U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

NUREG-1437, Vol. 1
Supplement 38

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 38

Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3

Draft Report for Comment Main Report

Office of Nuclear Reactor Regulation

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Any interested party may submit comments on this report for consideration by the NRC staff. Comments may be accompanied by additional relevant information or supporting data. Please specify the report number NUREG-1437, Supplement 38, draft, in your comments, and send them by March 11, 2009, to the following address:

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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 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 the NRC 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 draft 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 preliminary 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 draft 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 four exceptions—entrainment, impingement, heat shock from the facility's heated discharge, and impacts to aquatic endangered species. Overall effects from entrainment and impingement may be SMALL to

(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.

LARGE, depending on the species affected. Impacts from heat shock likely range from SMALL to MODERATE depending on the conclusions of thermal studies proposed by the New York State Department of Environmental Conservation (NYSDEC). NRC staff did not find data that suggest the effect of heat shock is likely to rise to LARGE. Given the uncertainties in the data NRC staff reviewed, impacts to the endangered shortnose sturgeon could range from SMALL to LARGE.

The NRC staff's preliminary 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 decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental report submitted by Entergy, (3) consultation with other Federal, State, and local agencies; (4) the NRC staff's own independent review, and (5) the NRC staff's consideration of public comments received during the scoping process.

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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, consistency with State water quality standards, and consistency with State coastal zone management plans. 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 draft 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. 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 adopt, by reference, the comments and responses in the Scoping Summary Report and provide information on how to electronically access the scoping summary or view a hard copy.

The NRC staff will hold public meetings in Cortlandt Manor, New York, in February 2009 to describe the preliminary results of the NRC environmental review, to answer questions, and to provide members of the public with information to assist them in formulating comments on this

(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.

draft SEIS. When the comment period ends, the NRC staff will consider and address all of the comments received. These comments will be addressed in Appendix A, Part 2, to the final SEIS.

This draft SEIS includes the NRC staff's preliminary 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 preliminary recommendation regarding the proposed action.

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

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

The 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 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 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 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 draft 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 two alternatives that included continued operation of IP2 and IP3 with either a closed-cycle cooling system, or a combination of intake modifications and habitat restoration projects that may achieve similar effects on aquatic organisms as closed cycle cooling because the New York State Department of Environmental Conservation (NYSDEC) issued a preliminary determination, in its 2003 draft State Pollutant Discharge Elimination System (SPDES) permit that closed cycle cooling is the site-specific best technology available to reduce impacts on fish and shellfish. NYSDEC's 2003 draft SPDES permit indicated that Entergy could propose another alternative that would have similar effects on aquatic species. The 2003 SPDES permit is currently subject to adjudication and has not gone into effect.

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 review of each issue. Six of the Category 2 issues are not applicable because they are related to the 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 may replace reactor vessel heads and control rod drive mechanisms at IP2 and IP3, though it has no firm plans to do so at this time. 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 draft SEIS. These include 15 Category 2 issues and two 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 four exceptions—entrainment, impingement, heat shock from the facility's heated discharge, and impacts to aquatic endangered species. The NRC staff jointly assessed the impacts of entrainment and impingement to range from SMALL to LARGE (depending on species affected), based on NRC's analysis of representative important species. Impacts from heat shock likely range from SMALL to MODERATE depending on the conclusions of thermal studies proposed by the New York State Department of Environmental Conservation (NYSDEC). NRC staff did not find data that suggest the effect of heat shock is likely to rise to LARGE. Given the uncertainties in the data NRC staff reviewed, impacts to the endangered shortnose sturgeon could range from SMALL to LARGE. The NRC staff considered mitigation measures for each applicable Category 2 issue.

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 the 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).

NRC analysis indicates that the adverse impacts of likely 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 preliminary 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 decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the ER submitted by Entergy, (3) consultation with other Federal, State, and local agencies, (4) the staff’s own independent review, and (5) the staff’s consideration of public comments received during the scoping process.

ABBREVIATIONS/ACRONYMS

°	degree(s)
µm	micron(s)
ac	acre(s)
AC	alternating current
ACC	averted cleanup and decontamination
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
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
Bq/L	bequerel per liter
Bq/kg	bequerel 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
CAMR	Clean Air Mercury Rule
CCF	common cause failure
CCMP	Comprehensive Conservation and Management Plan
CCW	component cooling water
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)
cm	centimeter(s)

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
CST	condensate storage tank
CSET	Containment Safeguards for Event Tree
cu ft	cubic feet
CV	coefficient of variation
CVCS	Chemical and Volume Control System
CWA	Clean Water Act
CWIS	Circulating Water Intake System
CWS	Circulating Water System
CWSH	Circulating Water Screenhouse
cy	cubic yards
CZMA	Coastal Zone Management Act
dB(A)	decibel(s)
DBA	Design-basis accident
DC	direct current
DEIS	Draft Environmental Impact Statement
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPS	distinct population segment
DSM	demand-side management
DWR	Division of Water Resources
ECL	Environmental Conservation Law
EDG	emergency diesel generator
EIA	Energy Information Administration
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
Enercon	Enercon Services, Inc.
Entergy	Entergy Nuclear Operations, Inc.
EO	Executive Order
EOP	emergency operating procedure
EPA	U.S. Environmental Protection Agency
EPACT2005	Energy Policy Act of 2005
EPRI	Electric Power Research Institute
ER	Environmental Report

ER-M	effects-range-median
ERS	Environmental Radiation Surveillance
ESA	Endangered Species Act
ESP	Early Site Permit
ESWS	Essential Service Water System
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
FFTM	far field thermal model
FIVE	fire-induced vulnerability evaluation
FJS	Fall Juvenile Survey
F_{MSY}	fishing mortality rate that can produce the maximum sustainable yield
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
ft/mi	feet per mile
FWS	U.S. Fish and Wildlife Service
g	gram(s)
gCeq/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
HAP	hazardous air pollutant
HCLPF	high confidence of low probability of failure
HEPA	high efficiency particulate air
HLW	high-level waste
hr	hour(s)
HRA	Human Reliability Analysis
HRERF	Hudson River Estuary Restoration Fund
HRF	Hudson River Foundation
HRFI	Hudson River Fisheries Investigation

HRIF	Hudson River Improvement Fund
HRPC	Hudson River Policy Committee
HRSA	Hudson River Settlement Agreement
HVAC	heating, ventilation, and air conditioning
Hz	hertz
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
IPEE	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)
kg/yr	kilograms per year
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
kW	kilowatt
kWh	kilowatt hour(s)
lbs	pounds
L	liter(s)
LERF	Large Early Release Frequency
LLMW	low-level mixed waste
LOCA	loss of coolant accident
LOE	Line(s) of Evidence
LOS	level of service
lpm	liters per minute
LPSI	low pressure safety injection
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
mA	milliampere(s)
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
MBq	megabequerel
MCL	maximum contaminant level

MDS	Minimum Desirable Streamflow
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)
MMACR	Modified Maximum Averted Cost-Risk
MMBtu	million British thermal unit(s)
mov	motor-operated valve
mph	miles per hour
mps	meter(s) per second
mrad	millirad(s)
mrem	millirem(s)
MSE	mean squared error
MSL	mean sea level
MSPI	Mitigating Systems Performance Indicator
mSv	millisievert
MT	metric ton(s)
MTU	metric ton of uranium
MUDS	Makeup Discharge Structure
MUSH	Makeup Water Screen House
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
NAS	National Academy of Sciences
NCP	normal charging pump
NEPA	National Environmental Policy Act of 1969, as amended
NESC	National Electric Safety Code
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
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

NRDC	Natural Resource Defense Council
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
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
NYCEF	New York City Environmental Fund
NYCRR	New York Code of Rules and Regulations
NYISO	New York Independent System Operator
NYNHP	New York Natural Heritage Program
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
OL	operating license
PAB	primary auxiliary building
PAH	polycyclic aromatic hydrocarbon
PAYS	Pay as You Save
PCB	polychlorinated biphenyls
pCi/L	picoCuries per liter
pCi/kg	picoCuries per kilogram
PDS	plant damage state
PILOT	payment-in-lieu-of-taxes
$PM_{2.5}$	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
POTW	publicly owned treatment works
ppm	parts per million
ppt	parts per thousand
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
PSD	Prevention of Significant Deterioration
PV	photovoltaic
PWR	pressurized water reactor
PWW	Poughkeepsie Water Works
PYSL	post yolk-sac larvae

REMP	Radiological Environmental Monitoring Program
R-EMP	regional environmental monitoring and assessment program
radwaste	radioactive waste
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)
RLE	review level earthquake
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
SER	Safety Evaluation Report
SFP	Spent Fuel Pool
SGBD	steam generator blowdown
SGTR	Steam Generator Tube Ruptures
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
SOP	standard operating procedure(s)
SPDES	State Pollutant Discharge Elimination System
SPU	stretch power update
sq mi	square mile(s)
SRP	Standard Review Plan
SSBR	spawning stock biomass per-recruit
SSE	safe shutdown earthquake

Sv	person-sievert
SWS	service water system
T	temperature
TD	turbine driven
TDS	total dissolved solids
TI-SGTR	thermally-induced Steam Generator Tube Ruptures
TL	total length
TLD	Thermoluminescent dosimeter
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TRC	TRC Environmental Corporation
UHS	ultimate heat sink
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USD	Unified School District
USGS	U.S. Geological Survey
UWNY	United Water New York
V	volt(s)
VALNF	value of non-farm wealth
VOC	volatile organic compound
WET	whole effluent toxicity
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, which was issued by the NRC, since August 1974. The IP2 operating license will expire on September 28, 2013. IP3 has operated under operating license DPR-64, which was issued by the NRC, since August 1976. The IP3 operating license will expire on December 12, 2015. Unit No. 1 (IP1) was shut down in 1974.

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).

This report is the draft facility-specific supplement to the GEIS (the supplemental EIS (SEIS)) for the Entergy license renewal application. This draft SEIS is a supplement to the GEIS because it

(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.

relies, in part, on the findings of the GEIS. The NRC staff will also prepare a separate safety evaluation report in accordance with 10 CFR Part 54.

1.1 Report Contents

The following sections of this introduction (1) describe the background for the preparation of this draft 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 draft SEIS closely parallel the contents and organization of the GEIS. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 and 4, respectively, discuss the potential environmental impacts of plant refurbishment and plant operation during the renewal term. Chapter 5 contains an evaluation of potential environmental impacts of plant accidents and includes consideration of severe accident mitigation alternatives. Chapter 6 discusses the uranium fuel cycle and solid waste management. Chapter 7 discusses decommissioning, and Chapter 8 discusses alternatives to license renewal. Finally, Chapter 9 summarizes the findings of the preceding chapters and draws conclusions about the adverse impacts that cannot be avoided, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and the irreversible or irretrievable commitment of resources. Chapter 9 also presents the NRC staff's preliminary 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 staff 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 draft SEIS (Appendix C)
- the organizations contacted during the development of this draft SEIS (Appendix D)
- the IP2 and IP3 compliance status in Table E-1 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)
- NRC staff evaluation of severe accident mitigation alternatives (Appendix G)

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 draft 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, 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 draft SEIS sections where the analysis is presented. The draft 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 (72 FR 26850; NRC 2007). 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 draft 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, 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 draft SEIS.

This draft SEIS presents the NRC staff's preliminary 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 preliminary 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 decisionmakers would be unreasonable.

A 75-day comment period will begin 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 will be held in Cortlandt Manor, New York, in February 2009. During this meeting, the NRC staff will describe the preliminary results of the NRC environmental review and answer questions related to it to provide members of the public with information to assist them in formulating their comments.

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 an operating license is to maintain the availability of the nuclear plant to meet system energy requirements beyond the current term of the unit's license.

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 the list and consulted with the appropriate Federal, State, and local agencies to identify any compliance or permit issues or significant environmental issues of concern to the reviewing agencies. These agencies did not identify any new and significant environmental issues. The ER 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.

1.6 References

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

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

40 CFR Part 1508. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

Atomic Energy Act of 1954. 42 *United States Code* 2011, *et seq*.

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.

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 has been placed 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.

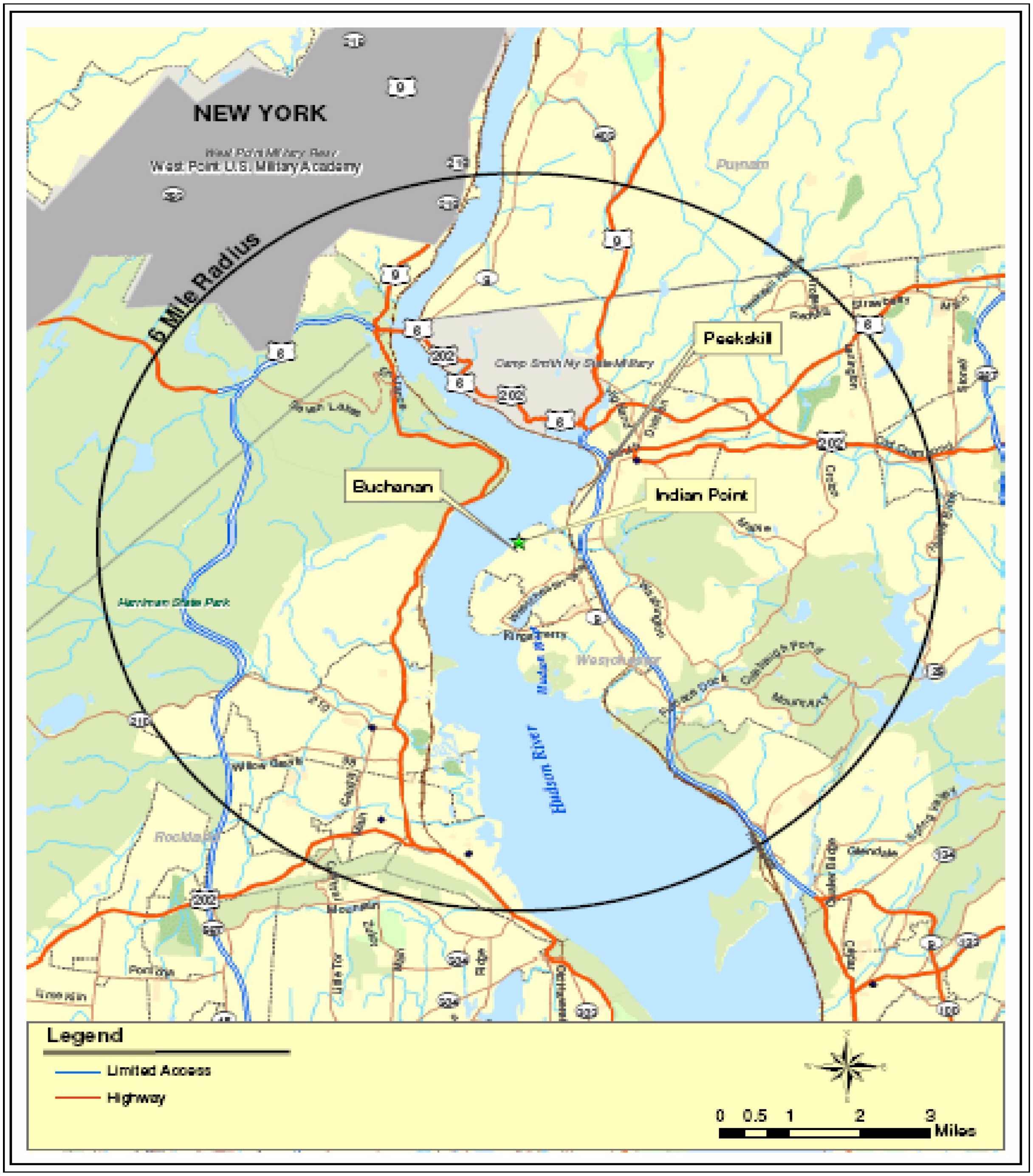
2.1.1 External Appearance and Setting

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 meters (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**



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.

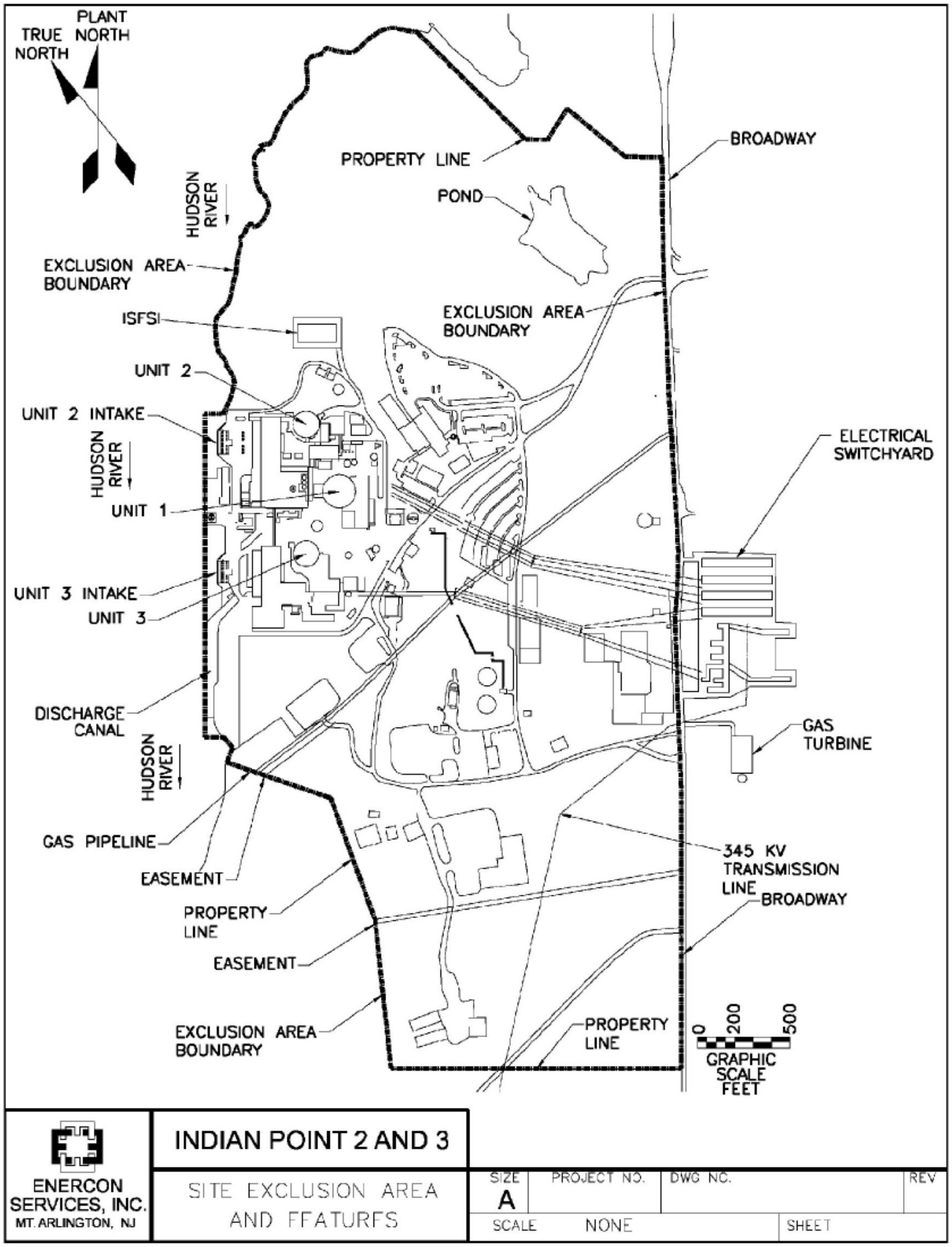
IP2 and IP3 each use two main transformers to increase voltage from their respective turbine generators. The transformers increase generator output from 22 kilovolts (kV) to 345 kV. Power is then delivered to the Consolidated Edison Company (Con Edison) transmission grid by way of two double-circuit 345-kV lines. These lines connect the main onsite transformers to the offsite Buchanan substation which is located 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).

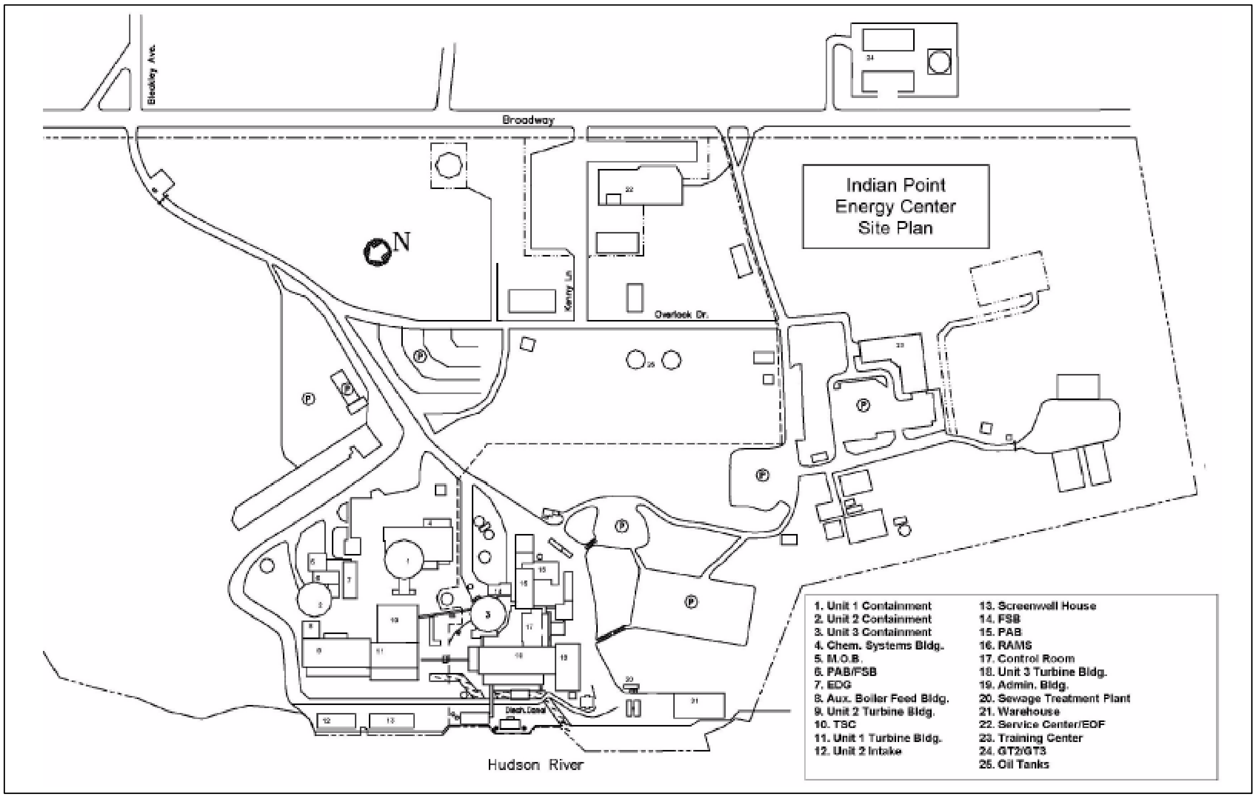
IP2 is currently licensed to operate at a core power of 3216 megawatt thermal (MW(t)), which results in a turbine generator output of approximately 1078 megawatt electric (MW(e)). IP3 is currently licensed to operate at 3216 MW(t), which results in a turbine generator output of approximately 1080 MW(e). 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



Source: Entergy 2007a

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-enrichment (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 2008a).

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.

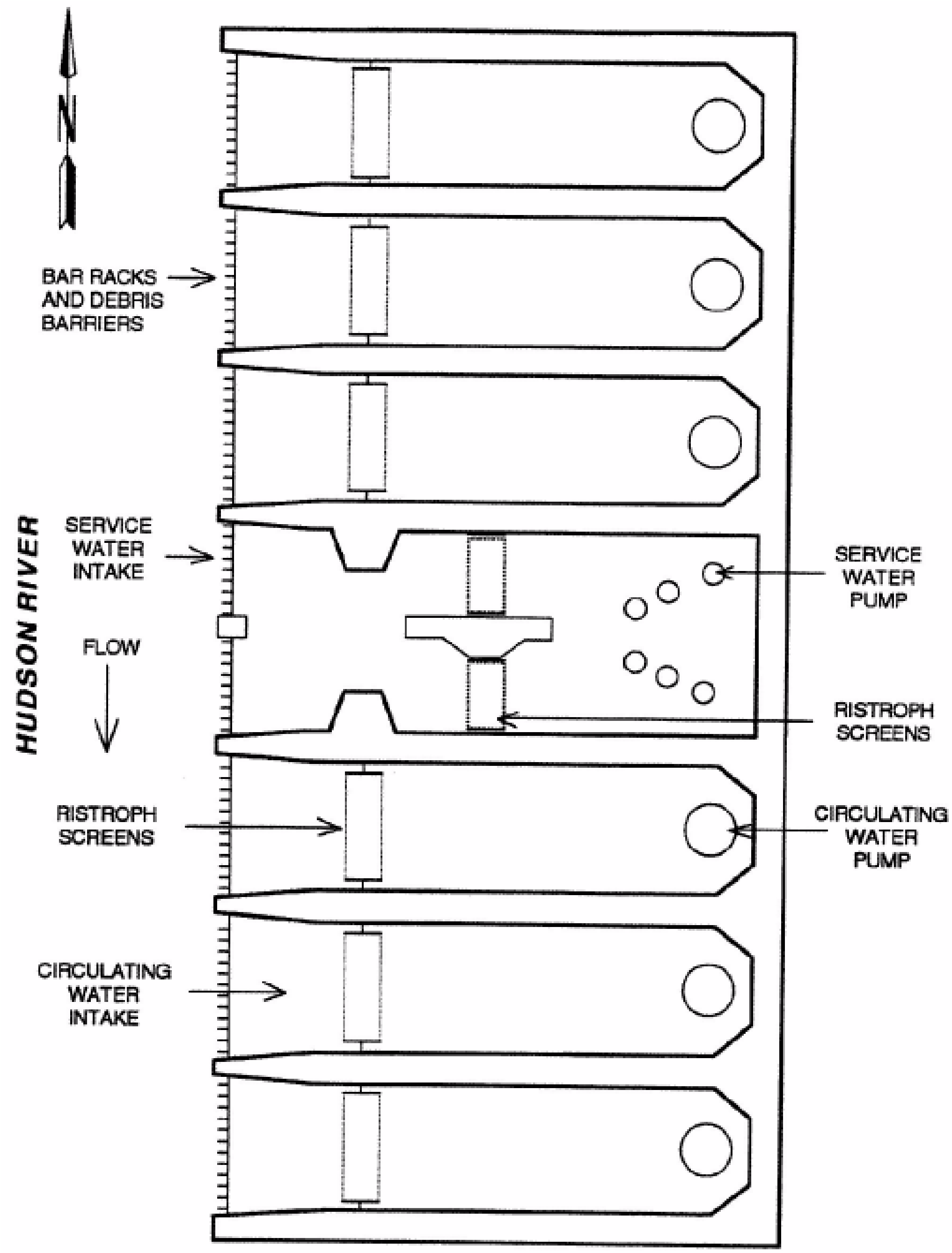
The maximum design flow rate for each cooling system is approximately 1870 cubic feet per second (cfs), 840,000 gallons per minute (gpm), or 53.0 cubic meters per second (m^3/s).

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

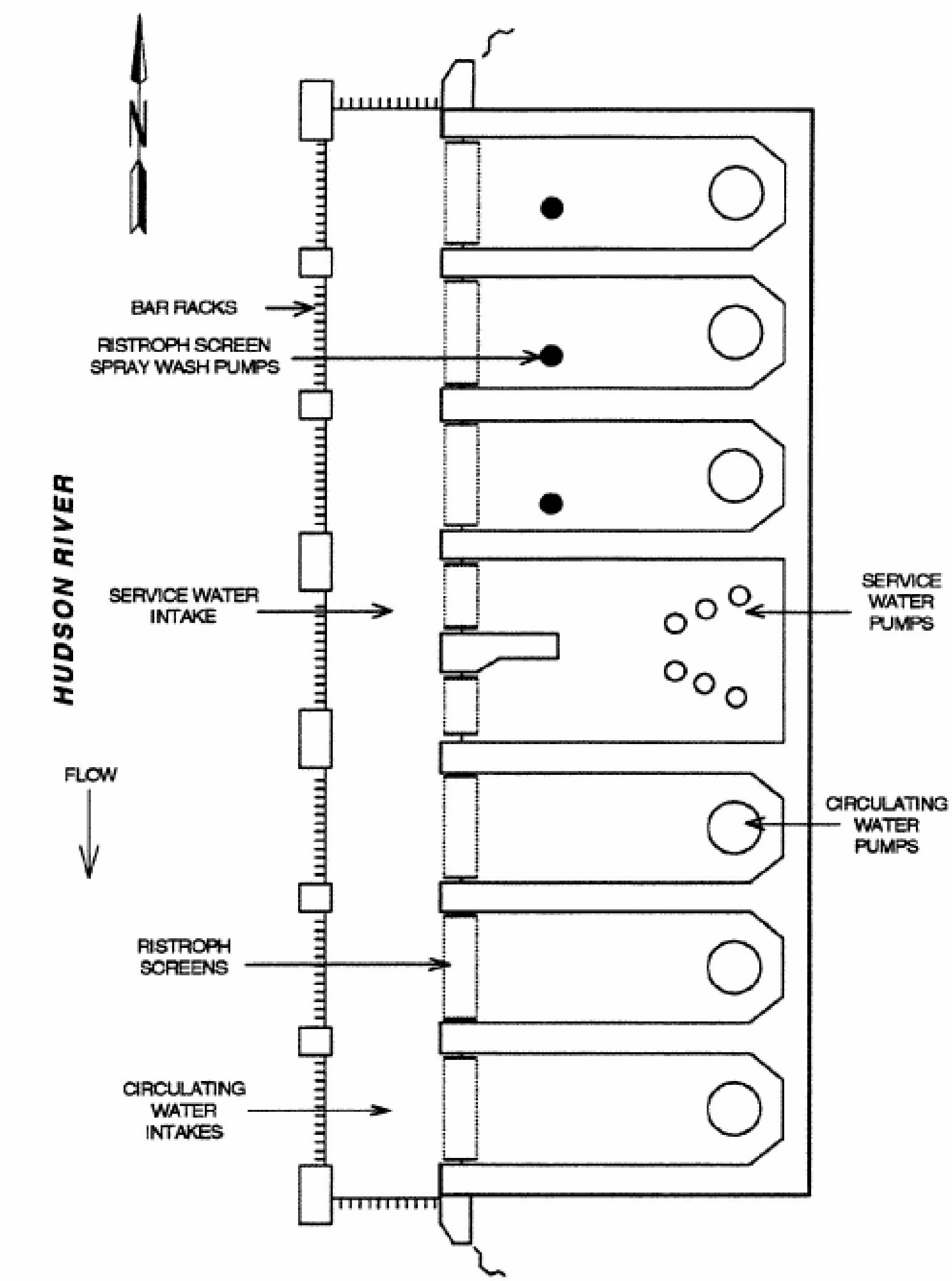
Section 2.2.5.3 for more information), the applicant adjusts the speed of the intake pumps to mitigate impacts to the Hudson River.

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.



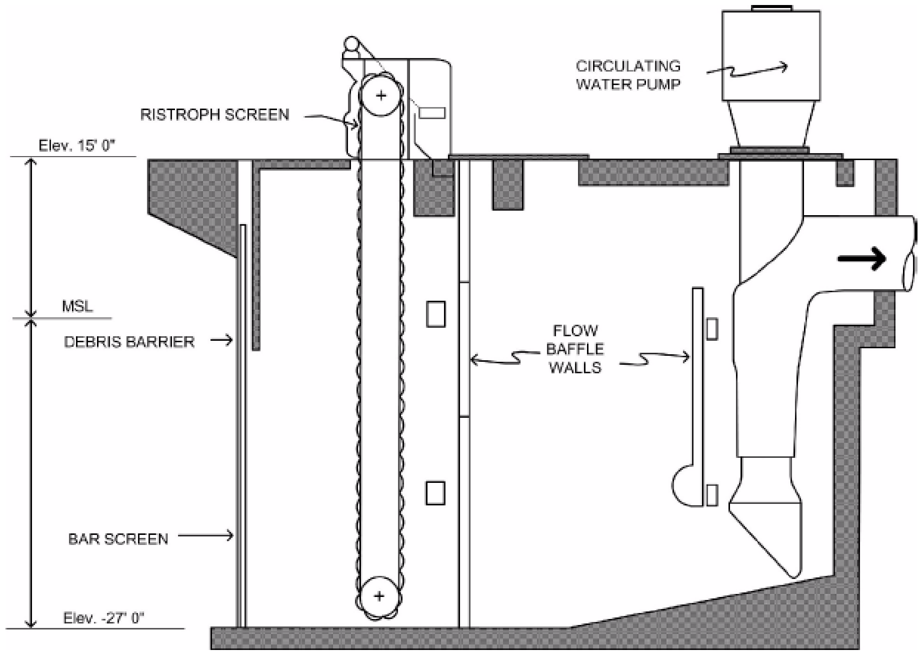
Source: Entergy 2007a

Figure 2-5. IP2 intake structure



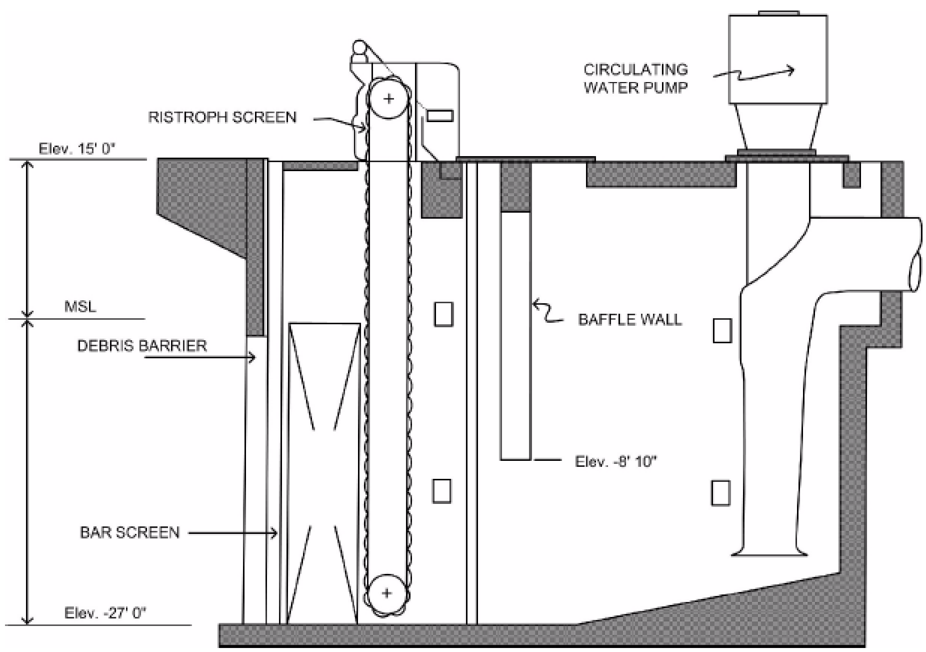
1 Source: Entergy 2007a

2 **Figure 2-6. FIP3 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. 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).

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 .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 six similar pumps, each rated at 13 cfs (6000 gpm; 170 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 (which is decommissioned) 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 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 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 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 the two operating units. 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 millirems (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 effectively 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. 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 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 Ground Water

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 ($7.03x10^{3}$ MBq) of tritium migrated directly to the Hudson River by the ground water flow path in 2006, resulting in an approximate total body dose of $2.10x10^{-6}$ mrem ($2.10x10^{-8}$ 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 (ground water 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 $5.70x10^{-4}$ Ci (21.1 MBq) from the ground water pathway, which resulted in a calculated annual dose of approximately $1.78x10^{-3}$ mrem ($1.78x10^{-5}$ mSv) to the total body, and $7.21x10^{-3}$ mrem ($7.21x10^{-5}$ 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 $9.40x10^{-2}$ Ci ($3.48x10^{3}$ MBq) of tritium, resulting in an approximate total body dose of $2.00x10^{-8}$ mrem ($2.00x10^{-10}$ mSv). Entergy asserts that the annual dose to a member of the public from the combined ground water 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 recent 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, 2004a, 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. 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 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 Studsvic facility in Irwin, 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. (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 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 2008b), 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 2008b), 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 requires a hazardous waste permit for facilities that store large quantities of hazardous waste for more than 90 days.

The IP2 and IP3 facility has hazardous and mixed waste storage facilities covered by permits issued by NYSDEC under NYCRR Part 373. The permits, NYD991304411 and NYD085503746, are for the accumulation and temporary onsite storage of hazardous and mixed waste for more than 90 days at IP2 and IP3 respectively. The permits have been administratively continued based on a conditional mixed waste exemption (Entergy 2007a).

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) (8158 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).

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.

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, 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).

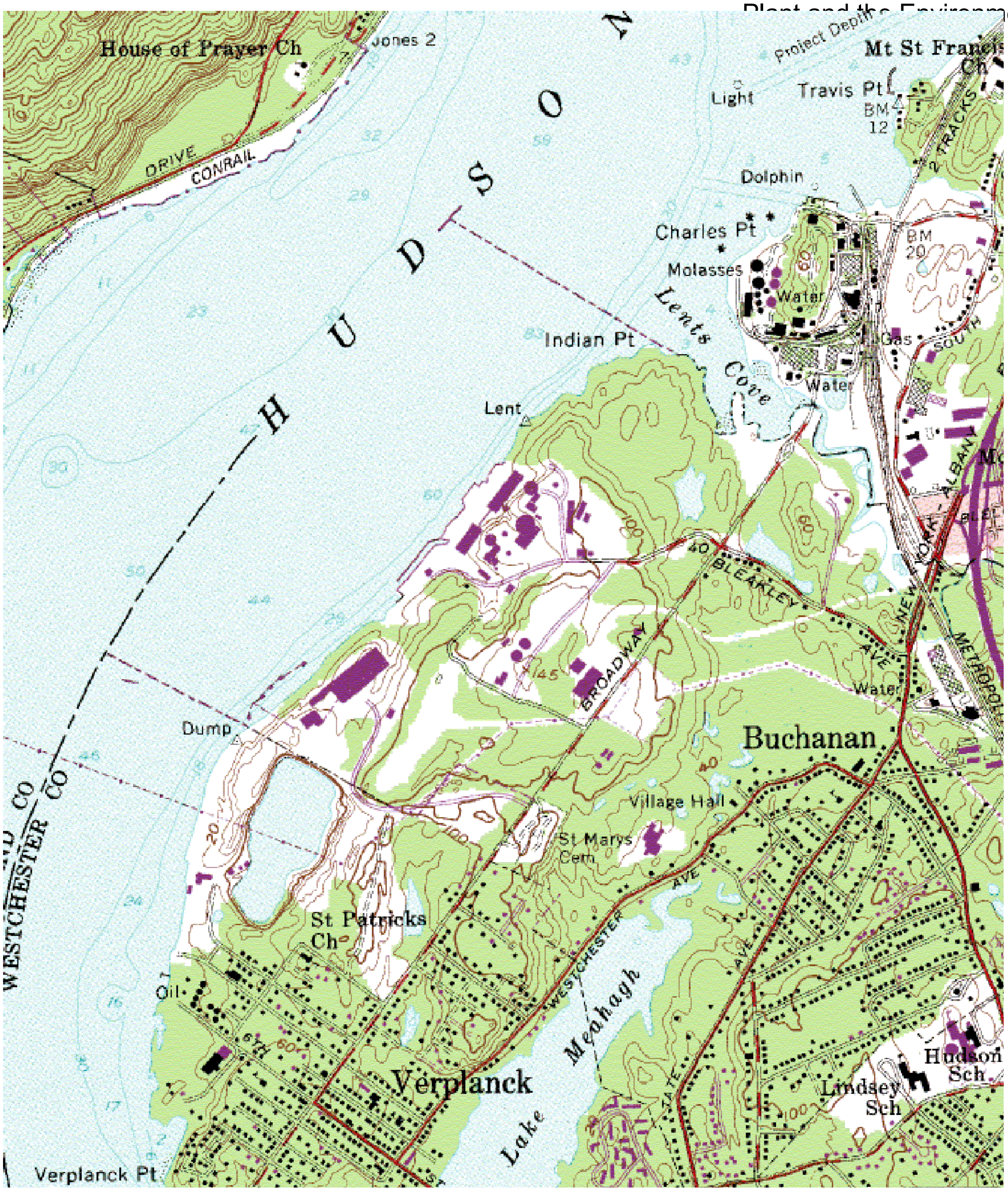
2.2.2 Water Use

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. Pursuant to the New York State Administrative Procedure Act, these permits do 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 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.



Source: Maptech, Inc.

Figure 2-9. Topographic features surrounding IP2 and IP3

IP2 and IP3 do not intentionally discharge contaminants in a manner that would contaminate the ground water 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 ground water is discussed in Section 2.2.7 of this draft SEIS (the leaks are also mentioned in Section 2.1.4.1 of this draft 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 degrees Fahrenheit (F) (-10 degrees Celsius (C)) in the central Adirondacks to 30 degrees F (-1.1 degrees C) on Long Island. The average July temperature in the central Adirondacks is 66 degrees F (19 degrees C), and 74 degrees F (23 degrees C) on Long Island. The highest temperature ever recorded in the State was 108 degrees F (42 degrees C) at Troy on July 22, 1926. The lowest recorded temperature, -52 degrees F (-47 degrees 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 degrees F (-2.2 degrees C) in winter to 87 degrees F (31 degrees C) in summer. The mean daily minimum temperatures range from about

20 degrees F (-6.7 degrees C) in winter to about 72 degrees F (22 degrees 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 2008a). 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 2008b).

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 eastern tip, 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, King, Nassau, Orange, Queens, Richmond, Rockland, Suffolk, and Westchester*—O_3 and $PM_{2.5}$

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

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 25 tons (t) (23 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.

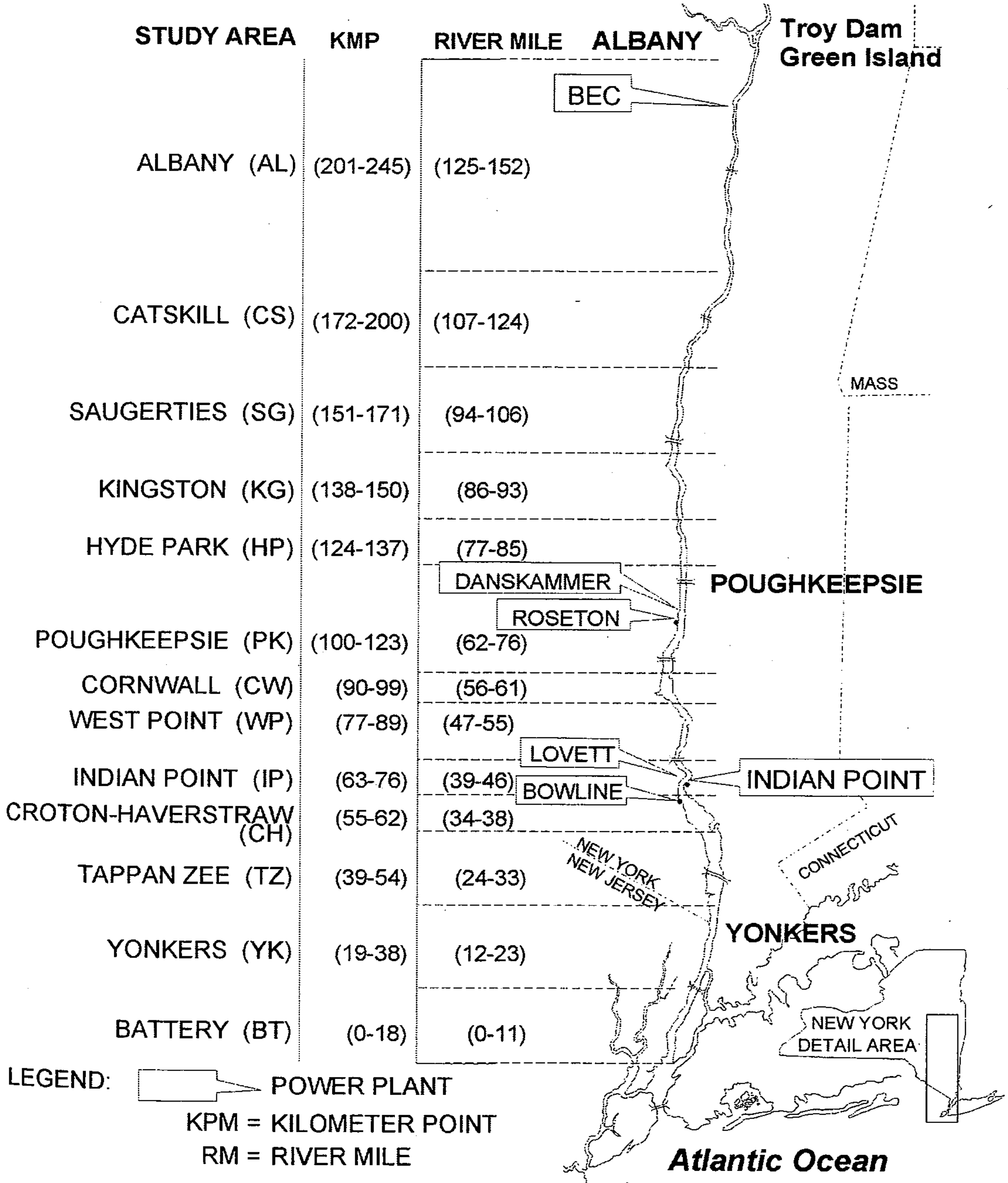
2.2.5.1 The Hudson River Estuary

Watershed Description

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 multiutility 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.

Lower Hudson River Basin Habitats

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**

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

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 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 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 identified 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 2-6). 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 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 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

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:

(1) polyhaline (high salinity): RM 1–19 (RKM 2–31)

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

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

(4) 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).

<u>Temperature</u>

Water temperatures in the Hudson River vary seasonally, with a maximum temperature of 25 degrees C (77 degrees F) occurring in August and a minimum temperature of 1 degree C (34 degrees 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 reject approximately $8x10^{11}$ British thermal units per day (Btu/day) ($2.3x10^8$ 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 degrees C (64 degrees 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 (1997), 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 2-6). 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 degrees C (54 degrees 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 degrees C (0.22 degrees F) per decade. The sharpest increase during that time occurred from 1971 to 1990 at 0.46 degrees C (0.83 degrees F) per decade; the sharpest cooling occurred from 1908 to 1923 at 0.79 degrees C (1.42 degrees 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 2-6). 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.

<u>Industry and Water Use Impacts</u>

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, 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
19^{th} 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 this facility, 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).

Municipal Wastewater Treatment Plants

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 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 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). 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 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.

<u>Nonpoint Pollution</u>

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 large invertebrates have established populations in the 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 and Van Winkle 1988).

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 and Van Winkle 1988).

<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 and Van Winkle 1988). 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 expired on October 1, 1992 (NYSDEC 2003a). HRSA conditions were incorporated into the permit language as before. Before the expiration of the permits 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.

Environmental Studies in the Lower Hudson Estuary

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 draft 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 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. No further studies were conducted after the installation of the modified Ristroph system at IP2 and 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. Table 2-3 Hudson River Environmental Studies Table
(Information used in draft SEIS to assess impacts; data provided by Entergy)

Study	Study Dates	Information Available
Impingement Abundance	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 estuary.

The NRC staff identified 18 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 RIS identified in this section are meant to represent the overall aquatic resource and reflect the 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. The distribution of each RIS is presented in Table 2-5.

Table 2-4. Representative Important Aquatic 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*	Anadromous protected	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	*Notropis*	Freshwater	Species eats aquatic insect larvae,

shiner	*hudsonius*		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 2-6) Where the Presence of 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>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">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>
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<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>PYSL</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">LRS</td></tr>
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1 **Table 2-5** (continued)

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1 **Table 2-5** (continued)

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Table 2-5 (continued)

Species	Lifestage	BT	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
Weakfish	Eggs													
	YSL													
	PYSL													
	YOY		FJS											
	Year +		FJS				FJS							
White catfish	Eggs													
	YSL													
	PYSL													
	YOY								FJS			FJS		
	Year +			FJS								FJS		
White perch	Eggs										LRS			
	YSL								LRS					
	PYSL								LRS					
	YOY			BSS		LRS						BSS		
	Year +			BSS								BSS		
Blue crab[i]	Eggs													
	Zoea													
	Megalops													
	Juvenile													
	Year +													

[a] BSS: Beach Seine Survey (1974–2005)
[b] FJS: Fall Juvenile Survey (also known as Fall Shoals Survey) (1979–2004)
[c] LRS: Long River Survey (1974–2004)
[d] YSL: yolk-sac larvae
[e] PYSL: post-yolk-sac larvae
[f] YOY: young of year
[g] Year +: yearling and older
[h] Obtained from ASMFC 2006a distribution
[i] Obtained from ASMFC 2006a distribution
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 degrees C (52 degrees F) and 27 degrees C (81 degrees 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 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 remains well below historic estimates (Haas-Castro 2006a).

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 degrees C (59.9 degrees 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 degrees C (39 degrees 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.

<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 degrees C (63 degrees 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). 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). 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 the 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).

Atlantic Tomcod

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 degrees C (30 degrees F) and have not been observed to inhabit waters at temperatures higher than 26 degrees C (79 degrees 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 degrees C (66 degrees F), and growth essentially ceases at temperatures above 22 degrees C (72 degrees 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).

Bay Anchovy

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 2-6). 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 degrees C (48 and 88 degrees 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 degrees C (81 degrees 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.

<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 degrees C (57 degrees F) and 27 degrees C (81 degrees 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). 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 is low, ranging from 0.2 to 0.7 percent for the same time period (CHGEC 1999).

<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 degrees C (57.2 to 60.8 degrees F) and exhibit signs of stress at temperatures below 11.8 degrees C (53.2 degrees F) and above 30.4 degrees C (86.7 degrees 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 degrees C (64.4 to 71.6 degrees 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 NMFS of data between 1974 and 1986 did not find evidence of a systematic decline of the species (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). Juvenile bluefish may be impinged, but the numbers are estimated to be relatively small (CHGEC 1999).

<u>Gizzard Shad</u>

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 degrees C (50 and 70 degrees 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. Entrainment of early life stages is thought to be low, and small gizzard shad are rare in utility ichthyoplankton surveys (CHGEC 1999).

<u>Hogchoker</u>

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 degrees C (68 to 77 degrees 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 degrees C (73.9 and 76.1 degrees 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).

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 degrees C (39 to 48 degrees 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 on 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. Larvae now 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 population decline in the Hudson River was observed from 1994, 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.

<u>Spottail Shiner</u>

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).

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 .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 degrees C (59 to 68 degrees F) but can occur between 10 and 23 degrees C (50 and 73 degrees 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).

<u>Weakfish</u>

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 degrees C (63 and 81 degrees 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 degrees C (53.6 to 88.7 degrees 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 degrees C (68 to 69.8 degrees 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).

<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 degrees F (21 degrees 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 degrees F (24 to 29 degrees 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 degrees F (15 degrees 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). Generally, early life stages of the species are not at risk of entrainment because spawning and early development occurs upstream near nests, which adult white catfish guard (CHGEC 1999). 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 (CHGEC 1999).

<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 begins in late April when water temperatures reach 10 to 12 degrees C (50 to 54 degrees F) and can continue until late May or early June when temperatures reach 16 to 20 degrees C (61 to 68 degrees 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 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. 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. 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.

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).

2.2.5.5 Protected Aquatic Resources

<u>Atlantic Sturgeon</u>

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, the males' migration occurs when water temperatures reach 5.6 to 6.1 degrees C (42 to 43 degrees F); the females appear when water temperatures warm to 12.2 to 12.8 degrees C (54 to 55 degrees 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 Status 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.

<u>Shortnose Sturgeon</u>

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) not in list. 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, which 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.

2.2.5.6 Other Potentially Affected Aquatic Resources

<u>Phytoplankton and Zooplankton</u>

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 2-6). 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 is 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 (*T. natans*) beds from 1995 to 1997 and in 2002. They determined that vegetated area constitutes roughly 8 percent of total river surface area with *V. americana* three times as abundant as *T. natans.* Plant coverage over the entire study area from the Troy Dam to Yonkers was about 6 percent of the river bottom area for *V. americana* and 2 percent for *T. natans,* 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.

<u>Coastal Marshes, Wetlands, and Riparian Zones</u>

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

Zebra Mussel

In the early 1990s, the nonnative zebra mussel, *Dieissena 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 filtration activity of the mussels.

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.

Water Chestnut

The water chestnut, *Trapa natans*, 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 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 2007). 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 draft 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.

<u>Federally Listed Species</u>

The three federally listed 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 above, 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).

<u>Indiana Bat</u>

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 occurs 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.

<u>Bog Turtle</u>

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 ground water 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.

<u>New England Cottontail</u>

The New England cottontail (*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 known to occur on the site currently or to have occurred there historically.

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)]

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]

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)]

1 **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]

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]

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	spreading 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]

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)]

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]

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]

1 **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 also 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 soil. Measurements of the media constituting 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 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)

New York State Department of Health Monitoring

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.
- 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.

Ground Water Contamination and Monitoring

In August of 2005, Entergy discovered tritium contamination in ground water outside the IP2 spent fuel pool (SFP). As a result, Entergy began an on-site and off-site ground water 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 release of radionuclides to ground water 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 ground water 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 ground water that it had initiated following the 2005 discovery of SFP leakage. Entergy stated that it had characterized and modeled the affected ground water 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 ground water monitoring program and initiated a remediation program to address the site ground water 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 ground water migration to the river is through the consumption of fish and invertebrates from the Hudson 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 leak as well Entergy's ground water monitoring program. This inspection focused on assessing Entergy's ground water 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):

(1) Currently, there is no drinking water exposure pathway to humans that is affected by the contaminated ground water conditions at the IP2 and IP3 site. Potable water sources in the area of concern are not presently derived from ground water 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.

(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 (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 ground water contamination (Entergy 2008d). Entergy indicated they would remove spent fuel from the IP1 SFP, process remaining water and "bottoms" from the IP1 SFP, and incorporate aspects of the long-term ground water 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. Entergy has indicated that it would process remaining water and bottoms from the IP1 SFP by April 30, 2009, and inform the NRC if they deviate from the commitment timeline.

New York State Ground Water Investigations

New York State performed its own ground water investigation of the tritium leakage from IP2 and IP3 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 ground water is moving toward surrounding properties.
- Contaminated ground water is moving into the Hudson River.
- Public exposure can occur from the ground water 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. 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 current results are described in "Indian Point Units 1, 2, and 3—2006 Annual Radioactive Effluent Release Report" (Entergy 2007c). 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 2006 is summarized below:

- The calculated maximum whole-body dose to an offsite member of the general public from liquid effluents was 8.80×10^{-4} mrem (8.80×10^{-6} mSv) for IP1 and IP2 and 1.27×10^{-4} mrem (1.27×10^{-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 (adult bone) dose to an off-site member of the general public from liquid effluents was 1.26×10^{-3} mrem (1.26×10^{-5} mSv) for IP1 and IP2 and 1.60×10^{-4} mrem (1.60×10^{-6} mSv) for IP3, 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 5.01×10^{-3} millirad (mrad) (5.01×10^{-5} milligray (mGy)) for IP1 and IP2 and 5.36×10^{-5} mrad (5.36×10^{-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 1.78×10^{-2} mrad (1.78×10^{-4} mGy) for IP1 and IP2 and 1.57×10^{-4} mrad

(1.57x10^{-6}mGy), 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 1.19x10^{-2} mrem (1.19x10^{-4} mSv) to the child thyroid for IP1 and IP2 and 1.07x10^{-3} mrem (1.07x10^{-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 ground water and storm drain pathways is 1.78x10^{-3} mrem (1.78x10^{-5} mSv).
- The calculated maximum organ (adult bone) dose to an offsite member of the general public from the site's combined ground water and storm drain pathways is 7.21x10^{-3} mrem (7.21x10^{-5} mSv).
- The calculated maximum total body dose to an off-site 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 7.07 mrem (7.07 x10^{-2} mSv), well below the 25 mrem (0.25 mSv) limit in EPA's 40 CFR Part 190.

The NRC staff reviewed the 2006 Radioactive Effluent Release Report and found that the 2006 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 draft 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

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. 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 6000 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 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 ground water 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 ground water 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 ground water 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. Ground water is the primary source of both community and noncommunity water supply systems and serves 60 to 85 percent of the population in the area (Entergy 2007a; 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 ground water sources. The ground water 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 ground water well system located downstream from the New Croton Dam and spillway. Ground water 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 = Ground water; 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 ground water 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 ground water 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 current 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 2002d). 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 (Entergy 2007a).

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 off site, 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, 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

<u>Transient Population</u>

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.

<u>Employment and Income</u>

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).

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

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 40 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 43 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	43
	2005	5.1	2.0	39
	2006	5.1	2.0	40

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	9000–7000 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.

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. The modern Stony Point Battlefield in Rockland County is across the Hudson River from 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. No systematic pedestrian or subsurface cultural resources surveys have been conducted at the IP2 and IP3 site.

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 & 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). 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.

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).

<u>Potential Archeological Resources</u>

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. Additionally, 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 further 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 draft SEIS.

The NRC staff identified several current Federal projects occurring near IP2 and IP3, which the staff will discuss in the following paragraphs. 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 draft 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 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).

<u>U.S. Army Corps of Engineers Hudson River Federal Navigation Project</u>

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).

<u>Coastal Zone Management Act</u>

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 2007b). 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.

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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 draft supplemental environmental impact statement (draft 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.

(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.

3.1 Potential Refurbishment Activities

Entergy, in its environmental report, 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 that they were not refurbishment activities as described in the GEIS.

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 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 IP 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 by 7.9 meters (26 feet by 25 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.

3.1 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.

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Surface Water Quality, Hydrology, and Use (for all plants)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
Aquatic Ecology (for all plants)	
Refurbishment	3.5
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 environmental report (Entergy 2007), its site audit, the SEIS scoping process, 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 biota. 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 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, or in Entergy's May 14, 2008, RAI response (Entergy 2008b). Therefore, the NRC staff expects that there would be no impacts 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.

3.1.1 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.

3.1.2 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*—potentially affected by the relicensing of Indian Point. As explained above under Section 3.1.1, 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.

3.1.3 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 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 (VOC), 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 $PM_{2.5}$ 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 (0.925 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 Part 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.

3.1.4 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.

3.1.5 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 3.1.4, 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.

3.1.6 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 3.1.4, 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.

3.1.7 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.

3.1.8 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.

3.1.9 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 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.

3.1.10 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 3.1, there would be no disproportionately high and adverse impacts to minority and low-income populations in the immediate vicinity of IP2 and IP3.

3.2 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.

3.3 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 replacement 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 replacement activities at IP2 and IP3, the NRC staff concluded—after reviewing guidance in the GEIS and Entergy's description of potential activities—that replacement 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.

3.4 References

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

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

Entergy Nuclear Operations, Inc. (Entergy). 2007. "Applicant's Environment Report, Operating 21 License Renewal Stage." (Appendix E of "IP2 and IP3, Units 2 and 3, License Renewal 22 Application"). April 23, 2007. Agencywide 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. 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. 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. 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. 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. April 9, 2008. ADAMS Accession No. ML080920983.

U.S. Nuclear Regulatory Commission. 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 draft 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

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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.

listed in Appendix F to this draft SEIS.

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 operation 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, 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
Eutrophication	4.2.1.2.3
Discharge of chlorine or other biocides	4.2.1.2.4
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4
Discharge of other metals in wastewater	4.2.1.2.4
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	4.2.2.1.11
HUMAN HEALTH	
Noise	4.3.7

The NRC staff reviewed information provided from the Entergy 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 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:

- <u>Altered current patterns at intake and discharge structures</u>. 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.

- <u>Temperature effects on sediment transport capacity</u>. 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.

- <u>Scouring caused by discharged cooling water</u>. 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.

- <u>Eutrophication</u>. 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.

- <u>Discharge of chlorine or other biocides</u>. 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 term.

[2] NPDES stands for National Pollutant Discharge Elimination System; in the case of IP2 and IP3, it is issued by the New York State Department of Environmental Conservation (NYSDEC) and the NRC staff refers to it as an SPDES throughout this draft SEIS.

- 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. 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 the Entergy ER, the NRC staff's site audit, the scoping process, the SPDES permits for IP2 and IP3 that expired in 1992 and the subsequent draft permit, ongoing Hudson River monitoring programs and their results, 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 draft SPDES permit, 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 addressed discharge from the currently operating IP2 and IP3, as well as the shutdown IP1 unit, expired in 1992 but has been administratively extended by NYSDEC. The NYSDEC proposed new SPDES permit for the site, currently in draft form, is in adjudication.

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 proposed 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.

Applicant Assessment

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 though 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. The last SPDES permit for IP2 and IP3 expired in 1992, but its terms have been 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 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.

NRC Assessment

Because the proposed SPDES permit (which includes NYSDEC’s 316(b) determination regarding the cooling water intake structure) is still in draft stage and 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 draft 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 draft 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 draft 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. Impingement 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 NRC staff analyses of available data. More detail appears in Appendix H.

Impingement monitoring at IP2 and IP3 was conducted by former plant owners and their contractors between 1975 and 1990 using a variety of techniques. (A complete description of the impingement monitoring studies conducted at IP2 and IP3 appears in Appendix H to this draft 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 1 year at IP2 (Figure 4-1); at IP3, the estimated number of RIS impinged was greater than 85 percent for all but 1 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.

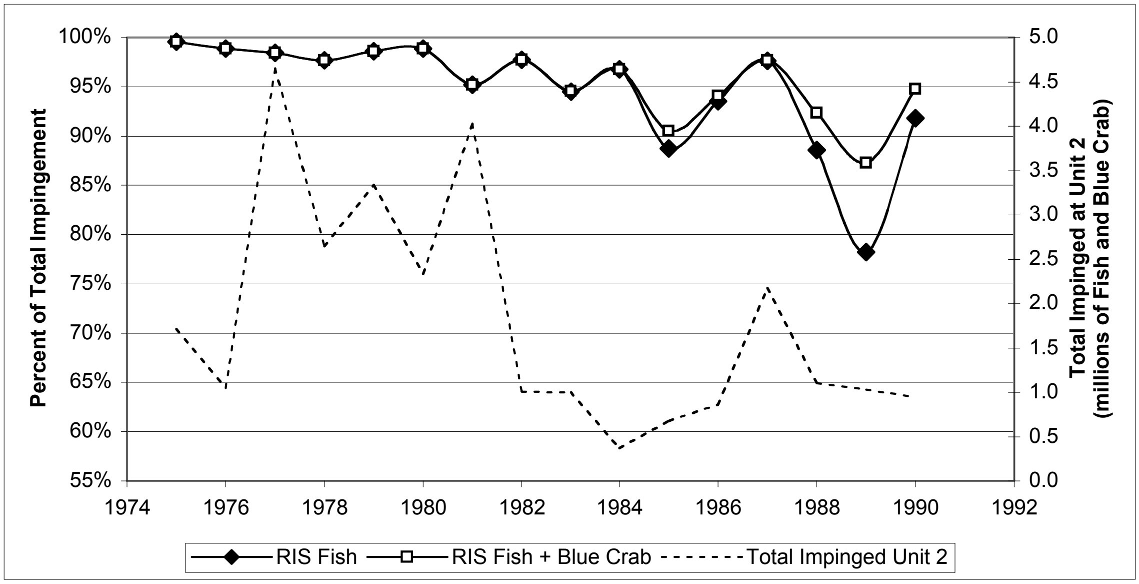


Figure 4-1. Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP2 (data from Entergy 2007b)

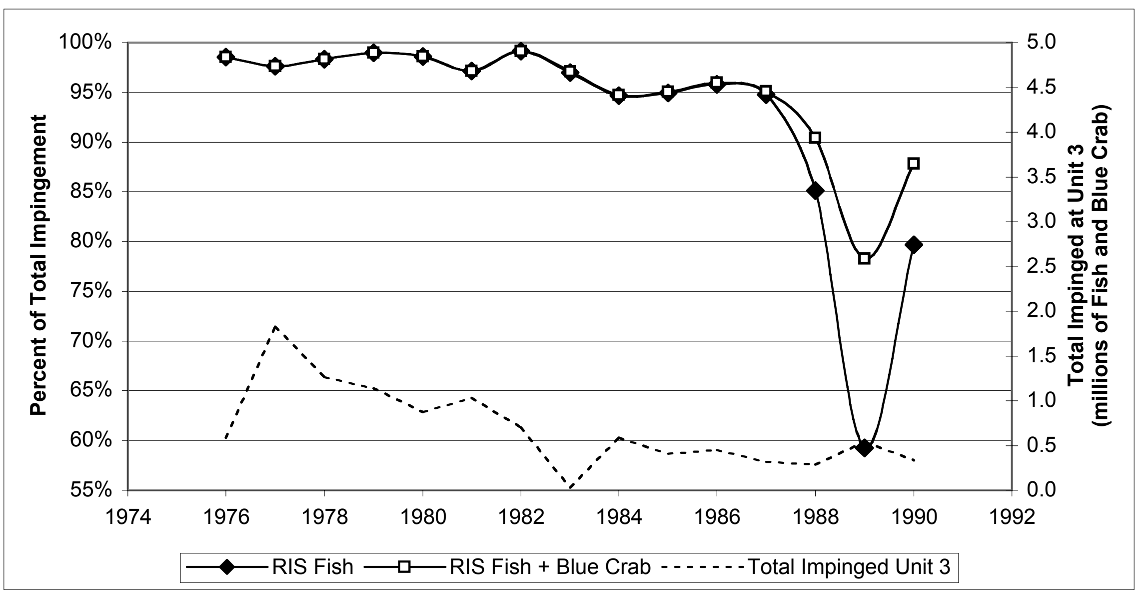


Figure 4-2. Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP3 (data from Entergy 2007b)

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 show 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 draft 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). The plant owners did not monitor impingement rates or validate impingement mortality estimates after the new Ristroph screens were installed at IP2 and IP3 in 1991.

Table 4-3. Assumed 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 several species exceeds 25 percent. Monitoring data (Entergy 2007b, reviewed by NRC staff) also suggest that impingement is 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, 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 draft 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 and 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 lifestage for IP2 and IP3 that were provided by the applicant. The NRC staff then multiplied the sum of the mean densities of all lifestages by the volume of circulated water to estimate the mean number entrained per taxa and season.

The NRC staff found that a total of 66 taxa were identified during entrainment monitoring in data supplied by Entergy (2007b). There were no blue crabs, shortnose or Atlantic sturgeon, or gizzard shad identified in the 1981–1987 entrainment data. Because of the difficulty in identification of early lifestages, RIS included those taxa that were identified only to family or genus (e.g., herring family, anchovy family, *Alosa* spp., and *Morone* spp.). The percent RIS fish entrained and the total entrainment are presented in Figure 4-3. Except for 2 weeks in 1984 and 1985 (1 week in May and 1 in June) for which amphipods (*Gammarus* spp.) were recorded, RIS represented at least 90 percent of all entrainment. The total number of identified fish entrained has decreased at a rate of 1.6 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).

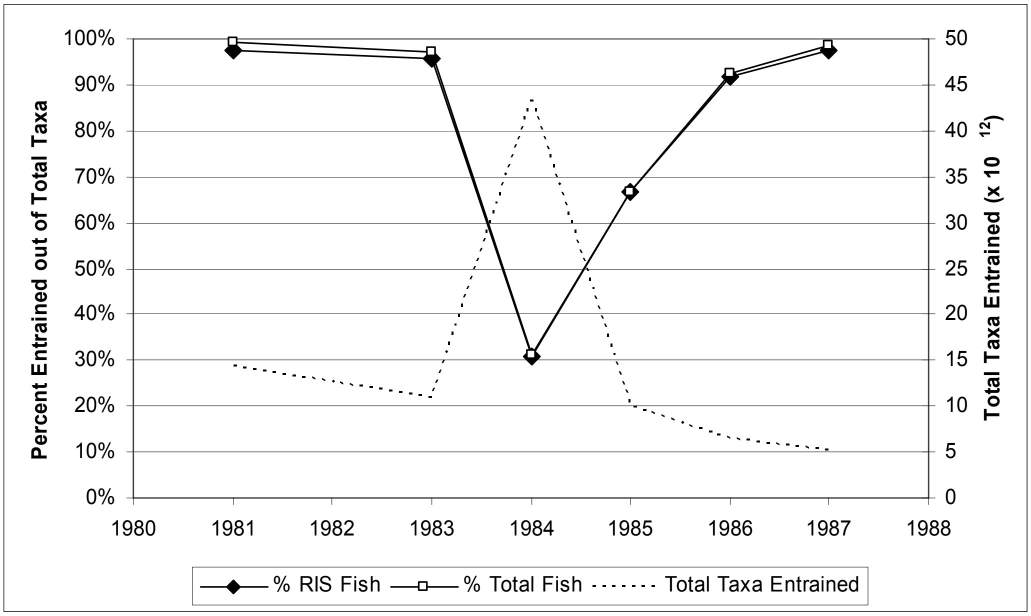


Figure 4-3. Percentage of entrainment comprised of RIS fish and total fish in relation to the total estimated entrainment at IP2 and IP3 combined (data from Entergy 2007b)

4.1.3 Combined Effects of Impingement and Entrainment

The NRC staff employed a modified WOE approach to evaluate whether the impingement and entrainment that occurs during the operation of the IP2 and IP3 cooling system has the potential to adversely affect RIS in the lower Hudson River. The term "weight of evidence" has many meanings, but it is defined by the NRC staff in this draft SEIS as an organized process for evaluating information or data from multiple sources to determine whether there is evidence to suggest that an existing or future environmental action has the potential to result in an adverse impact. The NRC staff employs a WOE approach adapted from the process described in Menzie et al. (1996). The overall approach is represented in Figure 4-4 and presented in detail in Appendix H to this draft SEIS; specific steps in the process are defined below.

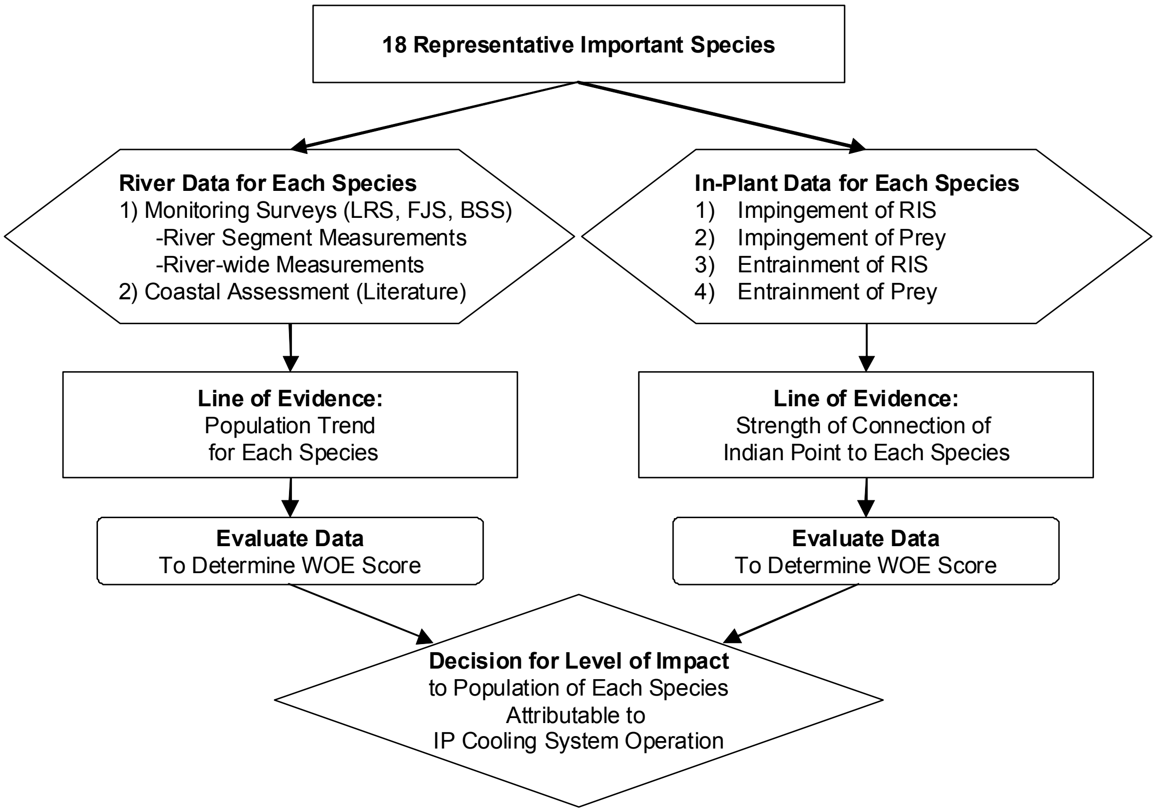


Figure 4-4. General weight-of-evidence approach employed to assess the level of impact to population trends attributable to IP cooling system operation

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 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 evaluate whether the IP2 and IP3 cooling system is contributing to the effect. The NRC staff developed two primary lines of evidence (LOE) to evaluate impacts. The first LOE included measurements of RIS population trends in the lower Hudson River and coastal areas to assess whether populations were increasing, decreasing, or stable; the second LOE addressed how much influence the operation of the IP2 and IP3 cooling systems had on the RIS populations in the lower Hudson River (i.e., the strength of connection between IP2 and IP3 and the aquatic environment). The NRC staff used impingement and entrainment monitoring data obtained from the IP2 and IP3 facility; 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), as described in Table 2-3 in the main text; and coastal fishery trend data, when available. A summary of measurements associated with each LOE is presented in Appendix H to this draft SEIS.

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 within each LOE as the average of the individual attribute numbers. Scores for each LOE are available in Appendix H, Section H.3.

Step 4: Develop Quantifiable Decision Rules for Interpreting the Results of Each Measurement

Decision rules are used to assign a level of potential impact based on an analysis of the data. In support of the first LOE, the NRC staff developed decision rules that described a small, moderate, and large potential for adverse impact. Because the development and use of these rules is complex, a general definition of a small, moderate, and large potential for adverse impact is presented below. A detailed discussion of how the decision rules were developed and used in the environmental assessment is presented in Appendices H and I to this draft SEIS.

- A small potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that a RIS population had remained stable over time and that the observed population levels were generally within the range of expected natural variability.

- A moderate potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that a RIS population was declining over time, OR that many of the observed population levels were outside the range of expected natural variability.

- A large potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that the population was declining over time, AND that many of the observed population levels were outside the range of expected natural variability.

These decision rules were applied to each RIS species if sufficient data were available to support a determination. If sufficient data were not available, the NRC staff called the level of impact "unknown."

In support of the second LOE, which evaluated 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 developed decision rules to assess whether the proportion of RIS present in impingement and entrainment samples obtained from IP2 and IP3 were similar to the proportions observed from the environmental sampling conducted in the lower Hudson River (e.g., the LRS, FJS/FSS, and BSS studies). The general definitions for each rule are presented below; a detailed discussion of decision rule development and use to assess strength of connection is presented in Appendices H and I to this draft SEIS.

- A low strength of connection was present if the proportional representation of a given RIS in the cooling system (entrainment and impingement samples) was less than the proportional representation obtained from the fishery studies, suggesting the RIS is underrepresented in the cooling system samples compared to the fishery studies.

- A medium strength of connection was present if the proportional representation of a given RIS in the cooling system samples was equal to the proportional representation observed in the fishery studies, suggesting the cooling system sample is equally representing the Hudson River population near IP2 and IP3.

- A high strength of connection was present if the proportional representation of a given RIS in the cooling system entrainment samples was greater than the proportional representation observed in the fishery studies, suggesting the cooling system sample is overrepresenting the Hudson River population near IP2 and IP3.

These decision rules were applied to each RIS species if sufficient data were available to support the determination. As described above, numerical scores were assigned to each impact level to facilitate integration.

Step 5: Integrate the Results and Assess Impact

The process used to integrate the two LOE and associated measurements brought together the assessment of population impacts and strength of connection derived from the use of the decision rules and the overall use and utility of each measurement with regards to decisionmaking. A detailed description of the process and statistical analysis employed is presented in Appendices H and I to this draft SEIS. The final determination of impact is 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

As described above, data from the LRS, FSS, and BSS studies of the lower Hudson River were used to assess population trends. Data from 1974 to 2005 were obtained from the applicant in electronic format. The NRC staff used an abundance index calculated by the applicant and calculated catch-per-unit-effort values where available. The NRC staff also evaluated coastal population trends for striped bass, American shad, Atlantic sturgeon, river herring, bluefish, Atlantic menhaden, and weakfish using commercial and recreational harvest statistics provided by the Atlantic States Marine Fisheries Commission (ASMFC).

To evaluate the population trend LOE, the NRC staff assessed population trends in river segment 4 (the region of the lower Hudson River encompassing IP2 and IP3), population trends in the lower Hudson River from the Troy Dam to the Battery, and the coastal trends reported by ASMFC. For each measurement, a WOE score was calculated, and a final WOE score was obtained. The results from this analysis appear in Appendix H to this draft SEIS and predict a moderate to large potential for adverse impacts for 13 of the 18 RIS. For two of these (Atlantic menhaden and Atlantic sturgeon) the moderate to large potential impact determination was based on only one LOE (coastal trends). The NRC staff predicts a small potential for adverse population-level impacts for blue crab based on only one LOE (coastal trends). The NRC staff could not reach an impact conclusion for gizzard shad because it was not a target species for the LRS, FSS, or BSS surveys. Likewise, NRC staff was unable to reach a determination of impact for the shortnose sturgeon because of a lack of available data for the YOY lifestage, the primary focus of the WOE assessment. Based on a lack of information for these species, the population trend LOE impact level could range from small to large. Population trends for year 1 and older Atlantic and shortnose sturgeon are presented in Section 4.6.1 of this draft SEIS based on electronic data provided by the applicant.

4.1.3.2 Assessment of Strength of Connection—The Second Line of Evidence

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, the NRC staff conducted strength of connection analyses. A summary of this analysis can be found in Appendix H, and detailed information on the analysis is presented in Appendix I to this draft SEIS.

The strength of connection analysis assumes the IP2 and IP3 cooling system can affect aquatic resources directly through impingement or entrainment, or indirectly by impinging and entraining potential food (prey). By comparing the rank order of RIS caught in the river to the order observed in impingement and entrainment samples, it is possible to evaluate how efficient the IP2 and IP3 cooling system is at removing RIS from the river (e.g., how strongly it is connected to the RIS of interest). The results of this analysis are presented in Table 4-4 and show that a HIGH strength of connection was observed for only two species (bluefish and striped bass). For those species, the IP2 and IP3 cooling system was removing either the species or its prey at levels that were proportionally higher than what was observed in the river studies. This suggests that there is strong evidence that the operation of the cooling system is affecting these species. For the remaining RIS, the strength of connection ranged from low (minimal evidence of connection) to medium (some evidence of connection). The strength of connection was unknown for five species (Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab) because of a lack of available data. For these species, actual strength of connection could be low, medium, or high, but the lack of data makes a specific determination impossible.

4.1.3.3 Impingement and Entrainment Impact Summary

The NRC staff presents the final integration of population-level and strength-of-connection LOE in Table 4-4. This table shows the final conclusions for both LOE (i.e., population trends and strength of connection). An adverse impact from IP2 and IP3 means that the data show both a measurable response in the RIS population and clear evidence that the RIS is influenced by the operation of the IP2 and IP3 cooling system. Thus, when the strength of connection is low, it is not possible to arrive at an impact level greater than SMALL because there is little evidence that a relationship between the cooling system and RIS exists. This logic also requires that for an RIS with a HIGH strength of connection to the IP2 and IP3 cooling system operation but little evidence of population decline, the final determination must also be SMALL.

Based on the final WOE assessment (available in Appendix H, Section H.3.3), a SMALL potential for adverse impact was predicted for two species (striped bass and weakfish) because there was no evidence of a population decline even though the strength of connection was MEDIUM or HIGH. A SMALL to MODERATE impact was predicted for seven species (alewife, bay anchovy, American shad, blueback herring, spottail shiner, Atlantic tomcod, and white catfish). A MODERATE impact was predicted for rainbow smelt, and a MODERATE to LARGE impact level was predicted for the hogchoker and white perch. A LARGE potential for adverse impact was predicted for only one species, the bluefish, based on observed population declines and an apparent HIGH strength of connection to the IP2 and IP3 cooling system. An impact determination could not be made for Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab because of a lack of data for YOY lifestages, and therefore specific impacts are unknown and could range from SMALL to LARGE. The NRC staff addresses mitigation measures for these impacts in Section 4.1.5 of this draft SEIS.

The NRC staff assigns an overall impact level of SMALL to LARGE for impingement and entrainment to encompass the range of impacts for individual species. The RIS identified in this section are meant to represent the overall aquatic resource, express uncertainty from unquantifiable impact levels for some individual RIS, and reflect the complexity of the Hudson River ecosystem by encompassing a broad range of attributes, such as biological importance, commercial or recreation value, trophic position, commonness or rarity, interaction with other species, vulnerability to cooling system operation, and fidelity or transience in the local community. This range of impacts, then, expresses the impact to the overall aquatic community.

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

Species	Population Line of Evidence	Strength of Connection Line of Evidence	Impacts of IP2 and IP3 Cooling System on Aquatic Resources
Alewife	Large	Low to Medium	Small to Moderate
Bay Anchovy	Moderate	Low to Medium	Small to Moderate
American Shad	Large	Low to Medium	Small to Moderate
Bluefish	Large	High	Large
Hogchoker	Large	Medium to High	Moderate to Large
Atlantic Menhaden	Moderate to Large	Unknown[a]	Unknown[b]
Blueback Herring	Large	Low to Medium	Small to Moderate
Rainbow Smelt	Large	Medium	Moderate
Shortnose Sturgeon	Unknown	Unknown[a]	Unknown[b]
Spottail Shiner	Large	Low to Medium	Small to Moderate
Atlantic Sturgeon	Large	Unknown[a]	Unknown[b]
Striped Bass	Small	High	Small
Atlantic Tomcod	Large	Low to Medium	Small to Moderate
White Catfish	Large	Low to Medium	Small to Moderate
White Perch	Large	Medium to High	Moderate to Large
Weakfish	Small	Medium to High	Small
Gizzard Shad	Unknown	Unknown[a]	Unknown[b]
Blue Crab	Small	Unknown[a]	Unknown[b]

[a] Strength of connection could not be established using WOE, therefore strength of connection could range from LOW to HIGH.
[b] Conclusion of impact could not be established using WOE, therefore impacts could range from SMALL to LARGE.

4.1.3.4 Discussion of Uncertainty

As part of reporting ecological risks, the EPA (1998) has recommended that practitioners review and summarize the major areas of uncertainty in their analyses. In this section, the NRC staff discusses the known uncertainties inherent with using the WOE approach.

As with any quantitative evaluation, the rigor of the analysis is dependent on the quality and source of data. The NRC staff acknowledges that the lack of studies and data on impingement and entrainment at IP2 and IP3 since 1990 and 1987, respectively, yields potential uncertainties for the staff's disposition of impingement and entrainment impacts using the WOE approach. The range and age of the data used is expected to introduce some inherent uncertainties (i.e., the current impacts, as described in Table 4-4, are inferred from impingement and entrainment data collected between 1975 and 1990). The NRC staff also notes that data collection for impingement and entrainment at Indian Point ended around the same time that the plant installed the modified Ristroph screens and fish return systems. Although it is expected that this system would likely have a positive effect on impingement mortality, there have been no additional data since 1990 to validate any impingement mortality estimates. More recent impingement and entrainment data, that reflect the effects of these plant modifications, could potentially affect the results of the Staff's WOE analysis; without such data, however, the NRC staff did not quantitatively incorporate this effect into the WOE approach. Nevertheless, as previously noted, the final design of the screens appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at Indian Point (Fletcher 1990). The NRC staff did not include the results of this pilot study during or following the application of the WOE approach. As such, the NRC staff recognizes, in Appendix H, that the WOE results may potentially yield overestimates.

As previously noted, using the same data available to the staff with a different analytical approach, and affording consideration to the plant modifications which have been made, the applicant assessed impacts from impingement and entrainment as SMALL in its ER. The NYSDEC, however, while acknowledging that the Ristroph screens provide some improvements, expressed a continuing concern with respect to mortalities from impingement and entrainment. For these impacts, the NRC staff has independently chosen the use of the WOE approach to make its determination as quantitatively as possible, using available data.

The Massachusetts Weight-of-Evidence Workgroup (Menzie et al. 1996) discussed the value and use of both quantitative and qualitative approaches in development of the weight-of-evidence methodology. As recommended by the Workgroup (Menzie et al. 1996), NRC staff has used professional judgment to select and refine methods before analyzing data and documented all steps (see Appendices H and I) to allow interested readers to gain an understanding of the assumptions and limitations associated with this assessment. The NRC staff has also employed a similar methodology (Menzie et al. 1996), using other data, for assessing the effects of power plant operation on fish populations in its GEIS Supplement 22, regarding Millstone Power Station, Units 2 and 3 (NRC 2005).

In summary, the NRC staff's findings for impact from impingement and entrainment, as described in Table 4-4, are subject to the potential uncertainties described above to varying degrees. They also represent the NRC staff's best estimates based on the WOE derived from the available data.

4.1.3.5 Overall Impingement and Entrainment Impact

Based on the results of the NRC staff WOE analysis for RIS and the uncertainties discussed in the previous section, the NRC staff concludes that the overall impact to aquatic resources from impingement and entrainment ranges from SMALL to LARGE, depending on species affected.

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 704.

Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR 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 degrees Fahrenheit 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 four Fahrenheit degrees over the temperature that existed before the addition of heat of artificial origin or a maximum of 83 degrees Fahrenheit, 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 83 degrees Fahrenheit an increase in temperature not to exceed 1.5 Fahrenheit degrees 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 four Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

Thermal discharges associated with the operation of IP2 and IP3 are regulated under 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 704, and the CWA. Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified in NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110 degrees F (43 degrees C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2 degrees F (34 degrees 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 degrees F (34 degrees 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 degrees Fahrenheit (F) isotherm. USAEC, in response, 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 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 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 degrees F (10 degrees Celsius (C)), with flow rates of 700,000 gpm (2650 m^3/min) required during the summer months when inlet temperatures exceeded 70 degrees F (21 degrees 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).

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 10^{th}-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 degrees F (2 degrees 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 degrees F (1.18 to 1.59 degrees C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4 degrees F (2 degrees 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 degrees F (1.80 degrees C) during June ebb tides to 4.63 degrees F (2.57 degrees C) during flood tides in August. Temperature increases exceeded 4 degrees F (2 degrees 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 degrees F (2 degrees 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 degrees F (2 degrees 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.

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).

Applicant's Assessment

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 acknowledge 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).

NYSDEC Assessment

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 four degrees (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 expired in 1992, but its terms have been continued under provisions of the NY State Administrative Procedure Act. 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 2006).

4.1.4.5 NRC Staff Assessment of Thermal Impacts

In the absence of the 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 lifestages 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. The NRC staff, after a review of available information on aquatic life in the Hudson River Estuary, did not find evidence of adverse effects on aquatic life that are clearly noticeable and sufficient to destabilize important attributes of an aquatic resource (the criteria for a LARGE finding). In the absence of specific studies, and in the absence of effects sufficient to make a determination of a LARGE impacts, the NRC staff concludes that thermal impacts from IP2 and IP# could thus range from SMALL to MODERATE depending on the extent and magnitude of the thermal plume, the sensitivity of various aquatic species and lifestages likely to encounter the thermal plume, and the probability of an encounter occurring that could result in lethal or sublethal effects. Additional thermal studies—as proposed by NYSDEC and Entergy—will generate data that could further refine or modify this impact level. For the purposes of this draft SEIS, the NRC staff concludes that impacts could range from SMALL to MODERATE.

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). 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 mitigation 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 draft 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.

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)
- restoration

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, as well as an alternative that includes restoration with other mitigation measures intended to offset the effects of the existing once-through cooling system. Because the NRC staff will address them in greater depth in Chapter 8, closed-cycle cooling and restoration 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 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 draft 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 degrees 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 2008). 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.

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 still 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.

<u>Behavioral Deterrent Systems</u>

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 draft 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 draft 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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections

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 draft 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 draft 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 draft 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 2008).

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 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 draft 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 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 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 exposures to public (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. 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 draft 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.

- <u>Aesthetic impacts of transmission lines (license renewal term)</u>. 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 draft 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, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms (CRDMs) at some time in the future before or during the license renewal term, and the decision to proceed with this replacement activity would be made based on future inspection results (Entergy 2008b). 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. Even though it is not certain whether Entergy will replace the reactor vessel heads and CRDMs, the NRC staff has reviewed the potential environmental impacts of this replacement activity. These impacts are discussed in Chapter 3 of this draft 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 draft 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 (NRC 2007a) does not project an increase in plant demand.

Because Entergy staff 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 draft SEIS, Entergy might 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 draft 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."

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 might 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 draft SEIS.

4.4.3.2 Tax-Revenue-Related Impacts

As discussed in Chapter 2 of this draft 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 43 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 draft SEIS, Entergy might 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 draft 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 nonoutage 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 draft SEIS, Entergy might 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 draft 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 draft 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. 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; however, none are located within the boundaries of the property.

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 draft 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. 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 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. However, Entergy indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal period. This activity would 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).

Therefore, 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 draft SEIS, there is the potential for prehistoric and historic archeological resources to be present on the northeastern portion of the site. Even though this area was previously disturbed by surface mining in the 19th century, the potential for intact prehistoric/historic and archeological resources remains. In addition, Section 106 of 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. Entergy 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 Act) 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.

Minority Population in 2000

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 draft 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.

Low-Income Population in 2000

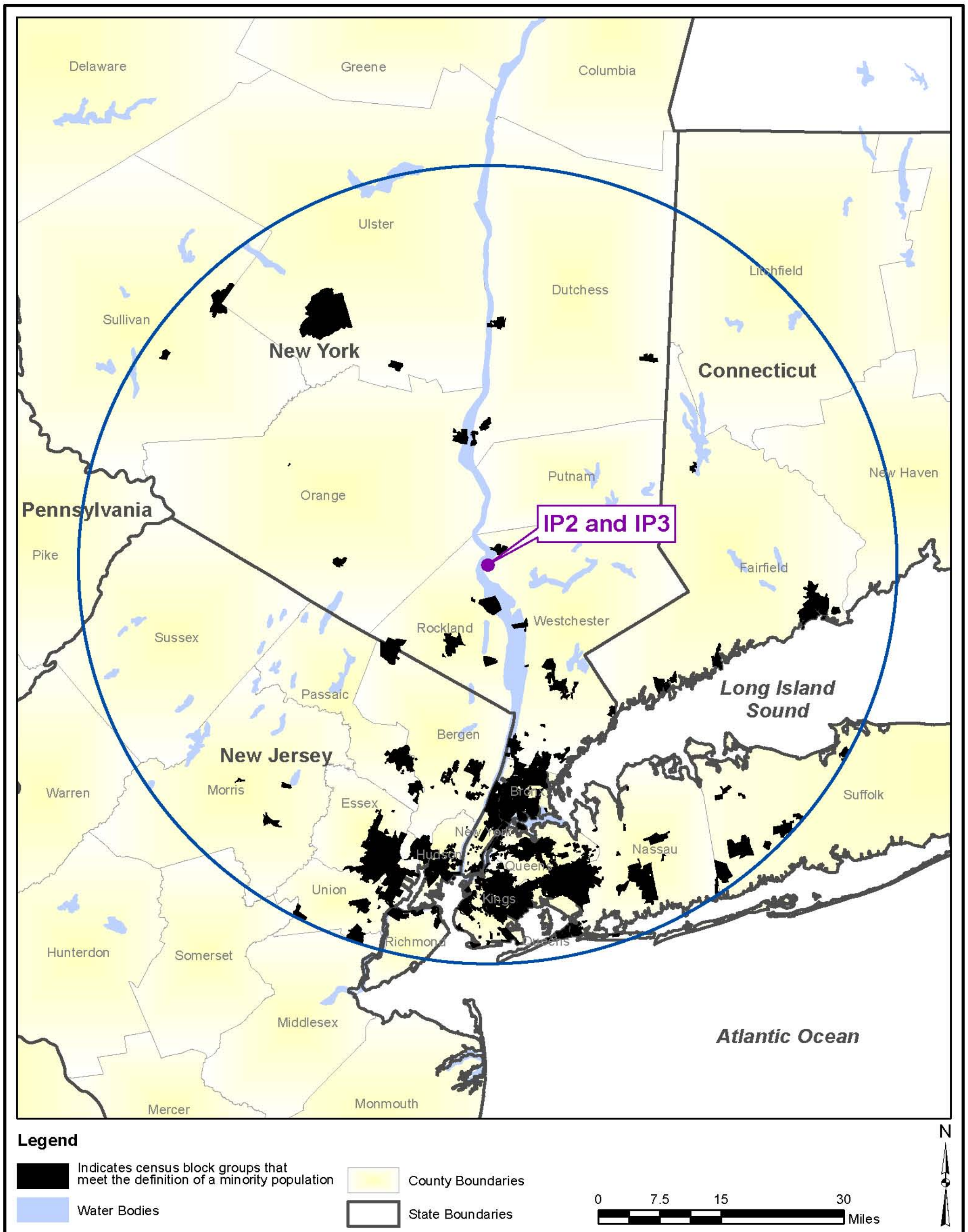
According to 2000 census data, approximately 484,000 families (approximately 11.7 percent) residing within a 50-mi (80-km) radius of the IP2 and IP3 were identified as living below the Federal poverty threshold in 1999 (USCB 2003—LandView 6). The 1999 Federal poverty threshold was $17,029 for a family 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).

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 draft SEIS shows low-income block groups within a 50-mi (80-km) radius of IP2 and IP3.

Analysis of Impacts

Consistent with the impact analysis for the public and occupational health and safety, the affected populations are defined as minority and low-income populations residing within a 50-mi radius of the IP2 and IP3. Based on the analysis of environmental health and safety impacts presented in this draft SEIS for other resource areas (contained in Chapters 2 and 4 of this SEIS), there would be no disproportionately high and adverse impacts to minority and low-income populations from continued operation of IP2 and IP3 during the license renewal period.



Printing Date: May 12, 2008
File: M:\IT\GIS Data\Indian Point\ArcView\Poverty.mxd

Figure 4-5. Minority block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

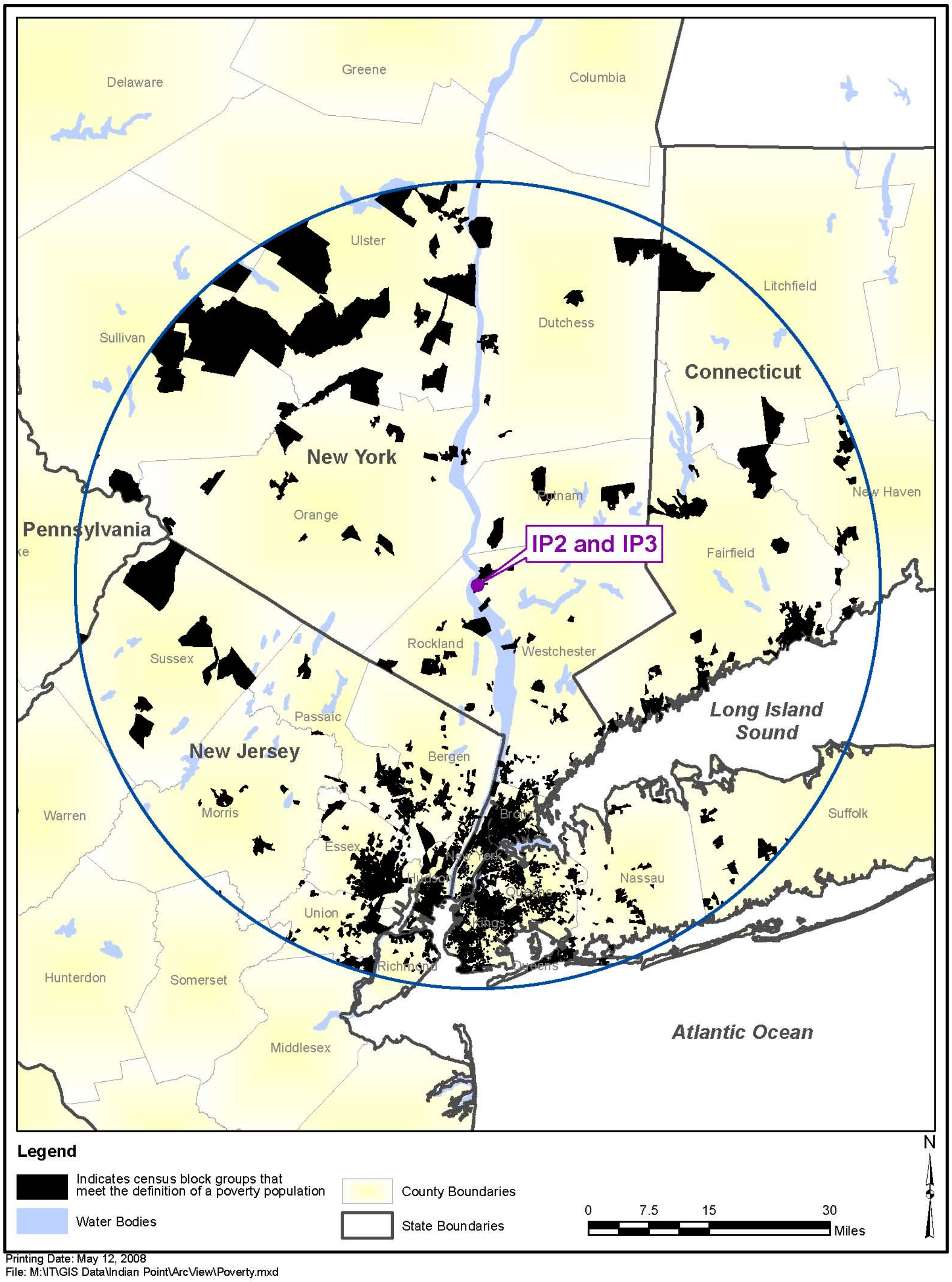


Figure 4-6. Low-income block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

As discussed in Section 4.4.1, Entergy might 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 draft SEIS.

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.

<u>Subsistence Consumption of Fish and Wildlife</u>

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 draft 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).

The NRC staff presents a summary of results from the IP2 and IP3 REMP program in Section 2.2.7 of this draft 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 draft 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	Draft 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 draft 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 draft 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 Threatened or Endangered 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, however, included an assessment of impact for the Atlantic sturgeon in this section, given its current status as a candidate for listing.

As described in Section 2.2.5.5 of this draft 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 draft 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 2007; 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 draft 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 draft SEIS.

Impingement data provided by the applicant (Entergy 2007b) suggest 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). Impingement data for the endangered shortnose sturgeon show that from 1975 to 1990, 317 fish were impinged at IP2 and 407 fish were impinged at IP3. Impingement of this species was greatest in 1984 and 1988, and no impinged fish were observed at either unit in 1981, 1982, 1983, 1985, and 1986 (Table 4-11). Impingement of Atlantic sturgeon was much greater than that observed for shortnose sturgeon, with 2667 fish impinged at IP2 and 1268 fish impinged at IP3 between 1975 and 1988. The only year when impingement of Atlantic sturgeon at both units was not observed (Table 4-11) was 1988. Because recent data are not available, it is not possible to 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 2007b)

Study Year	IP2		IP2 Total	IP3		IP3 Total	Grand Total
	Shortnose Sturgeon	Atlantic Sturgeon		Shortnose Sturgeon	Atlantic Sturgeon		
1975	3	302	305	-[a]	-	-	305
1976	2	17	19	-	14	14	33
1977	11	105	116	2	252	254	370
1978	5	38	43	5	31	36	79
1979	4	75	79	3	61	64	143
1980	-	24	24	2	17	18	42
1981	-	221	221	-	73	73	294
1982	-	217	217	-	127	127	344
1983	-	149	149	-	-	-	149
1984	176	363	539	154	179	333	872
1985	-	460	460	-	300	300	760
1986	-	696	696	-	126	126	822
1987	116	-	116	55	88	143	259
1988	-	-	-	186	-	186	186
1989	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-
Grand Total	317	2667	2984	407	1268	1674	4658

(a) – = not indicated in sample

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from NMFS. Because of the uncertainty of the current impingement losses of both species of sturgeon and because insufficient data exist to use the WOE approach used earlier in Chapter 4 to address impacts to RIS, operation of IP2 and IP3 has the potential to adversely affect the Atlantic and shortnose sturgeons during the license renewal term. Therefore, the NRC staff concludes that the impacts of an additional 20 years (beyond the current term) of operation and maintenance of the site, including associated transmission line ROWs, on aquatic species that are Federally listed as threatened or endangered could be SMALL to LARGE. However, if monitoring were to be reinstated at IP2 and IP3, the range of impact levels from continued operation could possibly be refined.

The NRC staff has included a biological assessment of the impacts of license renewal on the shortnose sturgeon in Appendix E to this draft SEIS for NMFS to review. Should NMFS determine that there is a potential that the continued operation of IP2 and IP3 will 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 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 draft SEIS. 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 draft 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, including associated transmission line ROWs, 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 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 draft SEIS.

As discussed in Section 2.2.7 of this draft 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 draft 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 draft 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 I 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 draft 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 follow list, is 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 draft 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 draft 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. It is also possible that the operation of IP2 and IP3 could be affecting the endangered shortnose 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 draft 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 draft 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 and 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 early lifestages of the estimated riverwide abundance of several species of fish coincided with the zebra mussel invasion, including American shad and white perch. Barnthouse et al. (2008) also concluded that zebra mussels may have contributed to declines in white perch, but rejected the hypothesis that zebra mussels were affecting American shad. Independent analyses by the staff suggested that the presence of zebra mussels resulted in a MODERATE to LARGE potential for adverse impacts to the American shad, blueback herring, spottail shiner, and white perch (see Appendices H and I to this draft SEIS). 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.

Fishing Pressure

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.

Habitat Loss

As described in Section 2.2.5 of this draft 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 draft 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 a 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 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 draft 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 draft 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 draft 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 draft 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 has 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 draft 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 draft 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 nonoutage 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, and the decision to proceed with this replacement activity would be made based on future component inspection results (Entergy 2008b). Nevertheless, 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. Since it is not certain if Entergy will replace the IP2 and IP3 reactor vessel heads and CRDMs, and 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 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 abnormal leaks to the ground water is discussed in Section 2.2.7 of this draft 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 off site in a direction that it might be captured by an offsite ground water user. The results of monitoring programs support this conclusion.

Because the water travels off site 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 limited 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 draft 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 will evaluate severe accident mitigation alternatives 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 MODERATE 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 range from SMALL to LARGE, depending on the species. Finally, the NRC staff found that impacts to threatened and endangered species could range from SMALL to LARGE but that existing data make it difficult for staff to assign a single impact level. Further sampling for threatened and endangered species at IP2 and IP3 could reduce this uncertainty.

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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

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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.

design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, 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	

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
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. The NRC staff's review is available in full in Appendix G to this draft SEIS; the SAMA evaluation is available in full in Entergy's ER.

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 and lower cost alternatives, several additional potentially cost-beneficial SAMAs were identified (Entergy 2008a). 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 need not 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 and G.6.2). The breakdown of CDF by initiating event for IP2 and IP3 is provided in Table 5-3.

Table 5-3. IP2 and IP3 Core Damage Frequency

Initiating Event	IP2 CDF (Per Year)	IP2 % Contribution to CDF	IP3 CDF (Per Year)	IP3 % 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 interfacing systems LOCA	3.0×10^{-7}	2	2.8×10^{-7}	2
Reactor vessel rupture	1.5×10^{-7}	<1	1.5×10^{-7}	1
Loss of 125 volts direct current power	1.0×10^{-7}	<1	1.0×10^{-7}	<1
Total loss of service water system	5.8×10^{-8}	<1	1.0×10^{-6}	9
Loss of essential service water	4.4×10^{-8}	<1	5.4×10^{-7}	5
	1.9×10^{-10}	<1	1.9×10^{-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.

Entergy estimated the dose to the population within 80 kilometers (50 miles) of the IP2 and IP3 site to be approximately 0.22 person-sievert (Sv) (22 person-rem) per year for IP2, and 0.24 Sv (24 person-rem) per year for IP3. 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 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

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	1.1	5	0.6	3
Gradual Overpressure	7.4	34	4.4	18
Late Hydrogen Burns	0.9	4	0.6	2
Early Hydrogen Burns	2.1	10	0.8	3
In-Vessel Steam Explosion	0.1	1	0.1	0
Reactor Vessel Rupture	1.0	5	0.4	2
Interfacing System LOCA	1.6	7	1.1	4
SGTR	7.7	35	16.6	68
Total	**22.0**	**100**	**24.3**	**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. Entergy identified 231 and 237 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training for IP2 and IP3, respectively.

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 concludes that Entergy 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

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 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 concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on 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 concludes 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).

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 (cost beneficial in revised analysis, with uncertainties).
- 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 (cost beneficial with uncertainties).
- 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 (cost beneficial in revised analysis, with uncertainties).
- 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 (cost beneficial with uncertainties).
- 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.
- 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 30—Provide a portable diesel-driven battery charger to improve 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 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 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 (cost beneficial in revised analysis, with uncertainties).
- 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, one additional potentially cost-beneficial SAMA was identified (applicable to SGTR events in both units; unnumbered for each unit because the applicant did not initially identify them), and one SAMA that was previously identified as potentially cost beneficial was found to be no longer cost beneficial based on correction of an error in the ER (IP3 SAMA 30).

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 the associated benefits.

5.2.6 Conclusions

The staff reviewed Entergy's analysis and concluded 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, 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 warranted. 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 the license renewal pursuant to 10 CFR Part 54.

5.3 References

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

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

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

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy,* Part 100, "Reactor Site Criteria."

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.

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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 AND SOLID WASTE MANAGEMENT

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.

(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.

6.1 The Uranium Fuel Cycle

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to 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 potentially new issue. The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this draft 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 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) (1 mSv) per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 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 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. 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, nitrogen oxides, particulates (i.e., PM_{10}), carbon monoxide, 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 draft 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

6.2.5 Qualitative

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; IAEA 2000; NEA 2002; and 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; 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.

6.2.6 Quantitative

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), 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 tonnes (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 occur 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 draft 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 draft 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.

6.2.7 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.

6.2.8 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.

6.2.9 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.
Source	GHG Emission Results

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.

6.2.10 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 55 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 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.”

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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

[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.

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 addressed this issue The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this draft 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 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) the closed-cycle cooling system alternatives 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, (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 discusses other alternatives that were deemed unsuitable for replacement of power generated collectively by IP2 and IP3.

The U.S. Nuclear Regulatory Commission (NRC) staff considered alternatives 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). These alternatives are described in Section 8.1 of this draft supplemental environmental impact statement (SEIS). IP2 and IP3 have been operating under timely renewal provisions of the New York SPDES permit process since 1992. In 2003, NYSDEC issued a draft SPDES permit for public comment, 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 draft SEIS,.

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

(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.

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 draft SEIS. The circulating water systems for IP2 and IP3 include two intake structures, each containing seven pumps. The normal design flow rate of 3,180,000 liters per minute (lpm) (840,000 gallons per minute (gpm)) for each unit is achieved using dual-speed pumps for IP2 and variable-speed pumps for IP3.

Warm discharge water from IP2 and IP3 flows from the condensers through six pipes that are 2.4 meters (m) (96 inches (in.)) in diameter and exits beneath the water surface into a discharge canal 12 m (40 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) (10 feet per second (fps)). The design of the outfall is intended to reduce the thermal impact the warm water has on the river. An assessment of the impacts of the current cooling-water system on the environment is presented in Section 4.1 of this draft 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. A draft SPDES permit identifying closed-cycle cooling as the BTA was issued on November 14, 2003 (NYSDEC 2003a).

The 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 2003a). The short-term steps include mandatory outage periods, reduced intake during certain times, continued operation of fish-impingement mitigation measures, the payment of $25 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 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. Based on NYSDEC's fact sheet addressing the draft SPDES permit, NYSDEC will not require closed cycle cooling if IP2 and IP3 do not receive renewed licenses from the NRC (NYSDEC 2003c).

Specifically, the 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 (2003a) has also indicated that an 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 2003b).

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 draft 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 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 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. In the Hudson River Utilities FEIS, NYSDEC indicated that the previous owners' closed-cycle cooling cost estimates were likely generally reasonable (NYSDEC 2003d), while EPA indicated that costs may have been somewhat inflated (EPA 2004). EPA also indicated some uncertainty with regard to outage duration for the plant retrofit.

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 26 MW(e), per unit) because of power demands of the closed-cycle system (Entergy 2007).

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 , 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. The NRC staff, however, notes that both NYSDEC (2003b) and EPA (2004) indicated that estimates for cooling conversion by the previous owners of IP2 and IP3 overestimated a variety of costs and selected a more-expensive technology than was necessary. Further, EPA (2004) indicated that Entergy's outage duration was likely exaggerated.

In 2004, EPA issued regulations for reducing impingement and entrainment losses at existing electricity-generating facilities (EPA 2004). These regulations, know as the Phase II rule, established standards for compliance with the requirements of Section 316(b) of the Clean Water Act (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. That decision is currently on appeal before the U.S. Supreme Court. Specifically, the EPA suspended 40 CFR Part 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). However, the issued SPDES permit remains in effect, pending the conclusion of related administrative and legal proceedings.

8.1.1 Closed-Cycle Cooling Alternative

As indicated in Section 8.1, NYSDEC identified closed-cycle cooling as a BTA in its 2003 draft SPDES permit (NYSDEC 2003a, 2003c). Entergy's preferred close-cycle alternative consists of two hybrid mechanical-draft cooling towers (Enercon 2003, Entergy 2007). IP2 and IP3 would each utilize one cooling tower. 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 (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). Hybrid towers are also appreciably more expensive, both in initial costs and in ongoing operating and maintenance costs (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.

Should hybrid towers prove prohibitively expensive (as determined by other, non-NRC authorities), the NRC staff notes that single-stage mechanical draft towers will produce similar decreases in impacts to aquatic life and may result in less land-clearing or blasting debris than the hybrid cooling tower option. Additionally, single-stage towers will be shorter, though plumes in cool or highly-saturated atmospheric conditions will impose slightly greater aesthetic impacts as well as creating greater deposition of ice or dissolved solids near the towers than the circular, hybrid towers proposed by Entergy would cause.

8.1.1.1 Description of the Closed-Cycle Cooling Alternative

As described in the ER (Entergy 2007), new hybrid cooling towers would be large, approximately 170 m (560 ft) in diameter and 46 to 50 m (150 to 165 ft) high. To provide construction access for tower erection and clearance for air intake, the excavation diameter for each tower would be approximately 700 ft. 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. A detailed description of a round hybrid cooling tower conceptual design is presented in the 2003 cooling tower evaluation (Enercon 2003). Crews excavating areas for the cooling tower basins and associated piping may 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 2003). 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 2003).

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 summarized in Table 8-1. In the areas of land use, terrestrial ecology, waste, 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 are also likely to 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 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.

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 (Entergy 2007). Disposal of 2 million cy (1.5 million m^3) of material from the excavations for the cooling towers may create offsite land use impacts. Excavated material also may be recycled or reused, which would reduce these impacts.

Entergy's 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 three natural gas pipelines that traverse the IP2 and IP3 site (Entergy 2007). 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 ROW easement agreement calls for AGTC to relocate the pipelines at Entergy's request. The Federal Energy Regulatory Commission (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). Feasibility studies and other regulatory approvals may also be necessary (Enercon 2003).

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. 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 of material, including significant rock as well as dirt (Entergy 2007).

The NRC staff concludes that construction activities associated with cooling tower installation at IP2 and IP3 would result in SMALL to LARGE land use impacts, depending largely on how much material Entergy is unable 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 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 250,000 to 314,000 lpm (66,000 to 83,000 gpm) for the combined needs of IP2 and IP3. This would be a 93-to-95-percent reduction in water use compared to the existing IP2 and IP3 once-through systems, which have a normal design flow rate of 3,200,000 lpm (840,000 gpm) for each unit. 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. 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), as well as the current intake bay area. 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 draft SEIS, the NRC staff has concluded that the once-through cooling system has a direct impact on some representative important species (RIS), which ranges from SMALL to LARGE depending on the species affected. The reduction in flow may also reduce impingement or entrainment of RIS to which the NRC staff could not assign a specific impact level, including blue crab (*Callinectes sapidus*), the endangered shortnose sturgeon (*Acipenser brevirostrum)*, and macroinvertebrates, such as small clams and mussels (bivalves), snails, worms, crustaceans, and aquatic insects. In Section 4.6.2, the NRC staff had indicated that the impacts to the shortnose sturgeon could range from SMALL to LARGE, because of uncertainty due to the lack of current sampling data.

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 would be significantly 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.

<u>Terrestrial ecology</u>. 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). 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 about 46 to 50 m (150 to 165 ft) tall and would produce a visible plume as well as minimal ground fog (Enercon 2003). 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 2003). Enercon reported, however, that the predicted deposition rates for the towers are on the order of the natural ambient salt deposition rate (Enercon 2003). The hybrid cooling towers evaluated in this section have a drift rate of 0.001 percent (Enercon 2003). This amounts to 2.6 lpm (0.7 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.

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 draft 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.

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.

Evaporation losses (23,000 to 46,000 lpm (6,000 to 12,000 gpm)) from the cooling towers 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 may 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.

Proper controls of runoff and treatment of other site discharges 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 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 cease when IP2 and IP3 return to service, with the exception of any output lost to new parasitic loads from the closed-cycle cooling system.

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 would, overall, be minor. As previously discussed, the cooling towers would emit tower drift consisting of water, salt, and suspended solids. These emissions would be considered PM10, and some portion may include PM2.5. Because IP2 and IP3 are located in a nonattainment area for PM2.5, 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. At a minimum, drift eliminators would likely be required to keep these emissions to a low level.

Because air quality effects during construction 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), because replacement power would be required to also comply with CAA requirements (and it would be short lived), and air quality effects during operations would be minor, the NRC staff concludes that overall impact to air quality is likely SMALL.

- **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 spills or other activities. Depending on the characteristics of the material, it may be possible to reuse or recycle it. 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. If disposed of, the waste will require additional offsite land use.

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.

Based primarily on the large volume of rock and soil that would require offsite transportation and may require disposal, 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 whether material can be reused or recycled.

- **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.

Hybrid cooling towers at IP2 and IP3 would likely be equipped with sound attenuators (Entergy 2007). 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 2003).

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 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 draft 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 are considered SMALL.

- **Socioeconomics**

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 draft 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.

The need for replacement power during construction may affect electricity prices, but the size of this effect depends on the cost of replacement power and the duration of the outages. Plant operators would likely schedule outages to avoid—to the extent possible—summer peak demand periods to avoid affecting grid reliability and power transmission into New York City.

The NRC staff concludes that most socioeconomic impacts related to construction and operation of cooling towers at the site would be SMALL.

- **Transportation**

Neither the NRC nor Entergy has conducted a study of the logistics for construction of cooling towers. However, some adverse transportation impacts are likely. The greatest impacts would likely occur during site excavation and would decline during 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, the excavation phase of construction would be expected to take at least 30 months to complete. In Entergy's estimates, over 300,000 round trips would be needed over a period of 30 months to remove the excavated materials in 6-cy dump trucks (370 truckloads per day at 7 days per week or 530 truckloads per day at 5 days per week given 10-hour workdays). 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).

An alternative to shipments of waste by truck may be to ship waste by barge on the Hudson River. Entergy estimates that if 1000-ton barges were used to transport excavation debris, at least five barges per day would have to be loaded and leave the site, with additional barge staging required for returning barges (Entergy 2007). If shipped by barge, the waste would need to be offloaded and likely would be transported by trucks to a disposal site. This would shift the traffic impacts from the trucks to another location but the impacts could still be significant.

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 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 addition of the two cooling towers, standing between 46 and 50 m (150 to 165 ft), would make the entire facility more visible as the developed footprint of the facility would be expanded. The clear-cutting of wooded areas for construction of the towers would remove a visual buffer for some site structures, while the towers may screen out other 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). Construction-related impacts would be relatively short lived.

While the hybrid mechanical-draft cooling towers under consideration are designed to reduce fog and ice production in the local area, fog and ice produced during operation could have an impact on the aesthetics of the surrounding area. In particular, visible drift, though attenuated by the hybrid design, may remain. 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).

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, based on the physical dimensions of the cooling towers, the size of deforested buffer areas, and the potential for fog and ice resulting from cooled water vapor.

- **Historic and Archeological Resources**

As noted in Section 4.4.5.1 of this draft SEIS, no previously recorded archeological or above ground historic architectural resources are identified on the IP2 and IP3 property. In addition, 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.

Entergy acknowledges that, before construction of cooling towers at the IP2 and IP3 facility can begin, a survey of cultural resources may be needed to identify the potential resources in previously undisturbed areas. The studies would include consultation with the State Historic Preservation Office and appropriate Native American Tribes, as required under Section 106 of the National Historic Preservation Act (NHPA). If 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), it has acknowledged the need to survey for unknown resources before construction, and no significant historical or archeological resources have yet been identified in areas likely to be disturbed. As a result, the NRC staff concludes that the impact from the closed-cycle cooling alternative is likely to be SMALL.

- **Environmental Justice**

The NRC staff addresses environmental justice impacts of continued operations in Section 4.4.6 of this draft SEIS. Construction and operation of cooling towers at IP2 and IP3 would have an impact on environmental justice if environmental impacts of cooling system construction and operation affected minority and low-income populations in a disproportionately high and adverse manner.

Within the 50-mi (80-km) radius of the IP2 and IP3 site, a number of potential environmental impacts (onsite land use, aesthetics, air quality, waste management, and socioeconomic impacts) could affect populations in the immediate vicinity of the site. However, the potentially affected populations for the construction and operation of the closed-cycle cooling alternative, including residents of the Villages of Buchanan and Verplanck, contain low percentages of minority and low-income populations.

Overall, low-income populations within the 50-mi (80-km) radius represent a small percentage of the total population. The low-income population was approximately 11.7 percent of the total population in the combined four-State reference area, or 10.4 percent when the individual States were used as the geographic area. According to 2004 census data, the percentages of people below the low-income criteria in Dutchess and Westchester Counties were 7.7 percent and 8.9 percent, respectively.

The 2000 census indicates that 32.1 percent of the population within the 50-mi (80-km) radius and 25.1 percent of the population for the four-State reference area were minority for all races combined. The 2000 census also indicates that the total minority populations of the Villages of Buchanan and Verplanck were 7 percent and 11 percent, respectively.

Therefore, the local populations that would be most directly affected by the proposed action contain lower percentages of minorities and low-income populations than the entire 50-mi (80-km) area and the four-State reference area.

As noted earlier in this section, replacement power required during a 42-week outage could increase air quality effects, 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 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. The NRC staff concludes, then, that the overall environmental justice impacts of constructing and operating a closed-cycle cooling system at the IP2 and IP3 site are likely to be SMALL.

8.1.2 Modified Existing Once-Through Cooling System with Restoration Alternative

The NYSDEC proposal of closed-cycle cooling as the site-specific BTA to protect aquatic life in the draft SPDES permit for IP2 and IP3 (NYSDEC 2003a) is intended to dramatically reduce the entrainment and impingement of aquatic life in the IP2 and IP3 cooling system, thus reducing impacts to fish populations in the Hudson River estuary. Under the terms of the draft SPDES permit, Entergy may propose a different approach that would reduce adverse environmental impacts to an equivalent level (NYSDEC 2003b). The alternative proposed in this section combines the existing once-through cooling system with alternative intake technologies and additional restoration alternatives so that the net impact of the IP2 and IP3 cooling water intake structures is equivalent to the impact from the operation of a new closed-cycle cooling system.

8.1.2.1 Description of the Modified Existing Once-Through Cooling System with Restoration Alternative

This alternative would reduce impingement and entrainment losses by retrofitting the IP2 and IP3 existing once-through cooling systems with improved intake technology, altering operations of the cooling system, and implementing restoration measures within the Hudson River estuary. Under the terms of the draft SPDES permit, the combined impacts of these actions would have to meet the same performance measures as a closed-cycle cooling system. As described in Section 8.1.1.2 (Aquatic Ecology for the closed-cycle cooling alternative), the amount of water withdrawn from the Hudson River for IP2 and IP3 following implementation of the closed-cycle cooling system alternative would be reduced by 93 to 95 percent. To meet the requirements of the draft SPDES permit (NYSDEC 2003a), the modified once-through cooling system and combined restoration alternatives would have to result in a net entrainment and impingement reduction of 93 to 95 percent for species most affected by the existing system. The NRC staff examined other potential mitigation options to reduce impacts to aquatic life in Section 4.1.5 of this draft SEIS and concludes that one or a combination of these mitigation measures could be used as part of this alternative.

Restoration of wetlands or other aquatic habitats in the Hudson River estuary would likely be included as an aspect of any program designed to offset the residual impacts of once-through cooling-water systems. The New York-New Jersey Harbor is one of the 28 National Estuary Programs charged with developing and implementing a plan to protect, conserve, and restore the estuary (NY-NJ HEP Undated-a). A Comprehensive Conservation and Management Plan (CCMP) establishes priorities for activities, research, and funding for the estuary program. The core areas of the estuary stretch north on the Hudson to Piermont Marsh (south of IP2 and IP3; Piermont Marsh is near the southern end of the Tappan Zee river segment in Figure 2-10 in Chapter 2) (NY-NJ HEP Undated-b), but priorities identified in the CCMP could guide possible restoration activities. In addition, restoration activities would also be conducted in accordance with the NYSDEC Hudson River Estuary Program, a regional partnership designed to protect, conserve, restore, and enhance the estuary.

The estuarine wetlands and shallows of the Hudson River provide foraging habitat and shelter, serve as nursery areas for early life stages and juveniles of fish and shellfish, and contribute to the aquatic food web. An increase in wetlands or other aquatic habitats in the Hudson River estuary could support increased populations of some species affected by the IP2 and IP3 cooling-system operations and thus offset entrainment and impingement losses of those species.

Staff, consultants, or contractors would need to determine where restoration projects should take place before a wetland restoration plan could be designed. The restoration plan would indicate the size and location of restoration projects needed to add to aquatic populations at essentially the levels that the modified once-through cooling system depletes them. Because of the steep slopes on the banks of the river near the IP2 and IP3 facility, there are no significant wetland areas in the immediate vicinity of the site. Therefore, wetland restoration activities would likely need to take place away from the site.

The restoration alternative could build on features of the Hudson River Settlement Agreement (HRSA; addressed in greater depth in Section 2.2.5.3 of this draft SEIS). Measures to limit aquatic impacts of Hudson River Power plants discussed in the HRSA include partial outages for some Hudson River power plants during key spawning months, funding and operating a striped bass hatchery, conducting biological monitoring, and setting up a $12-million endowment for a new foundation for independent research on mitigating fish impacts by power plants.

As noted in Chapter 2 of this SEIS, the HRSA was replaced by four consecutive judicially approved consent orders. Each of these consent orders effectively continued the HRSA terms and conditions, with two exceptions. Neither consent order required outages at IP2 or IP3 or the continued operation of the striped bass hatchery.

As described in the draft SPDES permit, financial support of organizations that can have a direct impact on the health of the Hudson River estuary, such as the Hudson River Estuary Restoration Fund (HRERF), is another possible piece of a restoration alternative. The draft SPDES permit would require a payment of $24 million to the HRERF by Entergy (NYSDEC 2003a, 2003c) until it constructs closed-cycle cooling. An alternative to the construction and operation of the closed-cycle cooling systems could include additional funding to the HRERF and groups like it.

8.1.2.2 Environmental Impacts of the Modified Existing Once-Through Cooling System with Restoration Alternative

In this section, the NRC staff discusses the impacts that would occur if the existing once-through cooling system intakes at IP2 and IP3 were modified, and restoration actions were implemented, as described in Section 8.1.2.1 of this draft SEIS. These actions would need to meet the expected requirements of the NYSDEC-issued SPDES permit. The anticipated environmental impacts of this alternative are summarized in Table 8-1 with discussions on each impact category provided in the following paragraphs.

For most issues, the impacts of operating the modified once-through cooling system and restoration alternative would be the same or lower than the impacts associated with the existing once-through cooling system presented in Section 4.1 of this draft SEIS. Only the impacts on land use would likely be greater with the modified cooling system and restoration alternative than with continued operation of the existing system.

- **Land Use**

Any restoration plan will have some impact on land use. Because of the steep slopes on the banks of the river near the IP2 and IP3 facility, there are no significant wetland or shallows areas near the site to support restoration activities. Therefore, restoration activities would likely need to take place at locations further away from the site.

There would be noticeable short-term construction impacts on land use in any areas designated for restoration by the restoration plan. Site preparation could include grading and recontouring, removal of contaminated sediments, and/or replacement of sediments. Restoration often requires the removal of invasive and nonnative plant species through the use of herbicides, prescribed burning, biocontrol, or a combination of techniques. Following the removal of invasive species, the planting of native wetland and upland species along a hydrologic gradient is often required. Restoration activities would likely be conducted in accordance with the NYSDEC Hudson River Estuary program.

Once initial restoration activities are complete, restored wetlands usually require periodic maintenance such as prescribed burning, herbicide application, and planting to maintain the desired mix of native plant species. Monitoring may be required for restored nearshore aquatic habitats. These activities could be required throughout the license renewal period. It is unlikely that "operation" of a restoration site will have long-term effects on land use unless restoration converts previously dry land into wetlands. Operation of the restoration site may have some benefits to nearby landowners or users if the site was previously degraded.

Land also would be needed for construction of a new fish hatchery. The impacts to land use would likely be minimal, especially if the construction site was in a previously developed area.

The NRC staff concludes that the activities related to restoration and maintenance of wetlands, and construction and operation of a new fish hatchery, would likely result in SMALL to MODERATE land use impacts.

- **Ecology**

Aquatic ecology. Implementation of a well-developed restoration plan would, as designed, have an overall positive impact on aquatic ecology. There may, however, be some short-term negative impacts during the initial stages of restoration and/or construction activities. A restoration plan would indicate specific locations where restoration activities would take place, as well as the types and duration of activities. In the absence of such a plan, only an estimate of impacts is possible. To achieve performance equivalent to the 93-to-95-percent reduction in impingement and entrainment likely to be achieved with closed-cycle cooling, the restoration alternative would likely also need to include some intake modifications as described in Section 4.1.5 of this draft SEIS, and/or modifications to pumping rates, which could reduce impingement or entrainment.

During wetland restoration and construction of the fish hatchery, the NRC staff expects that impacts to aquatic ecology would be negative. Wetland restoration could initially increase rates of runoff and sedimentation, or release pollutants trapped in sediments. Construction of the fish hatchery could create runoff during construction, though this would likely be minor. During operations, however, any fish hatchery would have to comply with requirements of its own State-issued SPDES permit to control releases of pollutants to any nearby water bodies, likely including the Hudson River.

If this alternative achieves its intended goals—which would require rigorous monitoring—then the NRC staff concludes that the overall net impacts of the cooling system modifications and restoration alternative on aquatic ecology would be SMALL during operation, and MODERATE during construction.

Terrestrial ecology. Implementation of a well-developed restoration plan, cooling system intake modifications, and construction activities will produce few impacts upon the terrestrial environment or threatened or endangered terrestrial species. Impacts to terrestrial ecology would be most noticeable during construction, when any land conversion would take place, and when site crews may need to construct roads or laydown areas for equipment used to restore the wetland or construct the hatchery. Impacts from these activities would be highly site specific, but they are localized and short lived.

Once construction and initial restoration conclude, impacts to terrestrial ecology will be minor, and may be positive for the restoration portion of this alternative. Wetlands can increase the ecological value of nearby land area and provide habitat for some species that are largely terrestrial. Overall, the NRC staff concludes that the terrestrial ecological impacts from the cooling system modification and restoration alternative at IP2 and IP3 would be SMALL to

MODERATE, as some impacts may be noticeable during construction.

- **Water Use and Quality**

As noted in the Ecology section for this alternative, wetland restoration could initially increase rates of runoff and sedimentation or release pollutants trapped in sediments. Wetland restoration will modify the hydrologic behavior of the restoration site, and often includes measures that can affect surrounding water quality once the site is operational. Hydrologic modifications at a restoration site could include (1) installation of structures that control water flow and affect flow patterns, (2) the removal of dikes or berms, (3) the removal of drainage channels that drain water away from a site, and (4) the creation of new drainage channels or basins. Once operational, wetland restoration sites help to improve surface water quality by allowing natural processes to break down pollutants before being transported into open water.

Construction of the fish hatchery will also create some site runoff, though good construction practices should limit this impact. Once operational, the fish hatchery would have to comply with requirements of its own State-issued SPDES permit to control releases of pollutants to any nearby water bodies, likely including the Hudson River. Fish hatcheries produce nutrient-rich water that may require treatment before release.

While some construction-stage impacts may be noticeable, the long-term operational effects are minor, and may be beneficial. Operational impacts are SMALL, while construction impacts are MODERATE.

- **Air Quality**

Because the restoration alternative contains only relatively small-scale construction projects and does not involve the installation of any major sources of air emissions, it is unlikely that this alternative would trigger noticeable air quality impacts. As a result, the NRC staff concludes that overall impacts to air quality from this alternative would be SMALL.

- **Waste**

Construction of a new fish hatchery would generate a small amount of construction debris, and wetland restoration may leave some land-clearing debris that crews would likely dispose of on site. Any cooling system modification activities are expected to generate modest amounts of wastes for a short period of time. Ongoing operation of the fish hatchery is also expected to generate small amounts of waste, most of which would probably leave the site in liquid form under the restrictions of a State-issued discharge permit. Therefore, the NRC staff concludes that waste-related impacts associated with the cooling system modification and restoration alternative at IP2 and IP3 would be SMALL.

- **Human Health**

Construction of a new fish hatchery would present some general construction-related occupational hazards, as would installation of cooling system modifications. Wetland restoration activities also would present some occupational and environmental exposure hazards. Restoration activities may have positive effects if they improve the quality of water in portions of the Hudson that supply drinking water, as well as to the extent that they provide unpolluted habitat for fish or shellfish that humans may consume.

As described in Section 4.3 of this draft SEIS, the NRC concludes that continued operation of the facility would not increase the impacts of occupational radiation exposures during the relicensing period, nor would they likely affect radiation exposures to the public. Furthermore, there would be no significant noise sources associated with construction or operation of the fish hatchery or restoration activities that could not be effectively mitigated to protect site workers or offsite individuals.

Overall, the NRC staff concludes that human health impacts from the cooling system modification and restoration alternative are SMALL.

- **Socioeconomics (including Transportation)**

Section 4.4 of this draft SEIS describes the socioeconomic impacts of the continued operation of the IP2 and IP3 facility. The cooling system modification and restoration alternative at IP2 and IP3 would not significantly change employment at or near IP2 and IP3. There would also be no significant changes in the tax base for the region or in traffic flow or traffic patterns.

Therefore, the NRC staff concludes that overall socioeconomic impacts of the alternative would be SMALL.

- **Aesthetics**

The proposed restoration alternative would have no significant impact on the aesthetic value of the IP2 and IP3 facility. Cooling system modification and restoration likely would not have any onsite impacts that would change the overall appearance of the site. Wetland restorations could have a long-term positive impact on aesthetics, or at least minimal negative impacts. Construction of a new fish hatchery would have limited visual effects because most structures (tanks or ponds, storage buildings, pumphouses) are unobtrusive. Even if some negative impacts occur during construction, long-term negative impacts during operation are unlikely.

The NRC staff concludes that the impact of the cooling system modification and restoration at IP2 and IP3 on aesthetics would be SMALL.

- **Historic and Archeological Resources**

As noted in Section 4.4.5.1 of this draft SEIS, no previously recorded archeological or above-ground historic architectural resources have been identified on the IP2 and IP3 site. In addition, a Phase 1A survey was conducted for the site in 2006. The NRC staff identified 76 resources listed on the NRHP within 5 miles of IP2 and IP3.

The NHPA requires archeological surveys to identify and evaluate historic and archeological resources in areas identified for restoration and construction would be required before initiation of ground-disturbing activities. The studies would include consultation with the State Historic Preservation Office (NYSHPO) and appropriate American Indian Tribes.

Many shell midden sites (ancient shell mounds) or other signs of past human activities occur adjacent to wetland areas, and such sites may be encountered during surveys. Aspects of the NHPA require that lands not previously surveyed be investigated by a professional archeologist in consultation with the NYSHPO before any ground-disturbing activities. Through consultation, whatever entity constructs the fish hatchery or wetland restoration site would identify ways to reduce or avoid adverse impacts. It is possible that construction may have a noticeable effect on historic and archeological resources.

Once operational, the restoration option would essentially have no impact on historic or archeological resources. The impact of restoration and construction on historic and archeological resources could range from SMALL during operation to MODERATE during construction, depending on the locations chosen for wetland restoration and construction of a new fish hatchery, the number of sites recorded in those locations, and whether the recorded sites are significant (i.e., eligible for listing on NRHP).

- **Environmental Justice**

Section 4.4.6 of this draft SEIS discusses the environmental justice impacts of continued plant operation. Modification to the existing once-through cooling system intakes at IP2 and IP3 and restoration of wetlands could have an impact on environmental justice if environmental impacts of modifications affected minority and low-income populations in a disproportionately high and adverse manner.

However, as described in Section 8.1.1.1 of this draft SEIS, under the Environmental Justice section, the local populations that would be most affected by the proposed action contain lower percentages of minorities and low-income populations than the entire 50-mi radius area and the four-State reference area. As such, the NRC staff concludes that the environmental justice impacts of the modified once-through cooling system and restoration alternative at the IP2 and IP3 site would be SMALL.

Table 8-1. Summary of Environmental Impacts of a Closed-Cycle Cooling Alternative and a Modified Existing Once-Through Cooling System with Restoration Alternative at IP2 and IP3

Impact Category	New Closed-Cycle Cooling Alternative		Once-Through Cooling with Restoration Alternative	
	Impact	**Comments**	**Impact**	**Comments**
Land Use	SMALL to LARGE	Construction of towers requires about 16 ha (40 ac). Waste disposal may require much offsite land.	SMALL to MODERATE	Short-term land disturbances may result from habitat restoration; land use changes at the fish hatchery site.
Ecology: Aquatic	SMALL	Entrainment and impingement of aquatic organisms, as well as heat shock would be reduced substantially.	SMALL to MODERATE	Entrainment and impingement of aquatic organisms reduced, while restoration of habitat benefits many species. Noticeable impacts occur during construction.
Ecology: Terrestrial	SMALL to MODERATE	Onsite forest habitats disturbed while drift from towers may affect vegetation.	SMALL to MODERATE	Impacts may occur from offsite construction and temporary impacts in the restoration area. Operational issues are minor.
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.	SMALL to MODERATE	Short-term impacts from construction and restoration can be controlled using management practices, though noticeable impacts may occur.

Table 8-1 (continued)

Impact Category	New Closed-Cycle Cooling Alternative		Existing Once-Through Cooling with Restoration Alternatives	
	Impact	Comments	Impact	Comments
Air Quality	SMALL	Primary impacts from vehicles and equipment emissions during construction, as well as replacement power. Existing regulations should limit effects.	SMALL	Minor impacts from fugitive dust and emissions from vehicles and equipment occur during construction.
Waste	SMALL to LARGE	Construction would generate about 2 million cy of soil, rock, and debris requiring offsite disposal.	SMALL	Activities would generate easily managed volumes of waste.
Human Health	SMALL	Workers experience minor accident risk during construction. No impacts on human health during operation.	SMALL	Workers experience minor accident risk during construction. No negative impacts on human health during operation.
Socioeconomics	SMALL	No impact to offsite housing or public services occurs.	SMALL	This alternative creates insignificant changes in area employment levels or tax revenues.
Transportation	SMALL to LARGE	Increased traffic associated with construction (workers and waste disposal) would be significant, though little effect during operations.	SMALL	Insignificant changes in traffic volumes result.
Aesthetics	MODERATE	Construction of two towers,150 to 165 ft tall, would have a noticeable impact on the aesthetics of the site. Minor plume and noise issues could occur.	SMALL	Onsite aesthetics would not likely change significantly. Wetland restorations would have a long-term positive effect on aesthetics.

Table 8-1 (continued)

Impact Category	New Closed-Cycle Cooling Alternative		Existing Once-Through Cooling with Restoration Alternatives	
	Impact	Comments	Impact	Comments
Historical and Archeological Resources	SMALL	Existing procedures are adequate to protect resources on the largely-disturbed site.	SMALL to MODERATE	Impacts could reach moderate during construction in sensitive areas.
Environmental Justice	SMALL	No significant impacts are anticipated that could disproportion-ately affect minority or low-income communities.	SMALL	No significant impacts are anticipated that could disproportion-ately affect minority or 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 draft 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.

1 **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 expected to be SMALL because there are no significant disproportionate impacts to minority or 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 draft 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 draft 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 draft 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 (2160 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.

- **Ecology**

In Chapter 4 of this draft SEIS, the NRC staff concluded that aquatic ecological impacts of

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(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.

continued plant operation were SMALL to LARGE because of the entrainment and impingement of aquatic species, depending on the species. The NRC staff also concluded that thermal shock could have a SMALL to MODERATE 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, including to the endangered shortnose sturgeon, 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 draft 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 draft 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 draft 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 affect on waste volumes associated with decommissioning.

- **Human Health**

In Chapter 4 of this draft 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 draft 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 draft 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); there may also be an immediate reduction in property tax revenues for Westchester County. 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 likely affect only 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 draft 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 draft 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 draft 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 draft 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 are not expected to be significantly disproportionate to minority and low-income populations.

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 following central generating station alternatives are considered in detail in the identified sections of this draft SEIS:

- supercritical coal-fired generation at an alternate site (Section 8.3.1)
- natural gas-fired generation at either the IP2 and IP3 site or an alternate site (Section 8.3.2)

The NRC staff considers the following nongeneration alternatives to license renewal in detail in the identified sections of this draft SEIS:

- purchased power (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 draft SEIS:

- continued operation of either IP2 or IP3, construction and operation of a gas-fired unit, renewable generation, and conservation programs (Section 8.3.5.1)
- construction and operation of new gas-fired plant, renewable generation, conservation, and purchased power (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 draft SEIS. Several of the alternatives discussed in Section 8.3.4 are included in the combinations addressed in 8.3.5.

Alternatives Process

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 natural gas-fired generation plant could be developed at the IP2 and IP3 facility because the site is too small to host other alternatives.

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. For instance, a recent analysis conducted by the U.S. Department of Energy (DOE) concluded that metropolitan New York southward through northern Virginia is a “critical congestion area” (DOE 2006). 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.

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. 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.

EIA Projections

Each year the Energy Information Administration (EIA), a component of DOE, issues an annual energy outlook. In its “Annual Energy Outlook 2007 with Projections to 2030,” EIA projects that natural gas-fired plants will account for approximately 26 percent of electric generating capacity in 2020, an increase of about 14 percent from 2005 levels (DOE/EIA 2007a). EIA projects that coal-fired plants will account for approximately 32 percent of generating capacity in 2020, increasing nearly 15 percent from 2005 levels (DOE/EIA 2007a). EIA projects that renewable energy sources, primarily hydropower and biomass, will account for 12 percent of capacity in 2020, increasing from 9 percent in 2005 (DOE/EIA 2007a). After 2020, however, new coal and nuclear plants are expected to displace some of the power currently generated at natural-gas-fired plants (DOE/EIA 2007a).

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. According to EIA, advanced coal-fired and advanced combined-cycle natural gas generating facilities will be approximately competitive with each other in 2015, and advanced coal-fired facilities will likely gain a competitive edge by 2030 (DOE/EIA 2007a). In line with the EIA projections, the alternative of a new advanced coal-fired plant at an alternate location is considered in this draft SEIS. The resulting impacts are presented in Section 8.3.1 of this draft

SEIS. The impacts of a new gas-fired combined-cycle plant located at either the IP2 and IP3 site or an alternate site are presented in Section 8.3.2 of this draft SEIS.

EIA indicated that, because of environmental needs and increasing fuel costs, oil-fired plants will account for little or none of the new generating capacity added in the United States through 2030 (DOE/EIA 2007a). This projection assumed that world oil prices would reach a low of $50 per barrel in 2014 and rise to $59 in 2030. After recent sharp price increases and declines, the EIA now projects that oil prices will average $51 per barrel in 2009 (DOE/EIA 2008b). The NRC staff notes that future oil prices will be driven by supply and demand.

The EIA projects that U.S. generators will increase total nuclear and renewable generation capacity throughout the forecast term, due partly to tax credits and other incentives. As a proportion of installed capacity, however, nuclear generation will decrease slightly through 2030, while renewable generation remains relatively constant (EIA 2007). EIA indicates that changes in electricity generation costs—which are highly dependent on emission control costs—will drive utilities' choices in generating technologies (EIA 2007). About 70 percent of new nuclear generating capacity is expected to be directly related to the availability of production tax credits under the Energy Policy Act of 2005 (EPACT2005; DOE/EIA 2007a).

The NRC staff uses EIA's analyses 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 Supercritical Coal-Fired Generation

In this section, the NRC staff analyzes new supercritical coal-fired boilers as an alternative to nuclear power generation at the IP2 and IP3 site. 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.

The NRC staff recognizes that some coal-fired power plant proposals have recently faced opposition or rejection in some jurisdictions, though other projects continue to move forward. Also, coal-fired generation faces greater regulatory uncertainty and risk from potential future greenhouse gas regulation than other generation alternatives. In New York, coal-fired power plants would need to comply with elements of the Regional Greenhouse Gas Initiative. Nonetheless, given EIA's projections and the progress of some new coal-fired proposals, the NRC staff has decided to include coal-fired generation as an alternative to license renewal.

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 tonnes (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 (3740-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 (98 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 draft 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 (3740 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 (3740 ac) 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 would be about 890 ha (2,200 ac) of the 19,400 ha required for the coal-fired alternative. 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 draft 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. A coal-fired plant of this size is unlikely to use ground water for cooling tower makeup, however. 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, 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 (5754 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 (1352 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.

Carbon monoxide emissions. The NRC staff estimates that the total CO emissions from coal combustion would be approximately 1230 MT/yr (1352 tons/yr) based on EPA-calculated emissions factors for coal-fired power plants.

Hazardous air pollutants including mercury. 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.

Uranium and thorium. 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 (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 (14.5 million tons) of CO_2 per year assuming a heat rate of 8661 BTU/kWh (DOE/EIA 2007b). Section 6.2 of this draft SEIS contains a discussion of current and likely future relative 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 (135 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 345,800 MT (380,000 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 190,190 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 (260,700 tons), 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 2600 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 draft 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 draft 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.

Table 8-3. Summary of Environmental Impacts of the Coal-Fired Plant Alternative Located at an Alternate Site

Impact Category	Impact	Comment
Land Use	MODERATE to LARGE	Uses up to 1500 ha (3700 ac) for plant, offices, parking, and waste disposal; additional impacts from transmission line and rail spur, as well as coal and limestone mining.
Ecology	MODERATE to LARGE	Impacts to terrestrial ecology would likely be MODERATE to LARGE, while impacts to aquatic ecology would likely be SMALL.

Table 8-3 (continued)

Impact Category	Impact	Comment
Water Use and Quality	SMALL to MODERATE	With closed-cycle cooling, the impact would likely be SMALL, though it would depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Air Quality	MODERATE	• SO_x: 5230 MT/yr (5748 tons/yr) • NO_x: 1129 MT/yr (1351 tons/yr) • Total suspended particulates: 175 MT/yr (192 tons/yr) • PM_{10}: 40 MT/yr (44 tons/yr) • CO: 1129 MT/yr (1315 tons/yr) • Small amounts of mercury and other hazardous air pollutants Extensive emissions controls and regulations limit impacts to MODERATE.
Waste	MODERATE	Total waste production would be approximately 645,000 MT/yr (710,000 tons/yr) of ash (after some is recycled) and scrubber sludge requiring approximately 150 ha (370 ac) for disposal during the 40-year life of the plant. The plant would also generate relatively small amounts of conventional, hazardous, and universal wastes during operation.
Human Health	MODERATE	Impacts are uncertain, but considered MODERATE as the plant would comply with health-informed standards in the CAA and other relevant emissions regulations. Minor risk to workers associated with construction and industrial accidents.
Socioeconomics	SMALL to LARGE	Construction impacts depend on location, but would be LARGE if the plant is located in an area that is rural or is growing less quickly than areas near IP2 and IP3. IP2 and IP3 communities may lose tax revenue and employment, though economic growth would likely offset much of this loss. Impacts from placement of a plant near to an urban area may be MODERATE. Impacts during operation would be smaller than during construction.
Transportation	MODERATE to LARGE	Transportation impacts could be MODERATE to LARGE, during construction, though operational impacts may be smaller during operations.
Aesthetics	SMALL to LARGE	The greatest impacts would be from new transmission lines, plant stacks, and rail lines to transport coal and lime. Impacts would be largest at an undeveloped site.

Table 8-3 (continued)

Impact Category	Impact	Comment
Historic and Archeological Resources	SMALL to MODERATE	Construction at an alternate location would necessitate cultural resource studies; construction would likely avoid highly sensitive areas.
Environmental Justice	SMALL to LARGE	Impacts would vary depending on population distribution and location of the new plant site.

8.3.2 Natural Gas-Fired Combined-Cycle Generation

In this section, the NRC staff examines the environmental impacts of the natural gas-fired 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 natural gas-fired 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. Combined-cycle gas-fired 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 gas-fired alternative would require smaller cooling towers and substantially less makeup water than the cooling system proposed in Section 8.1.1 of this draft 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 (2005).

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.

Combined-cycle gas turbines that are currently on the market can operate at a heat rate as low as 5700 BTU/kWh for units with net output of 400 MW(e) (GE Energy 2005). These units are more efficient than the 408-MW(e) units Entergy considered in its ER, and would consume about 30 percent less fuel, while producing approximately 30 percent 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. Other options would include four, 530-MW(e) units with heat rates of approximately 6000 BTU/kWh (GE Energy 2005), resulting in 2120 MW(e) net output.

The NRC staff discusses the overall impacts of the natural gas-fired generating system in the following sections and summarizes them in Table 8-4 of this draft SEIS. The extent of impacts at an alternate site would depend on the location of the site selected.

- **Land Use**

Existing facilities and infrastructure would be used to the extent practicable if a gas-fired 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 combined-cycle facilities require less space than the GEIS indicates, and may be more on the order of 16 ha (40 ac) per 1000 MW(e). (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 (239 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 gas-fired 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 gas-fired 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.

The environmental impacts of locating the gas-fired generation 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. Construction and operation of the gas-fired 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 gas-fired 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.

Regardless of where a gas-fired 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 (3600 ac) for wells, collection stations, and pipelines, or about 3000 ha (7300 ac) for a 2000-MW(e) facility (NRC 1996).

Overall, land use impacts of the gas-fired alternative are considered SMALL to MODERATE at the IP2 and IP3 site. Gas-fired generation land use impacts at a new previously industrial site are considered to be SMALL to MODERATE; while gas-fired 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 gas-fired facility. These impacts would be similar to those described in Section 8.1.1.2 of this draft SEIS, which discusses the ecological impacts of the construction of a closed-cycle cooling system to support IP2 and IP3. The gas-fired facility would likely utilizing most previously undeveloped property on site. 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 gas-fired alternative at the IP2 and IP3 site. Overall, construction effects are limited in both scope and duration. Impacts to terrestrial ecology of constructing the gas-fired alternative on site are likely to be SMALL.

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 would have substantial ecological impacts, though these would be temporary. Ecological impacts to the plant site and 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, however, are likely to be smaller than for a coal-fired facility and would likely be SMALL to MODERATE, depending on site characteristics.

Operation of the gas-fired alternative at the IP2 and IP3 site or another site would likely not introduce new terrestrial ecological effects after construction.

The gas-fired 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 gas-fired 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.

- **Water Use and Quality**

Surface Water: Combined-cycle gas-fired 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. Like the existing IP2 and IP3, a gas-fired 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 gas-fired alternative would likely be SMALL for both construction and operation.

At an alternate site, a gas-fired 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 the nuclear or coal-fired alternatives. 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 gas-fired 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. 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 gas-fired 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 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 clean-burning fuel relative to coal. The gas-fired alternative would release emissions similar to those from the coal-fired alternative, but in lesser quantities.

The NRC staff calculates that approximate emissions from the five-unit, 2000-MW gas-fired alternative using combined-cycle gas units with a heat rate of about 5700 BTU/kWh would be:

- SO_x—135 MT/yr (148 tons/yr)
- NO_x—444 MT/yr (475 tons/yr)
- CO—93 MT/yr (135 tons/yr)

- Filterable particulates (PM_{10})—75 MT/yr (83 tons/yr)[(3)]

Gas-fired 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 gas-fired 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 gas-fired alternative.

NO_x is typically the pollutant of greatest concern for a gas-fired power plant. Given the proper atmospheric conditions, NO_x helps to form ozone, as well as smog. The gas-fired 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 gas-fired 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 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.

A new gas-fired 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). Natural gas-fired 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 natural gas-fired power plants should be regulated under Section 112 of the CAA.

A natural gas-fired plant would have unregulated CO_2 emissions of about 117 pounds per MMBtu (DOE/EIA 2008a). The NRC staff calculates that a five-unit gas-fired alternative with technologically advanced turbines rated at 5700 BTU/kWh would emit approximately 4,965,000 MT (5,462,000 tons) of CO_2 per year. Section 6.2 of this draft 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

(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 natural gas-fired plant at the IP2 and IP3 or at an alternate 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 gas-fired alternative would generate small amounts of waste, though many construction wastes can be recycled. Land-clearing debris from construction at an alternate location could be land filled on site. Overall, the waste impacts would be SMALL for a natural gas-fired plant sited at an alternate site.

Cooling towers for a new gas-fired 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. The waste-related impacts associated with construction of a five-unit gas-fired 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 gas-fired 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 gas-fired 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 natural gas-fired alternate sited at IP2 and IP3 or at an alternate site would be considered SMALL.

- **Socioeconomics**

Construction of a natural gas-fired 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).

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 gas-fired 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 gas-fired 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 gas-fired 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 gas-fired 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 gas-fired 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 gas-fired plant is likely less than the impact the current nuclear plant, excepting when cooling towers produce noticeable plumes. Overall, aesthetic impacts from a gas-fired plant constructed at the IP2 and IP3 site would likely be SMALL.

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 gas-fired alternative at alternate site could be SMALL to LARGE.

- **Historic and Archeological Resources**

According to the IP2 and IP3 relicensing case study in the GEIS, archeological sites at or near the power plant were disturbed before construction of the plant, and so the impacts from plant construction and operation were not significant (NRC 1996). Section 2.2.9.2 of this draft SEIS also supports this conclusion.

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 gas-fired alternative at the IP2 and IP3 site would be similar to those described in Section 8.1.1.2 of this draft SEIS for the closed-cycle cooling alternative, can generally be effectively managed, and are considered SMALL.

Historic and archeological resource impacts can generally be effectively managed 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. 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 draft SEIS, impacts to the environment or community from actions at the IP2 and IP3 site, including the construction of a gas-fired 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 the geographical region's population. Therefore, the gas-fired alternative constructed at the IP2 and IP3 site would have SMALL impacts on environmental justice.

Impacts at an alternate site 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.

Table 8-4. Summary of Environmental Impacts of the Natural Gas-Fired Plant Alternative Located at IP2 and IP3 and an Alternate Site

Impact Category	5 Units Located at IP2 and IP3 Site		5 Units Located at Alternative Site	
	Impact	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	Onsite land used; most has been previously disturbed.	SMALL to LARGE	About 92 ha (224 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 iwould 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: 135 MT/yr (148 tons/yr) • NO_x: 444 MT/yr (475 tons/yr) • PM_{10}: 75 MT/yr (83 tons/yr) • CO: 93 MT/yr (102 tons/yr) • CO_2: 5 million MT/yr (5.5 million tons/yr)	SMALL to MODERATE	Operational impacts are the same as onsite plant but more emissions from additional construction activities.

Table 8-4 (continued)

Impact Category	5 Units Located at IP2 and IP3 Site		5 Units Located at Alternative Site	
	Impact	Comments	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.	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.	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.
Aesthetics	SMALL	The impact is likely less than the impacts of the current nuclear plant; more land would be cleared and new structures built.	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.

Table 8-4 (continued)

Impact Category	5 Units Located at IP2 and IP3 Site		5 Units Located at Alternative Site	
	Impact	Comments	Impact	Comments
Historical and Archeological Resource	SMALL	A cultural resources inventory would be needed to identify, evaluate, and mitigate potential impacts from construction.	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	No significant impacts are anticipated that could disproportion-ately affect minority or low-income communities.	SMALL to LARGE	Impacts would vary depending on population distribution and location of the new plant site.

8.3.3 Purchased Electrical Power

Based on currently scheduled retirements and demand growth projections, the New York Independent System Operator (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 coal- and gas-fired power plants or renewable alternatives, or it could purchase power from existing facilities at other sites outside the NYCA (National Research Council 2006).

Power sources within NYCA have an installed capacity of about 38,000 MW(e) and more than 6,300 km (4,000 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) 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. Replacement in the 2008–2010 time frame would be considerably more difficult, probably requiring extraordinary, emergency-like measures to achieve" (National Research Council 2006).

As of March 2008, New York Regional Interconnect, Inc. (NYRI), was 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. 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 (2855 ac). If approved, NYRI will clear 768 ha (1899 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).

While NYRI has proposed to construct additional transmission capacity that could be used to import power into the southern load zones for the NYCA, the proposed 1200-MW(e) capacity is not sufficient to completely replace the generating capacity of IP2 and IP3. Also, the project faces many hurdles before construction can begin. Since the NYRI project is, at this time, the only serious transmission project proposed in the NYCA that would supply additional power to the New York City area, the NRC staff does not consider purchased power as a viable stand-alone replacement option for IP2 and IP3. The NRC staff does, however, recognize that positive steps are being taken toward increasing the transmission capacity into the southern load zones of the NYCA. NYRI has evaluated the environmental impacts of its proposed project in Exhibit 4 of its petition to the NYPSC. Because the NRC staff does not consider purchased power as a viable stand-alone option for replacing IP2 and IP3, the staff did not conduct an independent evaluation of the NYRI findings. The NRC staff does, however, include purchased power across new transmission lines in the combination alternatives addressed in Section 8.3.7 of this draft SEIS.

8.3.4 Other Alternatives

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.

- **Conservation**

In this section, the NRC staff evaluates conservation[(4)]as an alternative to license renewal. 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 (NYSDEC 2003a) 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 because additional conservation could be a consequence of the no-action alternative, the NRC staff examines conservation in this draft 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

(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.

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 report estimates 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).

The NRC staff notes that while Statewide conservation efforts could result in a peak demand reduction of about 75 percent of the power output of both IP2 and IP3 by 2015, the National Research Council predicted that only about 800 MW(e) could be reduced from the IP2 and IP3 service area (National Research Council 2006). As such, the NRC staff does not expect that conservation efforts alone will be sufficient to replace either of the IP2 or IP3 units and for this reason has not evaluated conservation or efficiency programs as replacements for the full output for IP2 or IP3. The NRC staff has, however, considered conservation as part of a combination of alternatives presented in Section 8.3.5 of this draft SEIS.

- **Wind Power**

New York State is recognized as having about 5000 MW(e) of land-based wind potential, enough to generate about 13 million MW(h) or equivalent to 10 percent of the State's electricity consumption. There are also substantial offshore wind resources. The NYSERDA New York Energy $mart^SM program is currently supporting extensive wind resource prospecting efforts to identify promising new sites for wind development. Furthermore, NYSERDA is currently working with three developers to develop four projects totaling 425 MW (Power Naturally 2008). Wind currently accounts for only about 1 percent of the generating capacity, or 391 MW(e), Statewide (NYISO 2008). 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) (NYISO 2008); however, there is no assurance that a project in this process will go into service.

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 estimates that offshore wind could meet most of the IP2 and IP3 load by 2014 (National Research Council 2006). Currently, Winergy Power of Hauppauge, New York, is proposing to complete construction of a wind farm about 19 km (12 mi) off the south shore of Long Island by 2014. Winergy has recently increased the size of its project to 940 MW(e) (WINS 2008). This would mean building as many as 260 wind turbines off the shore of Long Island. Winergy says the number of turbines would decrease if turbine technology improves at the time construction begins in 2012.

It is currently unknown whether the Winergy project will be completed. The proposed 420-MW(e), 130-turbine Cape Wind project off Cape Cod—the East Coast's offshore wind farm project that is farthest along in its approval process—faces opposition.

Because of the scale of a single wind farm project that would be needed to replace the power from IP2 and IP3 and the obstacles that the project would face, the NRC staff does not consider wind power to be a suitable stand-alone alternative that could be implemented before the IP2 and IP3 licenses expire. The staff does, however, recognize that New York has utility-scale wind resources and that NYSERDA is actively pursuing economic potential in wind-derived power supplies. Therefore, the NRC staff includes wind power in the combination alternatives addressed in Section 8.3.7 of this draft SEIS.

- **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 2006 New York Renewable Electricity Profile (DOE/EIA 2008b), New York's power industry reported only 37 MW(e) of generating capacity for wood or wood waste derived power.

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 the generating capacity is from wood and wood wastes. In New York, the Laidlaw Energy Group, Inc. (Laidlaw 2008), is planning to convert a retired gas-fired cogeneration facility into a 7-MW(e) wood-fired power plant in Ellicottville, Cattaraugus County. The plant will supply about 1 MW(e) to a lumber drying business located adjacent to the plant and export about 6 MW(e) to the power grid (Laidlaw 2008). However, the project has not yet been finalized, and the future of the plant is uncertain.

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 resourced 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 in combinations of alternatives addressed in Section 8.3.7 of this draft SEIS.

- **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).

The Idaho National Energy and Environmental Laboratory (INEEL) estimated that the undeveloped hydropower potential total for New York is 1309 MW(e) with 134 undeveloped potential hydroelectric sites in the Hudson River basin (INEEL 1998). Development of these sites could result in more than 300 MW(e) of baseload capacity (INEEL 1998). The Statewide potential is 40 percent less than IP2 and IP3's current capacity, and the regional potential is 86 percent less than the IP2 and IP3 capacity. Therefore, the NRC staff does not consider hydropower to be a viable stand-alone alternative to license renewal.

- **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 had indicated that oil prices are expected to make oil-fired generation an unlikely option for future generation additions (EIA/DOE 2007a), 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.

- **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 reports 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 draft SEIS.

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. 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. Therefore, the NRC staff includes solar power in the combination alternatives addressed in Section 8.3.7 of this draft SEIS as a part of the conservation-derived demand reductions (as described in Section 8.3.4).

- **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. Based on the NRC’s current proposed schedule, no combined license (COL) application review is expected to be complete until the middle of 2010, at the earliest. Necessary reviews include the acceptance review as well as the safety and environmental reviews. Upon completion of the reviews, a public hearing process is initiated that is estimated to take at least 1 year. This brings the earliest approval of the submitted COL applications out to the middle of 2011.

While some plant construction activities can begin before issuing the COL, construction of a new plant is not expected to be completed until several years beyond the date the COL is issued. In late 2007, NRG Energy was the first to submit a full COL application to the NRC for its South Texas Project. The target for completion of the construction of the first of two units is

2014, after the end of the IP2 operating license.

Given the current 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.

- **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 2006 (DOE/EIA 2008). As such, the NRC staff concludes that geothermal energy would not be a feasible alternative to renewal of the IP2 and IP3 operating licenses.

- **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.

- **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 2006 (DOE/EIA 2008), which is considered above. For these reasons, the NRC staff concludes that power generation from biomass fuels does not offer a feasible alternative to the renewal of the IP2 and IP3 operating licenses.

- **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.

- **Delayed Retirement**

Based on currently scheduled power plant retirements and demand growth projections by the NYISO, 1200 to 1600 MW(e) from new projects that are not yet under construction could be needed by 2010, and a total of 2300 to 3300 MW(e) could be needed by 2015 (National Research Council 2006). In 2006, there were six new generation projects adding 2228 MW(e) of new capacity and scheduled retirements of 2363 MW of generating capacity (National Research Council 2006). Recent or scheduled retirements included the New York Power Authority’s 885-MW(e) Poletti Unit 1 and Lovett Units 3, 4, and 5 totaling 431 MW(e). Astoria Units 2 and 3, with a total capacity of 553 MW(e), also are scheduled for retirement before the end of the current IP2 and IP3 license periods.

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.

8.3.5 Combination of Alternatives

Even though 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 in part because other efforts to examine alternatives to IP2 and IP3, including Levitan and Associates (2005) and the National Research Council (2006), have addressed combinations of alternatives. The National Research Council (2006) noted, for example, that ". . . the additional 2 GW 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."

The NRC staff presents two possible combinations based partly on analysis by the National Research Council. In one of these combinations, the NRC has included the continued operation of either IP2 or IP3, and the second combination includes only alternative energy sources. The second combination is based entirely on new generation, efficiency improvements or demand-side management (jointly addressed as conservation), and new transmission capacity carrying power from upstate. These combinations include several alternatives that the NRC staff found to be unable to replace the entirety of IP2 and IP3 electrical capacity.

<u>Combination Alternative 1</u>

- continuing operation of either IP2 or IP3
- constructing a 330-MW(e) combined-cycle gas-fired plant at IP2 and IP3
- obtaining 200 to 400 MW(e) from renewable energy sources (primarily wood and wind)
- implementing 300 to 500 MW(e) of conservation programs based on the potential identified by the National Research Council and NYSERDA

<u>Combination Alternative 2</u>

- constructing a 400-MW(e) gas combined-cycle plant at the IP2 and IP3 site
- obtaining 200 to 400 MW(e) from renewable energy sources (primarily wood and wind)

- implementing 500 to 800 MW(e) of conservation programs based on the potential identified by the National Research Council and NYSERDA
- importing a net 800 MW(e) from upstate New York and Canada following the installation of a new transmission line

The following sections analyze the impacts of the two options 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 draft 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. 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. 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.) Constructing 330 MW(e) of gas-fired capacity would create roughly one-sixth the impacts of the on-site alternative described in 8.3.2, and would likely be able to make use of the AGTC pipeline on site without additional pipeline modifications (Levitan and Associates, Inc. 2005).

The NRC staff has not yet addressed in any depth in this SEIS the impacts of wind power, wood-fired generation, or conservation. A wind installation capable of yielding 100 to 200 MW(e) of capacity would likely entail placing wind turbines off Long Island on the Atlantic coast, in upstate New York, or on Lake Erie or Lake Ontario. A wind installation capable of delivering 100 to 200 MW(e) on average would require approximately 52 to 104 turbines with a capacity of 3.5 to 5 MW (Cape Wind Associates 2007). Because wind power installations do not provide full power all the time, the total installed capacity exceeds the capacity stated here.

As noted in Section 8.3.4, under Wood Waste, the wood-fired alternative would have impacts similar to a coal-fired plant of similar capacity. Unlike a coal-fired plant, however, the wood-fired plant does not release heavy metals (including mercury, uranium, and thorium) in fly ash. Wood-fired plants also tend to be slightly less efficient with slightly lower capacity factors.

Impacts from conservation measures are likely to be negligible, as the NRC staff indicated in the GEIS (1996). 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 draft SEIS. Construction of two hybrid cooling towers would have a SMALL to MODERATE 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. Section 8.3.2 states that the land use impacts from the construction of five gas-fired units at the IP2 and IP3 site would be SMALL to MODERATE. The combined alternative would need only one combined-cycle unit, which would fit on the existing site without purchasing offsite land. If the plant operator constructed a 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 not 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 can have significant environmental impacts. However, the NRC staff believes that the operation of 100 to 200 MW(e) of wood-fired generation would have minor impacts, especially if the plants were widely distributed and feedstocks were primarily preexisting waste streams. Construction impacts of the wood-fired 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. To fully utilize the power generated in these plants, they would need to be constructed inside the transmission bottlenecks leading to the NYCA discussed in Section 8.3.5 of this draft SEIS. Otherwise, new transmission capacity would have to be constructed resulting in additional land use impacts.

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 hundred acres, though turbines and infrastructure would actually occupy only a small percentage of that land area. Land around wind installations could remain in use for activities like agriculture (a practice consistent with wind farm siting throughout the U.S.).

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 draft SEIS, the construction of two hybrid cooling towers would have a SMALL impact on aquatic ecology and a SMALL impact on terrestrial ecology. 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 impacts of impingement and entrainment would likely be at least MODERATE for some species, though the NRC staff have not analyzed the specific level of impact for this option. Thermal shock would also be less significant. Not constructing a cooling tower would mean a smaller terrestrial impact.)

The SMALL to MODERATE impacts from the construction of five gas-fired units at the IP2 and

IP3 site (described in Section 8.3.2 of this draft SEIS) would be reduced to SMALL because only one smaller gas-fired unit is proposed under this alternative.

Offsite construction and operation of wood-fired 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 as described earlier in this section would be to aquatic ecological resources. An onshore wind farm located in upstate New York would primarily affect terrestrial ecology. Neither wind farm would be likely to destabilize ecological resources. The NRC staff concludes that SMALL to MODERATE ecological impacts could occur during the construction phase but could be managed by choice of construction methods (e.g., avoiding particularly sensitive habitats).

Overall, the NRC staff considers that the ecological impacts, both aquatic and terrestrial, from this combination alternative would be SMALL to MODERATE.

- **Water Use and Quality**

The primary water use and quality issues from this alternative would occur from wood-fired generation and the gas-fired unit. 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 wood-fired plants and a gas-fired unit on the IP2 and IP3 site. In general, site management practices keep these effects to a small level.

During operations, only the wood-fired and gas-fired plants would require water for cooling. Because the wood-fired plants are less efficient than the gas-fired unit and rely on a steam cycle for the full measure of their output, the effects of the wood-fired plant is roughly similar to the effect of the larger gas-fired unit. All of these units would likely use closed-cycle cooling, however, and this would limit the effects on water resources. As the NRC staff indicated for the coal-fired and gas-fired alternatives, the gas-fired 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 for this combination alternative. The onsite impacts at the IP2 and IP3 facility would be expected to be similar to the impacts described in Sections 8.1.1.2 and 8.3.2 of this draft SEIS.

- **Air Quality**

The first combined alternative will have some impact on air quality as a result of emissions from the wood-fired plants and the onsite gas turbine. Because of the size of the units, an individual unit's impacts would be SMALL. Section 8.1.1.2 of this draft SEIS describes the impacts on air quality from the construction and operation of two hybrid cooling towers to be SMALL. For the construction and operation of a single tower, the impacts would be SMALL. The continued operation of one of the nuclear power units and construction and operation of the wind farm will have only minor impacts on air quality.

Overall, the NRC staff considers that the air quality impacts from the first combination alternative would be SMALL.

- **Waste**

The primary source of waste under this option would be from the construction of the new hybrid cooling tower. Constructing a wind farm, wood-fired generation, and a new gas turbine facility would also create waste, though significantly less than the 2 million cy (1.5 million m^3) created during excavation of two cooling towers (roughly half would be attributable to one cooling tower). Operational wastes would come primarily from the wood-fired 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.

Section 8.1.1.2 of this draft SEIS describes the impacts from waste generated during construction of two towers to be SMALL to LARGE, depending on whether excavation waste could be reused or recycled. Waste impacts could be substantial during construction of the alternatives, and would remain SMALL to LARGE, depending on how the various sites handled wastes. If the remaining IP unit were to continue operation with the existing once-through cooling system, waste impacts would be SMALL. During operations, waste volumes would have only SMALL impacts.

- **Human Health**

The primary heath concerns under this option would be occupational health and safety risks during the construction of the new gas turbine, the new cooling tower, the wood-fired plants, and the wind farm. As described in previous sections (for coal-fired and gas-fired alternatives), 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 draft 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, but some would be replaced with jobs associated with the construction and operation of the gas-fired plant. The gas-fired plant may generate additional PILOT payments, which may offset shutdown effects. Levitan and Associates (2005) indicates that PILOT payments from a gas-fired facility smaller than IP2 and IP3 may supply PILOT payments near those provided by the existing plant. Other jobs would be generated by the construction of the offsite power alternatives. 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 draft SEIS, the construction of two hybrid cooling towers would have 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 transportation effects during construction. Given that the wood-waste facility 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 of the gas turbine facility will require fewer workers than the gas-fired alternative considered in Section 8.3.2 of this draft SEIS.

During operation, only the wood-waste facility is likely to create noticeable impacts (in gathering wood wastes), 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 draft 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 wood-fired generating plants would likely not have a major effect on visual resources, because the plants are small. Impacts would depend on the plants' locations.

The NRC staff concludes that the overall aesthetic impacts from the first combination alternative could range from SMALL to LARGE, depending on the aesthetic effects of the wind power portion.

- **Historic and Archeological Resources**

Onsite impacts to historical and cultural resources from the construction of a hybrid cooling tower and a single gas turbine plant are expected to be SMALL. The offsite impacts from the construction of wood-fired units and a wind farm 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. Therefore, the NRC staff concludes that the overall impacts on historic and archeological resources from the first combination alternative would be SMALL.

- **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, environmental justice impacts from the first combination alternative would depend substantially on the location of the installations and the characteristics of the surrounding populations. Impacts could range from SMALL to LARGE.

Impacts of Combined 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) gas-fired plant is considered because it can be constructed on the site, making use of existing transmission lines and the natural gas pipeline that transects the IP2 and IP3 site; however, modifications to the 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). Quantifying pipeline service adequacy and upgrade costs was beyond the scope of the Levitan report.

Like the first combination alternative, the second combination alternative employs 200 to 400 MW(e) from renewable energy sources (primarily wood and wind). The impacts of these sources are described in the discussion of Combination Alternative 1 in Section 8.3.7.1 of this draft SEIS.

This option requires more aggressive energy conservation programs that would result in an energy savings of 500 to 800 MW(e), the maximum potential expected by 2014 (National Research Council 2006). As described in Section 8.3.4 of this draft SEIS and in the GEIS, these conservation efforts would have overall SMALL impacts.

This alternative also includes importing 800 MW(e) from upstate New York or Canada, as described in Section 8.3.5 of this draft SEIS. This power would be purchased by an LSE for distribution in the New York City metropolitan area. However, to support such power imports, new transmission capacity would have to be established.

- **Land Use**

Siting a single 400-MW(e) gas-fired unit with a closed-cycle cooling system at the IP2 and IP3 site would require about 18 ha (45 ac) and would likely have SMALL impacts on land use as the existing site as the unit could likely be constructed on previously-disturbed land.

The construction of new transmission lines to support the purchased-power portion of this alternative would result in MODERATE to LARGE impacts as the lines may be several hundred miles in length. As described in Section 8.3.5 of this draft SEIS, a current plan for new transmission lines would impact 1155 ha (2855 ac).

The GEIS notes that gathering fuel for wood-fired plants can have significant environmental impacts. However, the NRC staff believes that the operation of 100 to 200 MW(e) of wood-fired generation would have minor impacts, especially if the plants were widely distributed and feedstocks were primarily preexisting waste streams. Construction impacts of the wood-fired 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. To fully utilize the power generated in these plants, they would need to be constructed inside the transmission bottlenecks leading to the NYCA discussed in Section 8.3.5 of this draft SEIS, or in a location to access new transmission from upstate areas described in the previous paragraph. Otherwise, new transmission capacity would have to be constructed resulting in additional land use impacts.

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 calculations indicate that onshore installations could require xx ha (xx ac) (reference). Land around wind installations could remain in use for activities like agriculture (a practice consistent with wind farm siting throughout the U.S.).

Overall, the NRC staff considers that the land use impacts from this combination alternative would be MODERATE to LARGE.

- **Ecology**

As described in Section 8.3.2 of this draft SEIS, the impacts from the construction of five gas-fired units at the IP2 and IP3 site would have a SMALL to MODERATE impact on aquatic and terrestrial ecology. Because the second combination alternatives would use only one gas-fired unit, the NRC staff concluded the resulting impacts on both the aquatic and terrestrial ecology to be SMALL.

Offsite construction and operation of wood-fired plants and new transmission lines would have a SMALL to MODERATE impact on both aquatic and terrestrial ecology, depending heavily on the location of the plants and transmission lines. Transmission lines and their associated ROWs may noticeably affect terrestrial habitats if they contribute to habitat fragmentation. They may affect aquatic ecology when they cross water bodies, particularly if it is necessary to construct pylons in the water bodies.

The principal ecological impacts of an offshore wind farm as described earlier in this section would be to aquatic ecological resources. An onshore wind farm located in upstate New York would primarily affect terrestrial ecology. Neither type of wind farm would be likely to destabilize ecological resources. The NRC staff concludes that SMALL to MODERATE ecological impacts could occur during the construction phase but could be managed by choice of construction methods (e.g., avoiding particularly sensitive habitats).

Overall, the NRC staff considers that the ecological impacts from the second combination alternative would be SMALL to MODERATE.

- **Water Use and Quality**

The primary water use and quality issues from this alternative would occur from wood-fired generation and the gas-fired unit. While construction impacts could occur from a wind farm, particularly if located offshore, these impacts are likely to shortlived. 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 wood-fired plants and a gas-fired unit on the IP2 and IP3 site. In general, site management practices keep these effects to a small level. Construction of the transmission line would also like have minor, if any effects on water use and quality. Erosion controls would likely minimize sedimentation.

During operations, only the wood-fired and gas-fired plants would require water for cooling. Because the wood-fired plants are less efficient than the gas-fired unit and rely on a steam cycle for the full measure of their output, the effects of the wood-fired plant is roughly similar to the effect of the larger gas-fired unit. All of these units would likely use closed-cycle cooling, however, and this would limit effects on water resources. As the NRC staff indicated for the coal-fired and gas-fired alternatives, the gas-fired 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).

The overall effects on water use and quality of the second combination alternative would likely be SMALL.

- **Air Quality**

The second combination alternative will have some impact on air quality as a result of emissions from the wood-fired plants and the onsite gas-fired unit. Because of the size of the wood-fired units and the gas-fired unit, an individual unit's impacts would be SMALL. However, the NRC staff concludes that the cumulative impacts from all of the new plants would be SMALL to MODERATE.

- **Waste**

The primary source of waste under the second combination alternative would be from the construction of the new power generation facilities, both on site and off site. Waste could include land clearing debris from all aspects of this combination alternative, excepting the wind farm if built offshore. Additional wastes would result from operation of the wood-fired plants. Additional wastes could be generated during operations of the gas-fired plants, or during maintenance at the wind power installations and the new transmission line. Overall, the NRC staff concludes that the impacts will be SMALL to MODERATE.

- **Human Health**

The primary heath concerns under this option would be occupational health and safety risks during the construction of the new gas turbine, transmission lines, the wood-fired plants, and the wind farm. As described in previous sections (for coal-fired and gas-fired alternatives), 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 because the plants would comply with health-informed standards in the CAA and other relevant emissions regulations.

Therefore, 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 draft SEIS, the socioeconomic impacts of shutting down the plants would be MODERATE because of the loss of PILOT payments to local municipalities. Under this option, those payments would be lost, but because of the gas plant that would be constructed on site, some new tax revenues would replace 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 power alternatives as well as the transmission line. 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 be SMALL to MODERATE 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. Given that the wood-waste facility 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. Similarly, impacts associated with constructing the transmission line will be spread over a large area, and are not likely to be intense in any location. Also, construction of the gas turbine facility will require fewer workers than the gas-fired alternative considered in Section 8.3.2 of this draft SEIS.

During operation, only the wood-waste facility is likely to create noticeable transportation impacts (in gathering wood wastes), and these may not affect any important aspects of local transportation. The gas-fired unit may create noticeable impacts on gas transmission, but upgrades to the pipeline system should compensate for these effects. Because winter heating customers take priority over utility generation customer, the plant is unlikely to have noticeable effects for others, though it may need to burn fuel oil during peak demand periods.

Transportation impacts for this alternative would be minimal 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 be SMALL.

- **Aesthetics**

As described in Section 8.3.5 of this draft SEIS, new transmission lines would be 305 km (190 mi) long or longer. Transmission lines have a significant impact on visual aesthetics.

Aesthetic impacts would occur during operation of the wind farm 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 wood-fired generating plants could also be MODERATE, depending on the plants' locations.

Therefore, the NRC staff concludes that the overall aesthetic impacts from the second combination alternative would be MODERATE to LARGE, depending on the locations of transmission lines and the wind farm.

- **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 wood-fired units, a wind farm, and new transmission lines 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. Therefore, the NRC staff concludes that the overall impacts on historic and archeological resources from the second combination alternative would be SMALL.

- **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, environmental justice impacts from the second combination alternative would depend substantially on the location of the installations and the characteristics of the surrounding populations. Impacts could range from SMALL to LARGE.

1 **Table 8-5. 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 and the site selection for the wood-fired plants, as well as land-disposal if a cooling tower is constructed at the remaining IP unit.	MODERATE to LARGE	Impacts would depend on the site selection for the wood-fired plants, and the placement of new transmission lines and the wind farm.
Ecology	SMALL to MODERATE	Impacts would depend on location of wind farm and the site selection for the wood-fired plants.	SMALL to MODERATE	Impacts would depend on site selection for the wood-fired plants, the wind farm, and transmission line.
Water Use and Quality	SMALL	Minor impacts occur if the wind farm is located offshore.	SMALL	SMALL impacts at the IP2 and IP3 site because of less onsite power production; minor impacts at offshore wind farms, and locations of wood-fired plants and transmission lines.
Air Quality	SMALL	Air emissions of the small wood-fired plants and gas-fired unit would be minor considering their size and possible multiple locations. A wind farm would not impact air quality. A cooling tower could have a minor effect on air quality.	SMALL to MODERATE	Emissions estimated in Table 8-4 reduced about 80 percent because only one gas-fired unit would operate at the IP2 and IP3 site. Air emissions of the small wood-fired plants would be minor considering their size and possible multiple locations. A wind farm would not impact air quality.

1 **Table 8-5** (continued)

Impact Category	Combination 1		Combination 2	
	Impact	Comments	Impact	Comments
Waste	SMALL to LARGE	There would be construction waste from the IP2 and IP3 site if a cooling tower is constructed; construction of other alternatives would increase waste volumes. Operational wastes are SMALL.	SMALL to MODERATE	There would be far less construction waste from the IP2 and IP3 site. The other alternatives would not generate significant waste volumes except during construction.
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	Minor impacts from commuting plant personnel. More significant short-tem impacts from offsite transportation of construction waste, including large volumes of soil and rock.	SMALL	Minor impacts from commuting plant personnel. Short-tem impacts from offsite transportation of construction waste.
Aesthetics	SMALL to LARGE	Visual impacts from new wind turbines, depending on the location. Limited impact from wood-fired and gas plants.	MODERATE to LARGE	Visual impacts from new wind turbines and visual impacts of new transmission lines, depend on the location chosen. Limited impact from wood-fired and gas plants.
Historic and Archeological Resources	SMALL	Cultural resources inventories would be needed to identify, evaluate, and mitigate potential impacts from construction.	SMALL	Cultural resources inventories would be needed to identify, evaluate, and mitigate potential impacts from construction.

Table 8-5 (continued)

Impact Category	Combination 1		Combination 2	
	Impact	Comments	Impact	Comments
Environmental Justice	SMALL to LARGE	Impacts would depend on plant locations.	SMALL to LARGE	Impacts would depend on plant and transmission line locations.

8.4 Summary of Alternatives Considered

In this draft 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 (supercritical coal-fired generation, natural gas, nuclear, and conservation alternatives discussed in Sections 8.3.1 through 8.3.4), purchased electrical power (discussed in Section 8.3.5), alternative power-generating technologies (discussed in Section 8.3.6), and two combinations of alternatives (discussed in Section 8.3.7).

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.

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 decisionmakers (or non-NRC Federal-level decisionmakers where applicable).

The environmental impact levels of the alternatives considered by the NRC staff in this draft SEIS are similar to the impact levels of continued IP2 and IP3 operation under a renewed license with or without modifications to the existing once-through cooling system combined with aquatic ecology restoration activities designed to comply with the site's draft SPDES permit, though impacts differ significantly across resource areas.

Impacts from combinations of alternatives including conservation and generation technologies (e.g., coal, gas, wind) are also likely to be similar to the impacts of renewing the IP2 and IP3 operating licenses and implementing modifications to the open-cycle cooling system and participating in and/or funding aquatic resource restoration activities.

8.5 References

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

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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 30, 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, 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 this 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

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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.

Accession Number ML083360115).

The NRC staff plans to hold public meetings in Cortlandt Manor, New York, in February of 2009 to present the preliminary results of the NRC environmental review, answer questions from the public, and receive comments on this draft SEIS. When the comment period ends, the NRC staff will consider and address all of the comments received. These comments will be addressed in Part 2 of Appendix A to the final SEIS.

This draft SEIS includes the NRC staff's preliminary 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 draft SEIS also includes the NRC staff's preliminary recommendation regarding the proposed action.

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

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

The 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 would contribute to the NRC's ultimate determination of 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 the scope of the generic determination in 10 CFR 51.23(a) and in accordance with

10 CFR 51.23(b).[(2)]

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 on the basis of the Council on Environmental Quality 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 NRC staff analysis in the GEIS shows the following:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

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

(2) The title of 10 CFR 51.23 is "Temporary Storage of Spent Fuel after Cessation of Reactor Operations—Generic Determination of No Significant Environmental Impact."

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the NRC staff relied on conclusions as amplified by supporting information in the GEIS for issues designated 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 draft 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. When possible, these alternatives were evaluated assuming that the replacement power generation plant, if any, could be located at either the IP2 and IP3 site or some other unspecified location.

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 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 draft 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 23 total 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 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 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 8 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) range from SMALL to LARGE, depending on fish species affected. Impacts from heat shock could range from SMALL to MODERATE. Finally, given a lack of current impingement monitoring data, impacts to the endangered shortnose sturgeon could range from SMALL to LARGE (see Chapter 4 of this draft SEIS).

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.

Mitigation measures were considered for each Category 2 issue. 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. These alternatives included plant operation with a new closed-cycle cooling system (Section 8.1.1) and operation of the existing once-through cooling system with enhanced controls and restoration efforts (Section 8.1.2).

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 because the plant is in existence at the license renewal stage and has operated for a number of years. As a result, adverse impacts associated with the initial construction have 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.

Unavoidable adverse impacts of continued operation from heat shock and the combined effects of entrainment and impingement of fish and shellfish are considered SMALL to MODERATE and SMALL to LARGE, respectively. Unavoidable adverse impacts from license renewal may be SMALL to LARGE for the endangered shortnose sturgeon as a result of limited data. Other unavoidable adverse impacts are considered to be of SMALL significance.

Unavoidable adverse impacts of likely alternatives to the operation of IP2 and IP3 vary greatly. All have smaller impacts to aquatic resources than the current IP2 and IP3, though all also have larger impacts than the current 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 draft 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 the draft SPDES permit does in its current form) 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) to invest in cooling water intake modifications and restoration activities. 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 may also be committed to constructing and installing new reactor vessel heads and control rod drive mechanisms.

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 because Entergy currently has no obligation to support power production in the New York area should IP2 and IP3 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), alternatives involving altering plant operations to comply with the NYSDEC draft SPDES discharge permit, construction of coal- or 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 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 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 draft SEIS describes the SMALL to LARGE impacts of plant operation on aquatic ecology through impingement and entrainment (impact levels vary by species), and the SMALL to MODERATE impacts from thermal shock. Overall, impacts to aquatic ecology from continued operation of IP2 and IP3 without cooling system modifications or restoration actions is 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).

NRC staff 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 submitted by Entergy, (3) consultation with Federal, State, and local agencies, (4) the NRC staff's consideration of public scoping comments received, and (5) the NRC staff's independent review, the preliminary 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 decisionmakers would be unreasonable.

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

	Proposed Action	No-Action Alternative[b]	License Renewal with		Coal-Fired Plant[d]
Impact Category	**License Renewal**	**Denial of Renewal**	**New Closed-Cycle Cooling**	**Once-Through Cooling with Restoration**	**Alternate Site**
Land Use	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	MODERATE to LARGE
Ecology—Aquatic	SMALL to LARGE[a]	SMALL	SMALL	SMALL to MODERATE	SMALL
Ecology—Terrestrial	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	MODERATE to LARGE
Water Use and Quality	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE
Air Quality	SMALL	SMALL	SMALL	SMALL	MODERATE
Waste	SMALL	SMALL	SMALL to LARGE	SMALL	MODERATE
Human Health	SMALL [c]	SMALL	SMALL	SMALL	SMALL to LARGE
Socioeconomics	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL to LARGE
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL	MODERATE to LARGE
Aesthetics	SMALL	SMALL	MODERATE	SMALL	SMALL to LARGE
Historical and Archeological Resources	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE
Environmental Justice	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE

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Table 9-1 (continued)

Impact Category	Natural-Gas-Fired Generation(d): Five 400-MW(e) Units at IP2 and IP3	Natural-Gas-Fired Generation(d): Five 400-MW(e) Units at Alternate Site	Combination of Alternatives: Option 1: One IP unit, onsite gas, offsite renewables, and conservation	Combination of Alternatives: Option 2: Onsite gas, offsite renewables, additional imported power, and conservation
Land Use	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	MODERATE to LARGE
Ecology	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water Use and Quality	SMALL	SMALL to MODERATE	SMALL	SMALL
Air Quality	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL to MODERATE
Waste	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE
Human Health	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL to MODERATE
Transportation	SMALL to MODERATE	SMALL to MODERATE	MODERATE	SMALL

Summary and Conclusions

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Table 9-1 (continued)

	Natural-Gas-Fired Generation(d)	**Combination of Alternatives**		**Natural-Gas-Fired Generation(d)**
Aesthetics	SMALL	SMALL to LARGE	SMALL to LARGE	MODERATE to LARGE
Historical and Archeological Resources	SMALL	SMALL to MODERATE	SMALL	SMALL
Environmental Justice	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE

(a) NRC staff analysis indicates that impingement and entrainment impacts vary by species, and may be SMALL to LARGE. Thermal shock effects may be SMALL to MODERATE, and impacts to the endangered shortnose sturgeon may range from SMALL to LARGE given uncertainties in the data.
(b) The no-action alternative does not, on its own, meet the purpose and need of the GEIS. No-action may 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 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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

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8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Same as 8 Above

10. SUPPLEMENTARY NOTES

Docket Nos. 05000247 and 05000286

11. ABSTRACT *(200 words or less)*

This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted 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 the NRC 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 draft SEIS contains the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC staff's preliminary recommendation regarding the proposed action.

The NRC staff's preliminary recommendation 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 decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental report submitted by Entergy, (3) consultation with other Federal, State, and Local agencies; (4) the NRC staff's own independent review, and (5) the NRC staff's consideration of public comments received during the scoping process.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*	13. AVAILABILITY STATEMENT
Indian Point Nuclear Generating Unit Numbers 2 and 3 IP2 IP3 IPEC Supplement to the Generic Environmental Impact Statement DSEIS National Environmental Policy Act NEPA License Renewal GEIS NUREG-1437, Supplement 38	unlimited 14. SECURITY CLASSIFICATION *(This Page)* unclassified *(This Report)* unclassified 15. NUMBER OF PAGES 16. PRICE

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