to be issues that need to be dealt with as a part of the current (and renewed) operating license. Security issues are reviewed and updated at every operating plant. These reviews continue throughout the period of an operating license, whether during the original or renewed license term. If issues related to security are discovered at a nuclear plant, they are addressed immediately, and any necessary changes are reviewed and incorporated under the operating license. As such, decisions and recommendations concerning safeguards and security at nuclear power plants are ongoing and outside the regulatory scope of license renewal.

After the terrorist attacks of September 11, 2001, the NRC issued security related orders and guidance to all nuclear power plants. These orders and guidance include interim measures for emergency planning. Nuclear industry groups and Federal, State, and local government agencies assisted in the prompt implementation of these measures and participated in drills and exercises to test these new planning elements. The NRC has reviewed licensees' commitments to address these requirements and verified the implementation through inspections to ensure public health and safety.

The NRC and other Federal agencies have heightened vigilance and implemented initiatives to evaluate and respond to possible threats posed by terrorists, including the use of aircraft against commercial nuclear power facilities and independent spent fuel storage installations. These acts remain speculative and beyond the regulatory scope of a license renewal review. However, the NRC assesses threats and other information provided by other Federal agencies and sources on an ongoing basis. The NRC also works to ensure that licensees meet security requirements through the ongoing regulatory process (routine inspections) as this issue affects all nuclear power plants. The issue of security and risk from terrorist acts against nuclear power plants is not unique to facilities that have requested a renewal to their operating licenses. These comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments express concern about safety issues stemming from the possibility of corrosion in plant components, continued storage of spent fuel in aging spent fuel pools, and reliance on dry cask storage, in light of the high and growing population near the Indian Point site. Some commenters suggest that the population has a different set of characteristics with sensitive receptor issues that differ from those encountered at other reactor sites.

44-b-AM/DE/SF, 50-b-DE/PA, 50-h-DE/PA, 141-b-AM/DE/PA/RW, 170-c-DE/PA

Response: *As discussed in Section 2.2.8.5 in the SEIS, IP2 and IP3 are located in a high-population area. The NRC is responsible for licensing and regulating the operation of nuclear power plants to ensure the protection of public health and safety and the environment. Before a plant is licensed to operate, the NRC must have "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." The NRC's decision of reasonable assurance is based on licensees complying with NRC regulations and guidance. Safety refers to operating the plant in a manner that protects the public and the environment.*

The safe operation of nuclear power plants is not limited to license renewal but is dealt with on an ongoing basis as a part of the current operating licenses. Safety issues and concerns are addressed by the NRC on an ongoing basis at every nuclear power plant. Safety inspections are and will be conducted throughout the operating life of the plant, whether during the original or renewed operating license. If safety issues are discovered at a nuclear power plant, they are addressed immediately, and any necessary changes are incorporated into the current operating license. As such, the regulatory safety oversight of IP2 and IP3 are ongoing and outside the regulatory scope of license renewal. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing age, race, and ethnographic demographics and other site-related factors.

The focus of the environmental review of IP2 and IP3 is on environmental impacts of license renewal and is distinct and separate from the safety review. Safety issues become important to the environmental review when they could result in environmental impacts, which are why the environmental effects of postulated accidents associated with IP2 and IP3 are considered in the IP SEIS. These comments do not present any significant new information that would warrant a change to the final SEIS.

A.2.7.2 Aesthetics

The following comment indicates that the SEIS does not consider the aesthetic impacts of the Indian Point facility and the construction of a cooling tower on communities along the Hudson River Valley.

30-a-AL/AQ/AS/EJ/GE

Response: *Aesthetic impacts were evaluated in the 1996 GEIS for license renewal of nuclear plants and are considered Category 1 issues. The NRC believes that the analysis conducted for the GEIS (which included a case study on Indian Point) bounds the impacts of continued operation and refurbishment on aesthetic resources, and that renewing the operating license would not alter the existing visual intrusiveness of any nuclear power plant. It is understood that some people (including minority and low-income populations) perceive nuclear plant structures (including cooling towers) and vapor plumes negatively. Most of these negative perceptions are based on aesthetic considerations (i.e., that the plant is out of character or scale with the environment), as well as environmental and safety concerns or on an anti-nuclear orientation. Whatever the consideration, the NRC believes that for these people the enjoyment of the environment has been diminished by the presence of a nuclear power plant. However, because license renewal would not alter the visual intrusiveness of the nuclear power plant, negative perceptions would remain unchanged, and the impacts of license renewal on aesthetic resources would therefore not change. Nevertheless, since these are Category 1 issues, the aesthetic impact of IP2 and IP3 was evaluated for new and significant information for the IP DSEIS.*

As discussed in Section 4.4 of the IP DSEIS, the NRC reviewed and evaluated the IP2 and IP3 Environmental Report, scoping comments, other available information, and visited the Indian Point Energy Center in search of new and significant information on aesthetic impacts that could change the conclusions presented in the GEIS. However, no new and significant information was identified during this review and evaluation. Therefore, it is expected that there would be no additional impact related to these Category 1 issues during refurbishment and the renewal term beyond those evaluated in the GEIS.

The aesthetic impacts of constructing and operating cooling towers at the Indian Point Energy Center is not part of the proposed action nor is it within the regulatory scope of license renewal. The aesthetic impacts of constructing and operating cooling towers is, however, discussed in Chapter 8 of the SEIS. The comment does not present any significant new information that would warrant a change to the final SEIS.

A.2.7.3 Socio-Psychological Effects

The following comments indicate that the SEIS does not analyze psychological and social stress impacts of nuclear power, accidents, safety, security, acts of terrorism, and emergency preparedness; and suggests that an independent third party prepare the SEIS:

16-a-PS; 16-b-PS/ST; 16-c-EP/PA/PS; 50-r-EP/PS

Response: *Psychological and social stresses do not constitute environmental impacts that are subject to evaluation under NEPA. Pursuant to NEPA and the NRC's environmental regulations at 10 CFR Part 51, the NRC is required to prepare an environmental impact statement for license renewal actions. The SEIS cannot be prepared by an independent third party as one of the commenters suggests. The comment does not present any significant new information that would warrant a change to the final SEIS.*

A.2.7.4 Environmental Justice

The following comments expressed support for nuclear power and the renewal of IP2 and IP3 operating licenses, because Indian Point provides clean, safe, and affordable electricity, and keeping Indian Point open means that families in the working-class and the low-income neighborhoods will not be held hostage to rapidly increasing electricity bills. They also expressed concerns about serious health issues and poor air quality in minority and low-income communities caused by air emissions from fossil-fueled power plants in their neighborhoods that would be used to generate electrical power if Indian Point were to be shut down. Of special concern is the issue of disproportionate health effects, especially asthma rates, experienced by low-income and minority communities, including African Americans and Hispanics.

14-a-AQ/EJ/SR; 14-d-AL/EJ/GL; 31-a-EJ/SR; 31-b-EC/EJ/HH; 45-a- AQ/EJ; 45-b-AL/EC/EJ; 46-b-AQ/EJ; 49-b-AQ/EJ; 49-d-AQ/EJ/SR; 49-f-AQ/EJ; 49-g-AL/AQ/EJ; 58-b-AL/AQ/EJ; 62-a-EJ/SR; 62-b-/EJ/SR; 118-a-AQ/EJ/SR; 118-b-EC/EJ/SR; 134-b-AL/AQ/EJ; 158-a-EJ/SR; 177-d-AQ/EJ/SR

Response: *These comments are generally supportive of nuclear power and the license renewal of IP2 and IP3. The NRC is responsible for licensing and regulating the operation of nuclear power plants to ensure the protection of public health and safety and the environment. Air quality impacts from alternative energy power generation including environmental justice concerns are discussed in Chapter 8 in the SEIS. These comments do not present any significant new information that would warrant a change to the final SEIS.*

The following comments pertain to the NRC staff's finding of a "small" impact level of the construction and operation of a closed-cycle cooling system at Indian Point, and asks why the 1996 GEIS does not address environmental justice as a generic issue.

14-b-AL/EJ; 46-c-AL/EJ/SR; 49-e-AL/EJ

Response: *The NRC has no role in energy planning decisions. State regulatory agencies, system operators, power plant owners, and, in some cases other Federal agencies, ultimately decide whether the power plant should continue to operate. The NRC has no authority or regulatory control over this decision. While the NRC considers a range of replacement power alternatives to license renewal, the only alternative within NRC's decision-making authority is whether or not to renew a plant's operating license. The NRC considers the decision to not renew the plant's operating license in the No-Action Alternative.*

The NRC also has no role in a decision regarding changes to nuclear power plant cooling systems (other than those involving safety-related issues) to mitigate adverse impacts; that decision is under the jurisdiction of State or other Federal agencies. The environmental impacts of closed cycle cooling systems (cooling towers) are discussed in Chapter 8 of the SEIS. Nevertheless, the discussion of potential impacts from the construction and operation of a closed-cycle cooling system has been revised in the final SEIS.

Environmental justice was not evaluated on a generic basis in the 1996 GEIS, because guidance for implementing Executive Order 12898 was not available prior to the completion of the 1996 GEIS. The analysis of environmental justice impacts are addressed in plant-specific reviews.

The following comments pertain to an inadequate discussion of evacuation plans and emergency planning in the DSEIS:

50-i-EJ/LE; 50-j-EJ/PA; 164-f-EJ/EP

Response: *All human health and environmental risks are considered during plant specific license renewal environmental reviews. In addition, all minority and low-income people are considered in NRC's assessment of environmental justice impacts. The environmental impacts of postulated accidents including severe accidents are discussed in Chapter 5. The Commission has generically determined that impacts associated with such accidents are SMALL because nuclear plants are designed to successfully withstand design basis accidents, and the probability weighted consequences (risk) of severe accidents are also SMALL.*

Providing projected growth rates of environmental justice communities would not present information needed to support or complete the environmental justice impact analysis since the location of existing minority and low-income populations have been identified and potential human health and environmental impacts to minority and low-income communities have been discussed. Minority and low-income populations would most likely remain where they are and grow in their current locations. In addition, no reason appears to suggest that these populations would materially change during the license renewal period, and projecting the growth of minority and low-income population would not necessarily increase the significance of any environmental justice impacts, should they exist.

The NRC staff performed a site specific evaluation which evaluated the impacts of the leaks of radioactive material at IPEC from a general human health perspective as well as from the environmental justice perspective using subsistence living factors. The evaluations are contained in Chapters 2 and 4 of the Draft SEIS. Additional information related to the human health aspects of these comments is addressed in the Human Health section of this appendix.

The safe operation of nuclear power plants is not limited to license renewal but is dealt with on a daily basis as a part of the operating license. Safety issues and concerns are addressed by the NRC on an ongoing basis at every nuclear power plant. Safety inspections are and will be conducted throughout the operating life of the power plant, whether during the original or renewed operating license term. If safety issues are discovered at a nuclear plant, they are addressed immediately, and any necessary changes are incorporated into the operating license. As such, the regulatory safety oversight of IP2 and IP 3 are ongoing and outside the regulatory scope of license renewal. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing age, race, and ethnographic demographics and other site-related factors.

The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR Part 54, which included public notice and comment. As discussed in the statement of consideration for rulemaking (56 FR 64966), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. Requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR Part 50. These requirements apply to all operating licenses and will continue to apply to facilities with renewed licenses.

The Commission has determined that there is no need for a special review of emergency planning issues in the context of an environmental review for license renewal. Therefore, *decisions and recommendations concerning emergency preparedness at nuclear plants are ongoing and outside the regulatory scope of license renewal. These comments do not present any significant new information that would warrant a change to the final SEIS.*

The following comments are in opposition to concerns about an increase in air pollution in minority and low-income communities:

50-t-EJ/AL; 182-d-AL/EJ/OR

Response: *All human health and environmental risks are considered during plant specific license renewal environmental reviews. In addition, all minority and low-income people are considered in NRC's assessment of environmental justice impacts for alternatives presented in Chapter 8 of the SEIS. These comments do not present any significant new information that would warrant a change to the final SEIS.*

The following comments expressed concern that the Draft EIS does not adequately assess environmental justice and fails to consider immobile people with disabilities and institutionalized individuals in special facilities. One Commenter goes on to suggests that there may be a disparate impact on minority communities and subsistence fishermen for cancer related to radiation releases from Indian Point. Concern was also expressed about a large minority, low-income and disabled population in special facilities within 50 miles who will be severely impacted if there is an evacuation from the area from Indian Point. The Draft SEIS fails to take into account the high percentage of minority and low-income populations in the lower Hudson Valley region who engage in subsistence fishing. Another commenter indicates that the Draft EIS does not assess the impact of uranium mining on Native Americans and the disposal of the radioactive waste on environmental justice communities, and that the NRC Staff relies on incomplete demographic analyses and/or inconsistent data in making assessments. Another commenter suggests that the Draft EIS discusses the population within 20 miles of Indian Point based on 2000 census data without mention of the minority composition within 20 miles of Indian Point. The commenter also identifies the use of projected population growth rates for the total population during the license renewal period while not including projected growth rates for environmental justice communities over that same time period as an inconsistency.

One commenter also expresses concern that the NRC Staff relies on incomplete demographic analyses and/or inconsistent data in making assessments. For example, the Draft EIS discusses the population within 20 miles of Indian Point based on 2000 census data; however there is no mention of the minority composition within 20 miles of Indian Point. Another inconsistency found in the Draft EIS is the use of projected population growth rates for the total population during the license renewal period while not including projected growth rates for environmental justice communities over that same time period. The DSEIS does not evaluate the impacts of relicensing on the environmental justice communities in Peekskill, Haverstraw and West Haverstraw. Without complete and consistent data the Draft SEIS does not meet the minimum requirements of NEPA. The use of Census block groups in the analysis obscures smaller neighborhood concentrations of minority populations. Probable real-life impacts on environmental justice communities are neither presented nor analyzed. There is a particular need to consider the full range of health, accident risk, and terrorist risk impacts on minority populations residing immediately adjacent to Indian Point.

68-c-DE/EJ/NE; 79-h-EJ; 79-n-EJ; 79-o-EJ; 79-p-EJ; 79-q-EJ; 79-t-EJ; 96-i-EJ/UF

Response: *All minority and low-income people are considered in NRC's assessment of environmental justice impacts regardless of whether they are immobilized with disabilities and/or institutionalized (in federal or state prisons; local jails; federal detention centers; juvenile institutions; nursing or convalescent homes for the aged or dependent; or homes, schools, hospitals, or wards for the physically handicapped, mentally retarded, or mentally ill; or in drug/alcohol recovery facilities). The location of minority and low-income populations identified in a SEIS environmental justice assessment are determined on the basis of where they are living at the time of the census. All people living in the U.S. (including institutionalized persons) on April 1, 2000 were counted based on where they were living at the time.*

Before a plant is licensed to operate, the NRC must have "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." The NRC's decision of reasonable assurance is based on licensees complying with NRC regulations and guidance. The emergency plans for nuclear power plants cover preparations for evacuation, sheltering, and other actions to protect residents near plants (including institutionalized persons) in the event of a serious incident. Nuclear power plant owners, government agencies, and State and local officials work together to create a system for emergency preparedness and response that will serve the public in the unlikely event of an emergency. Federal oversight of emergency preparedness for licensed nuclear power plants is shared by the NRC and Federal Emergency Management Agency (FEMA).

As part of the reactor oversight process, the NRC reviews licensees' emergency planning procedures and training. These reviews include regular drills and exercises that assist licensees in identifying areas for improvement, such as in the interface of security operations and emergency preparedness. These reviews are used by the NRC to make radiological health and safety decisions before issuing new licenses and in the continuing oversight of operating reactors. The NRC also has the authority to take action, including shutting down any reactor deemed not to provide reasonable assurance of the protection of public health and safety.

The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR Part 54, which included public notice and comment. As discussed in the statement of consideration for rulemaking (56 FR 64966), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. Requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR Part 50. These requirements apply to all operating licenses and will continue to apply to facilities with renewed licenses. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing age, race, and ethnographic demographics and other site-related factors.

The Commission has determined that there is no need for a special review of emergency planning issues in the context of an environmental review for license renewal. Therefore, decisions and recommendations concerning emergency preparedness at nuclear plants are ongoing and outside the regulatory scope of license renewal.

The NRC does not question the existence of subsistence fishing in close proximity to IP2 and IP3. The NRC staff reviewed the results of IPEC's radiological environmental monitoring program (REMP). The REMP monitoring results show that concentrations of radioactive contaminants in native leafy vegetation, soils and sediments, Hudson River surface water and fish from the vicinity of IPEC are very low (at or near the threshold of the survey instrument's *detection capability) and seldom above background levels. Based on the data, the NRC staff concluded that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.*

The NRC is also committed to ensuring that all nuclear materials including uranium fuel, spent fuel, and radioactive wastes are managed to prevent detrimental health impacts to the public. The radiological and nonradiological environmental impacts of the uranium fuel cycle were evaluated for all nuclear power plants on a generic basis in the 1996 GEIS. The review included a discussion of the values presented in Table S-3, Table of Uranium Fuel Cycle Environmental Data, presented in 10 CFR Part 51.

On the basis of the evaluation presented in the GEIS, the Commission concluded that, other than for the disposal of spent fuel and high-level waste, impacts on individuals from radioactive gaseous and liquid releases will remain at or below the Commission's regulatory limits. The aggregate nonradiological impact of the uranium fuel cycle resulting from the renewal of an operating license for any plant would be small.

The environmental impacts of individual operating uranium fuel cycle facilities (including uranium mining) are addressed in separate EISs prepared by the NRC. These documents include analyses that address human health and environmental impacts to minority and low-income populations. Electronic copies of these EISs are available through the NRC's public Web site in the Publications Prepared by NRC Staff document collection of the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and the NRC's Agency wide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html.

The impacts of spent fuel and high level waste disposal have also been addressed on a generic basis. The human health impacts of transporting spent nuclear fuel are addressed in an addendum to the 1996 GEIS in which the NRC evaluated the applicability of Table S–4 to future license renewal proceedings given that the spent fuel was planned to be shipped to a single repository. Further, as part of the site characterization and recommendation process for the proposed geologic repository at Yucca Mountain, Nevada, DOE is required by the Nuclear Waste Policy Act of 1982 to prepare an EIS. By law, the NRC is required to adopt DOE's EIS, to "the extent practicable," as part of any possible NRC construction authorization decision. As a result, DOE prepared and submitted to NRC the Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Repository SEIS) DOE/EIS-0250F-S1. This document includes analyses that address human health and environmental impacts to minority and low-income communities including Native Americans.

As noted in DOE's Repository SEIS, shipments of spent nuclear fuel (as well as fresh fuel) would use the nation's existing railroads and highways. DOE estimates that transportation-related impacts to land use; air quality; hydrology; biological resources and soils; cultural resources; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; and waste management would be small. The small effect on the population as a whole would be likely for any segment of the population, including minority and low-income populations, as well as members of American Indian tribes.

DOE did not identify any potentially high and adverse impacts to members of the public from the transport of spent nuclear fuel. DOE determined that subsections of the population, including *minority or low-income populations, would not receive disproportionate impacts, and no unique exposure pathways, sensitivities, or cultural practices that would expose minority or low-income populations to disproportionately high and adverse impacts were identified. DOE concluded that no disproportionately high and adverse impacts would result from the national transportation of spent nuclear fuel to Yucca Mountain. On September 8, 2008, NRC staff recommended that the Commission adopt, with supplementation, DOE's Repository EIS and supplements (73 FR 53284). While DOE subsequently requested the withdrawal of its Yucca Mountain repository application (which remains pending before the NRC), it has not identified any alternatives for the disposal of spent nuclear fuel and high-level waste, and the impact of any alternative disposal are speculative and cannot be evaluated at this time.*

Complete and consistent demographic data has been presented in the Draft SEIS. Section 2.2.8.5 in the SEIS provides demographic (including minority composition) information on populations residing in Dutchess, Orange, Putnam, and Westchester counties in 2000 and 2006. These counties stretch out more than 20 miles from IP2 and IP3. As stated in the text and according to the U.S. Census Bureau's 2006 American Community Survey, minority populations in the four-county region were estimated to have increased by nearly 90,000 persons and made up 32.7 percent of the total four-county population in 2006 (see SEIS Table 2-13). This represents an increase of 19 percent relative to the total population from 2000 to 2006. The largest increases in minority populations were estimated to occur in Hispanic or Latino and Asian populations, an estimated increase of 29.2 percent since 2000, and a 2.9 percent increase as a percent of the total population. The Black or African-American population increased by approximately 5 percent from 2000 to 2006 but remained unchanged as a percentage of the total four-county population. Asian populations grew by approximately 37 percent since 2000, but this resulted in only a one percent increase as a percent of the total population.

Providing projected growth rates of environmental justice communities would not present information needed to support or complete the environmental justice impact analysis since the location of existing minority and low-income populations have been identified and potential human health and environmental impacts to minority and low-income communities have been discussed. Concentrations of minority and low-income populations would most likely remain where they are and grow in their current locations. In addition, no reason appears to suggest that these populations would materially change during the license renewal period, and projecting the growth of minority and low-income population would not necessarily increase the significance of any environmental justice impacts, should they exist.

The discussion and figures in Section 4.4.6 in the SEIS indentify concentrated locations of minority and low-income block group populations residing within a 50-mile (80-kilometer) radius of IP2 and IP3. Even though minority and low-income Census block groups were identified in these communities in the Draft SEIS, the SEIS has been revised to specifically note that Peekskill, Haverstraw and West Haverstraw have been identified as potential environmental justice areas.

While Census block data is preferred for identifying minority communities, Census block group data was chosen because poverty and income information is not available from Census at the block level. The NRC acknowledges that Census block data on race and ethnicity would further define the location of minority communities, and does not question the existence of these populations and communities in close proximity to IP2 and IP3. The NRC addresses environmental justice matters for license renewal through (1) identifying the location of minority and low-income populations that may be affected by the proposed license renewal, and (2) *examining any potential human health or environmental effects on these populations to determine if these effects may be disproportionately high and adverse.*

As discussed in Section 2.2.8.5 in the IP SEIS, IP2 and IP3 are located in a high-population area. The NRC requires that nuclear power plants be both safe and secure. Safety refers to operating the plant in a manner that protects the public and the environment. Security refers to protecting the plant (i.e., using people, equipment, and fortifications) from intruders who wish to damage or destroy it in order to harm people and the environment.

Security issues such as safeguards planning are not tied to a license renewal action but are considered to be issues that need to be dealt with constantly as a part of the current (and renewed) operating license. Security issues are reviewed and updated at every operating plant. These reviews continue throughout the period of an operating license, whether the original or renewed license. If issues related to security are discovered at a nuclear plant, they are addressed immediately, and any necessary changes are reviewed and incorporated under the operating license. As such, decisions and recommendations concerning safeguards and security at nuclear power plants are ongoing and outside the regulatory scope of license renewal.

After the terrorist attacks of September 2001, the NRC issued security related orders and guidance to nuclear power plants. These orders and guidance include interim measures for emergency planning. Nuclear industry groups and Federal, State, and local government agencies assisted in the prompt implementation of these measures and participated in drills and exercises to test these new planning elements. The NRC has reviewed licensees' commitments to address these requirements and verified the implementation through inspections to ensure public health and safety.

The NRC and other Federal agencies have heightened vigilance and implemented initiatives to evaluate and respond to possible threats posed by terrorists, including the use of aircraft against commercial nuclear power facilities and independent spent fuel storage installations. These acts remain speculative and beyond the regulatory scope of a license renewal review. However, the NRC assesses threats and other information provided by other Federal agencies and sources on an ongoing basis. The NRC also works to ensure that licensees meet security requirements through the ongoing regulatory process (routine inspections) as this issue affects all nuclear power plants. The issue of security and risk from terrorist acts against nuclear power plants is not unique to facilities that have requested a renewal to their operating licenses. Nevertheless, the SEIS has been revised to more fully describe the overall potential human health and environmental effects that could affect minority and low-income populations. These comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments express concern with the effects of Strontium-90 on subsistence fishermen and persons who eat fish from the Hudson River:

73-b-EJ/HH/LE; 73-c-EJ/HH/LE; 73-e-EJ/HH; 79-b-EJ/HH; 93-g-EJ/HH; 96-g-EJ/HH/LE; 97-a-EJ/HH; 97-k-EJ/HH/LE; 124-b-EJ/EP/HH/PA; 138-a-EJ/HH/LE; 149-b-EJ/HH

Response: *The NRC's primary mission is to protect the public health and safety and the environment from the effects of radiation from nuclear reactors, materials, and waste facilities. The NRC's regulatory limits for radiological protection are set to protect workers and the public from the harmful health effects of radiation on humans. The limits are based on the recommendations of standards-setting organizations. Radiation standards reflect extensive* *scientific study by national and international organizations. The NRC actively participates and monitors the work of these organizations to keep current on the latest information concerning radiation protection.*

The NRC reviewed the results of IPEC's radiological environmental monitoring program (REMP). The REMP monitoring results show that concentrations of radioactive contaminants in native leafy vegetation, soils and sediments, Hudson River surface water and fish from the vicinity of IPEC are very low (at or near the threshold of the survey instrument's detection capability) and seldom above background levels. Based on the data, the NRC concluded that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

The NRC has already fully considered and addressed these issues in Chapters 2 and 4 of the SEIS and these comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment expresses concern about the lack of an environmental justice discussion in the generic GEIS, and suggests that there's no framework or guidance for addressing environmental justice in the Draft SEIS. The lack of guidance at the generic level may lead to an inadequacy at the specific EIS components.

113-c-EJ/GE

Response: *Environmental justice was not evaluated on a generic basis in the GEIS, because guidance for implementing Executive Order 12898 was not available prior to its completion in 1996. The analysis of environmental justice impacts are addressed in plant-specific environmental reviews.*

NRC staff is guided in its consideration of environmental justice in plant-specific environmental reviews by Office of Nuclear Reactor Regulation (NRR), Office Instruction LIC-203, Appendix C "Environmental Justice in NRR NEPA Documents." The environmental justice review involves identifying minority and low-income populations in the vicinity of the plant that may be affected by license renewal, any concerns and potential environmental impacts that may affect these populations, including their geographic locations, the significance of such concerns and effects and whether they would be disproportionately high and adverse when compared to the general population, and if so, the mitigation measures available to reduce and/or eliminate these impacts. The NRC performs the environmental justice review to determine whether there would be disproportionately high and adverse human health and environmental effects on minority and low-income populations and report the results of this review in the SEIS. This comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments express concern that the Draft SEIS failed to address, or inadequately addressed:

1. **Impact of cancer on minority and low-income populations that are more susceptible to cancer from Indian Point radionuclide emissions than other populations;**

2. **impact to subsistence fishing in the Hudson River;**

3. **fact that low-income populations will be more severely and negatively impacted by an evacuation resulting from a radiological event at Indian Point; (see also 79-u-EJ/SM)**

4. **the fact that disabled and institutionalized residents of special facilities will be more severely and negatively impacted by an evacuation or radiological event at Indian Point, including disabled patients in the dozens of hospitals and long term care facilities, and inmates in the many prisons in the area; and (see also 79-v-EJ/EP/SM)**

5. **environmental justice concerns relating to production and long term storage of Indian Point's fuel, especially upon Native American populations. (see also 79-y-EJ/UF)**

79-r-EJ

Response:

1. *Aspects of this comment related to cancer incidence due to radionuclide emissions from Indian Point are addressed in Chapter 4 of the SEIS and the Human Health portion of this Appendix.*

2. *Impacts to subsistence fishing are addressed in the "Subsistence Consumption of Fish and Wildlife" discussion in Section 4.4.6 Environmental Justice in the SEIS.*

3. *The emergency plans for nuclear power plants cover preparations for evacuation, sheltering, and other actions to protect residents near plants in the event of a serious incident. Nuclear power plant owners, government agencies, and State and local officials work together to create a system for emergency preparedness and response that will serve the public in the unlikely event of an emergency. Federal oversight of emergency preparedness for licensed nuclear power plants is shared by the NRC and Federal Emergency Management Agency (FEMA).*

   The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR Part 54, which included public notice and comment. As discussed in the statement of consideration for rulemaking (56 FR 64966), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. Requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR Part 50. These requirements apply to all operating licenses and will continue to apply to facilities with renewed licenses. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing age, race, and ethnographic demographics and other site-related factors.

   The Commission subsequently determined that there is no need for a special review of emergency planning issues in the context of an environmental review for license renewal. Therefore, decisions and recommendations concerning emergency *preparedness at nuclear plants are ongoing and outside the regulatory scope of license renewal.*

4. *All minority and low-income people are considered in NRC's assessment of environmental justice impacts regardless of whether they are immobilized with disabilities and/or institutionalized (in federal or state prisons; local jails; federal detention centers; juvenile institutions; nursing or convalescent homes for the aged or dependent; or homes, schools, hospitals, or wards for the physically handicapped, mentally retarded, or mentally ill; or in drug/alcohol recovery facilities). The location of minority and low-income populations identified in a SEIS environmental justice assessment are determined on the basis of where they are living at the time of the census. All people living in the U.S. (including people living in prisons) on April 1, 2000 were counted based on where they were living at the time. Same response as 3.*

5. *The NRC is committed to ensuring that all nuclear materials including uranium fuel, spent fuel, and radioactive wastes are managed to prevent detrimental health impacts to the public. The radiological and nonradiological environmental impacts of the uranium fuel cycle are evaluated in the 1996 GEIS. The review included a discussion of the values presented in Table S-3, Table of Uranium Fuel Cycle Environmental Data, presented in 10 CFR Part 51.51.*

   On the basis of the evaluation presented in the GEIS, the Commission concluded that, other than for the disposal of spent fuel and high-level waste, impacts on individuals from radioactive gaseous and liquid releases will remain at or below the Commission's regulatory limits.

   As part of the site characterization and recommendation process for the proposed geologic repository at Yucca Mountain, Nevada, the DOE is required by the Nuclear Waste Policy Act of 1982 to prepare an EIS. By law, the NRC is required to adopt DOE's EIS, to "the extent practicable," as part of any possible NRC construction authorization decision. As a result, DOE prepared and submitted to NRC the Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Repository SEIS) DOE/EIS-0250F-S1. This document includes analyses that address human health and environmental impacts to minority and low-income communities including Native Americans.

The following comments express concern that low-income populations, residents of special facilities, including disabled patients and inmates in prisons will be more severely and negatively impacted by an evacuation resulting from a radiological event at Indian Point. Potential impacts upon disabled and institutionalized individuals was completely ignored, and the relicensing of Indian Point places these individuals, including children, seniors, and veterans at risk.

79-u-EJ/SM; 79-v-EJ/EP/SM; 79-w-EJ

Response: *All minority and low-income people are considered in NRC's assessment of environmental justice impacts regardless of whether they are immobilized with disabilities and/or institutionalized (in federal or state prisons; local jails; federal detention centers; juvenile institutions; nursing or convalescent homes for the aged or dependent; or homes, schools, hospitals, or wards for the physically handicapped, mentally retarded, or mentally ill; or in drug/alcohol recovery facilities). The location of minority and low-income populations identified* *in a SEIS environmental justice assessment are determined on the basis of where they are living at the time of the census. All people living in the U.S. (including people living in prisons) on April 1, 2000 were counted based on where they were living at the time.*

The NRC is responsible for licensing and regulating the operation of nuclear power plants to ensure the protection of public health and safety and the environment. The safe operation of nuclear power plants is not limited to license renewal but is dealt with constantly on a daily basis as a part of the operating license. Safety issues and concerns are addressed by the NRC on an ongoing basis at every nuclear power plant. Safety inspections are and will be conducted throughout the operating life of the power plant, whether during the original or renewed operating license term. If safety issues are discovered at a nuclear plant, they are addressed immediately, and any necessary changes are incorporated into the operating license. As such, the regulatory safety oversight of IP2 and IP 3 are ongoing and outside the regulatory scope of license renewal.

Before a plant is licensed to operate, the NRC must have "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." The NRC's decision of reasonable assurance is based on licensees complying with NRC regulations and guidance. The emergency plans for nuclear power plants cover preparations for evacuation, sheltering, and other actions to protect residents near plants in the event of a serious incident. Nuclear power plant owners, government agencies, and State and local officials work together to create a system for emergency preparedness and response that will serve the public in the unlikely event of an emergency. Federal oversight of emergency preparedness for licensed nuclear power plants is shared by the NRC and Federal Emergency Management Agency (FEMA).

As part of the reactor oversight process, the NRC reviews licensees' emergency planning procedures and training. These reviews include regular drills and exercises that assist licensees in identifying areas for improvement, such as in the interface of security operations and emergency preparedness. These reviews are used by the NRC to make radiological health and safety decisions before issuing new licenses and in the continuing oversight of operating reactors. The NRC also has the authority to take action, including shutting down any reactor deemed not to provide reasonable assurance of the protection of public health and safety.

The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR Part 54, which included public notice and comment. As discussed in the statement of consideration for rulemaking (56 FR 64966), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. Requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR Part 50. These requirements apply to all operating licenses and will continue to apply to facilities with renewed licenses. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing age, race, and ethnographic demographics and other site-related factors.

The Commission has determined that there is no need for a special review of emergency planning issues in the context of an environmental review for license renewal. Therefore, decisions and recommendations concerning emergency preparedness at nuclear plants are ongoing and outside the regulatory scope of license renewal. These comments do not present any significant new information that would warrant a change to the final SEIS.

The commenter wants the Final SEIS to address the impact on employment for environmental justice communities and low-income populations.

79-x-AL/EJ

Response: *The NRC addresses environmental justice matters for license renewal through (1) identifying the location of minority and low-income populations that may be affected by the proposed license renewal, and (2) examining any potential human health or environmental effects on these populations to determine if these effects may be disproportionately high and adverse. The SEIS provides a discussion of potential impacts to minority and low-income populations from license renewal, refurbishment (vessel head replacement), and replacement power alternatives, including potential employment impacts.*

Socioeconomic conditions in minority and low-income communities would not change as a result of renewing the IP2 and IP3 operating licenses. Employment levels would remain relatively unchanged, so direct and indirect employment opportunities caused by IPEC would remain unchanged. Therefore, there would be no additional socioeconomic impact to minority and low-income populations during the license renewal term beyond what is currently being experienced. The SEIS has been revised to more fully describe the overall potential human health and environmental effects of license renewal that could affect minority and low-income populations.

The following comment expresses environmental justice concerns relating to production and long term storage of Indian point's fuel, especially upon Native American populations

79-y-EJ/UF

Response: *The NRC is committed to ensuring that all nuclear materials including uranium fuel, spent fuel, and radioactive wastes are managed to prevent detrimental health impacts to the public. The radiological and nonradiological environmental impacts of the uranium fuel cycle are evaluated in the 1996 GEIS. The review included a discussion of the values presented in Table S-3, Table of Uranium Fuel Cycle Environmental Data, presented in 10 CFR Part 51.51.*

On the basis of the evaluation presented in the GEIS, the Commission concluded that, other than for the disposal of spent fuel and high-level waste, impacts on individuals from radioactive gaseous and liquid releases will remain at or below the Commission's regulatory limits.

As part of the site characterization and recommendation process for the proposed geologic repository at Yucca Mountain, Nevada, the DOE is required by the Nuclear Waste Policy Act of 1982 to prepare an EIS. By law, the NRC is required to adopt DOE's EIS, to "the extent practicable," as part of any possible NRC construction authorization decision. As a result, DOE prepared and submitted to NRC the Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Repository SEIS) DOE/EIS-0250F-S1. This document includes analyses that address human health and environmental impacts to minority and low-income communities including Native Americans. This comment does not present any significant new information that would warrant a change to the final SEIS.

A.2.8 Comments Concerning Land Use Issues

The following comment indicates that the SEIS does not analyze offsite land use impacts of continued operations and the additional storage of spent fuel on real estate values in the surrounding areas.

129-d-AL/LU

Response: *The impacts evaluated for the 1996 GEIS (NUREG-1437) identified 92 environmental issues that were considered for the license renewal of nuclear power plants. Members of the public, citizen groups, industry representatives, and other Federal, state, and local governmental agencies commented on and helped identify these 92 issues during the preparation of the GEIS. Offsite land use impacts were determined to be Category 2 issues to be addressed in plant-specific supplemental environmental impact statements (SEISs). The impact of nuclear plant operations on real estate values was not identified as an issue to be addressed by license renewal.*

The regulatory authority over licensee economics (including the need for power and the No Action Alternative) falls largely within the jurisdiction of the states and to some extent within the jurisdiction of the Federal Energy Regulatory Commission. The proposed rule for license renewal had included a cost-benefit analysis and consideration of licensee economics as part of the National Environmental Policy Act (NEPA) review. However, during the comment period, state, Federal, and licensee representatives expressed concern about the use of economic costs and cost-benefit balancing in the proposed rule and the GEIS. They noted that President's Council on Environmental Quality (CEQ) regulations interpret NEPA to require only an assessment of the cumulative effects of a proposed Federal action on the natural and man-made environment and that the determination of the need for generating capacity has always been the states' responsibility. For this reason, the purpose and need for the proposed action (i.e., license renewal) is defined in the 1996 GEIS as follows:

> *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, licensee, and, where authorized, Federal (other than NRC) decision-makers.*

The SEIS for license renewal is not required to address the economic costs and economic benefits of the proposed action or of alternatives to the proposed action. In addition, the SEIS need not discuss other issues not related to the environmental effects of the proposed action and the alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b) (see 10 CFR 51.95 (c)(2)). The draft SEIS must contain an analysis of issues identified as Category 2 in appendix B to subpart A of this part that are open for the proposed action. Table B-1 summarizes the Commission's findings on the scope and magnitude of environmental impacts of renewing the operating license for a nuclear power plant as required by section 102(2) of the National Environmental Policy Act of 1969, as amended.

Offsite land use impacts of spent fuel storage in an ISFSI are not part of the proposed action and are not within the regulatory scope of license renewal and therefore are not addressed in the IP DSEIS. These impacts have been addressed as part of a separate NEPA review conducted by the NRC.

The comment does not present any significant new information that would warrant a change to the final SEIS.

A.2.9 Comments Concerning Postulated Accidents

The following comments assert that studies by Lamont-Doherty Earth Observatory show that the Indian Point plant may be more vulnerable to earthquakes than previously thought because it sits less than a mile south of a newly-identified seismic zone (Ramapo Fault) running from Stamford, Connecticut, to Peekskill, New York. It appears that this information was not included in the draft SEIS. We recommend that NRC include and analyze any new geologic and seismic data in the final SEIS, particularly concerning recent seismic activity occurring in the northern New Jersey-New York metropolitan region.

9-c-LE/OE/PA/RW, 10-d-OE/PA, 13-c-PA/SF/ST, 32-a-AM/OP/PA, 51-a-HH/PA/UF, 55-e-PA, 55-f-AE/PA/RW, 71-b-OE/PA, 76-b-OR/PA, 79-j-HH, 87-b-HH/PA/RW/ST, 97-g-EP/OE/PA, 102-j-OE/PA, 124-b-EJ/EP/HH/PA, 129-e-SM; 140-ii-SM; 162-d-GW/LE/PA, 164-a-OE/PA/ST, 174-d-PA, 179-c-PA, 180-e-OE/PA, and 183-c-EP/HH/PA

The following comments assert that, given the proximity of the Indian Point site to the Ramapo Fault, the NRC should provide a site-specific analysis of whether the dry casks and the spent fuel pools would be able to withstand a significant earthquake.

10-a-OE/PA; 20-a-PA/SF/ST; 96-j-LR/PA/RW; 129-e-SM; 140-ii-SM

Response: *Insofar as these comments raise a safety issue, these comments are not unique to the license renewal action; rather, they pertain to the current operating license and are being addressed as a part of the current operating license reactor oversight process. The NRC staff is aware that recent updates to seismic data and models indicate that estimates of the earthquake hazard at some nuclear plant sites in the Central and Eastern United States (CEUS) may be larger than previous estimates. Based on a preliminary review of the updated seismic data and models, the NRC staff concluded that the seismic hazards remain small in an absolute sense and that the currently operating plants in the CEUS remain safe. Nevertheless, the NRC staff determined that the recent data and models warrant further study and analysis. Those activities have been initiated and are being pursued under the Generic Issue Program (GIP) as Generic Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and United States on Existing Plants." This issue is now in the Safety/Risk Assessment stage of the GIP, in which the NRC staff is collecting and analyzing hazard information from the US Geological Survey and other sources, and developing an up-to-date understanding of the seismic spectra at each site. Should the NRC staff evaluations determine the seismic risk increase exceeds established safety values, GI-199 will proceed to the Regulatory Assessment stage of the GIP, where appropriate regulatory actions would be identified.*

Insofar as the comments suggest that a seismic event during the period of license renewal could result in environmental impacts, such impacts were considered as part of the SEIS discussion of severe accidents initiated by external phenomena and by the GEIS in its "Review of Existing Impacts." As discussed in section 5.1.2 of the draft SEIS, the NRC staff evaluated the risk of beyond-design-basis earthquakes at existing nuclear power plants, and determined that the risk from such events is SMALL; further, the NRC determined that the risks from other external events are adequately addressed by the generic consideration of internally-generated severe accidents in the GEIS, and that this issue should be considered on a site-specific basis in a plant's SAMA analysis. Entergy's SAMA analysis included a search for mitigation measures for accident scenarios initiated by fire and seismic external events (see section G.2.2 of the draft SEIS). In addition, Entergy increased the benefit derived from the internal event PRA by a multiplication factor to account for the combined contribution from internal and external events. The NRC staff has not identified any new and significant information with *regard to the environmental consequences of a severe accident at IP2 and IP3, including externally-initiated accidents. The comment provides no new and significant information; therefore no changes were made to the SEIS in response to this comment.*

The following comments assert that the Indian Point plant and spent fuel are potential targets of a terrorist attack based upon their proximity to the New York City metropolitan area; they also assert that the draft SEIS ignores the possibility – as well as the possible effects on the environment and public health – of another terrorist attack.

13-c-PA/SF/ST, 38-b-PA/RW/ST, 39-c-PA/ST, 50-m-PA/ST, 87-b-HH/PA/RW/ST, 102-d-OW/PA/ST, 128-r-SM/UF; 129-o-SM

Response: *The NRC and other Federal agencies have heightened vigilance and implemented initiatives to evaluate and respond to possible threats posed by terrorists, including the use of aircraft against commercial nuclear power facilities and independent spent fuel storage installations. While these are legitimate matters of concern, they will continue to be addressed through the ongoing regulatory process as a current and generic regulatory issue that affects all nuclear facilities and many of the activities conducted at nuclear facilities. The issue of security and risk from malevolent acts at nuclear power facilities is not unique to facilities that have requested a renewal of their licenses. In the Pilgrim license renewal proceeding, the Commission affirmed that the National Environmental Policy Act (NEPA) imposes no legal duty to consider malevolent acts in conjunction with license renewal (CLI-10-14). In any event, the NRC performed a discretionary analysis of terrorism in developing the GEIS. The NRC concluded that core damage and radiological release from such acts would be no worse than the damage and release from internally initiated events. The comment is outside the scope of a plant-specific license renewal review; therefore, no changes were made to the SEIS in response to this comment.*

The following comments assert that the draft SEIS fails to address the effects of a spent fuel pool fire at Indian Point, in particular, the release of cesium-137 from the spent fuel pools.

13-d-PA/SF, 89-a-HH/PA/SF; 140-hh-SM

Response: *As noted by the ASLB in LBP-08-13, "spent fuel pool fires are Category 1 environmental issues and are addressed generically in the GEIS for license renewal. The Commission reaffirmed this designation in Vermont Yankee/Pilgrim" (CLI-07-3). The Commission has subsequently reviewed two related petitions for rulemaking seeking to overturn this classification, and has denied these petitions on the basis that the risk of a fire is very low. As such, a plant-specific analysis of the effects of a spent fuel pool fire is not required. Spent fuel pools are robust structures constructed of very thick steel-reinforced concrete walls and possess a stainless steel liner. They contain enormous quantities of water, and as a result for most events, plant operators would have significant amounts of time to correct any problems. In addition, nuclear plants possess many other sources of cooling water that are readily available for cooling spent fuel. Recently, the Commission reiterated that a "'SAMA that addresses [spent fuel pool] accidents would not be expected to have a significant risk for the site' because the spent fuel pool accident 'risk level is less than that for a reactor accident." (CLI-10-14). The* *comment is outside the scope of a plant-specific license renewal review; therefore, no changes were made to the SEIS in response to this comment.*

The following comment asserts that the DSEIS (in Section 5.1.2) acknowledges that "[s]evere nuclear accidents.., such as... floods, earthquakes, fires, and sabotage, traditionally have not been discussed in quantitative terms in [past environmental documents] and were not specifically considered for IP2 and IP3 in the GEIS." This section continues, however, to note that NRC did evaluate impact assessments at 44 other nuclear plants and concluded that the risk from these types of events at those plants is small.

17-e-NE/PA

Response: *In the GEIS (Section 5.3.3.1), the Commission concluded that the risk from sabotage and beyond-design-basis events 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 accident. These conclusions were based on the results of detailed external event probabilistic risk assessments for a limited number of plants, together with additional rationale that supports the extrapolation of the findings to the entire population of plants. Based on the 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, and codified this result in 10 CFR Part 51. Thus, the Commission addressed these impacts in the GEIS.*

It should be noted that the statement in the DSEIS that "severe accidents initiated by external phenomena… were not specifically considered for IP2 and IP3 in the GEIS" is not completely correct. As indicated on page 5-17 of the GEIS, the NRC staff reviewed or performed detailed probabilistic assessments of external events for a number of plants, including IP2 and IP3. This statement will be corrected in the FSEIS.

The following comments assert that the population density around Indian Point is much higher than that around any other nuclear power station in the country. An accident at Indian Point would have a potentially much greater impact on human health and safety than a similar event at a nuclear power station in a less urbanized part of the country. The Draft SEIS does not adequately consider the millions of lives that would be destroyed in the event of a disaster, or the population growth at Indian Point. Because the magnitude of these impacts does not parallel the situation at other reactors, the SEIS must address questions of risk that are ruled out in the GEIS.

17-f-PA, 17-n-EP/PA/ST, 50-b-DE/PA, 50-c-PA, 50-h-DE/PA, 97-f-DE/OE/PA, 122-a-DE/PA/ST, 170-c-DE/PA, 170-f-HH/PA/UF

The following comments assert that the environmental impact statement needs to consider operation of an aging nuclear facility within a highly populated area and include modeling to determine the possible outcome of accidents.

22-a-HH/OR/OS/PA, 145-a-AM/PA, 171-b-PA/ST

Response: *The methodology used in the GEIS to predict the environmental impacts of postulated accidents accounts for the site-specific population within 50-miles of each nuclear power plant including Indian Point, and the projected growth of this population through the license renewal period (year 2030 for Indian Point). See GEIS Chapter 5. Based on this methodology, it was recognized that plant sites with larger populations, such as Indian Point, have a larger number of persons at risk for a given severe accident release, and that an accident would have higher impacts on human health and safety than a similar event at a nuclear power station in a less urbanized part of the country. Thus, the issue of large population size was considered in the GEIS. Moreover, the population in the vicinity of IP2 and IP3 was fullly considered in Entergy's SAMA analysis, which utilizes the projected population to determine the potential costs associated with severe accidents. The comments provide no new or significant information; therefore, no changes were made to the SEIS in response to these comments. These comments are outside the scope of the license renewal review; therefore, no changes were made to the SEIS in response to these comments.*

The following comment asserts that the probability of an accident, no matter how remote, does not diminish the severity of an accident should it occur. Therefore, weighting the severity as a function of probability is meaningless. Unless it can be shown that the probability is really zero, then the consequences pertain, and they need to be fully described, analyzed, and mitigated.

50-j-EJ/PA

Response: *The GEIS provides an evaluation of the environmental impacts of two classes of postulated accidents – design basis accidents and severe accidents. Design basis accidents are those that both the licensee and the NRC staff evaluate to ensure that the plant meets acceptable design and performance criteria. The results of these accidents are not probabilistically-weighted since they are considered to be within the scope of the licensing basis, and can be expected to occur within the lifetime of the population of operating plants. Severe accidents are events beyond the design basis of the plant. Although the environmental consequences of severe accidents can be substantially greater than for design basis accidents, the likelihood of severe accidents is extremely small. Thus, the GEIS presents the environmental impacts of severe accidents in a risk context, wherein risk is expressed as the product of the frequency of the event and the consequences of the event. This same approach was used to address the environmental impacts of severe accidents in plant-specific final environmental statement (FES) reports published since 1980 (see GEIS Section 5.3.3.1). This approach does not diminish the severity of an accident, but presents this information from a risk perspective so that severe accident risks can be compared with that for other risks. The comment is outside the scope of a plant-specific license renewal review; therefore no changes were made to the SEIS in response to this comment.*

The following comments assert that the fact that the draft SEIS examines mitigation for accidents but not the consequences of accidents is inappropriate, and the brief treatment of different scenarios in Tables 5.3 - 5.4 falls short of meeting the need for analysis of accidents. This section must be expanded in the final SEIS to present a thorough analysis of what it would mean for the affected populations should any of the potential event scenarios unfold.

50-k-PA, 50-l-HH/PA, 50-m-PA/ST, 155-b-PA

Response: *A detailed discussion of accident consequences is presented in Section 5.2 of the GEIS. This includes consideration of multiple exposure pathways (i.e., atmospheric releases, fallout onto open bodies of water, and groundwater releases), and additional risk metrics (e.g., early and latent fatalities, economic impacts, and land contamination). The GEIS concluded that the probabilistically-weighted consequences due to severe accidents are of small significance for all plants. Thus, these consequences need not be addressed in the SEIS.*

The ER and SEIS do include additional, plant-specific information regarding the frequency and consequences of severe accidents as part of the severe accident mitigation alternatives analysis. See, e.g., SEIS Chapter 5. However, the scope of the consequence information presented therein is limited to that which is necessary to assess the risk reduction associated with candidate design alternatives in accordance with established NRC regulatory analysis guidelines. The comment is outside the scope of a plant-specific license renewal review; therefore no changes were made to the SEIS in response to this comment.

A.2.10 Comments Concerning Severe Accident Mitigation Alternatives (SAMAs)

The following comments assert that the draft SEIS notes that some SAMAs were potentially cost beneficial, but need not be implemented as part of license renewal pursuant to 10 CFR 54 because they do not relate to adequately managing the effects of aging during the re-licensing period. An EIS must rigorously explore and objectively evaluate all reasonable alternatives, and not defer their further analysis to some undetermined point in the future. We urge Entergy to continue to refine and implement these alternatives as they appear to be cost beneficial and would mitigate the impact of a severe accident should one occur.

55-d-SM, 137-b-GW/PA/RW/SF, 137-f-AL/LE/PA/RF/SF, 137-i-PA, 170-d-PA/SM

Response: *The SAMA analysis constitutes a systematic and comprehensive process for identifying potential plant improvements, evaluating the implementation costs and risk reduction for each SAMA, and determining which SAMAs may be cost beneficial to implement. . The analysis is technically rigorous and consistent with the NEPA expectation that federal agencies take a "hard-look" at the environmental impacts of their proposed actions, including consideration of viable alternatives. If a SAMA is determined to be potentially cost beneficial but is not related to adequately managing the effects of aging during the re-licensing period, it is not required to be implemented as part of license renewal pursuant to 10 CFR Part 54. Further refinement beyond determining whether a SAMA is potentially cost beneficial is not necessary for an objective evaluation. Nevertheless, potentially cost-beneficial alternatives are identified and considered as part of the license renewal process, and licensees often commit to further evaluate the most promising cost-beneficial SAMAs among those that have been identified, for possible future implementation in order to further reduce plant risk, as Entergy has done for Indian Point. Such a commitment to perform a further evaluation is not a condition of granting a renewed license. Accordingly, a license renewal applicant's decision to defer this further evaluation of the potentially cost-beneficial SAMAs which it has identified, to some point in the future (i.e., outside the license renewal SAMA review), is acceptable. The comments provide no new and significant information; therefore, no changes were made in the SEIS in response to this comment.*

The following comment assert that the SAMA analysis in the DSEIS is defective because it incorporated an outdated air dispersion model (i.e., the ATMOS air dispersion module in the MACCS2 computer code) that will not accurately predict the dispersion of radionuclides traversing a complex terrain over long distances. An accurate SAMA analysis depends on the accuracy of the estimates of human exposure to radiation from a severe accident, which in turn depends on the validity of air dispersion models used to predict the manner in which radiation will be geographically dispersed through the atmosphere. ATMOS's simplistic assumptions directly affect its ability to accurately model the dispersion of radioactivity from the Indian Point plant.

97-e-PA, 129-m-SM

Response: *The MACCS2 code was developed under NRC sponsorship for use in evaluating the potential impacts of severe accidents at nuclear power plants on the surrounding public. The MACCS2 code considers, among other things, phenomena related to atmospheric transport and deposition under time variant meteorology, short- and long-term mitigative actions, potential exposure pathways, deterministic and stochastic health effects, and economic costs. The NRC is aware of no model other than the MACCS2 code that fully addresses each factor completely. The issue of concern in a SAMA analysis is not the results of a single meteorological data trial but the results of numerous meteorological trials that provide the mean dispersion over the entire 50-mile radius. In this regard, the atmospheric transport model used in MACCS2 has been found to generally perform as well as several more modern atmospheric transport models (Ref. NUREG/CR-6853), and within the level of accuracy of other portions of the analysis. As such, the MACCS2 model has proven its acceptability for the purpose of conducting a SAMA analysis. The adequacy of the atmospheric transport model used in the MACCS2 code was raised in a contention filed by the State of New York in the license renewal adjudicatory proceeding. The contention includes the criticisms mentioned above and has been admitted for litigation by the ASLB. Additional discussion of the atmospheric transport model and its impact on the SAMA analysis has been provided in Section G.2.3 of Appendix G of the FSEIS.*

The following comment asserts that the projections of the 2035 population likely to be living within 50 miles of Indian Point, on which the SAMA analysis is based, appear to underestimate the potential exposed population. It was projected that in 2035 the population of New York County (Manhattan) will be 1,570,657, whereas data from the U.S. Census estimates that in 2007 Manhattan's population was 1,620,867 – over 50,000 more than Entergy asserts would be at risk 29 years later.

129-m-SM

Response: *A concern regarding the adequacy of the population projections used in the SAMA analysis was raised in a contention filed by the State of New York in the license renewal adjudicatory proceeding. The contention includes the criticisms mentioned above and has been admitted for litigation by the ASLB. Additional discussion of the population projections and their impact on the SAMA analysis has been provided in Section G.2.3 of Appendix G to the FSEIS.*

The following comment asserts that the cost formula contained in the MACCS2 computer program underestimates the decontamination costs likely to be incurred as a result of a dispersion of radiation. The NRC Staff should use the analytical framework contained in the 1996 Sandia National Laboratories report concerning site restoration costs (D. Chanin and W. Murfin, "*Site Restoration: Estimation of Attributable Costs from Plutonium-Dispersal Accidents*," SAND96-0957). The NRC Staff should revise the Sandia

results for the densely populated and developed New York City area, incorporate the region's property values, and ensure that the resulting financial costs are expressed in present value and future value.

129-n-SM

Response*: A concern regarding the adequacy of the decontamination cost estimates used in the SAMA analysis was raised in a contention filed by the State of New York in the license renewal adjudicatory proceeding. The contention includes the criticisms mentioned above and has been admitted for litigation by the ASLB. Additional discussion of the decontamination cost estimates and their impact on the SAMA analysis has been provided in Section G.2.3 of Appendix G to the FSEIS.*

The following comments assert that the SAMA assessment is flawed because it fails to consider the risks and the contribution to severe accident costs from intentional attacks on Indian Point. Conventional PRA techniques can be adapted for this analysis by postulating an initiating event (malicious act) and then examining the outcomes of that event. The SAMA assessment should address National Infrastructure Protection Plan principles for increasing the inherent robustness of infrastructure facilities against attack, and should consider the mitigation measures recommended by the 2006 NAS Study to reduce the risk of impacts from intentional attacks, including: additional surveillance to detect and/or thwart attacks, creating earthen berms to protect casks from aircraft strikes, placing visual barriers around storage pads to prevent targeting of individual casks, re-spacing the casks to reduce likelihood of cask-to-cask interactions in the event of aircraft attack, and implementing design changes to newly manufactured casks to improve cask resistance to attack.

128-r-SM/UF, 140-bb-SM, 140-jj-SM

Response: *The NRC and other Federal agencies have heightened vigilance and implemented initiatives to evaluate and respond to possible threats posed by terrorists, including the malevolent use of aircraft against commercial nuclear power facilities and independent spent fuel storage installations. The NRC has required, and nuclear power plants have implemented, various security and mitigation measures that, along with the robust nature of nuclear power plants and spent fuel pools, make the probability of a successful terrorist attack (i.e., one that causes the release of a large amount of radioactive material into the environment) very low. In the Pilgrim license renewal proceeding, the Commission affirmed that NEPA imposes no legal duty to consider malevolent acts in conjunction with license renewal (CLI-10-14). In any event, the NRC performed a discretionary analysis of terrorism in developing the GEIS. The NRC concluded that core damage and radiological release from such acts would be no worse than the damages and release from internally initiated events. Thus, on this basis the NRC staff finds that the environmental impacts of renewing a nuclear power plant license, in regard to a terrorist attack, are not significant. The comment provides no new and significant information; therefore no changes were made in the SEIS in response to this comment.*

The following comments assert that the SAMA analysis in the draft SEIS is incomplete because it did not consider the contribution to severe accident costs from a fire in either of the SFPs at Indian Point. No SAMAs that would avoid or mitigate such costs have been identified. If the costs of SFP fires were considered, the value of SAMAs would be significant.

102-I-NE/OE/PA, 128-r-SM/UF, 140-cc-SM, 147-b-NE/OE/PA, and 174-e-NE/OE/PA

Response: *The objective of the SAMA evaluation is to identify and evaluate potential plant improvements that provide the greatest level of risk reduction in a cost-beneficial manner. The focus of SAMA evaluations is on reactor accidents because reactor accidents account for the majority of the severe accident risk for a nuclear power plant facility. Previous studies show that the risk associated with spent fuel pool accidents and dry cask storage accidents is considerably less than that for reactor accidents (e.g., NUREG-1738 and NUREG-1864). Given that a spent fuel pool accident risk is considerably less than that for a reactor accident, a SAMA that addresses spent fuel accidents would not be expected to have a significant impact on total risk for the site. Additional mitigation strategies implemented subsequent to September 11, 2001 further reduce the risk from SFP fires by enhancing spent fuel coolability and the ability to recover SFP water level and cooling prior to a potential SFP fire, and make it even more unlikely that additional SFP safety enhancements could substantially reduce risk or be cost-beneficial. Further, as the Commission recently observed in the Pilgrim license renewal proceeding, the GEIS determined that the impacts of onsite spent fuel storage, including spent fuel pool accidents, are "small" and constitute a Category 1 issue for which site-specific consideration in a license renewal proceeding is not required (CLI-10-14). The comments provide no new and significant information; therefore no changes were made in the SEIS in response to this comment.*

The following comment asserts that the SAMA analysis in the draft SEIS underestimates the potential for containment bypass during a core-damage accident. In light of current knowledge about severe reactor accidents, it is prudent to assume that all accident sequences that proceed to core damage with a dry secondary side and at high reactor coolant system pressure would result in induced failure of steam generator tubes, and that one or more of the secondary side safety valves downstream of the affected steam generator(s) would remain open after tube failure. This would significantly increase the conditional probability of an Early High release from that used in the ER. If the economic benefit of averted containment bypass accidents were appropriately considered, a number of SAMAs rejected as too costly would be cost-effective.

140-dd-SM

Response: *The proposed assumptions are bounding in nature, and fail to acknowledge that only a portion of the accidents that proceed to core melt with high primary side pressure and a dry secondary side would be expected to result in an induced SGTR. In many sequences, other reactor coolant system (RCS) piping components are estimated to fail prior to (or very close to) the estimated time of SG tube rupture, thereby depressurizing the RCS and reducing the potential for an induced SGTR. Use of bounding assumptions is inconsistent with Commission policy on the use of PRA evaluations in support of regulatory decisions which states that such PRAs should be as realistic as practicable. Nevertheless, the impact of assuming a substantially higher probability of induced steam generator tube rupture was assessed as part of Entergy's SAMA evaluation. As described in Section G.6.2 of Appendix G of the SEIS, no additional cost beneficial SAMAs were identified as a result of this assessment. The comment provides no new and significant information; therefore no changes were made in the SEIS in response to this comment.*

The following comment asserts that the source term used to estimate the consequences of the most severe accidents with early containment failure was based on radionuclide release fractions generated by the MAAP code, and is smaller than that specified in NRC

guidance such as NUREG-1465, *Accident Source Terms for Light- Water Nuclear Power Plants* (1995) and the NRC's recent reevaluation for high-burnup fuel, ERI/NRC 02-202, *Accident Source Terms for Light-Water Nuclear Power Plants. High Burnup and MOX Fuels* (2002).

140-ee-SM

Response: *The source terms (radionuclide release fractions) described in the referenced documents were developed primarily to support reactor siting criteria wherein substantial meltdown into containment is postulated and the containment is assumed to leak at its maximum allowable leak rate. These source terms do not account for fission product removal, such as would occur if the release were into the containment (e.g., fission product removal by containment sprays), or if the release were the result of a SGTR event (e.g., fission product deposition within the primary system piping and within the steam generators). As such, use of the source terms proposed by the commenter represents a very conservative (non-realistic), essentially bounding estimate of releases to the environment for the "early high" release category. Use of bounding assumptions is inconsistent with Commission policy on the use of PRA evaluations in support of regulatory decisions which states that such PRAs should be as realistic as practicable. In fact, the radionuclide release fractions calculated by the MAAP code for SGTR events (which dominate the "early high" release category) are in generally good agreement with those calculated by NRC-sponsored codes, as indicated in the NRC staff's review of the Indian Point Individual Plant Examination. The comment provides no new and significant information; therefore no changes were made in the SEIS in response to this comment.*

The following comment asserts that the SAMA analysis significantly underestimated offsite costs resulting from a severe accident at Indian Point because it failed to adequately consider the uncertainties in its consequence calculations resulting from meteorological variations.

140-ff-SM

Response: *To account for potential uncertainties in the SAMA analysis, estimated benefits for each SAMA were increased by a multiplier of approximately 2 based on the ratio of the 95th percentile core damage frequency to the mean core damage frequency. The comment fails to recognize that: (1) there are additional conservatisms in other parts of the analysis, specifically, the risk reduction estimates and the cost estimates, (2) the SAMA analysis is a probabilistic assessment of a broad range of accident sequences, meteorological conditions and other pertinent factors rather than an assessment of one accident under a single set of meteorological conditions, and (3) combining the estimated uncertainties in each step of the SAMA evaluation would result in an over-estimate of the uncertainties, and could lead to inappropriate decisions regarding whether a SAMA would realistically be cost-beneficial. Consistent with the use of risk methods and uncertainties in other regulatory applications, the SAMA analysis is based on best estimate (mean value) risk estimates, but considers the potential impact of uncertainties on the results of the evaluation, i.e., whether additional SAMAs would be cost-beneficial given the uncertainties. Although on its surface a multiplier of about 2 may appear small relative to the uncertainties in other parts of the analysis, the staff considers the margin adequate to cover those uncertainties, since the risk reduction and cost estimates were evaluated in a conservative manner. The comment provides no new and significant information; therefore no changes were made in the SEIS in response to this comment.*

The following comment asserts that the SAMA analysis significantly underestimated offsite costs of a severe accident because it inappropriately used a $2,000/person-rem dose conversion factor. The $2,000/person-rem conversion factor is intended to represent the costs associated with stochastic health effects (i.e., fatal cancers, nonfatal cancers, and hereditary effects), and does not account for the costs associated with deterministic effects (i.e., early fatalities from acute radiation exposure). The total cost of latent cancer fatalities could also be higher because some members of the public will receive doses above the threshold level for application of a dose- and dose-rate reduction effectiveness factor. These deficiencies undervalue the offsite costs of severe accidents and the benefits of SAMAs that would mitigate the environmental impacts of severe accidents.

140-ff-SM

Response: *The NRC staff estimates that the costs associated with deterministic health effects would be less than 3 percent of the costs of stochastic health effects estimated using the $2000 per person-rem dose conversion. Thus, the inclusion of deterministic health effects, while consistent with the regulatory guidance in NUREG-1530, would have a negligible impact on the results of the SAMA analysis. The comment provides no new and significant information; therefore no changes were made in the SEIS in response to this comment.*

The following comment asserts that the NRC should be more vigilant in assessing cost measures and not engage in a pro forma, deferential analysis of the costs of safety design measures provided by the plant owner.

170-d-PA/SM

Response: *The NRC Staff did not engage in a pro forma, deferential analysis of the cost estimates provided by the licensee. Rather, the Staff reviewed the bases for the licensee's cost estimates and also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' SAMA analyses. Where Entergy's cost estimates appeared high, the Staff obtained additional information and justification for the values. The Staff concluded that the cost estimates provided by Entergy were reasonable and consistent with estimates provided in other license renewal applications. The comment provides no new and significant information; therefore no changes were made in the SEIS in response to this comment.*

The following comments assert that editorial corrections should be made in the FSEIS. The NRC Staff's review of the comments led the Staff to conclude that certain editorial corrections should be made to the FSEIS, and are indicated in the category "Editorial Comments – To Be Addressed in FSEIS" below. Other comments were rejected by the NRC Staff, as indicated in the category "Editorial Comments – Not applicable" below, where the comment was determined to be incorrect, insignificant, inconsistent, confusing, and/or adequately addressed elsewhere.

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SAMA Editorial Changes Incorporated in the SEIS:

Page 5-6, Table 5-3. The last entry for IP3 (loss of essential service water) should be $1.8x10^{-8}$ rather than $1.9x10^{-8}$. [40-ww-ED/SM]

Page G-3, Table G-1. The last entry for IP3 (loss of essential service water) should be $1.8x10^{-8}$ rather than $1.9x10^{-8}$. [40-III-ED/SM]

Page G-14, line 5-6. Parenthetical information indicates that gas turbine and AFW components are located in 'sheet metal clad structures'. It should list EDG components rather than AFW components. ER Section E.1.3.3.1 indicates that the high wind analysis resulted in proposal of an enhancement to upgrade the EDG building. [40-III-ED/SM]

Page G-17, line 22-25. Change the text to read "The information was derived from Westinghouse Electric Company, Core Radiation Sources to Support IP2 Power Uprate Project, CN-REA-03-4 (3/7/2005), and Westinghouse Electric Company, Core Radiation Sources to Support IP3 Stretch Power Uprate (SPU) Project, CN-REA-03-40 (5/19/2005)". (See the response to RAI 4a in reference Entergy 2008A.) [40-III-ED/SM]

Page G-21, line 32-34. Text states that a modification to replace the existing gas turbines with an IP2 SBO/Appendix R diesel is planned for the near future. In fact, installation of this diesel was made a condition of acceptance of the LRA for review. The diesel was installed and operational prior to 4/30/08. See Entergy letter NL-08-074, Indian Point, Units 2 and 3, Amendment 4 to License Renewal Application (LRA), April 30, 2008 (ML081280491). [40-III-ED/SM]

Page G-32, line 31-33. The overall multiplier shown has been rounded to one decimal place for each unit: "(i.e. 3.8x2.1=8.0 for IP2 and 5.5xl.4=7.7 for IP3)". While not incorrect, this does create a slight apparent disconnect with the description, which states that the multiplier of 8 slightly exceeds the (actual calculated value). Suggest keeping the second decimal (as follows) to provide some clarification: "(i.e., 3.80x2.10=7.98 for IP2 and 5.53x1.40=7.73 for IP3)". [40-III-ED/SM]

SAMA Editorial Changes Not Incorporated in the SEIS

Page 5-7, Table 5-4. The entries for In-vessel steam explosion for IP2 and IP3 are 1 and 0, respectively. This appears to be due to rounding up or down at 0.5%. However, this is not consistent with the treatment for Intact Containment and may lead to confusion since the percentages for IP2,no longer add up to 100%. Suggest that the percentage for In-vessel steam Explosion be shown as "<1" for both IP2 and IP3. [40-ww-ED/SM]

Page 5-7, Table 5-4. The total population dose for I P3 is 24.5 rather than 24.3. Suggest changing "22.0" and "24.3" to "22" and "24" for IP2 and IP3, respectively. [40-ww-ED/SM]

Page 5-8, Line 30-34. The DSEIS states that Entergy identified 5 potentially cost-beneficial SAMAs for IP2 in the baseline analysis and two additional potentially cost-beneficial SAMAs (44 and 56) when uncertainties are considered. ER Table 4-4 (page 4-74) indicates that SAMA 28 was not cost-beneficial without accounting for uncertainty. The FSEIS should state that Entergy identified 4 potentially cost-beneficial SAMAs for IP2 in the baseline analysis and three additional (28, 44, and 56) when uncertainties are considered. [40-ww-ED/SM]

Page 5-9, Line 11-14. See comment for pages 5-8, lines 30-34. For consistency with SAMAs 44 and 56, SAMA 28 should be annotated “(cost beneficial with uncertainties)”. [40-ww-ED/SM]

Page G-4, Table G-2. The entries for In-vessel steam explosion for IP2 and IP3 are 1 and 0, respectively. This appears to be due to rounding up or down at 0.5%. However, this is not consistent with the treatment for Intact Containment and may lead to confusion since the percentages for IP2 no longer add up to 100%. Suggest that the percentage for In-vessel steam Explosion be shown as "<1" for both IP2 and IP3. [40-III-ED/SM]

Page G-4, Table G-2. The total population dose for IP3 is 24.5 rather than 24.3. Suggest changing "22.0" and "24.3" to "22" and "24" for IP2 and IP3, respectively. [40-III-ED/SM]

Page G-25, Table G-6. Change population dose risk reduction from "18" to "1' for IP2 SAMA 56. The value is 0.45 (see ER Table E.2-2). [40-III-ED/SM]

Page G-25, Table G-6. Change population dose risk reduction from "20" to "40" for IP2 SAMA 65. The value is 40.45 (see ER Table E.2-2). [40-III-ED/SM]

Page G-30, line 10-15. Text states that Entergy identified 5 potentially cost-beneficial SAMAs for IP2 in the baseline analysis and two additional (44 and 56) when uncertainties are considered. ER Table 4-4 (pg 4-74) indicates that SAMA 158 G-30 10-15 28 was not cost-beneficial without accounting for uncertainty. FSEIS should state that Entergy identified 4 potentially cost-beneficial SAMAs for IP2 in the baseline analysis and three additional (28, 44, and 56) when uncertainties are considered. [40-III-ED/SM]

Page G-30, line 25-28. See comment #158 for page G-30, lines 10-15. For consistency with SAMAs 44 and 56, SAMA 28 should be annotated "(cost beneficial with uncertainties)". [40-III-ED/SM]

A.2.11 Comments Concerning Uranium Fuel Cycle and Waste Management Issues

The following comments raise concerns about the long term storage of spent fuel in spent fuel pools and dry casks, and state that the risk is greater than described in the draft SEIS. Also, they generally assert that, because of radioactive waste leaks, there should be increased inspection of the sources of nuclear waste leakage and their effects on current and future human health:

9-c-LE/PA/RW; 11-e-RW/ST; 12-e-RW/ST; 17-r-EP/GI/RI; 20-a-PA/SF/ST; 38-g-RW; 47-c-RW; 61-a-LE/RW/ST; 63-b-RW; 72-a-EP/LE/OR/RW; 80-a-EP/OR/RW/ST; 80-b-LE/RW/SF/ST; 87-b-HH/PA/RW/ST; 91-e-OR/RW/ST; 106-a AE/LE/RW/SF; 123-e-RW/SF; 126-a-DE/RW/SF/ST

Response: *A generic assessment of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes is contained in 10 CFR Part 51, Tables S-3 and S-4, respectively. 10 CFR Part 51.51(a) states in part, "Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel-cycle activities to the environmental costs of licensing the nuclear power reactor." The information, with the exception of Radon-222 (Rn-222), Technetium-99 (Tc-99), provides the basis for the environmental information provided by applicants and must be used at individual licensing proceedings for the construction of light-water reactors. The GEIS for license renewal* *supplements the data on environmental impacts of the uranium fuel cycle presented in Table S-3 and of transportation of radioactive wastes presented in Table S-4 to to extend the evaluation of impacts to Rn-222, Tc-99, higher fuel enrichment, higher fuel burnup, and license renewal for an additional 20 years of operation. The data in Table S-3 were developed to represent the worst case on bounding estimates of the potential releases from the uranium fuel cycle while still being in compliance with NRC regulatory limits. The GEIS for license renewal provides a review of regulatory requirements of the various stages of the fuel cycle, including detailed discussions of the on-site and off-site requirements. The storage and disposal of spent fuel, low-level radioactive waste, and mixed waste storage and the radiological and Nonradiological impacts to the environment are also discussed.*

Based on the information contained in the GEIS for license renewal, the Commission concluded that the impacts from the uranium fuel cycle are SMALL except for the off-site radiological collective impacts from the fuel cycle and from high-level waste and spent fuel disposal, which the Commission concluded, are acceptable.

The NRC staff did not identify any new and significant information related to the uranium fuel cycle during its review of the IP2 and IP3 environmental report, the site audit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS for license renewal.

The NRC ensures that nuclear power plants are operated safely within radiation protection requirements; the NRC does this by licensing the plants and the plant operators, and establishing license conditions for the safe operation of each plant. The NRC provides continuous oversight of plants through its Reactor Oversight Process (ROP) to verify that they are being operated in accordance with NRC regulations. The NRC has authority to take action to protect public health and safety and may demand immediate licensee actions, up to and including a plant shutdown. The NRC currently inspects existing radioactive waste handling and storage facilities at IPEC. Security issues for the facility and all radioactive material are also part of the ROP which the NRC provides continuous oversight.

The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that nuclear power has significant environmental impacts, specifically from uranium mining and discharges of radioactive effluents into the atmosphere and groundwater from nuclear power plants:

13-e-RW/UF

Response: *The comment is noted. The SEIS, in chapter 6, contains a discussion of the impacts from the uranium fuel cycle and greenhouse gas emissions. The SEIS, in chapters 2 and 4, contains an evaluation of the impacts to human health from radioactive emissions from IPEC. The Human Health and Leaks comment response sections also contain information on the impacts from radioactive effluents.*

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments raise concerns about the safe transportation of radioactive waste in the public domain:

35-c-AM/RW; 84-a-RW

Response: *The transportation of radioactive waste is evaluated in chapter 6 of the SEIS and in chapter 6 of the GEIS for license renewal. The GEIS addresses both the radiological and nonradiological environmental impacts resulting from shipments of low-level radioactive waste (LLW) and mixed waste to off-site disposal facilities and of spent fuel to a monitored retrievable storage or permanent repository. The nonradiological impacts are traffic density, weight of the loaded truck or railcar, heat from the fuel cask, and transportation accidents. The radiological impacts include possible exposures of transport workers and the general public along transportation routes. Radiation exposure to these groups also may occur through accidents along transportation corridors.*

In addition, Table S-4 in 10 CFR Part 51 lists the environmental impacts of transportation of spent fuel and waste to and from a nuclear power reactor.

The environmental impacts from the transportation of fuel and waste attributable to license renewal were found to be small when they are within the range of impact parameters indentified in Table S-4. The estimated radiological effects are within NRC's regulatory standards. The nonradiological impacts are those from periodic shipments of fuel and waste by individual trucks or rail cars and thus would result in infrequent and localized minor contributions to traffic density.

The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that radioactive waste pollutes the Hudson River and the local region, the region where it is disposed, and potentially areas through which it is transported.

38-b-PA/RW/ST; 38-f-RW/SF

Response: *All nuclear plants were licensed with the expectation that they would release some radioactive material to both the air and water during normal operation. NRC regulations require that radioactive gaseous and liquid releases from nuclear power plants meet radiation dose-based limits specified in 10 CFR Part 20, the "as low as is reasonably achievable" (ALARA) dose criteria in Appendix I to 10 CFR Part 50, and the EPA's regulations in 40 CFR Part 190. Regulatory limits are placed on the radiation dose that members of the public might receive from radioactive material released by nuclear plants. The NRC regulations are dose based, such that the dose resulting from the radioactive effluent is the value used by the NRC to determine compliance with regulatory limits. Nuclear power plants are required to report their radioactive gaseous, liquid, and solid effluent releases as well as the results of their radiological environmental monitoring program annually to the NRC. The annual effluent release and radiological environmental monitoring reports submitted to the NRC are available to the public through the ADAMS electronic reading room on the NRC website (www.NRC.gov).*

The NRC staff performed an evaluation of the impacts from radioactive effluents discharged into the environment in chapters 2 and 4 of the SEIS. As indicated, the staff reviewed the results of IPEC's radiological environmental monitoring program (REMP), which show that concentrations of radioactive contaminants in native leafy vegetation, soils and sediments, Hudson River surface water and fish from the vicinity of IPEC are very low (at or near the threshold of the survey instrument's detection capability) and seldom above background levels. Based on these data, the NRC staff concluded that no disproportionately high and adverse human health *impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.*

The issues of transportation of radioactive waste, radioactive pollution in the local area where it is generated and stored, and the impacts associated with its disposal are evaluated in chapter 6 of the dSEIS and in chapter 6 of the GEIS for license renewal. The GEIS addresses both the radiological and nonradiological environmental impacts resulting from shipments of low-level radioactive waste (LLW) and mixed waste to off-site disposal facilities and of spent fuel to a monitored retrievable storage or permanent repository. The nonradiological impacts are traffic density, weight of the loaded truck or railcar, heat from the fuel cask, and transportation accidents. The radiological impacts include possible exposures of transport workers and the general public along transportation routes. Radiation exposure to these groups also may occur through accidents along transportation corridors.

In addition, Table S-4 in 10 CFR Part 51 lists the environmental impacts of transportation of spent fuel and waste to and from a nuclear power reactor.

The environmental impacts from the transportation of fuel and waste attributable to license renewal are found to be small when they are within the range of impact parameters indentified in Table S-4. The estimated radiological effects are within NRC's regulatory standards. The Nonradiological impacts are those from periodic shipments of fuel and waste by individual trucks or rail cars and thus would result in infrequent and localized minor contributions to traffic density.

The issue of radioactive leaks is addressed in chapter 2 and 4 of the dSEIS and in the Human Health and Leaks comment response sections.

The comment does not present any significant new information or arguments that would warrant a change to the final SEIS.

The following comments assert that radioactive waste was used to make weapons used in Iraq that cause more damage to homes and people than regular weapons:

38-c-RW/SF/ST; 38-e-RW/SF; 38-f-RW/SF

Response: *The comment appears to relate to the use of depleted uranium used for military applications. Radioactive waste from commercial nuclear power plants licensed by the NRC is not used to make weapons. The NRC requires its licensees to maintain strict control over the use, storage, transportation, and disposal of radioactive material and waste. Spent nuclear fuel is stored at the reactor site under strict controls for its safety and security in accordance with NRC regulations.*

The comments are out of scope and do not present any significant new information that would warrant a change to the final SEIS.

The following comment raises concerns about the cost of storing radioactive wastes :

39-a-RW/SF

Response: *The regulatory authority over licensee economics (including the need for power) falls within the jurisdiction of the states and, to some extent, within the jurisdiction of the Federal Energy Regulatory Commission. It should be noted that the President's Council on Environmental Quality (CEQ) regulations interpret NEPA to require an assessment of the* *cumulative effects of a proposed Federal action on the natural and man-made environment and indicate that the determination of the need for generating capacity is the states' responsibility.*

The NRC, in accordance with 10 CFR 51.53(c)(2), does not require the licensee to address the need for power or the economic costs and economic benefits of the license renewal or of alternatives to the proposed action, except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or are relevant to mitigation. An evaluation of the economic costs associated with IPEC's storage of radioactive waste and of the leaks of radioactive material is outside the scope of the license renewal review.

The impacts related to the leaks of radioactive material are evaluated in chapters 2 and 6 of the SEIS and in the Human Health and Leaks comment response sections.

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments indicate that the GEIS does not adequately evaluate the long term impacts and safety of the generation and long-term storage of radioactive waste:

50-n-RW/SF; 96-j-LR/PA/RW; 38-g-RW; 38-i-RW; 47-c-RW

Response: *The GEIS for license renewal contains a complete and thorough evaluation of the uranium fuel cycle and solid waste management. The NRC is conducting a rulemaking, including public notice and consideration of public comments, to codify the conclusions of the GEIS in Table B–1 of Appendix B to 10 CFR Part 51.*

Additionally, the NRC's Waste Confidence Rule, found in 10 CFR 51.23, states that "the Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installation. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time." While the Commission has initiated a rule making proceeding regarding the Waste Confidence Rule, the rule remains in effect at this time.

Accordingly, no discussion of the environmental impact of spent fuel storage in reactor facility storage pools or independent spent fuel storage installation is required for an environmental impact statement associated with license renewal.

The NRC has considered and addressed the issue; the comments do not present any significant new information that would warrant a change to the final SEIS or to the GEIS for license renewal.

The following comments assert that nuclear waste is accumulating without possible future disposal. License renewal lengthens this storage period. As a result, the SEIS should evaluate the case where Indian Point's spent fuel is permanently stored at the site:

38-c-RW/SF/ST; 38-f-RW/SF; 38-g-RW; 47-a-SF; 47-b-LE/EP/SF; 54-a-LE/OR/RW/SF; 71-c-LE/RW; 84-a-RW; 102-c-RW/SF; 102-k-RW; 103-b-RW/SF

Response: *As discussed above, the NRC's Waste Confidence Rule, found in 10 CFR 51.23, states that "the Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installation. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time."*

Accordingly, no discussion of any environmental impact of spent fuel storage in reactor facility storage pools or independent spent fuel storage installation is required for an environmental impact statement associated with license renewal.

The comments are out of scope and do not present any significant new information or arguments that would warrant a change to the final SEIS.

The following comments assert that the final SEIS should contain specific information (i.e. location, shielding, storage duration, and security) on IP's plan for the storage of low-level radioactive waste:

55-c-RW; 129-c-RW; 137-g-NE/RW

Response: *Issues regarding storage of low-level radioactive waste are outside of the scope of the environmental review process for license renewal. The NRC has determined that the environmental impacts related to the storage of low-level radioactive waste, as set forth in NUREG–1437 and in Table B–1 of Appendix B to 10 CFR Part 51, are small. That finding is based on the comprehensive regulatory controls that are in place and the low public doses being achieved at all power reactors. The NRC staff included a brief discussion of IPEC's plan for low-level radioactive waste due to the closure of the Barnwell, South Carolina facility to states outside of the Atlantic compact. The NRC ensures that nuclear power plants are operated safely within radiation protection requirements; the NRC does this by licensing the plants and the plant operators, and establishing license conditions for the safe operation of each plant. The NRC provides continuous oversight of plants through its Reactor Oversight Process (ROP) to verify that they are being operated in accordance with NRC regulations. The NRC has authority to take action to protect public health and safety and may demand immediate licensee actions, up to and including a plant shutdown. The NRC currently inspects existing radioactive waste handling and storage facilities at IPEC. Security issues for the facility and all radioactive material are also part of the ROP which the NRC provides continuous oversight. Any future facility used for the storage of radioactive waste will be inspected in accordance with the ROP to ensure that the radiation doses to plant workers and members of the public are within regulatory limits.*

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that radioactive material has been lost at some nuclear power plants because they do not have an adequate accountability measures for high-level radioactive wastes stored in the spent fuel pools:

63-f-RW/ST

Response: *The comment is noted. The issue is not unique to license renewal; it is a current operating issue that is addressed through the NRC's inspection program. Radioactive material accountability issues are periodically reviewed by NRC inspectors for compliance with NRC requirements. The reviews continue throughout the term of the operating license, whether the original or renewed license. If issues related to radioactive material accountability are discovered at a nuclear plant, they are addressed immediately, and any necessary changes are incorporated under the operating license.*

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that used fuel is a resource that can be used in future generations through recycling, as is done in other countries:

71-d-RW; 120-h-OP/RW

Response: *The comment raises a generic national policy issue that is outside the scope of the environmental review for license renewal and the NRC's regulatory authority under the Atomic Energy Act of 1954, as amended.*

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that storage of spent fuel in storage pools and dry casks at Indian Point are very robust and are not vulnerable from natural events and terrorist attack:

79-j-HH; 120-m-RW/SF

Response: *The comment is noted. The comment does not present any significant new information that would warrant a change to the final SEIS.*

The following comment asserts that if Indian Point shuts down, spent fuel could be left unmonitored onsite until decommissioning:

124-a-AL/RW/SF

Response: *The NRC staff does not agree with the comment. Although the comment is outside the scope of the environmental review, the NRC staff notes that any spent fuel stored at the site after the plant is shutdown will be controlled in a safe and secure manner.*

NRC regulations require that spent nuclear fuel be stored and maintained in a safe and secure manner while the plant is operating and after the plant operating license expires. The spent fuel remains under the direct control of the licensee and the regulatory oversight of the NRC until its ultimate disposition.

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that the basis for the impacts of the uranium fuel cycle are out of date and need to be revised:

50-u-GL/UF; 123-d-GE/SF

Response: *The NRC committed to review and revise the GEIS for license renewal on a 10-year cycle, if necessary. In July 2009, the NRC staff issued a draft for public comment of revision 1 to the GEIS. Since publication of the 1996 GEIS, over 30 plant sites (50 reactor units) have applied for license renewal and undergone environmental reviews, the results of which were published as supplements to the 1996 GEIS. The revised GEIS will include a review and reevaluation of the technical issues and findings of the 1996 GEIS. It will incorporate lessons learned and knowledge gained during previous license renewal reviews. In addition, new research, findings, and other information will be considered in evaluating the significance of impacts associated with license renewal. Nevertheless, the draft revision has not been adopted; the 1986 GEIS is still applicable. Section 4.12.1 of the draft GEIS contains the environmental consequences of the uranium fuel cycle.*

The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that the NRC inadequately evaluated negative impacts of uranium mining, fuel fabrication, and storage of waste on communities, including low income and minority populations' water resources and health:

51-a-HH/PA/UF; 70-b-UF; 79-y-EJ/UF; 164-h-UF

Response: *A generic assessment of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes is contained in 10 CFR Part 51, Tables S-3 and S-4, respectively. 10 CFR Part 51.51(a) states in part, "Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel-cycle activities to the environmental costs of licensing the nuclear power reactor." The information, with the exception of Radon-222 (Rn-222), Technetium-99 (Tc-99), provides the basis for the environmental information provided by applicants and must be used at individual licensing proceedings for the construction of light-water reactors. The GEIS for license renewal supplements the data on environmental impacts of the uranium fuel cycle presented in Table S-3 and of transportation of radioactive wastes presented in Table S-4 to extend the evaluation of impacts to Rn-222, Tc-99, higher fuel enrichment, higher fuel burnup, and license renewal for an additional 20 years of operation. The data in Table S-3 were developed to represent the worst case on bounding estimates of the potential releases from the uranium fuel cycle while still being in compliance with NRC regulatory limits. The GEIS for license renewal provides a review of regulatory requirements of the various stages of the fuel cycle, including detailed discussions of the on-site and off-site requirements. The storage and disposal of spent fuel, low-level radioactive waste, and mixed waste storage and the radiological and Nonradiological impacts to the environment are also discussed.*

Based on the information contained in the GEIS for license renewal, the Commission concluded that the impacts from the uranium fuel cycle are SMALL except for the off-site radiological collective impacts from the fuel cycle and from high-level waste and spent fuel disposal, which the Commission concluded, are acceptable.

The NRC staff did not identify any new and significant information related to the uranium fuel cycle during its review of the IP2 and IP3 environmental report, the site audit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS for license renewal.

The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that greenhouse gases attributable to the mining of uranium, its manufacture in to fuel, and use at Indian Point needs to be fully disclosed in the SEIS:

81-a-UF; 96-i-EJ/UF; 103-a-AL/UE

Response: *The issue of greenhouse gases (GHG) is discussed in chapter 6 of the SEIS. The NRC staff concluded that estimating the GHG emissions associated with current nuclear energy sources is challenging because of differing assumptions and noncomparable analyses performed by the various authors. The differences and complexities in these assumptions and analyses increase when using them to project future GHG emissions. However the NRC staff was able to draw some conclusions.*

(1) The current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.

(2) IP2 and IP3 license will involve continued uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not).

(3) Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the IP2 and IP3 periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements could extend this timeframe.

The comment does not present any significant new information or arguments that would warrant a change to the final SEIS.

A.2.12 Comments Concerning Radiological Impacts

The following comment questioned GEIS statements that the radiological impacts from license renewal are SMALL. An article in the Wall Street Journal about a drop in power demand that worries utilities, and an article in TIME magazine about increased energy efficiency:

2-a-AL/RI

Response: *The comment is noted. The comment appears to relate to the need for power from IP2 and IP3; that issue is beyond the scope of license renewal and of the NRC's regulatory authority. The comment does not present any significant new information that would warrant a change to the final SEIS.*

The following comment asserts that Entergy's radiological environmental monitoring program should include the testing of lichen as an indicator of radioactive contamination:

93-b-RI/TE

Response: *IPEC conducts a radiological environmental monitoring program (REMP) in which radiological impacts to the environment and the public around the IPEC site are monitored, documented, and compared to NRC standards. Entergy summarizes the results of its REMP in an Annual Radiological Environmental Operating Report. The reports are publicly available on the NRC's public website. The purpose of IPEC's REMP is to enable the identification and quantification of changes in the radioactivity of the area and to measure radionuclide concentrations in the environment attributable to operations at the IPEC site.*

The REMP samples environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The media samples are representative of the radiation exposure pathways to the public from plant radioactive effluents. The REMP measures direct radiation and airborne, and waterborne pathways for radioactivity in the vicinity of the IPEC site. Direct radiation pathways include radiation from buildings and plant structures and airborne material that may be released from the plant. In addition, the REMP also measures background radiation (i.e., cosmic sources, naturally occurring radioactive material, including radon and global fallout). Thermoluminescent dosimeters (TLDs) are used to measure direct radiation. The airborne pathway includes measurements of air, precipitation, drinking water, and broad leaf vegetation samples. The waterborne pathway consists of measurements of Hudson River surface water, fish and invertebrates, aquatic vegetation, bottom sediment, and shoreline soil.

The results of the REMP are intended to supplement the results of the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive material and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. The two programs work together as a check against each other.

The REMP provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposure to members of the public. It does not require that every type of environmental media or biota in the area be sampled and analyzed. The NRC requires that only commercially or recreationally important species in the vicinity of the discharge point be sampled and analyzed. Other biota, such as lichen, which may be present in the area, do not represent a significant dose pathway to humans and are not required to be part of the REMP.

The radiological effluent monitoring and environmental monitoring programs are part of the NRC's Reactor Oversight Process inspection program for every nuclear power plant to ensure compliance with regulatory requirements. For license renewal, the NRC staff reviewed these programs and found them to be acceptable. The Staff's evaluation can be found in Chapters 2 and 4 of the final SEIS.

The NRC has considered and addressed this issue in the SEIS. The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments assert that the draft SEIS does not adequately discuss the long term health impacts from radioactive emissions and from radionuclides leaking into the environment:

96-d-HH/LE/RI; 98-c-HH/LE/RI; 117-a-AM/LE; 117-b-AM/LE; 126-d-LE/RI

Response: *The issue of radioactive leaks from IPEC was addressed in chapters 2 and 4 of the SEIS and in the Human Health and Leaks comment resolution sections.*

The NRC has considered and addressed these issues in the SEIS. The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that the EIS does not evaluate the synergistic impacts of radioactive effluents and chemical toxins such as PCBs and mercury:

102-h-HH/RI; 174-a-HH/RI; 174-c-HH; 180-e-HH/LE/RI

Response: *The NRC's primary mission is the safe regulation of commercial uses of nuclear materials, and to protect the public health and safety and the environment from the effects of radiation from nuclear reactors, materials, and waste facilities. The NRC's regulatory limits for radiological protection are set to protect workers and the public from the harmful health effects of radiation on humans. The limits are based on the recommendations of standards-setting organizations. Radiation standards reflect extensive scientific study by national and international organizations. The NRC actively participates and monitors the work of these organizations to keep current on the latest trends in radiation protection.*

Federal regulatory agencies, such as the U.S. Environmental Protection Agency regulate hazardous materials that are released into the air, water, and land. Additionally, individual State regulatory agencies regulate non-radioactive materials and from industrial facilities.

The combination of radiological and non-radiological controls in place at IPEC ensures that the public and the environment are adequately protected. If the NRC, EPA, or State agency determines that there is a need to revise its regulations to protect the public, facility workers, or the environment, the agency will initiate a rulemaking. The assessment models used by federal and state agencies to assess an impact typically use conservative assumptions and are based on data obtained from actual effluent waste streams or directly from the environment to develop a protection standard or limit.

The comment does not present any significant new information or arguments that would warrant a change to the final SEIS.

A.2.13 Comments Concerning Spent Fuel

The comment states that spent fuel storage, disposal and groundwater contamination must conform to state standards and should not impact coastal uses, users, and resources:

4-c-LR/SF

Response: *The State of New York, not the NRC, is responsible for coastal zone management and for assuring that coastal zone management issues are properly addressed. The NRC is responsible for protecting the public health and safety and the environment from the radiological impacts of IP2 and IP3 operation. Nevertheless, the NRC's process for the license renewal of nuclear power facilities includes substantial involvement and cooperation with state and local government agencies. These requirements are contained in 10 CFR 51.71(d), which states:*

"Consideration will be given to compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection, including applicable zoning and land-use regulations and water pollution limitations or requirements issued or imposed under the Federal Water Pollution Control Act. The environmental impact of the proposed action will be considered in the analysis with respect to matters covered by environmental quality standards and requirements irrespective of whether a certification or license from the appropriate authority has been obtained. While satisfaction of Commission standards and criteria pertaining to radiological effects will be necessary to meet the licensing requirements of the Atomic Energy Act, the analysis will, for the purposes of NEPA, consider the radiological effects of the proposed action and alternatives."

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments raise concerns about the long term impacts from the storage of spent fuel in spent fuel pools and dry casks, especially with regard to terrorist attacks and the U.S. Department of Energy's failure to open a disposal site that is sized to accommodate all the spent fuel expected to be generated. In addition, the comments assert that the SEIS should evaluate the impacts of a fire, accident, or attack on the spent fuel:

13-c-PA/SF/ST; 13-d-PA/SF; 17-a-NE/SF; 17-p-EP/PA/RI; 17-h-SF; 17-i-SF/ST; 17-k-SF/ST; 20-a-PA/SF/ST; 27-e-SF/ST; 37-b-LE/SF/ST; 41-b-AM/SF; 44-b-AM/DE/SF; 50-n-RW/SF; 79-k-SF; 80-a-EP/OR/RW/ST; 80-b-LE/RW/SF/ST; 89-a-HH/PA/SF; 103-b-RW/SF; 106-a-AE/LE/RW/SF; 117-c-OR/SF; 123-d-GE/SF; 123-e-RW/SF; 126-a-DE/RW/SF/ST; 128-r-SM/SF/ST; 129-b-UF; 140-gg-UF; 162-e-AM/RW; 162-a-OR/RW; 174-b-RI; 178-LE/OR/RW; 180-f-RW; 17-p-EP/PA/RI;

Response: *A generic assessment of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes is contained in 10 CFR Part 51, Tables S-3 and S-4, respectively. 10 CFR Part 51.51(a) states in part, "Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel-cycle activities to the environmental costs of licensing the nuclear power reactor." The information, with the exception of Radon-222 (Rn-222), Technetium-99 (Tc-99), provides the basis for the environmental information provided by applicants and must be used at individual licensing proceedings for the construction of light-water reactors. The GEIS for license renewal supplements the data on environmental impacts of the uranium fuel cycle presented in Table S-3 and of transportation of radioactive wastes presented in Table S-4 to extend the evaluation of* *impacts to Rn-222, Tc-99, higher fuel enrichment, higher fuel burnup, and license renewal for an additional 20 years of operation. The data in Table S-3 were developed to represent the worst case on bounding estimates of the potential releases from the uranium fuel cycle while still being in compliance with NRC regulatory limits. The GEIS for license renewal provides a review of regulatory requirements of the various stages of the fuel cycle, including detailed discussions of the on-site and off-site requirements. The storage and disposal of spent fuel, low-level radioactive waste, and mixed waste storage and the radiological and Nonradiological impacts to the environment are also discussed.*

Based on the information contained in the GEIS for license renewal, the Commission concluded that the impacts from the uranium fuel cycle are SMALL except for the off-site radiological collective impacts from the fuel cycle and from high-level waste and spent fuel disposal, which the Commission concluded, are acceptable.

The NRC staff did not identify any new and significant information related to the uranium fuel cycle during its review of the IP2 and IP3 environmental report, the site audit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS for license renewal.

The NRC ensures that nuclear power plants are operated safely within radiation protection requirements; the NRC does this by licensing the plants and the plant operators, and establishing license conditions for the safe operation of each plant. The NRC provides continuous oversight of plants through its Reactor Oversight Process (ROP) to verify that they are being operated in accordance with NRC regulations. The NRC has authority to take action to protect public health and safety and may demand immediate licensee actions, up to and including a plant shutdown.

In regard to the frequency of malevolent acts, the NRC has determined that security and mitigation measures the NRC has imposed upon its licensees since 9/11, coupled with national anti-terrorist measures and the robust nature of reactor containments and spent fuel pools, make the probability of a successful terrorist attack, though numerically indeterminate, very low.

The security-related measures and other mitigation measures implemented since 9/11 include actions that would improve the likelihood of identifying/thwarting the attack before it is initiated, mitigating the attack before it results in damage to the plant, and mitigating the impact of the plant damage such that reactor core damage or a spent fuel pool fire is avoided. Given the implementation of additional security enhancements and mitigation strategies, as well as further consideration of the factors identified above, the NRC staff concludes that the frequency of large radionuclide releases due to malevolent acts is very low. In addition, the NRC currently inspects existing radioactive waste handling and storage facilities at IPEC. Security issues for the facility and all radioactive material are also part of the ROP which the NRC provides continuous oversight.

Regarding the long term storage and ultimate disposition of spent nuclear fuel, the NRC's Waste Confidence Rule, found in 10 CFR 51.23, states that "the Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installation. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and *sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time."*

Accordingly, no discussion of any environmental impact of spent fuel storage in reactor facility storage pools or independent spent fuel storage installation is required for an environmental impact statement associated with license renewal.

The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment indicates that storage of spent fuel in dry casks, while safer than spent fuel pool storage, will not reduce the amount of spent fuel in the pools.

17-j-SF

Response: *The comment is noted.*

Regardless of the final quantity of spent nuclear fuel generated during the operation of a nuclear power plant, the NRC's Waste Confidence Rule, found in 10 CFR 51.23, states that "the Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installation. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time."The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that the National Academy of Sciences supports the need for an evaluation of the potential impacts from a terrorist attack:

17-l-SF/ST

Response*: The comment is noted. The NRC and other Federal agencies have heightened vigilance and implemented initiatives to evaluate and respond to possible threats posed by terrorists, including the use of aircraft against commercial nuclear power facilities and independent spent fuel storage installations.*

In regard to the frequency of malevolent acts, the NRC has determined that security and mitigation measures the NRC has imposed upon its licensees since 9/11, coupled with national anti-terrorist measures and the robust nature of reactor containments and spent fuel pools, make the probability of a successful terrorist attack, though numerically indeterminate, very low.

The security-related measures and other mitigation measures implemented since 9/11 include actions that would improve the likelihood of identifying/thwarting the attack before it is initiated, mitigating the attack before it results in damage to the plant, and mitigating the impact of the plant damage such that reactor core damage or a spent fuel pool fire is avoided. Given the implementation of additional security enhancements and mitigation strategies, as well as further consideration of the factors identified above, the NRC staff concludes that the frequency of large *radionuclide releases due to malevolent acts is very low. In addition, the NRC currently inspects existing radioactive waste handling and storage facilities at IPEC. Security issues for the facility and all radioactive material are also part of the ROP which the NRC provides continuous oversight. The NRC will continue to assess security-related measures and other mitigation measures that may be needed to assure adequate protection of the licensed facility. In the Pilgrim license renewal proceeding, the Commission affirmed that the National Environmental Policy Act (NEPA) imposes no legal duty to consider malevolent acts in conjunction with license renewal (CLI-10-14). The comment does not present any significant new information that would warrant a change to the final SEIS.*

The following comment indicates that the storage of nuclear waste is not good for humans and the environment:

21-a-AE/OR/SF

Response: The comment is noted. The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comments indicate that the Iraqi people were killed by nuclear waste-tipped warheads and continue to be impacted by the fallout from the weapons:

38-e-RW/SF; 38-f-RW/SF

***Response**: The comment appears to relate to the use of depleted uranium used for military applications. Radioactive material and waste from commercial nuclear power plants licensed by the NRC is not used to make weapons. The NRC requires its licensees to maintain strict control over the use, storage, transportation, and disposal of radioactive material and waste. Spent nuclear fuel is stored at the reactor site under strict controls for its safety and security in accordance with NRC regulations.*

The comments are out of scope and do not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that radioactive waste is going to last a long time at potentially great cost:

39-a-RW/SF

***Response**: The regulatory authority over licensee economics (including the need for power) falls within the jurisdiction of the states and, to some extent, within the jurisdiction of the Federal Energy Regulatory Commission. It should be noted that the President's Council on Environmental Quality (CEQ) regulations interpret NEPA to require an assessment of the cumulative effects of a proposed Federal action on the natural and man-made environment and indicate that the determination of the need for generating capacity is the states' responsibility.*

The NRC, in accordance with 10 CFR 51.53(c)(2), does not require the licensee to address the need for power or the economic costs and economic benefits of the license renewal or of alternatives to the proposed action, except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or are relevant to mitigation. An evaluation of the economic costs associated with IPEC's storage of radioactive waste and of the leaks of radioactive material is outside the scope of the license renewal review.

The impacts related to the leaks of radioactive material are evaluated in chapters 2 and 6 of the SEIS and in the Human Health and Leaks comment response sections.

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment indicates that Yucca Mountain is no longer a viable option for the disposal of IP's spent fuel. Consideration should be given to evaluating the use of monitored retrievable storage in the NRC's GEIS on License Renewal as well as for IP:

50-g-GE/SF

Response: *The comment is on an issue that is beyond the scope of license renewal and of the NRC's regulatory authority. The U.S. Department of Energy (DOE) is responsible for the preparation of an environmental impact statement for a storage or disposal facility for spent nuclear fuel. The NRC is responsible to evaluate the safety issues associated with the method of storage/disposal repository proposed by the DOE. The NRC's evaluation will determine the suitability of the proposed method for a license. However, regarding the long term storage or monitored retrievable storage and ultimate disposition of spent nuclear fuel, the NRC's Waste Confidence Rule, found in 10 CFR 51.23, states that "the Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installation. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time."*

Accordingly, no discussion of any environmental impact of spent fuel storage in reactor facility storage pools or independent spent fuel storage installation is required for an environmental impact statement associated with license renewal.

The comments do not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that the SEIS should evaluate the case where Indian Point's spent fuel is permanently stored at the site:

102-c-RW/SF

Response: *The NRC addressed similar comments related to the issues associated with spent fuel in the Uranium Fuel Cycle and Waste Management and Spent fuel comment response sections.*

The following comment asserts that storage of spent fuel in storage pools and dry casks at Indian point are not vulnerable to natural events and terrorist attack:

120-m-RW/SF

Response: *The comment is noted. The NRC addressed comments related to the issues associated with spent fuel in the Uranium Fuel Cycle and Waste Management and Spent fuel comment response sections.*

The comment does not present any significant new information that would warrant a change to the final SEIS.

The following comment asserts that spent fuel would be left onsite for 60 years, unmonitored, until the facility is decommissioned:

124-a-AL/RW/SF

Response: *This comment was addressed in the Uranium Fuel Cycle and Waste Management and Spent fuel comment response sections.*

A.2.14 Comments Concerning Alternatives

The following comments are generally opposed to power alternatives due to environmental impacts, lack of proven feasibility or resource availability, or potential effects on electric rates:

34-a-AL/EC); 57-f-AL/AQ; 99-c-AL/EC; 9-h-AE/AL/AQ/HH; 14-c-AL/AQ; 14-d-AL/EJ/GL; 23-c-AL/AQ; 42-g-AL/AQ; 45-b-AL/EC/EJ; 49-g-AL/AQ/EJ; 52-c-AL/AQ/EJ; 52-d-AL; 56-a-AL/AQ/EC; 56-f-AL/SA; 58-b-AL/AQ/EJ; 67-d-AL; 90-c-AL/AQ/HH; 90-e-AL/AQ; 99-d-AL/AQ; 108-b-AL/GI/SR; 105-b-AL/EC; 112-a-AL/AQ/EC; 112-b-AL/AQ/EC; 112-c-AL; 112-d-AL/AQ; 112-e-AL/AQ; 112-f-AL/AQ; 112-g-AL/AQ/EC; 113-k-AL/AQ/RG; 113-f-AL/AQ;; 120-c-AL/AQ/EC; 120-i-AL/AQ/GI; 120-j-AL/AQ – IP; 127-c-AL/SR; 133-d-AL/AQ/SR; 134-a-AL/AQ/GI; 134-b-AL/AQ/EJ; 144-d-AL/OS; 148-a-AL/SO; 148-b-AL/SO; 148-c-AL/SO; 148-p-AL/SO; 157-b-AL/EC/SO, 157-f-AL/EC/SO; 158-b-AL/AQ/EC; 159-b-AL/SA/SR; 159-e-AL/AQ/SR; 166-b-AL/EC/SO; 166-c-AL/HH; 166-f-AL/HH; 169-b-AL/AQ/EC; 169-o-AL/EC/SO

Response*: In Chapter 8 of this SEIS, NRC staff evaluates potential effects of alternatives to license renewal. Many of these comments express concerns about air quality effects of alternatives to license renewal. NRC staff has evaluated potential air quality effects from alternatives in Chapter 8 of this SEIS. The staff's findings indicate that alternatives to license renewal would not necessarily have major effects on air quality, though those alternatives that utilized combustion technologies would have proportionately greater impacts. Air quality impacts from continued operation of IP2 and IP3 are Category 1 issues, and the staff has not found any new and significant information that would challenge this determination.*

During the public comment period on the draft SEIS, many commenters expressed concerns about the impacts of shutdown for minority and low-income populations, based on an increased reliance on older and less clean (or less efficient) electric generating stations located near minority or low income populations. While NRC staff cannot predict with certainty how electric generators would respond to the loss of Indian Point, the NRC staff assumes that new generation or new market access for existing generation (via transmission projects, for example) to loads in and around New York City would occur to offset electricity supplied by IP, rather than an increased loading for old, inefficient, and expensive generation capacity located in New York City. The NRC's framework, set forth by the GEIS, assumes that there is a need for the power generated by the IP units, and thus, simply shutting the units down would not fulfill the need for power. Thus, the staff assumes the need for some sort of replacement, which includes new *generation and energy efficiency/energy conservation (though not generation alternatives, per se, they are options used by energy planners to address the need for power). These matters are, however, outside of NRC's jurisdiction.*

The NRC staff recognizes substantial efforts on the part of New York State regulatory, policy-setting, and policy-implementing agencies to promote and further renewable energy and energy efficiency in New York. The NRC staff acknowledges the State's estimates regarding the potential of renewable energy and energy conservation, as these are matters which the State exercises jurisdiction. As a result, the NRC staff disagrees with commenters who indicated that conservation or energy sources considered renewable by New York State couldn't replace at least a portion of the electricity supplied by the IP units. The NRC staff's review of alternatives includes consideration of proposed transmission projects, which could facilitate to power from new generation projects – like wind power – to reach New York City or other downstate regions served by IP2 and IP3. Thus, replacements won't necessarily occur in Westchester County or New York City. The staff also recognizes, however, that repowered facilities could be built on existing power plant sites in Westchester or New York City, though these new facilities would have modern emissions controls and would likely be substantially cleaner than the facilities they replaced.

The NRC staff has also reviewed comments indicating that coal-fired power would be infeasible, and the staff has now removed the coal-fired alternative from the range of alternatives considered in depth.

The following comments state that the socioeconomic effects discussed under the "No Action Alternative" do not accurately address the negative impacts on local communities:

9-g-AL/SO; 23-h-AL/AQ; 90-d-AL/EC/SO; 94-c-AL/EC/OE; 169-a-AL/EC/SO

Response: *Actual decisions about what types of power plants will operate, whether IP2 and IP3 get renewed licenses or not, will be made by state and utility decision makers. The NRC does not play a role in energy planning decision-making in New York. The NRC staff does, however, in Chapter 8, provide an evaluation of environmental impacts that may result from potential alternatives to license renewal. This evaluation addresses effects to air quality and whether these effects may be high and disproportionate for low income and minority communities. Issues of electrical grid stability that may result from an Indian Point shutdown would be addressed by the New York Independent System Operator (NYISO). NYISO has indicated that Indian Point plays an important role in electric reliability and supply in downstate New York, and has also indicated a potential need for Indian Point's generators to continue operating as synchronous condensers in the event that the reactors themselves shut down. (A synchronous condenser is required to provide the necessary reactive power loading for electric grid operation.) Matters related to electric rates are outside the NRC's jurisdiction; rates are set by entities buying and selling power on New York's restructured energy system.*

The following comments request that the license be conditioned to require the installation of a closed-cycle cooling system:

9-e-AE/AL; 87-d-AE/AL; 97-h-AE/AL/OE

Response: *Under the Federal Clean Water Act, the New York State Department of Environmental Conservation (NYSDEC) has the sole authority to require installation of* *measures to reduce the discharge of pollutants – including heat from operating the Indian Point reactors – to surface waters. The decision of whether to require cooling towers is a matter for the NYSDEC to decide. Information on the NYSDEC permitting processes, hearings, and decisions regarding cooling towers at Indian Point can be found at http://www.dec.ny.gov/permits/57609.html (State Pollution Discharge Elimination System process) and http://www.dec.ny.gov/permits/63150.html (Water Quality Certification process). The NYSDEC, not the NRC, has the authority to require installation and operation of cooling towers for water quality purposes.*

The following comments request that the staff include a discussion of additional environmental impacts for the coal-fired generation alternative:

92-c-AL/AQ; 92-f-AL/EC; 113-i-AL/AQ; 120-I-AL; 157-c-AL/EC

Response: *Based on comments on the draft SEIS, the NRC staff has removed the coal-fired alternative from the range of alternatives considered in depth. The comments no longer apply to the SEIS.*

The following comments request more information about the natural gas fired combined-cycle generation alternative including feasibility, type, retrofitting, and location:

9-i-AL/ED; 140-oo-AL

Response: *The decision regarding which alternatives would replace IP2 and IP3 in the event that the licenses are not renewed is within the authority of New York State and utility decision-makers, not the NRC. As a result, the NRC staff's analysis in Chapter 8 is not prescriptive about the specific type of units that would be built or their specific locations. Further, Entergy is a merchant operator that sells power to load serving entities in New York, and does not have a firm obligation to serve load. Entergy, therefore, would not need to replace IP2 and IP3 if the two units cannot continue to operate. The alternatives analysis in Chapter 8 is intended to provide insight into the likely impacts of alternatives to license renewal so that the NRC can 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 (see 10 CFR 51.95(c)(4)).*

Regarding the onsite, natural gas-fired alternative, the NRC staff understands that construction potentially could proceed while IP2 and IP3 are operating, so that the alternative might be available when IP2 and IP3 would have to shut down if the licenses are not renewed (or if Entergy chose not to continue operating the facility). The NRC staff has, as suggested in these comments, replaced "gas-fired alternative" with NGCC in the text of Chapter 8. In addition, the NRC staff has reworded the conclusion in Chapter 8 to more clearly differentiate relative impact levels of alternatives.

Finally, the NRC staff acknowledges, as suggested in these comments, that natural gas plays an important and growing role in New York State's energy portfolio.

The following comment requests greater specificity in the staff's consideration of alternatives, including wind power sourced solely from offshore windfarms, removing wood burning, and basing alternative locations on proposed but unfinished existing projects:

9-j-AL/ED/OE

Response: *The NRC staff cannot assume that wind-generated power would come from offshore wind projects, given that the vast majority of proposed wind generating projects likely to be online in New York State and surrounding areas by the time the IP2 and IP3 licenses expire is planned for onshore locations. The NRC staff notes that the wind power portion of the combination alternatives does not include specific project locations because the capacity needed exceeds any one currently-proposed project; the staff's consideration of possible impacts addresses the range that may occur at various locations. Regarding wood-fired power, the NRC staff notes that wood-burning is explicitly included in New York State's Renewable Portfolio Standard as a qualifying resource (under the category of "biomass"). Finally, the staff notes that it may be possible to locate alternatives at proposed but unfinished project locations for single-source replacements (like the NGCC alternative). The staff's consideration of both a new site and an existing power plant site (either IP or a repowered site), encompasses the potential impacts that would result from an NGCC unit at a proposed but unfinished location.*

The following comments indicate that relying on alternative means of energy production would avoid creation of nuclear waste:

11-f-AL/OR; 38-d-AL;103-c-AL

Response: *During operation, IP2 and IP3 generate several categories of radioactive waste materials, which can range from slightly contaminated clothing items to spent nuclear fuel. The NRC staff reviews waste management at IP2 and IP3 in Chapter 2, and addresses the nuclear fuel cycle – including spent fuel – in Chapter 6 of this SEIS. In Chapter 8 of this SEIS, the NRC staff evaluates environmental impacts of alternatives to license renewal, including waste generation. In general, the alternatives to license renewal considered in this SEIS do not produce radioactive waste materials.*

Insofar as portions of these comments address conversion of the IP site to a wind power site, the NRC staff notes that the site has relatively low wind potential and space for few turbines, and the staff did not, therefore, explicitly consider a wind alternative at the IP site. In addition, the NRC staff notes that comments suggesting the conversion of Sing Sing Correction Facility to a manufacturing plant, or promotion by NRC of wind and solar power are outside the NRC's statutory purview and authority.

The following comments support alternative energy sources, indicate that NRC staff's analysis of alternatives in the draft SEIS was too restrictive, or indicate that the staff's analysis was based on limited data:

2-a-AL/RI; 12-f-AL; 41-d-AL; 68-a-AL/NE/OE; 68-d-AL/OE; 73-f-AQ/WA/AL; 79-c-AL; 79-x-AL/EJ; 79-z-AL; 81-c-AL; 86-c-AL; 86-d-AE/AL/GL; 87-f-AL/OE; 95-a-AL/OE; 96-o-AL; 98-b-AL/SA; 102-a-AL/OE; 102-f-AL/OE; 110-c-AL/OP/ST; 122-d-AL; 124-a-AL/RW/SF; 129-f-AL; 129-h-AL; 129-k-AL/LR; 129-l-AL; 140-pp-AL; 140-rr-AL; 140-ss-LR; 141-d-AL/OR; 155-c-AL/SA; 170-g-AL; 173-b-AL/OR; 174-i-AL; 180-b-AL/OE; 182-d-AL/EJ/OR

Response: *In response to these comments and others, the NRC staff has updated its consideration of energy alternatives in this SEIS. In particular, the SEIS now includes conservation/energy efficiency as a full replacement alternative for Indian Point, and considers state-level reports to characterize renewable energy potential. The NRC staff addresses the impacts from alternatives in Chapter 8 of this SEIS.*

After reviewing the comments as well as available reference documents, the NRC staff determined that solar power alone, or a combination of wind and solar, would be insufficient to replace the power generated by IP2 and IP3 upon expiration of the licenses without license renewal. Similarly, sufficient tidal power capacity is not likely to be available by 2013 or 2015 to replace IP2 and IP3. New York does not have sufficient geothermal resources to function as a replacement for IP2 and IP3.

Insofar as these comments address alternatives as merely a consequence of the no-action alternative, the NRC staff disagrees. In developing and finalizing the staff's license renewal environmental rule, NRC staff specifically indicated – in response to comments from EPA, the Council on Environmental Quality, and others – that alternatives would not be handled as simply consequences of the no-action alternative. The NRC staff includes in this SEIS a range of alternatives that includes likely options that are "technically feasible and commercially viable," as set out in the GEIS. These alternatives can also be consequences of the no-action alternative, though they may be pursued by utilities even if the NRC renews a power plant license.

The GEIS limits the extent to which the staff must consider combinations of alternatives, stating, "While many methods are available for generating electricity, and a huge number of combinations or mixes can be assimilated to meet a defined generating requirement, such expansive consideration would be too unwieldy to perform given the purposes of this analysis." The GEIS also indicates the ". . . NRC has determined that a reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially available." GEIS S8.1. Based on scoping-stage and draft SEIS comments, the NRC staff included – and now updated – two combinations of alternatives. The staff does not include a broader portfolio of combination alternatives in this SEIS, although the impacts of the more likely individual components of such combinations have been considered.

Finally, several of these comments address issues related to energy policy choices, suggesting, for example, that the government or utilities ought to pursue different energy generating (or energy demand reducing) options. The NRC, for its part, does not engage in energy planning or in energy portfolio policy development. These matters fall under the purview of New York State (as New York asserted during the NRC's 1996 GEIS rulemaking), utility company planners, or other Federal (non-NRC) actors as indicated by law or regulation.

The following comments request additional information on the impacts of a cooling tower:

4-b-AL/LR; 10-b-AL/OE; 14-b-AL/EJ/OE; 30-a-AL/AQ/AS/EJ; 40-f-AE/OE

Response: *The NRC staff has updated its impact analysis – contained in Chapter 8 – of potential impacts from installing cooling towers at IP2 and IP3, including potential impacts to aesthetics. The NRC staff considered analyses provided to the New York State Department of Environmental Conservation (NYSDEC) by Entergy in 2010 (attachments to the analyses were developed in earlier years). These analyses are available from NYSDEC at http://www.dec.ny.gov/permits/57609.html. As the NRC staff notes throughout this SEIS, the decision of whether to install cooling towers would be made by NYSDEC, under its authority to issue SPDES permits under the Clean Water Act.*

Regarding comments that specifically address the need to provide more information for the purposes of consistency with New York's Coastal Management Plan, the NRC staff notes that Entergy will be separately applying to the New York State Department of State (NYSDOS), and the NRC SEIS is not intended to meet the specific data needs of NYSDOS for its Federal Consistency review.

Finally, several commenters expressed concerns that cooling towers would trigger major impacts because Entergy would cease operating IP2 and IP3 rather than install cooling towers. The NRC staff notes that such decisions are solely under the purview of Entergy, and the commenters' assumption that Entergy would close IP2 and IP3 appears to be speculative. As such, the NRC staff has not assumed that installing cooling towers would cause Entergy to close IP2 and IP3. Nonetheless, the impacts of license renewal denial have been considered in the Alternatives analysis of the SEIS.

The following comments indicate that environmental impacts from cooling towers would be larger than indicated in the draft SEIS:

40-j-AE/AL; 40-v-AL/TS; 40-dd-AE/AL; 40-ii-AE/AL/OE/TS; 40-pp-AL; 40-ddd-AL/TS; 40-bbb-AL/OE; 40-ccc-AL/TE; 40-dddd-TS; 40-gggg-AL; 40-hhhh-AL; 40-jjjj-AL; 40-kkkk-AL; 40-eee-AL/AQ; 40-fff-AL; 40-ggg-AL; 40-llll-AL; 40-mmmm-AL; 40-nnnn-AL; 40-oooo-AL; 40-pppp-AL; 46-c-AL/EJ/SR; 49-e-AL/EJ;49-g-AL/AQ/EJ; 112-h-AL/RG; 113-g-AE/AL/AQ; 137-f-AL/LE/PA/RF/SF; 137-h-AL; 139-f-AL/LR; 140-kk-AL

Response: *The NRC staff has updated its impact analysis, in Chapter 8, of the potential impacts from installing cooling towers at IP2 and IP3, including potential impacts to aesthetics. The NRC staff considered analyses provided to the New York State Department of Environmental Conservation (NYSDEC) by Entergy in 2010 (attachments to the analyses were developed in earlier years). These analyses are available from NYSDEC at http://www.dec.ny.gov/permits/57609.html. As NRC staff notes throughout this SEIS, the decision of whether to install cooling towers falls to NYSDEC, not NRC.*

In addition, the staff has updated all impact areas addressed by these comments and included either new information provided by the comments or new information in recent documents submitted to the NYSDEC. In general, the NRC staff does not assume that IP2 and IP3 would shut down if they are required by NYSDEC to install cooling towers. Should, after various adjudicatory and administrative process are completed, NYSDEC issue a SPDES permit indicating that IP2 and IP3 have to install cooling towers, the decision of whether to continue to operate would fall to Entergy. Nonetheless, the potential impacts of plant shutdown are considered in the SEIS.

Regarding concerns about replacement power for electricity consumed by cooling tower components and generating capacity lost due to lower thermal efficiency of the retrofitted units, the NRC staff notes that the alternatives considered in Chapter 8 would also be available to replace the capacity losses. In general, the 127 MW of replacement power that would be required during the periods of maximum capacity loss could be installed with relatively little additional environmental impact. A gas-fired alternative of this size would create an impact that is a fraction of those created by the NGCC alternative considered in Chapter 8, and could be constructed on an existing power plant site, including the existing IP site.

The following comments express support for conservation as an alternative:

51-c-AL; 103-a-AL/UF; 130-c-AL; 129-g-AL; 140-qq-AL; 154-b-AL; 160-a-AL/SA/ST; 161-i-AL/OR

Response: *As a result of comments received on the draft SEIS and as a result of efforts on the part of many State and local level organizations, the NRC staff has revised its assessment of energy conservation (used interchangeably with energy efficiency) in the FSEIS. The NRC staff now considers energy conservation as a viable, stand-alone alternative to license renewal. The staff addresses this alternative in Chapter 8 of the FSEIS.*

The following comment indicates that comparisons of greenhouse gas emissions in the SEIS should include Carbon Capture and Sequestration and address the importance of IP2 and IP3 to New York's participation in the Regional Greenhouse Gas Initiative:

40-xx-AL/AQ/OE

Response: *The NRC staff's comparisons of relative greenhouse gas emission levels in the draft SEIS did not include the effect of carbon capture and sequestration (CCS) on fossil fuel emissions. Relative emission levels in the studies the NRC staff reviewed did not assume that CCS was in place. While such efforts may well reduce the levels of carbon gas emissions, the specific cost-benefits of such methods are for State and utility decision-makers to resolve.*

The NRC staff recognizes that New York State is a part of the Regional Greenhouse Gas Initiative (RGGI), but the staff does not state the relative importance of Indian Point to achieving RGGI or State emission reduction goals. Those are matters for RGGI program administrators and State decision-makers to determine.

No change has been made to the SEIS as a result of this comment.

The following comments indicate that the draft SEIS has incorrectly addressed cooling tower costs and outage duration:

40-zz-AL/OE; 40-sss-AL; 40-iiii-AL

Response: *The NRC staff has updated the cooling towers impact assessment with information submitted since the draft SEIS publication, including cooling tower installation costs and construction times. This includes information from these comments as well as new information submitted by Entergy as part of the ongoing NYSDEC review processes. The NRC staff notes that decisions about whether to require cooling tower implementation are for the NYSDEC to determine. Evaluations of the potential impact levels are included to fulfill NRC's requirements under NEPA.*

The NRC staff has revised discussion of cooling tower installation costs and timelines based on the information that it has received. This discussion occurs in Chapter 8 of this SEIS.

The following comments request that the cooling tower alternative be removed:

34-b-AE/AL; 40-aaa-AE/AL/OE; 40-rrr-AL; 113-b-AE/AL/EJ

Response: *The NRC staff disagrees with these comments. The cooling tower alternative is considered in the SEIS, consistent with NEPA's requirements that reasonable alternatives be* *considered, regardless of whether the alternatives are outside the agency's specific regulatory purview.*

The NRC staff has included additional information about the staff's rationale for maintaining the cooling tower alternative in Chapter 8 of this SEIS. The NRC staff's consideration of a cooling tower alternative is in no way intended to prejudice NYSDEC's determinations or any part of ongoing administrative and adjudicatory processes.

The following comments indicate that the restoration alternative should be removed:

40-oo-AE; 40-www-AL; 128-i-AL; 123-g-AL; 140-ll-AL

Response: *In light of comments received on the draft SEIS, as well as the staff's review of recent judicial decisions and applicable law, the NRC staff has removed the restoration alternative from the range of alternatives considered in Chapter 8 of the SEIS.*

The following comment indicates difficulty comparing the impacts of different alternatives across issue areas;

139-f-AL/LR

Response: *The NRC staff acknowledges that impacts in one resource area may not be directly comparable to impacts in another resource area. In the GEIS, however, the staff developed a system for assigning impact levels for all resource areas based on the resource characteristics. As such, a large impact on aesthetic values, for example, is not necessarily directly comparable to a large impact on land use. Impacts within resource areas are, however, directly comparable among alternatives.*

No change has been made to the SEIS as a result of this comment.

The following comment requests that the impacts of the No Action Alternative include the impacts to property values:

129-d-AL/LU

Response: *Offsite land use impacts of spent fuel storage in an ISFSI are not part of the proposed action and are not within the regulatory scope of license renewal and therefore are not addressed in the SEIS. These impacts have been addressed as part of a separate NEPA review conducted by the NRC.*

Regarding potential impacts to land use as a result of no action, the NRC staff assigned an impact level of SMALL. In the staff's discussion of possible socioeconomic impacts of no action, the staff notes that no action may result in positive effects on property values while it may also cause reductions in tax revenues for local jurisdictions.

The NRC staff notes that it is not likely that the site would be cleared by 2025, as the commenter asserts, if the licenses are not renewed. Denial of the license renewal applications would not result prompt removal of spent fuel from the IPEC site. Spent fuel would continue to be stored at the site, prior to eventual decommissioning. Even in cases where licensees immediately decommission a power plant site, dismantle existing structures, and decontaminate the site to applicable standards, ISFSIs can remain onsite and are subject to separate licensing *procedures. Further, Entergy has not indicated that it would immediately initiate site dismantling and decontamination if its licenses are not renewed. NRC decommissioning regulations provide that licensees may maintain a facility in SAFSTOR status for up to 60 years before fully decommissioning a site.*

The following comments request that the staff address New York's renewable portfolio standard and efforts to implement renewable energy in the alternatives analysis:

129-i-AL; 132-a-AL/OE

Response: *The NRC staff has revised the SEIS to add information regarding New York State's renewable energy and energy efficiency (energy conservation) programs to the extent that they are useful in determining whether alternatives are reasonable. Also, the staff considers a stand-alone conservation/energy efficiency alternative to license renewal in the final SEIS. In addition, the NRC staff has drawn on projections of renewable energy capacity developed by and for New York State agencies, and has updated its treatment of renewable alternatives.*

The following comment indicates that the staff's characterization of a critical transmission congestion area and transmission line capabilities are inaccurate:

129-j-AL

Response: *The NRC staff has removed language regarding critical congestion areas and has instead indicated that power transmission in New York State is highly congested. The NRC staff has also included a discussion in Chapter 8 of this SEIS of several proposals for new transmission as indicative of potential ways to transmit energy from upstate New York to New York City and Long Island.*

The following comment requests the use of updated information from the Energy Information Administration (EIA) concerning alternative energy sources:

140-mm-AL

Response: *The NRC staff has included updated information from EIA's 2010 Annual Energy Outlook, and has generally updated related information in Chapter 8 of this SEIS.*

The following comment indicates that the NRC staff devoted most of its alternatives analysis to a coal-fired replacement and also requests that staff consider the alternative of license renewal for one of the Indian Point units:

140-nn-AL

Response: *Regarding a separate analysis of each unit, the NRC staff has addressed – in both the draft and final SEISs – renewal of only one unit as a portion of a combination of alternatives.*

Regarding portions of this comment that address the coal-fired alternatives, the NRC staff has removed the coal-fired alternative from the range of alternatives considered in depth in the final SEIS.

The following comment calls for an expanded analysis of the no action alternative:

9-f-AL/OE

Response: *The NRC staff notes that, in the 1996 Statement of Consideration accompanying the publication of the NRC's environmental regulations for the license renewal rule, the NRC committed to review alternatives to license renewal as direct alternatives to the proposed action, rather than merely as consequences of the no-action alternative. As such, the NRC staff reviews a variety of alternatives to the proposed action in this SEIS. The NRC staff's consideration of no action is limited to the direct effects of shutdown because the staff has reviewed effects of decommissioning as well as the effects of other reasonable alternatives in other sections of the SEIS. The NRC staff indicates, in Chapter 8, that additional impacts as a result of replacement power or other actions will occur beyond the direct impacts of IP2 and IP3 shutdown and those impacts are considered in the SEIS.*

Typically, matters related to energy costs are within the purview of State and utility decision-makers. In New York State's restructured energy market, energy costs are also dependent on competition among energy producers and suppliers, as well as transmission owners and operators, and the New York Independent System Operator. These matters are generally outside of NRC's jurisdiction.

The following comment requests a change in classification of the impacts of green house gases and air quality of the proposed alternatives:

40-hhh-AL/ED

Response: *The NRC staff has removed the coal-fired alternative from the range of alternatives considered in depth and has adjusted the performance of the NGCC alternative as indicated by these comments. Given that there is no specific regulatory system for assigning impacts from greenhouse gases, the NRC staff has not assigned specific impact levels as a result of greenhouse gas emissions. The NRC staff does, however, assess relative GHG emission levels in Chapter 6 of this SEIS, and addresses the cumulative impacts of climate change in Chapter 4. The NRC staff has also corrected the land use figures for wind power in consideration of these comments.*

The following comments are general statements opposed to alternatives to license renewal involving coal- or natural-gas fired power generation and general support of Indian Point on the grounds of avoided incremental impacts on existing air quality and greenhouse gas (GHG) emissions.

23-e-AQ; 46-b-AQ/EJ; 86-b-AQ; 88-a-AQ; 90-b-AQ; 119-h-AQ; 133-c-AQ; 177-c-AQ

Response: *In Chapter 8 of this SEIS, NRC staff evaluates potential effects of alternatives to license renewal including impacts on air quality. Section 2.2.4.3 in the IP SEIS describes the existing ambient air quality within a 50-mi (80-km) radius of the site and encompassing the currently designated nonattainment areas of New York and New Jersey. Actual decisions about what types of power plants will operate, whether IP2 and IP3 get renewed licenses or not, will be made by decision makers on the state level and the utility level. NRC does not play a role in energy planning decision-making. The NRC staff does, however, in Chapter 8, provide an evaluation of environmental impacts that may result from potential alternatives to license renewal. As described in Section 8.3 of this SEIS, the NRC staff has now removed the coal-fired alternative from the range of alternatives considered in depth based in part on comments indicating that coal-fired power would be infeasible or highly unlikely. Replacement of the* *electricity supplied by the IP units with a natural-gas fired plant, now referred to as the Natural Gas-Fired Combined-Cycle (NGCC) alternative, remains a reasonable alternative. Section 8.3.1 specifically addresses the impacts of a new NGCC plant located at either the IP2 and IP3 site or an alternate site; Chapter 8 also considers combinations of alternatives that include substantial amounts of renewable energy sources. Air quality impacts from continued operation of IP2 and IP3 are Category 1 issues, and the staff has not found any new and significant information that would challenge this determination. The NRC staff also assesses relative GHG emission levels in Chapter 6 of this SEIS, and addresses some cumulative impacts of climate change in Chapter 4. As presented in Chapter 8, the staff's findings indicate that alternatives to license renewal would not necessarily have major effects on air quality, though those alternatives that utilized combustion technologies would have proportionately greater impacts.*

A.2.15 Comments Concerning Decommissioning Issues

The following comment questions the decommissioning process regarding spent fuel and the current status of 'long term storage' at the facility:

96-f-DC/LE/WA

Response: *The storage of spent nuclear fuel is discussed in Chapter 7 of the SEIS. The safety and environmental effects of spent fuel storage have been evaluated by the NRC and, as set forth in the Waste Confidence Rule (10 CFR 51.23), the Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life of operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations. In addition, on September 15, 2010, the Commission approved a revision to the agency's "Waste Confidence" findings and regulation, expressing its confidence that the nation's spent nuclear fuel can be safely stored for at least 60 years beyond the licensed life of any reactor and that sufficient repository capacity will be available when necessary. However, until a revised final rule is issued, the current determination under 10 CFR 51.23 remains in effect at this time and governs the consideration of this issue.*

The GEIS for license renewal (NUREG-1437) evaluated a variety of spent fuel and waste storage scenarios, including on site storage of these materials for up to 30 years following expiration of the operating license, transfer of these materials to a different plant, and transfer of these materials to an Independent Spent Fuel Storage Installation (ISFSI). During dry cask storage and transportation, spent nuclear fuel must be "encased" in NRC-approved casks. An NRC-approved cask is one that has undergone a technical review of its safety aspects and been found to meet all of the NRC's requirements. These requirements are specified in 10 CFR Part 72 for storage casks and 10 CFR Part 71 for transportation casks. For each potential scenario involving spent fuel, the GEIS determined that existing regulatory requirements, operating practices, and radiological monitoring programs were sufficient to ensure that impacts resulting from spent fuel and waste storage practices during the term of a renewed operating license would be small, and that this is a Category 1 issue. This conclusion is contained in

Table B-1 of Appendix B to Part 51. In sum, the Commission concluded that the impacts associated with spent fuel and high-level waste disposal are Small. The Staff's evaluation of the IP2 and IP3 license renewal application did not find any new and significant information related to the storage of spent nuclear fuel. Thus, there are no impacts related to spent nuclear fuel storage beyond those discussed in the GEIS.

The staff notes that on March 3, 2010, DOE submitted a motion to the Atomic Safety and Licensing Board seeking to withdraw its application for a permanent geologic repository at Yucca Mountain, Nevada. The ASLB denied that request and this matter is now pending before the Commission. Notwithstanding DOE's decision to seek to withdraw its Yucca Mountain repository application, the Nuclear Waste Policy Act establishes the Federal government's responsibility to provide a place for the permanent disposal of high-level waste and spent nuclear fuel. The Act authorizes and requires the DOE to locate and build a permanent repository and an interim storage facility and develop a transportation system between nuclear power plants and the repository and interim storage facility. Accordingly, while DOE has not yet specified an alternative to Yucca Mountain, there is every reason to believe that a permanent solution to the issue of spent fuel storage will be achieved. Further, until the DOE takes possession of it, the spent nuclear fuel will be safely stored at the nuclear power reactor site, subject to NRC oversight ad regulation.

The following comment questions why the assessment of decommissioning is not a site specific issue:

137-I-DC/RW

Response: *The NRC's license renewal process classifies environmental and human health issues as either Category 1 (generic to all nuclear power plants) or Category 2 (requires a site specific evaluation). For license renewal, the NRC performed a comprehensive evaluation of all nuclear power plants in the United States to assess the scope and impact to public health and safety and the environment from radioactive material released from a nuclear power plant for an additional 20 years of operation. That impact evaluation is presented in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants NUREG-1437 (GEIS). The GEIS identified 92 environmental issues that were considered for the license renewal evaluation for power reactors in the U.S. The nuclear industry, Federal, state, and local governmental agencies, members of the public, and citizen groups commented on and helped identify these 92 issues during the preparation of the GEIS. For each of the identified 92 issues, the staff evaluated existing data from all operating power plants throughout the U.S. From this evaluation, the staff determined which issues could be considered generically and which issues do not lend themselves to generic consideration. The GEIS divides the 92 issues that were assessed into two principle categories: One for generic issues (which are termed "Category 1 issues") and the other for site-specific issues (termed "Category 2 issues").*

Category 1 issues are termed "generic" issues because the conclusions related to their environmental impacts were found to be common to all plants (or, in some cases, to plants having specific characteristics such as a particular type of cooling system). For Category 1 issues, a single level of significance was common to all plants, mitigation was considered, and the NRC determined that it was not likely to be beneficial. Issues that were resolved generically are not reevaluated in the site-specific supplement to the generic environmental impact *statement on license renewal (SEIS) because the conclusions reached would be the same as in the GEIS, unless new and significant information is identified that would lead the NRC staff to reevaluate the GEIS's conclusions. During the environmental reviews of license renewal applications, the NRC staff makes a concerted effort to determine whether any new and significant information exists that would change the generic conclusions for Category 1 issues. The following issues associated with decommissioning were evaluated in the GEIS: radiation doses, waste management, air quality, water quality, ecological resources, and socioeconomic impacts. The evaluation concluded that all of the issues were Category 1 issues that are generic to all nuclear power plants and the impacts would be small.*

During the scoping process and the environmental review, the NRC looks for any information that could demonstrate that there are unique characteristics related to the facility or the environment surrounding the facility that would lead to the conclusion that the generic determination for a particular issue is not valid for a specific site. The NRC staff discusses and evaluates potential new and significant information on impacts of operations during the renewal term in the SEIS.

As with all Category 1 conclusions, the NRC staff review evaluates each license renewal application and the site to determine if there is new and significant information that would change the conclusion in the GEIS.

The comments relating to decommissioning issues have been thoroughly evaluated in the GEIS for license renewal. No new and significant information was identified during the scoping process, the review of the IPEC Environmental Report, and the Staff's site visit beyond those identified and evaluated in the GEIS. No changes will be made to the SEIS based on these comments.

A.2.16 Comments Concerning Greenhouse Gas Issues

The following comments indicate that the greenhouse gas analysis in the draft SEIS is based on one outdated study:

10-c-GL; 50-t-GL/UF

Response: *The NRC staff's consideration of potential greenhouse gas emissions from nuclear power as well as other alternatives relied on a number of studies, and not merely on Mortimer's work, as stated in the comment. The NRC staff mentioned Mortimer as an early example of an attempt to determine greenhouse gas emissions from nuclear power, and included his 1990 study as only one of many. While some of Mortimer's assumptions may no longer be valid, the NRC staff notes that some of changes to his assumptions (like ore grades) may result in greater greenhouse gas (GHG) emissions from the nuclear fuel cycle, while others (e.g., new enrichment methods and programs like the Megatons to Megawatts program that turns former Soviet nuclear warheads into U.S. reactor fuel) likely result in lower GHG emissions from the nuclear fuel cycle than Mortimer calculated. The NRC staff considered each of these factors prior to including Mortimer, and determined that it was reasonable to include Mortimer's study along with other, more-recent studies. The NRC staff concluded that reduced grades of nuclear fuel in the future would likely lead to greater GHG emissions, but that improved enrichment technologies may reduce GHG emissions. On the whole, the staff concluded that GHG emissions from the nuclear fuel cycle would likely remain below the GHG emissions from equivalent fossil-fuel facilities throughout the period of extended operation, and that GHG emissions from equivalent renewable sources may be lower during the period of extended* *operation. The comments provided no new or significant information, and NRC staff has made no changes to the SEIS as a result of these comments.*

The following comment states that emissions from fossil fuel power plants result in global climate change:

14-d-AL/EJ/GL

Response: *The NRC staff acknowledged, in Chapter 6 of the draft SEIS, that all forms of power generation, including fossil fuel power plants, result in GHG emissions during their lifecycles. No changes have been made to the SEIS as a result of this comment.*

The following comment indicates that climate change effects on the Hudson River may become catastrophic in the future:

86-d-AE/AL/GL;

Response: *In Section 4.8.1, the NRC staff indicated that climate change could have widespread and noticeable effects on the Hudson River ecosystem. This comment does not present any new information, and the staff has not made any changes to the SEIS as a result of the comment.*

The following comments indicate that continued operation of Indian Point in concert with climate change results in even greater effects to Hudson River biota:

87-e-GL; 102-b-AE/GL/OE; 102-i-AM/GL/OE; 147-a-GL/LE; 180-d-AM/GL/OE

Response: *The NRC staff noted, in section 4.8.1, that cumulative effects to the Hudson River ecosystem are likely to be large. In reaching this conclusion, the NRC staff considered the impacts from continued Indian Point operation and the effects of climate change, as well as other environmental stressors like water withdrawals and invasive and nuisance species. Should rising river temperatures cause Indian Point to exceed the discharge temperature limits in its SPDES permit at some point in the future, the New York State Department of Environmental Conservation may take action to enforce the terms of the SPDES permit. These comments contain no new information, and the staff has not made any changes to the SEIS as a result of these comments.*

The following comments indicate that climate change will result in more-frequent storms and flooding, thus increasing corrosion and the likelihood of leaks:

102-i-AM/GL/OE; 147-a-GL/LE; 180-d-AM/GL/OE

Response: *These comments indicate that potentially increased storm and flooding events as a result of climate change would accelerate corrosion in buried piping and other systems. In general, aging of plant systems, structures and components is a matter for the safety review, and monitoring for leakage is a matter for ongoing NRC oversight.*

As part of the license renewal safety review, the NRC staff reviewed Entergy's proposed Aging Management Program (AMP) for managing the aging effects of buried and underground piping. The NRC staff is also in the process of revising its guidance in the Generic Aging Lessons Learned (GALL) Report to capture recent industry and plant-specific operating experience to *effectively manage any potential aging effects for such piping. The results of the staff findings for the safety review are documented in the Safety Evaluation Report (SER) for license renewal.*

Although climate change may trigger storms with increased severity, and may also increase the likelihood of flooding events at some sites, climate change could also trigger longer periods of dry weather or drought, which may result in reduced precipitation and soil moisture. Thus, potential climate change, by itself, does not warrant new evaluations or conclusions regarding buried piping beyond the staff's finding in the SER for license renewal or ongoing oversight of any potential leaks at reactor facilities.

The NRC staff has not made any changes to the SEIS as a result of these comments.

The following statements indicate that IP emits few greenhouse gases and is inexpensive to operate:

33-a-AE/GL/LE; 159-a-EC/GL

Response: *The NRC staff notes that nuclear facilities, while emitting essentially no GHGs during power generation, do result in GHG emissions during their lifecycles. Fuel mining, enrichment, fabrication, and transportation, for example, all result in GHG emissions. Also, GHGs are produced in manufacturing raw materials to construct nuclear power plants. Similarly, other energy sources that do not produce carbon dioxide or other GHGs while generating electricity result in GHG emissions at other points in their lifecycles.*

The NRC has no authority to choose between alternative energy generating technologies, or to consider cost of operation in its license renewal decisions. Such decisions are within the jurisdiction of State, utility, and where appropriate, other Federal entities.

No changes have been made to the SEIS as a result of this comment.

The following are general statements expressing concern over potential climate change effects on the Hudson River and indicate that Indian Point has either minor or mitigative effects on climate change by comparison:

113-h-AE/GL; 113-d-AQ/GL/SR

Response: *The NRC staff evaluated cumulative impacts to the Hudson River, including impacts as a result of climate change along with other factors affecting the river. In addition, staff evaluated the potential impacts of continued Indian Point operation and other alternatives on the Hudson River and its biota. These comments provide no new information, and, as a result, the staff has made no changes to the SEIS in response to these comments.*

A.2.17 Comments Concerning Editorial Issues Not Otherwise Addressed in This Appendix

Page 2-77, line 34-35 – Delete extra words and add reference:

40-t-AE/ED

Response: *Editorial change made.*

Remove the reference to transmission lines on page 4-52, line 9-11 because the lines are all on the Indian Point site.

40-rr-AE/ED/TL

Response: *Editorial change made.*

Change section heading to "protected species"

40-u-ED/TS

Response: *The NRC staff has changed the SEIS section heading to 4.6.1, Aquatic Special Status Species.*

Page 8-54, line 18-19 – Change "hypotheses" to "conclusions."

40-ooo-AE/ED/OE

Response: *Editorial change made.*

Page 2-16, line 3 – The FSEIS should stat that IP1 provides waste processing for IP2 only.

40-l-ED

Response: *Editorial change made.*

Page 2-22, line 15-18 – Replace the paragraph with one suggested.

40-m-ED

Response: *Editorial change made, with some modifications.*

Page 4-53, line 26 – Start new paragraph after "… vicinity of the site."

40-ss-ED

Response: *Editorial change made.*

Page 4-2, Table 4-1 – Remove "Eutrophication" from table
Page 4-3, line 1-4 – Replace the sentence with one suggested.
Page 4-6, line 6-10 – Replace the sentence with one suggested.

40-x-ED

Response: *The NRC staff has considered these editorial comments. NRC staff has retained "eutrophication" as a Category I issue in Table 4-1 as it is listed in the GEIS as applicable to all plants. As the NRC staff noted, no new and significant information related to this issue was identified during the staff's review. The NRC staff has made the indicated text changes on page 4-3 and 4-6. .*

Page 4-8, line 12-13 – Replace the sentence with one suggested.
Page 4-8, line 31-32 – Revise FSEIS to note that the NYSDEC was discussing generalized characteristics of ecosystems, not the specific characteristics of the Hudson River ecosystem.

40-aa-ED

Response: *The NRC staff has made the change on lines 12-13 regarding the status of the SPDES permits. The NRC staff has not changed the quoted text on lines 31-32, as that text was taken directly from page 29 of NYSDEC's 2003 Hudson River Power Plants FEIS. The statement is quoted directly from an NYSDEC staff-written portion of the document.*

Page 4-63, line 15-7 – Insert suggested wording after "… depending on the species."
Page 5-6, Table 5-3 – The last entry for IP3 (loss of essential service water) should be $1.8x10^{-8}$ rather than $1.9x10^{-9}$.

40-vv-ED

Response: *The NRC staff has made the proposed change to what were formerly lines 15-17 of page 4-63. The NRC staff has also changed the text in Table 5-3.*

Page 8-2, line 6-7 – Revise FSEIS to note that the "normal design flow rate" given in the DSEIS is actually the maximum design flow rate.
Page 8-2, line 14 – "Has" should be changed to "may potentially have."

40-yy-ED

Response: *Editorial changes made.*

Page 9-9, Table 9-1 – Change "SMALL to LARGE" under Coal-Fired Plant Alternate Site column to "MODERATE."
Page E-3, Table E-2 – Add footnotes suggested.
Page E-4, Table E-2 – Add footnotes suggested.
Page E-4, Table E-2 – Provided updated status of various certificates and permits.

40-iii-ED

Response: *The first editorial change is no longer applicable due to changes to the SEIS. The staff has made the remainder of the changes in this comment.*

A.2.18 Comments Concerning Refurbishment

The following comment indicates that the draft SEIS did not address the potential impacts of replacing the reactor vessel heads and control rod drive mechanisms for IP2 and IP3:

137-k-RF

Response: *Chapter 3 of the DSEIS provides the NRC staff's analysis of the potential impact of refurbishment activities associated with the possible replacement of reactor vessel heads and control rod drive mechanisms at IP2 and IP3. No change has been made to the SEIS as a result of this comment.*

A.2.19 Comments Outside the Scope of the Environmental Review for License Renewal: Safeguards and Security; Operational Safety; Aging Management; Need for Power; Energy Costs, etc.

The following comments address various issues outside the scope of license renewal:

83-a-OS; 131-a-OS; 151-b-OS; 120-d-OS

Response: *These comments include a narrative about personal involvement in a fish study, a statement indicating that Indian Point provides funding for scholarships in nuclear fields, an assertion that Riverkeeper has historically worked to restore the Hudson River, and an assertion that individuals living near Three Mile Island unit 2 would've traded economic gains from the power plant to avoid the 1979 accident at that facility.*

These comments do not address matters within the scope of this review, and the staff has made no changes to the SEIS as a result of these comments.

The following comment is a general statement that nuclear waste is used for weapons:

84-b-OS

Response: *The commenter appears to address the use of depleted uranium by the United States armed forces for certain types of munitions meant to pierce hardened vehicles or facilities. Depleted uranium is a byproduct of uranium enrichment and is not produced at the Indian Point site. Spent nuclear fuel and the other types of radioactive waste materials generated at IP2 and IP3 are disposed of according to federal regulations. Spent fuel resides in IP2 and IP3 spent fuel pools or the site's dry cask storage facility, as discussed in Chapter 6. Low-level wastes are either stored onsite or shipped offsite for disposal, as discussed in Chapter 2.*

A.2.19.1 Aging Management

The following comments question the reliability and performance of plant operations to ensure proper plant management:

13-f-AM/GE/OM; 32-a-AM/OP/PA; 35-c-AM/RW; 41-b-AM/SF; 44-b-AM/DE/SF; 63-e-AM; 73-h-AM/LR/ST; 96-c-AM/LE/OM; 96-n-AM/LE; 102-n-AM; 121-b-AM/LE; 141-b-AM/DE/PA/RW; 145-a-AM/PA; 147-c-AM; 153-e-AM; 174-g-AM; 179-g-AM; 180-i-AM

Response: *Extensive studies and experience have shown that commercial nuclear power facilities can be safely operated for more than 40 years. As a result, the NRC has provided an option in Title 10 of the Code of Federal Regulations (10 CFR) that allows owners of nuclear power reactors to seek license renewal for up to an additional 20 years with no limitations on the number of times the license may be renewed. The decision whether to seek license renewal, including the length of the renewal period, rests entirely with nuclear power reactor owners and typically is based on the plant's economic viability and whether it can continue to meet NRC safety and environmental requirements. The NRC bases its decision regarding license renewal on whether the facility would continue to meet the requirements for safe operation and whether the protection of the environment can be assured during the renewal term.*

Steps the NRC takes to ensure that each licensee meets its primary responsibility of plant safety include the ongoing licensing process, the Reactor Oversight Process, and the Enforcement Program.

The Reactor Oversight Process is composed, in part, of an inspection program. The core of the NRC inspection program for nuclear power plants is carried out by a minimum of two, on site resident inspectors. The NRC baseline inspection program typically consists of approximately 2700 hours per site. In the implementation of the baseline program, the NRC can make adjustments to the inspection plan based on plant performance trends. The NRC screens each event and assesses its safety significance, identifies the need for prompt follow-up, determines the need for plant-specific or generic licensing-related action, and/or identifies abnormal occurrences.

The concerns expressed in these comments are assessed on an ongoing basis and are outside the scope of the environmental review for license renewal.

The following comments question the IP exemption from a one-hour fire rating requirement:

87-c-AM/HH/OM; 102-o-AM; 152-b-AM/SA; 152-b-AM/SA; 153-c-AM; 174-h-SA; 180-j- AM

Response: *The fire exemption addressed in these comments refers to the Hemyc electrical raceway fire barrier system (ERFBS). In response to testing performed by the NRC in 2005 reflecting potential non-conformance to the 1-hour fire rating, Entergy performed testing on the system and declared the Hemyc ERFBS at Indian Point 3 inoperable. Entergy implemented temporary compensatory measures including an hourly fire watch and verification that the fire detection systems were operable in the affected areas until compliance was restored for the Hemyc ERFBS.*

In a letter dated July 24, 2006, Entergy stated that it would modify the installed Hemyc ERFBS based on the test results. These modifications provided at least a 24-minute rated fire barrier for cable tray configurations, and a 30 minute rating for conduit and box configurations, between redundant trains of safe shut down equipment and cables. Entergy asserted that in light of the *minimal fire hazards and the existing fire protection features in the affected areas, this configuration continues to satisfy the basis for an exemption in accordance with 10 CFR 50.12.*

Upon extensive review the NRC staff concluded that the 30-minute fire barrier is adequate for protection of the redundant safe shutdown equipment, due to the lack of significant combustible loading in the area, the partial fire wall which localizes a postulated fire from affecting redundant equipment, and the available fire detection and manual suppression systems. The referenced exemption was granted on September 28, 2007. The exemption relates to a safety issue and is beyond the scope of the environmental review for license renewal.

The following comments question the inspection process and ability to manage buried piping:

102-i-AM/GL; 153-d-AM/LE/OM; 180-d-AM/GL; 183-b-AM/OM

Response: *The principal concerns presented in these comments relate to the aging of buried piping important to the continued safe operation of the facility. As part of the safety review for license renewal, the NRC staff makes the determination whether aging effects will be adequately managed throughout the period of extended operation.*

The buried piping and tanks inspection program includes preventative measures to mitigate corrosion and inspections to manage the effects of corrosion on the pressure retaining capability of buried carbon steel, gray cast iron, and stainless steel components. The Generic Aging Lessons Learned (GALL) contains the staff's generic recommendation and evaluation of plant programs and documents the technical basis for determining whether existing programs are adequate without modification or should be augmented for the extended period of operation.

In consideration of recent operating history, which involved a February 2009 leak on the return line to the condensate storage tank for Unit 2, the applicant submitted an amendment to the License Renewal Application which modified the Buried Piping and Tanks Inspection Program. The applicant's modification to the Buried Piping and Tanks Inspection program significantly increases the number of inspections as compared to its original submittal.

The aging management of safety systems is part of the license renewal safety review. The Buried Piping and Tanks Inspection Program is addressed in the "Safety Evaluation Report Related to the License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3," Section 3.0.3.1.2.

Issues raised in these comments are beyond the scope of the environmental review for license renewal.

The following comments are concerns over inspections of the containment dome:

35-a- AM/LE; 152-d-AM/OP

Response: *The principal concerns raised in these comments relate to the aging management of the containment and potential loss of intended function. As part of the safety review for license renewal, the NRC makes the determination whether aging effects will be adequately managed throughout the period of extended operation.*

The aging management of safety systems is part of the safety review. The Containment Inservice Inspection Program is addressed in the NRC staff's "Safety Evaluation Report Related *to the License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3," Section 3.0.3.3.2.*

These comments pertain to issues that are beyond the scope of the license renewal review for license renewal.

A.2.19.2 Safety

The following comments express general support for the safety of the plant:

29-c-EC/SA; 48-g-AQ/SO; 57-a-SA; 52-a-SA; 56-f-AL/SA; 57-c-SA/SE/SO; 90-a-SA; 115-a-SA/SE/SO; 120-a-EC/SA; 127-a-SA/SR; 137-a-SA/SR; 144-a-EC/SA/SR; 150-a-SA/SE; 150-b-SA/SO; 150-c-SA/SE; 159-b-AL/SA/SR

Response: *The comments support the general safety of Indian Point. The comments provide no new and significant information; therefore, no changes were made to the SEIS in response to these comments.*

The following comments are opposed to Nuclear Power due to the associated risks of operation:

9-b-OR/SA; 13-f-AM/GE/OM; 64-a-LE/OM/OR/RW; 74-b-SA; 75-c-EC/SA; 87-c-AM/HH/OM; 96-c-AM/LE/OM; 98-b-AL/SA; 102-m-GE/OM; 151-c-SA; 155-c-AL/SA; 160-a-AL/SA/ST; 164-d-LR/OM; 174-f-GI/OM; 179-a-SA/RW/SF; 179-b-LE/OP/SA; 179-h-OR/SA; 180-h-GI/OM;

Response: *These comments are general in nature and address concerns regarding the safe operation of IPEC. Steps the NRC takes to ensure that each licensee meets its primary responsibility of plant safety include the ongoing licensing process, the Reactor Oversight Process, and the Enforcement Program.*

The concerns expressed in these comments are assessed on an ongoing basis and are outside the scope of the environmental review for license renewal.

A.2.19.3 Energy Costs/Energy Needs

The following are general comments stating the energy supplied by Indian Point will need to be replaced if the license is not renewed:

7-d-AQ/EC/SR; 34-a-AL/EC; 36-c-AL/AQ/EC; 52-c-AL/AQ/EC; 56-a-AL/AQ/EC; 67-b-EC

Response: *The NRC staff assumes, as part of its environmental review, that the power supplied by a power plant currently undergoing license renewal review is needed. Thus, NRC staff assumes that some form of power generation or demand reduction would be necessary if a license were not to be renewed. In Chapter 8, the NRC staff considers the environmental impacts of a range of alternatives to license renewal.*

These comments contain no new information, and the NRC staff has made no changes to the SEIS as a result of them.

The following comments indicate that Indian Point shutdown would increase energy costs, reduce reliability, or would be problematic because alternatives are not available or are too difficult to site and permit:

1-b-EC/SE; 1-c-EC/SO; 19-a-EC/SR; 19-b-EC/SO/SR; 23-f-EC/SO; 23-i-EC/SO/SR; 26-a-EC/LR; 26-c-EC/SO/SR; 28-a-EC/SR; 28-b-EC/SO; 29-c-EC/SA; 42-a-EC/SR; 42-f-EC/SO; 57-b-AQ/EC/SO; 57-e-EC/OP/SO; 65-b-EC/SR; 65-c-EC/SO/SR; 67-c-EC; 85-c-EC/SO/SR; 88-c-EC/SR; 90-d-AL/EC/SO; 111-c-EC/SO; 116-b-EC/SO; 118-b-EC/EJ/SR; 120-g-EC; 133-b-EC; 144-a-EC/SA/SR; 146-b-EC; 157-c-AL/EC; 157-d-EC/SR; 159-d-EC; 169-b-AL/AQ/EC; 177-a-AQ/EC/SO; 177-b-EC; 1-a-EC/SO/SR; 1-d-AQ/EC; 31-b-EC/EJ/HH; 45-b-AL/EC/EJ; 46-a-EC/SR; 48-b-EC/SO; 49-h-AQ/EC; 92-a-EC/SO; 92-f-AL/EC; 105-c-EC/SR; 113-j-EC; 119-c-AQ/EC/SO; 119-e-EC/GI/SO; 120-c-AL/AQ/EC; 157-b-AL/EQ/SO; 157-f-AL/EC/SO; 169-a-EL/EC/SO; 19-c-EC/SO/SR; 23-d-EC; 40-g-EC; 42-b-EC/SO; 58-c-AQ/EC/SO; 78-b-EC/GI/ST; 85-a-EC/SO/SR; 88-b-EC/SR; 99-c-AL/EC; 101-b-EC; 108-a-EC/SO/SR; 109-b-EC/EP; 119-b-EC/SO; 119-g-EC/SO/SR; 120-a-EC/SA; 131-e-AQ/EC/SR; 133-a-EC/SO/SR; 146-d-EC/SO; 150-d-EC/SR; 158-b-AL/AQ/EC; 159-a-EC/GL

Response: *The issues raised in these comments – electric rates, grid reliability, difficulty siting and permitting new power plants, concerns about the relative success of electric-sector restructuring, or restrictions on replacement options due to the Regional Greenhouse Gas Initiative (RGGI) – are all outside the jurisdiction of the NRC and generally outside the scope of license renewal.*

Matters relating to electric system planning, transmission planning, electric grid reliability, and new power plant siting and permitting are generally under the jurisdiction of New York State. In the case of grid function and reliability, the New York Independent System Operator – established under New York State law – is the responsible organization. Electricity prices are established by New York utilities or energy supply companies depending on available market rates.

The NRC staff acknowledges NYISO concerns regarding reliability and also discusses RGG I in Chapter 8 of this SEIS.

Many commenters raised concerns about electric prices as a result of possible shutdown. In general the staff is not required to address economic costs or economic benefits of the proposed action (license renewal or alternatives), as indicated in 10 CFR 51.95(c)(2):

> *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.*

NRC staff have, however, included a statement recognizing concern with possible electrical price effects in Chapter 8 of this SEIS.

The following is a general comment indicating that IP2 and IP3 can be replaced:

75-c-EC/SA

Response: *In Chapter 8 of this SEIS the NRC staff consider alternative means of supplying electrical power that are capable, in the NRC staff's professional judgment, of replacing the power currently supplied by Indian Point. If NRC decides to issue renewed licenses, then the choice about whether to operate Indian Point or rely on other energy alternatives is up to utility and state-level decision makers. If NRC decides not to issue renewed licenses, then it will be up to utility and state-level decision makers to decide how to replace the capacity currently supplied by Indian Point. No changes have been made as a result of this comment.*

The following comment indicates that nuclear power is subsidized and asserts that NRC should provide actual costs for nuclear power:

81-b-EC

Response: *The cost of power from continued operation of Indian Point and its alternatives, as well as cost-benefit analyses of Indian Point and its alternatives, are generally outside the scope of the NRC's license renewal environmental review. As indicated in 10 CFR 51.95(c)(2):*

> *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 this case, continued operation of Indian Point is already included in the range of alternatives, and none of the alternatives considered by staff in Chapter 8 were eliminated on the basis of cost. This comment provides no new information, and no changes have been made to this SEIS as a result.

The following are general comments expressing a need for power:

92-a-EC/SO/SR; 92-b-EC/SO; 94-c-AL/EC/OE; 105-b-AL/EC; 112-a-AL/AQ/EC; 112-b-AL/AQ/EC; 127-b-EC/SO; 144-b-EC/SO; 155-a-EC/SO; 159-c-EC/SR

Response: *NRC license renewal rules assume that a need exists for the power currently supplied by Indian Point. The New York Independent System Operator (NYISO) is the state-level organization tasked with maintaining electric grid reliability and monitoring adequacy of state-level power supplies. Other state-level agencies, like the Department of Public Service, oversee permitting for new power projects. The NRC plays no role in either electric system planning or new facility construction in New York State, and has no authority to reinstate the State's expired Article X power plant siting authority. As a result, issues related to electric system planning and consequences of Article X's expiration are outside the scope of license renewal. No changes have been made to this SEIS as a result of these comments.*

A.2.19.6 Emergency Preparedness

The following are general comments expressing opposition to the evacuation plan:

6-a-EP/OR/OS; 9-d-EP; 13-g-DE/EP; 17-b-EP/ST; 17-m-EP; 17-r-EP/GI/RI; 35-b-EP; 47-b-EL/EP/SF; 50-d-EP/HH; 50-p-DE/EP/NE; 72-a-EP/LE/OR/RW; 73-d-EP; 75-b-EP/LE/OP/ST; 80-a-EP/OR/RW/ST; 87-a-DE/EP; 97-g-EP/PA; 98-a-EP/OR/PA; 124-b-EJ/EP/HH/PA; 125-a-DE/EP; 128-b-AE/EP/TS; 128-s-EP; 137-q-EP; 140-b-EP; 149-d-EP/HH/RI; 151-d-EP; 152-a-

GE/PA; 164-b-EP; 164-e-EP/PA; 164-f-EJ/EP; 172-b-DE/EP; 173-a-AE/EP/ST; 182-c-EP/ST; 183-c-EP/HH/PA;

Response: *These comments are addressed under Demographics*

The following comments question the psycho-social analysis factor for evacuations:

16-c-EP/PA/PS; 50-q-EP/PS

Response: *These comments are addressed under Psycho-Social Effects*

The following comments express concerns for the lack of planning for the evacuation of Special Facilities:

79-v-EJ/EP/SM; 96-h-EP; 125-b-EP

Response: *These comments are addressed under Environmental Justice*

The following comments express support of the Emergency Planning technical expertise and general support for the evacuation plan:

56-d-EP; 109-b-EC/EP; 146-a-EP/SE; 148-a-AL/SO; 148-b-AL/SO

Response: *The comments are supportive of the emergency management plan at Indian Point, and are general in nature. The comments provide no additional information; therefore, there were no changes made to the supplement.*

A.2.19.7 Comments Related to Terrorism

The following comments express concern regarding either the potential for Indian Point to be a terrorist target or the need for the NRC staff to assess the environmental impacts of such potential attacks:

11-e-RW/ST; 12-e-RW/ST; 13-d-PA/RW/ST; 16-b-PS/ST; 17-b-EP/LI/ST; 17-g-OS/ST; 17-i-SF/ST; 17-k-SF/ST; 17-l-SF/ST; 17-n-EP/PA/ST; 18-b-OE/ST; 20-a-PA/SF/ST; 27-e-SF/ST; 37-b-LE/SF/ST; 38-b-PA/RW/ST; 38-h-ST; 39-d-PA/ST; 50-m-PA/ST; 52-b-ST; 54-b-DE/ST; 61-b-LE/RW/ST; 63-f-RW/ST; 73-h-AM/LR/ST; 75-b-EP/LE/OP/ST; 80-a-EP/OR/RW/ST; 80-b-LE/RW/SF/ST; 87-b-HH/PA/RW/ST; 91-e-OR/RW/ST; 102-d-OW/PA/ST; 110-c-AL/OP/ST; 120-n-ST; 122-a-DE/PA/ST; 126-a-DE/RW/SF/ST; 135-c-RW/SF/ST; 137-d-LR/ST; 137-q-ST; 144-c-ST; 145-b-RW/SF/ST; 160-a-AL/SA/ST; 161-c-RW/ST; 161-g-ST/UF; 161-h-DE/ST; 162-b-AL/SF/ST; 164-a-OE/PA/ST; 171-b-PA/ST; 172-c-ST; 173-a-AE/EP/ST; 176-e-RW/SF/ST; 179-f-SF/RW/ST; 182-c-EP/ST; 183-d-ST

Response: *The issue of security and risk from malevolent acts at nuclear power plants is generally beyond the scope of license renewal. This matter will continue to be addressed through the ongoing regulatory oversight process as current and generic regulatory issues that affect all nuclear facilities. Appropriate safeguards and security measures have been incorporated into the site security and emergency preparedness plans. Any required changes to emergency and safeguards contingency plans related to terrorist events will be incorporated and reviewed under the operating license.*

The NRC's environmental review is confined to environmental impacts related to the extended period of operation. To the extent that these comments urge the NRC staff to consider *environmental impacts of potential terrorist attacks, the Commission's long-standing position is that NEPA does not require inquiry into the consequences of a hypothetical terrorist attack.*

In a Memorandum and Order concerning the renewal of the operating license for the Oyster Creek Nuclear Generating Station, Amergen Energy Company, LLC (License Renewal for Oyster Creek Nuclear Generating Station), CLI-07-8, 65 NRC 124 (February 26, 2007), ADAMS Accession No. ML070570511), the Commission stated that it "respectfully . . . disagrees" with the Ninth Circuit Court of Appeals decision in San Luis Obispo Mothers for Peace, v. NRC, 449 F.3d 1016 (9th Cir. 2006) regarding consideration of the potential environmental impacts of terrorist attacks at Diablo Canyon, and will follow the decision of the court as applicable to that proceeding. But, as to other proceedings, the Commission continues to believe that such inquiry is not required.

In the Oyster Creek Memorandum and Order, the Commission also reached the following conclusions. First, terrorist issues are unrelated to "the detrimental effects of aging" and are beyond the scope of license renewal. Second, the environmental effect caused by terrorists is simply too far removed from the natural or expected consequences of agency action to require a study under NEPA. Third, a NEPA-driven review of the risks of terrorism would not be necessary because the NRC has undertaken extensive efforts to enhance security at nuclear facilities. These ongoing post-9/11 enhancements provide the best vehicle for protecting the public. Fourth, substantial practical difficulties impede meaningful NEPA-terrorism review, while the problem of protecting sensitive security information in the quintessentially public NEPA and adjudicatory process presents additional obstacles. Finally, the GEIS documents "a discretionary analysis of terrorist acts in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release to be expected from internally initiated events."

No change to the SEIS will be made as a result of these comments.

A.2.19.8 Support for Entergy

The following comments are generally supportive of Entergy:

1-b-EC/SE; 7-a-SE/SL; 8-d-SE/SR; 23-a-SE/SR; 40-xxxxx-SE; 42-d-SE/SR; 42-h-SE/SL; 43-a-SE/SO; 48-a-SE/SO; 48-c-SE; 53-a-SE/SR; 56-c-HH; 56-e-SE; 57-c-SA/SE/SO; 57-h-SE/SR;60-a-SE; 60-b-AQ/SE; 67-e-SE/SO; 109-c-SE/SO; 114-a-SE; 115-a-SA/SE/SO; 119-d-AQ/SE; 119-j-SE/SR; 131-b-SE; 131-c-SE/SR; 131-d-SE; 136-c-SE; 146-a-EP/SE; 148-b-OS/SE; 148-c-SE; 150-a-SA/SE; 150-c-SA/SE; 156-a-SE/SR; 163-a-SE/SO/SR; 181-a-SE/SR

Response: *The comments are in support of Entergy and are general in nature. No new information in provided and therefore, the comments will not be evaluated further. No change to the SEIS will be made as a result of this comment.*

NRC FORM 335 (9-2004) NRCMD 3.7

U.S. NUCLEAR REGULATORY COMMISSION

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10. SUPPLEMENTARY NOTES

Docket Nos. 05000247 and 05000286, TAC Nos. MD5411 and MD5412

11. ABSTRACT *(200 words or less)*

This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted to the NRC by Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC (all applicants will be jointly referred to as Entergy) to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20 years under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This SEIS includes the NRC staff's analysis which 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.

The NRC staff's recommendation is that the Commission determine that the adverse environmental impacts of license renewals for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental report and other information submitted by Entergy, (3) consultation with other Federal, State, Tribal, 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 and in response to the draft SEIS.

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