Plant and the Environment

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

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

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

2.2.8.2 Public Services

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

Water Supply

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

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

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

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

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

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

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

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

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

The Village of Ossining Water System in Westchester County is supplied from two surface water sources, the Indian Brook Reservoir, located near Fowler Avenue and Reservoir Road, and the Croton Reservoir, which is part of the New York City Water System. The average blend

of water is approximately 63 percent from the Croton Reservoir and 37 percent from the Indian Brook Reservoir. The system obtains its water from the Croton watershed in Putnam and Westchester counties and serves approximately 30,000 people. The Village of Ossining Water System services an average daily demand of approximately 3.7 mgd (14,000 m^3/day) (VOWS 2005).

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

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

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

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

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

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

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

Education

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

Transportation

Several major highway routes serve as transportation corridors along either side of the Hudson River Valley. Westchester County and Putnam County are located on the eastern side of the Hudson River. The primary highways in Westchester County include Interstate 684, US 9, US 6, and US 202, as well as the Taconic State and Saw Mill River Parkways (see Figures 2–1 and 2-2). US 9 runs north and south along the Hudson River Valley through both Westchester and Putnam Counties. Further east, the Taconic State Parkway also runs north and south

through both counties. The Taconic State Parkway and the Saw Mill River Parkway connect near Hawthorne, New York, southeast of the site. Interstate 684 runs north and south along the eastern side of Westchester County and connects to Interstate 84 in Putnam County. US 6 runs east and west through the southern end of Putnam County and the northern portion of Westchester County. US 202 runs east and west across northern Westchester County. The Saw Mill River Parkway extends northeast and southwest between US 9 at Riverdale, New York, and Interstate 684. Additional highways within the two counties include State Routes 117, 120, 129, 100, 139, and 301.

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

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

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

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

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

Source: NYSDOT 2005

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

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

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

2.2.8.3 Offsite Land Use

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

Dutchess County

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

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

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

Orange County

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

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

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

Putnam County

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

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

Westchester County

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

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

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

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

2.2.8.4 Visual Aesthetics and Noise

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

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

showed that IP2 and IP3 meet the Village of Buchanan's sound ordinance (Enercon Services 2003).

2.2.8.5 Demography

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

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

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

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

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

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

— = No data available.

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

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

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

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

Source: USCB 2008c

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

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

Source: USCB 2008c

Transient Population

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

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

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

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

Source: USCB 2008c

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

avg = percent average for counties within the IP2 and IP3 50-mi radius and excludes state percentage

Migrant Farm Workers

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

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

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

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

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

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

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

Table 2-15 (continued)

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

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

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

2.2.8.6 Economy

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

Employment and Income

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

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

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

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

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

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

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

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

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

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

Source: NYSOSC 2008; ENN 2007c

2.2.9 Historic and Archeological Resources

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

2.2.9.1 Cultural Background

Prehistory

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

Table 2-19. Cultural Sequence and Chronology

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

Paleo-Indian Period

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

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

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

Archaic Period

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

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

Woodland Period

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

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

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

European Contact, 1524–1608

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

Historic Period

The Colonial Period, 1608–1776

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

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

and after some negotiation, the Dutch capitulated. The English seized the entire colony of New Amsterdam and renamed the area New York and New Jersey.

The Revolutionary War, 1776–1783

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

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

19th Century Development

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

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

20th Century Development

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

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

2.2.9.2 Historic and Archeological Resources at the IP2 & IP3 Site

Previously Recorded Resources

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

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

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

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

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

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

Results of Walkover Survey

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

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

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

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

Potential Archeological Resources

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

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

2.2.10 Related Federal Project Activities and Consultations

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

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

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

The NRC is required under Section 102(c) of NEPA to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. Federal agency comment correspondence is included in Appendix E.

New York/New Jersey/Philadelphia Airspace Redesign

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

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

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

Hudson River PCBs Site

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

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

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

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

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

Coastal Zone Management Act

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

This law authorizes individual states to develop plans that incorporate the strategies and policies they will employ to manage development and use of coastal land and water areas. Each

plan must be approved by NOAA. One of the components of an approved plan is "enforceable polices," by which a state exerts control over coastal uses and resources.

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

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

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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 supplemental environmental impact statement (SEIS) unless new and significant information is identified.

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

License renewal actions may include associated refurbishment actions that provide for safe and economic operation during the period of extended operation. These actions may have impacts on the environment that require evaluation, depending on the type of action and the plant-specific design.

3.1 Potential Refurbishment Activities

Entergy, in its environmental report (ER), stated that its evaluation of structures and components required by Title 10, Section 54.21, "Contents of Application—Technical Information," of the *Code of Federal Regulations* (10 CFR 54.21), did not identify the need for refurbishment of structures or components for purposes of license renewal and that Entergy planned no such refurbishment activities (Entergy 2007). Entergy indicated that routine operational and maintenance activities would be performed during the license renewal period but refurbishment activities as described in the GEIS were not planned.

During the license renewal environmental scoping process, the staff of the U.S. Nuclear Regulatory Commission (NRC) received comments (Kaplowitz 2007; Shapiro 2007) indicating that Entergy had taken steps toward procuring replacement reactor vessel heads and control rod drive mechanisms (CRDMs) for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and

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

IP3). The scoping comments indicated that an overseas firm plans to deliver replacement reactor vessel heads and CRDMs for IP2 and IP3 in October 2011 and October 2012, respectively. Based on this information, the staff requested, by letter to Entergy dated December 5, 2007, additional information regarding these potential refurbishment activities (NRC 2007).

Entergy's response, dated January 4, 2008, indicated that "no reactor vessel head replacements are required for purposes of aging management during the period of extended operation. Accordingly, no evaluation of the environmental impacts of reactor vessel head replacement as a refurbishment activity is required or presented in the Environmental Report." The response also stated that "the decision to proceed with procurement of long lead items [replacement vessel heads] is strictly economic" and therefore need not be addressed in Entergy's environmental report (Entergy 2008a).

During a telephone conference call on March 18, 2008 (NRC 2008a), the staff acknowledged that while there may be no requirement to replace the reactor vessel heads at IP2 and IP3 for license renewal, Section 2.6.1 of the GEIS discusses initiating actions for environmental impacts associated with license renewal. These actions include (1) refurbishment, repair, or replacement activities that "may be performed to ensure that this objective [aging management and maintaining functionality of certain SSCs] is achieved" and (2) activities that licensees may choose to undertake, including "various refurbishment and upgrade activities at their nuclear facilities to better maintain or improve reliability, performance, and economics of power plant operation during the extended period of operation." Since the GEIS considers refurbishment activities beyond those that are related to aging management during the period of extended operation, the NRC staff indicated that Entergy's response to the staff's request for additional information (RAI) did not effectively address the staff's need for information about the potential refurbishment activities.

During the conference call, Entergy staff indicated that if license renewal were not being pursued for IP2 and IP3, Entergy would not have ordered the vessel head forgings. Entergy also indicated that the vessel head forgings that were procured for IP2 and IP3 may never be needed at IP2 and IP3.

Given that Entergy has taken steps toward obtaining the replacement reactor vessel heads and CRDMs, and given that these replacement activities, should they occur, would be associated with license renewal (i.e., they would not be undertaken in the absence of license renewal), the NRC staff issued an additional RAI on April 14, 2008 (NRC 2008b), in which the staff requested information from Entergy regarding the process Entergy would use in deciding whether to replace the vessel heads and CRDMs, as well as indicating the potential environmental impacts of these replacement activities. Entergy submitted its response to NRC on May 14, 2008 (Entergy 2008b).

In its RAI response, Entergy reasserted that it did not believe vessel head and CRDM replacement constituted a refurbishment activity (Entergy 2008b). In addition, the response indicated that the current vessel heads are in good condition, though Entergy may eventually decide to replace them pending the results of future inspections.

Entergy's response also provided a likely hypothetical scenario for the replacement activities, should they occur. The scenario includes the following characteristics (Entergy 2008b):

- Approximately 250 additional workers would be required for the replacement of each reactor vessel head and CRDM. The replacement would take place during a 60-day refueling outage for each unit, when approximately 950 refueling outage workers are at the Indian Point site. An additional 50 workers would be required to construct the vessel head storage structure, though their work would be largely completed before the beginning of the refueling outage.
- The reactor vessel heads would be manufactured overseas, transported to a U.S. port, and shipped up the Hudson River via barge, with the CRDMs installed, to the existing Indian Point barge slip.
- Once delivered to the IP2 and IP3 site, storage and preinstallation preparation would take place at onsite temporary structures. If possible, existing warehouses would also be used. The only permanent building constructed would be used to store the old reactor vessel heads and CRDMs; this building would likely be constructed near the onsite structure storing the old IP2 and IP3 steam generators and occupy less than 446 square meters (4800 square feet). All structures would be constructed on previously disturbed areas.
- Staff or contractors would cut a temporary opening in containment approximately 7.6 meters by 7.9 meters (25 feet by 26 feet) to allow for removal of the old heads and CRDMs and installation of the new ones. Containment concrete would be removed by hydro-demolition, while rebar and a portion of steel liner would be removed by other means.
- Before removing the old reactor vessel head from containment, Entergy would remove any loose contamination or affix it with a coating. The old head would then be transported to the onsite storage facility (for possible offsite permanent disposition). Meanwhile, the new head (with CRDMs) would be installed.
- Upon project completion, each unit's containment would be returned to its original configuration.

The NRC staff considered the GEIS guidance on refurbishment activities, the need to disclose potential impacts of the proposed action, and Entergy's analysis of possible impacts of vessel head and CRDM replacements. The NRC staff also acknowledged that vessel head and CRDM replacements may not occur. Nevertheless, to ensure that, should these refurbishment activities occur, their environmental impacts will have been characterized and disclosed in accordance with the National Environmental Policy Act and NRC implementing regulations, the NRC staff determined that it would be appropriate to evaluate the potential impacts of these possible replacement activities using the GEIS framework for refurbishment.

Since the NRC staff published the draft SEIS, Entergy indicated (at the 2009 Annual Assessment meeting in Tarrytown, NY), that it planned to replace the Unit 2 vessel head in 2014, and the Unit 3 vessel head in 2016. Entergy did not directly address timing for CRDM replacement at this meeting, but NRC staff finds it likely that Entergy would replace vessel heads and CRDMs at the same time. NRC staff addresses the potential environmental impacts

of vessel head and CRDM replacements below.

3.2 Refurbishment Impacts

The IP2 and IP3 site was one of seven case study reactor locations the NRC staff used in determining potential environmental impacts from refurbishment activities while developing the GEIS. After reviewing construction-stage impacts at these seven plant sites and then scaling them down to better approximate the duration and intensity of impacts expected during plant refurbishment activities, the NRC staff determined that nine refurbishment-related issues would be Category 1 issues. The GEIS approach to refurbishment assumed longer duration outages, more workers, and a wider array of activities on site than would occur during the reactor vessel head and CRDM replacement project discussed here. The GEIS also noted, in Appendix B, that outages would grow shorter as licensees gained experience with major replacement activities. Additionally, the GEIS noted that some licensees may choose to perform only a few activities.

Even given larger workforces, more activities, and longer outages, the NRC staff determined in the GEIS that the impacts for these nine issues are SMALL.

Table 3-1 contains a list of Category 1 issues associated with refurbishment.

Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Surface Water Quality, Hydrology, and Use (for all plants)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
Aquatic Ecology (for all plants)	
Refurbishment	3.5
Ground Water Use and Quality	
Impacts of refurbishment on ground water use and quality	3.4.2
Land Use	
Onsite land use	3.2
Human Health	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	3.7.4, 3.7.4.3, 3.7.4.4, 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Provided below are the results of the NRC staff reviews and a brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, "Environmental Protection Regulations

for Domestic Licensing and Related Regulatory Functions," Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," for each of the Category 1 refurbishment issues listed in Table 3-1. For each Category 1 issue, the NRC staff has not identified any new and significant information during its review of the Entergy ER (Entergy 2007), its site audit, the SEIS scoping process, public comments on the draft SEIS, and its evaluation of other available information, including Entergy's May 14, 2008, RAI response (Entergy 2008b).

- Impacts of refurbishment on surface water quality. Based on information in the GEIS, the Commission found the following:

  Impacts are expected to be negligible during refurbishment because best management practices are expected to be employed to control soil erosion and spills.

- Impacts of refurbishment on surface water use. Based on information in the GEIS, the Commission found the following:

  Water use during refurbishment will not increase appreciably or will be reduced during plant outage.

- Impacts of refurbishment on aquatic ecology. Based on information in the GEIS, the Commission found the following:

  During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.

- Impacts of refurbishment on ground water use and quality. Based on information in the GEIS, the Commission found the following:

  Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.

- Impacts of refurbishment on onsite land use. Based on information in the GEIS, the Commission found the following:

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

- Radiation exposures to the public during refurbishment. Based on information in the GEIS, the Commission found the following:

  During refurbishment, the gaseous effluents would result in doses that are similar to those from current operation. Applicable regulatory dose limits to the public are not expected to be exceeded.

- Occupational radiation exposures during refurbishment. Based on information in the GEIS, the Commission found the following:

  Occupational radiation doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risks from all causes including radiation is in the mid-range for industrial settings.

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

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

- Aesthetic impacts (refurbishment). Based on information in the GEIS, the Commission found the following:

  No significant impacts are expected during refurbishment.

The NRC staff identified no new and significant information related to these issues during its review of the Entergy ER, during the SEIS scoping process, in correspondence identified in Section 3.1 of this chapter, in Entergy's May 14, 2008, RAI response (Entergy 2008b) or from public comments on the draft SEIS. Therefore, the NRC staff expects that there would be no impacts related to these issues during the renewal term beyond those discussed in the GEIS.

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

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53 (c)(3)(ii) Subparagraph
Terrestrial Resources		
Refurbishment impacts	3.6	E
Threatened or Endangered Species (for all plants)		
Threatened or endangered species	3.9	E
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
Socioeconomics		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed[a]	Not addressed[a]

[a] Environmental justice is not addressed in the GEIS because Executive Order 12898 issued on February 11, 1994, and implementation guidance were not available prior to completion of the GEIS. Table B-1 of Appendix B, Part A of 10 CFR Part 51 indicates that this issue will be addressed in site specific reviews. The NRC staff groups Environmental Justice with Category 2 issues because the NRC staff addresses it in site specific reviews along with Category 2 issues.

The results of the review for each Category 2 refurbishment issue are provided in the following sections.

3.2.1 Terrestrial Ecology—Refurbishment Impacts

Refurbishment impacts on terrestrial ecology are a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 notes that "Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application.

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment.

Entergy indicated, however, that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3. Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units. Because Entergy plans to conduct all of these activities on previously disturbed land within a relatively short period of finite duration, the level of impact on terrestrial natural resources is expected to be SMALL.

Mitigation measures would include routine land and vegetation management practices, as well as using the most disturbed areas possible for new buildings and staging areas. The NRC staff did not identify any cost-benefit studies associated with these measures.

3.2.2 Threatened or Endangered Species—Refurbishment Impacts

Refurbishment impacts on threatened or endangered species are a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Generally, plant refurbishment and continued operation are not expected to adversely affect threatened and endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected.

The NRC staff identified three federally listed terrestrial species—bog turtle, *Clemmys muhlenbergii*; New England cottontail, *Sylvilagus transitionalis*; and Indiana bat, *Myotis sodalist*—and one aquatic species—shortnose sturgeon, *Acipenser brevirostrum—as* potentially affected by the relicensing of Indian Point. As explained above under Section 3.2.1, Entergy plans to conduct all terrestrial refurbishment activities on previously disturbed land within a relatively short period of finite duration. Entergy does not plan to conduct these activities on undisturbed land, and no designated critical habitat occurs on the site (Entergy 2008b). As a result, the NRC staff finds that refurbishment activities are not likely to adversely affect the continued existence of listed terrestrial species or adversely modify designated critical habitats.

Based on analyses presented in Section 4.6.1, shortnose sturgeon eggs and larvae probably do not occur, or occur only rarely, in the vicinity of Indian Point. Juvenile and adult shortnose sturgeon do occur in the vicinity of Indian Point. For refurbishment, the replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). Entergy does not have plans to dredge to accommodate the barge at its dock and is not planning any other activities that would adversely affect aquatic species or habitats. Also, any onsite activities will have to follow existing regulations to control runoff from construction or industrial sites. Because no activities are planned that would adversely affect the aquatic environment, refurbishment activities are not likely to adversely affect the continued existence of endangered shortnose sturgeon.

Essential fish habitat, as defined under the 1996 amendments to the Magnuson-Stevens

Fishery Conservation and Management Act, occurs in the vicinity of IP2 and IP3 for red hake (*Urophycis chuss*) larvae, winter flounder (*Pleuronectes americanus*) larvae, windowpane (*Scophthalmus aquosus*) juveniles and adults, and Atlantic butterfish (*Peprilus triacanthus*) juveniles and adults. Because Entergy plans no refurbishment activities that would adversely affect the aquatic environment, there should be no adverse individual or cumulative effects on essential fish habitat in the project area.

3.2.3 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)

Air quality during refurbishment (nonattainment and maintenance areas) is a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage.

The May 14, 2008, RAI response from Entergy (Entergy 2008b) indicates that the replacement of reactor vessel heads and CRDMs for IP2 and IP3 will result in minor impacts to air quality. Citing the GEIS, Entergy states that the only potential sources of impacts to air quality would be (1) fugitive dust from site excavation and grading for construction of any new waste storage facilities and (2) emissions from motorized equipment and workers' vehicles.

Entergy indicates that the bulk of air quality impacts during the postulated refurbishment activity would result from exhaust emissions released by onsite motorized equipment and workers' vehicles (Entergy 2008b). These effects include temporary increases in atmospheric concentrations of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOCs), ammonia, and particulate matter (PM).

A table summarizing the attainment status of the counties within the immediate area of IP2 and IP3 shows nonattainment of the National Ambient Air Quality Standards (NAAQS) for 8-hour ozone in Dutchess, Orange, Putnam, Rockland, and Westchester Counties. There is nonattainment of the NAAQS for particulate matter, 2.5 microns or less in diameter ($PM_{2.5}$) in Orange, Rockland, and Westchester Counties. Westchester County is designated as a maintenance county for CO.

Based on a conservative assumption that 400 additional vehicles would travel to and from the site each day during a 65-day outage period (conservative because Entergy projects that only 300 additional workers over 60 days could accomplish the replacement activities), Entergy estimated that air emissions of VOCs, CO, and NO_x would increase by 0.95 tons (0.86 metric tons (MT)), 16.1 tons (14.6 MT), and 1.02 tons (0.926 MT), respectively (Entergy 2008b). The regulatory conformity thresholds for VOCs, CO, and NO_x are 50 tons (45 MT), 100 tons (90.7 MT), and 50 tons (45 MT), respectively, as indicated in 40 CFR 51.853(b). A comparison of Entergy's conservative estimates for vehicle emissions versus the associated regulatory conformity levels indicates that none of the thresholds would be exceeded. Based on this analysis, the NRC staff finds that air quality impacts during the postulated reactor vessel head and CRDM replacement would be SMALL.

The NRC staff identified a variety of measures that could mitigate potential air quality impacts resulting from the vessel head and CRDM replacements at IP2 and IP3. These include the use of multiperson vans and carpooling policies to reduce the number of vehicles used to transport workers to the site. The NRC staff did not identify any cost-benefit studies applicable to these mitigation measures.

3.2.4 Housing Impacts—Refurbishment

Housing impacts during refurbishment are a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

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

Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers at the Indian Point site for up to 60 days during two separate refueling outages, one for each unit, 12 months apart. Approximately 250 workers would be needed for each replacement in addition to the normal number of refueling outage workers. An additional 50 workers would construct a storage structure for the old reactor vessel heads and CRDMs. This work would be completed before the beginning of the refueling outage (Entergy 2008b).

The number of additional workers would cause a short-term increase in the demand for temporary (rental) housing units in the region beyond what is normally experienced during a refueling outage at the Indian Point site. Since IP2 and IP3 are located in a high-population area (see Section 2.2.8.5) and the number of available housing units has either kept pace with or exceeded changes in county populations (see Section 2.2.8.1), any changes in employment would have no noticeable effect on the availability of housing in the socioeconomic region of influence. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs and the availability of housing in the region, employment-related housing impacts would have no noticeable impact.

3.2.5 Public Services: Public Utilities—Refurbishment

Public utilities is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[a]n increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability."

Since there is no water shortage in the region and public water systems located in Dutchess, Orange, and Putnam Counties have excess capacity (indicated in Table 2-9 in Chapter 2), any changes in the Indian Point site and employee public water usage would have little noticeable effect on public water supply availability in these counties. As discussed in Section 2.2.8.2, the Indian Point site acquires potable water from the Village of Buchanan water supply system, and there are no restrictions on the supply of potable water from the village.

As discussed in Section 3.2.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers at the Indian Point site for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). The additional number of refueling outage workers needed to replace the reactor vessel heads and CRDMs would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of the Indian Point site. Since the region has excess water supply capacity with no restrictions, these activities would create no impacts.

3.2.6 Public Services: Education—Refurbishment

Education is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[m]ost sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors."

As discussed in Section 3.2.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers for up to 60 days at the Indian Point site (Entergy 2008b). Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, workers would not be expected to bring families and school-age children with them; therefore, there would be no impact on educational services during this extended refueling outage.

3.2.7 Offsite Land Use—Refurbishment

Offsite land use is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "Impacts may be of moderate significance at plants in low population areas."

Since IP2 and IP3 are located in a high-population area, any changes in employment would have little noticeable effect on land use in the region. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, the additional number of refueling outage workers would not cause any permanent changes in population and tax-revenue-related land use in the immediate vicinity of IP2 and IP3.

3.2.8 Public Services: Transportation—Refurbishment

Transportation is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

The additional number of refueling outage workers and truck material deliveries needed to support the replacement of each reactor vessel head and CRDM would cause short-term level-of-service impacts on access roads in the immediate vicinity of the Indian Point site. According to Entergy, increased traffic volumes entering and leaving the Indian Point site during refueling

outages, which occur at intervals of approximately 12 months for one unit or the other, have not degraded the level-of-service capacity on local roads, and the higher number of refueling outage workers during IP2 and IP3 steam generator replacement outages did not require any road improvements (Entergy 2008b). During routine periods of high traffic volume (i.e., morning and afternoon shift changes), Entergy has previously employed staggered shifts (starting and quitting times) during refueling outages to minimize level-of-service impacts on State Routes 9 and 9A (Entergy 2008b). Based on this information and because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs (up to 60 days), and given that the activity occurs at the same time as a normal refueling outage, the NRC staff finds that no transportation (level-of-service) impacts, beyond impacts from normal outages, would occur.

3.2.9 Historic and Archeological Resources—Refurbishment

Historic and archeological resources is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection.

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment. However, Entergy indicated that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). Should Entergy replace the vessel heads and CRDMs, ground-disturbing activities would be reviewed in accordance with Entergy Nuclear fleet procedures, which are designed to ensure that investigations and consultations are conducted as needed and that existing or potentially existing cultural resources are adequately protected (Enercon 2006). The procedures have been reviewed by the New York State Historic Preservation Office (NY SHPO). According to Entergy, the area of construction would be in an area that requires no prior consultation for historic, cultural, or archeological resources (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3.

Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units.

The impacts associated with this activity are not expected to adversely impact historic or archeological sites in the area of IP2 and IP3. Therefore, the potential impacts from this activity on National Register-eligible historic or archeological resources would be SMALL. However, should historic archeological resources be encountered during construction, work would cease until Entergy environmental personnel would perform an evaluation and consider possible mitigation measures through consultation with the NY SHPO.

3.2.10 Environmental Justice—Refurbishment

Environmental justice is a plant-specific refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[t]he need for and the content of an analysis of environmental justice will be addressed in plant specific reviews."

Since IP2 and IP3 are located in a high-population area, the small, short duration change in employment associated with the potential replacement activities would likely have no noticeable effect on minority and/or low-income populations in the region. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, and based on the analysis of impacts for the other resource areas discussed in Section 3.2, the NRC staff concludes there would be no disproportionately high and adverse impacts to minority and low-income populations in the immediate vicinity of IP2 and IP3.

3.3 Evaluation of New and Potentially Significant Information on Impacts of Refurbishment

Entergy, in its May 14, 2008, RAI response (Entergy 2008b), indicated that it had reviewed the findings included in Chapter 3 of the GEIS and identified no new and significant information that would invalidate the findings made in the GEIS. Further, the NRC staff has reviewed Entergy's response, has evaluated the likely impacts of the vessel head and CRDM replacement, and has not identified any new and significant information associated with these activities.

3.4 Summary of Refurbishment Impacts

The NRC staff did not identify any information that is either new or significant related to any of the applicable Category 1 issues associated with refurbishment activities at IP2 and IP3 during the renewal term. The NRC staff concludes that the environmental impacts associated with those issues are bounded by the impacts described in the GEIS (NRC 1996). For each of the Category 1 issues addressed in this section, the GEIS concludes that impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For all Category 2 issues related to refurbishment activities at IP2 and IP3, the NRC staff concluded—after reviewing guidance in the GEIS and Entergy's description of potential activities—that refurbishment activities would have SMALL or no impacts. The NRC staff's conclusions for Category 2 impact levels considered the activities' limited scope and duration compared to the refurbishment programs identified in the GEIS.

3.5 References

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

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

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

Entergy Nuclear Operations, Inc. (Entergy). 2007. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E of "IP2 and IP3, Units 2 and 3, License Renewal Application"). April 23, 2007. Agency wide Documents Access and Management System (ADAMS) Accession No. ML071210530.

Entergy Nuclear Operations, Inc. (Entergy). 2008a. "Indian Point, Units 2 and 3—Reply to Request for Additional Information Regarding Environmental Review for License Renewal Application." January 4, 2008. ADAMS Accession No. ML080110372.

Entergy Nuclear Operations, Inc. (Entergy). 2008b. "Indian Point Units 2 & 3, Reply to Request for Additional Information Regarding License Renewal Application—Refurbishment." May 14, 2008. ADAMS Accession No. ML081440052.

Kaplowitz, Michael. 2007. Letter to Pao-Tsin Kuo, "Incompleteness and Inaccurate License Renewal Application for Indian Point Energy Center, Units 2 and 3." June 27, 2007. ADAMS Accession No. ML071990093.

Shapiro, Milton B. and Susan H. Shapiro. 2007. Letter to Pao-Tsin Kuo, "Comments on Scope of Environmental Impact Statement and Scoping Process Indian Point Energy Center Unit 2 and Unit 3." October 24, 2007. ADAMS Accession No. ML073100985.

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

U.S. Nuclear Regulatory Commission. (NRC) 1999. "Generic Environmental Impact Statement for License Renewal of Nuclear Plant." NUREG-1437, Volume 1, Addendum 1. Office of Nuclear Reactor Regulation, Washington, DC.

U.S. Nuclear Regulatory Commission. (NRC) 2007. "Request for Additional Information Regarding Environmental Review for Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal (TAC Nos. MD5411 and MD5412)." December 5, 2007. ADAMS Accession No. ML073330931.

U.S. Nuclear Regulatory Commission. (NRC) 2008a. Summary of Telephone Conference Call between NRC and Entergy Nuclear Operations, Inc., Pertaining to the Indian Point Units 2 & 3, License Renewal Application—Environmental Request for Additional Information. March 18, 2008. ADAMS Accession No. ML080920983.

U.S. Nuclear Regulatory Commission. (NRC) 2008b. "Request for Additional Information Regarding the Review of the License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2 & 3 (TAC Nos. MD5411 and MD5412)." April 14, 2008. ADAMS Accession No. ML080940408.

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

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

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

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

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

This chapter addresses the issues related to operation during the renewal term that are listed in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to Indian Point Nuclear Generating Units 2 and 3 (IP2 and IP3). In Section 4.1 of this supplemental environmental impact statement (SEIS), the U.S. Nuclear Regulatory Commission (NRC) staff addresses issues applicable to the IP2 and IP3 cooling systems. In Section 4.2, the NRC staff addresses issues related to transmission lines and onsite land use. In Section 4.3, the NRC staff addresses the radiological impacts of normal operations, and in Section 4.4, the NRC staff addresses issues related to the socioeconomic impacts of normal operations during the renewal term. In Section 4.5, the NRC staff addresses issues related to ground water use and quality, while the NRC staff addresses the impacts of renewal term operations on threatened and endangered species in Section 4.6. The NRC staff addresses potential new information in Section 4.7 and addresses cumulative impacts in Section 4.8. The results of the evaluation of environmental issues related to operation during the renewal term are summarized in Section 4.9. Finally, Section 4.10 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable to IP2 and IP3 because they are related to plant design features or site characteristics not found at IP2 and IP3 are listed in Appendix F to this SEIS.

[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

4.1 Cooling System

Generic (Category 1) issues in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 that are applicable to IP2 and IP3 cooling system operations during the renewal term are listed in Table 4-1. Entergy Nuclear Indian Point 2 and Entergy Nuclear Indian Point 3, LLC (Entergy) stated in its environmental report (ER) (Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses related to cooling system operation. The NRC staff has not identified any new and significant information related to cooling system operation during its independent review of the Entergy ER, the site visit, the scoping process, comments on the draft SEIS, or the evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the Category 1 issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

A brief description of the NRC staff's review and the GEIS conclusions, as codified in 10 CFR Part 51, Table B-1, for each of these issues follows.

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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Temperature effects on sediment transport capacity	4.2.1.2.3
Scouring caused by discharged cooling water	4.2.1.2.3
Discharge of chlorine or other biocides	4.2.1.2.4
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4
Discharge of other metals in wastewater	4.2.1.2.4
Water-use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY (ALL PLANTS)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4
Entrainment of phytoplankton and zooplankton	4.2.2.1.1
Cold shock	4.2.2.1.5
Thermal plume barrier to migrating fish	4.2.2.1.6
Distribution of aquatic organisms	4.2.2.1.6
Premature emergence of aquatic insects	4.2.2.1.7
Gas supersaturation (gas bubble disease)	4.2.2.1.8
Low dissolved oxygen in the discharge	4.2.2.1.9

Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10
Stimulation of nuisance organisms (e.g., shipworms)	4.2.2.1.11
HUMAN HEALTH	
Noise	4.3.7

The NRC staff reviewed information provided from Entergy's ER, the NRC staff's site visit, the scoping process, the New York State Pollutant Discharge Elimination System (SPDES) permits for IP2 and IP3 that expired in 1992 and have since been administratively continued, the subsequent draft permit, ongoing Hudson River monitoring programs and their results, and other available information. The NRC staff has not identified any new and significant information for Category 1 issues applicable to the operation of the IP2 and IP3 cooling system during the period of extended operation.

Therefore, the NRC staff concludes that there would be no impacts for these issues during the renewal term beyond those discussed in the GEIS. The following bullets identify the Category 1 issues applicable to the operation of the IP2 and IP3 cooling system during the period of extended operation and the Commission's findings as indicated in the GEIS:

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

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

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

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

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

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

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

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

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

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

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

  Effects are readily controlled through the NPDES permit[2] and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

- Discharge of other metals in wastewater. Based on information in the GEIS, the Commission found the following:

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

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

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

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

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

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

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

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

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

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

term.

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

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

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

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

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

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

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

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

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

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

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

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

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

  Stimulation of nuisance organisms has been satisfactorily mitigated at the single

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

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

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

The NRC staff identified no new and significant information related to these issues during its independent review (including information provided from Entergy's ER, the NRC staff's site audit, the scoping process, the SPDES permits for IP2 and IP3 that expired in 1992 and have since been administratively continued, the subsequent draft permit, ongoing Hudson River monitoring programs and their results, comments on the Draft SEIS, and other available information). Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The Category 2 issues (issues that the NRC staff must address in a site-specific review based on the framework established in the GEIS) related to cooling system operation during the renewal term that are applicable to IP2 and IP3 are discussed in the sections that follow and are listed in Table 4-2.

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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(a)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY			
Entrainment of fish and shellfish in early lifestages	4.2.2.1.2	B	4.1.2
Impingement of fish and shellfish	4.2.2.1.3	B	4.1.3
Heat shock	4.2.2.1.4	B	4.1.4

For power plants with once-through cooling systems, the NRC considers the impingement and entrainment of fish and shellfish and thermal impacts from nuclear power plant cooling systems to be site-specific (Category 2) issues for license renewal. The NRC staff reviewed the applicant's ER (Entergy 2007a), visited the plant site, and reviewed the applicant's existing and draft SPDES permits, fact sheets describing it, and the NYSDEC permit renewal process (NYSDEC 2003b). The NRC staff also reviewed relevant scientific publications, technical articles, and compilations associated with the study area, as well as documents and technical reports from NYSDEC, the National Marine Fisheries Service (NMFS), and other sources.

The SPDES permit for the Indian Point site, which addresses discharge from the currently operating IP2 and IP3, as well as the shutdown IP1 unit, was administratively continued by NYSDEC since a timely SPDES permit renewal application was filed 180 days prior to the current permit's stated expiration date of April 3, 1992. That permit remains in effect while

NYSDEC administrative proceedings continue.

Section 316(b) of the Clean Water Act of 1997 (CWA) (Title 33, Section 1326, of the United States Code (33 USC 1326)) requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. In the fact sheet for the site's draft SPDES permit, NYSDEC states that it has determined that the site-specific best technology available to minimize the adverse environmental impacts of the IP Units 1, 2, and 3 cooling water intake structures is closed-cycle cooling (NYSDEC 2003b). Under the terms of the draft SPDES permit, NYSDEC (2003b) states that it will evaluate proposals from Entergy to institute alternative methods to avoid adverse environmental impacts. Given NYSDEC's statements in the proposed SPDES permit, the NRC staff decided to consider the environmental impacts that may occur if Entergy institutes closed-cycle cooling at IP2 and IP3—as well as the environmental impacts of a possible alternative method of reducing impacts to aquatic life—in Chapter 8 of this SEIS. In the following sections, the NRC staff addresses impacts from the current cooling system.

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 through 1997 have not shown any negative trend in overall aquatic populations attributable to plant operations and that current mitigation measures will ensure that entrainment impacts remain SMALL during the license renewal term. Therefore, the applicant asserted (Entergy

2007a) that continued operation of once-through cooling at the site "does not have any demonstrable negative effect on representative Hudson River fish populations nor does it warrant further mitigation measures." Barnthouse et al. (2008) used an ecological risk assessment approach to evaluate the potential for adverse impacts to the representative important species (RIS) of the Hudson River from a variety of natural and anthropogenic stressors, including the operation of the IP2 and IP3 cooling water intake system, fishing pressure, the presence of zebra mussels, predation by striped bass, and water temperature. The authors concluded that operation of the IP2 and IP3 cooling met the NRC criteria for a SMALL impact level.

NYSDEC Assessment

Under the CWA, the U.S. Environmental Protection Agency (EPA) has delegated authority for the NPDES permit and Water Quality Certification programs in the State of New York to NYSDEC. The regulatory role of NYSDEC in the operation of the IP2 and IP3 cooling system includes protecting aquatic resources from impacts associated with impingement, entrainment, and thermal and chemical discharges through issuance of State (SPDES) permits and other means. As indicated above, the SPDES permit for IP2 and IP3 has been administratively continued under provisions of the New York State Administrative Procedure Act. Regarding Section 316(b) of the CWA and New York Code, Rules and Regulations, Section 704.5 (6 NYCRR Section 704.5), NYSDEC (2003b) has determined that the site-specific best technology available to minimize the adverse environmental impact of the IP1, IP2, and IP3 cooling water intake structures is closed-cycle cooling.

In 2003, NYSDEC developed a final environmental impact statement (FEIS) (NYSDEC 2003a) in response to the DEIS submitted by the operators of IP2 and IP3, Roseton, and Bowline Point (CHGEC et al. 1999). In the FEIS, NYSDEC noted that "while the DEIS was acceptable as an initial evaluation and assessment, it was not sufficient to stand as the final document, and additional information as to alternatives and evaluation of impacts must be considered." In responding to public comments on the DEIS (CHGEC et al. 1999), NYSDEC noted that, in contrast to the utilities' assertions that the Hudson River fish community is healthy and robust, changes in "total species richness and diversity suggest that the Hudson estuary ecosystem is far from equilibrium." NYSDEC points out that the approach used by the utilities assumes "selected cropping" of individual fish species while "the impacts associated with power plants are more comparable to habitat degradation; the entire natural community is impacted" because entrainment, impingement, and warming of the water simultaneously affect the entire aquatic community of organisms. Emphasizing a more ecological approach, NYSDEC detailed the importance of food webs, trophic and other interspecies relationships, and ecosystem functioning.

NYSDEC (2003a) also stated that, while the changes to the IP2 and IP3 cooling system, including the use of dual-speed and variable-flow pumps and the installation of modified Ristroph traveling screens, "represent some level of improvement compared to operations with no mitigation or protection, there are still significant unmitigated mortalities from entrainment and impingement at all three of the Hudson River Settlement Agreement (HRSA) facilities." NYSDEC (2003a) concluded that the millions of fish killed by impingement, entrainment, and thermal effects at the HRSA power plants represent a significant source of mortality and stress on the Hudson River's fish community and must be taken into account when assessing the observed fish population declines. To help mitigate such losses, the NYSDEC (2003b) fact

sheet for the draft SPDES permit states that "This permit does not require the construction of cooling towers unless: (1) the applicant seeks to renew its NRC operating licenses, (2) the NRC approves extension of the licenses, and determines that the installation and operation of closed-cycle cooling is feasible and safe, and (3) all other necessary Federal approvals are obtained." Furthermore, NYSDEC states that if the NRC grants extensions of the operating licenses, Indian Point would have to submit for NYSDEC approval a revised construction schedule for closed-cycle cooling.

NYSDEC, in Section 1, "Biological Effects," of Attachment B to the 2003 SPDES fact sheet (NYSDEC 2003b), states that operation of IP2 and IP3 results in the mortality of more than a billion fish of various lifestages per year and that losses are distributed primarily among seven species, including bay anchovy, striped bass, white perch, blueback herring, Atlantic tomcod, alewife, and American shad. Of these, NYSDEC indicates that the populations of Atlantic tomcod, American shad, and white perch are known to be declining in the Hudson River and considers current losses to be substantial.

Studies have also been conducted to detect trends of fish populations in the Hudson River. Both the applicant and NYSDEC have used the results of these studies to assess the potential for adverse effects associated with the operation of the IP2 and IP3 cooling system. The results of these assessments are described below. Some nongovernmental organizations (NGOs) and citizens have also evaluated publicly available information and data associated with the Hudson River and have expressed the opinion that many species of fish in the Hudson River are in decline and that the entrainment and impingement of all lifestages of fish and shellfish at IP2 and IP3 is contributing to the decline of these important aquatic resources.

On April 2, 2010, NYSDEC issued a Notice of Denial regarding the Clean Water Act Section 401 Water Quality Certification for IP2 and IP3. Entergy has since requested a hearing on the issue, and the matter will be decided through NYSDEC's hearing process.

NRC Assessment

Because the draft SPDES permit (which includes NYSDEC's 316(b) determination regarding the cooling water intake structure) is subject to ongoing adjudication, the NRC staff conducted an independent impact analysis for the purpose of addressing the Category 2 issues identified in Table 4-2 of this SEIS. The operation of the IP2 and IP3 cooling system can directly affect the aquatic communities of the Hudson River through impingement, entrainment, and thermal releases. Evaluating the potential for adverse impacts of the cooling system to the aquatic resources of the Hudson River estuary presents a significant challenge for three primary reasons:

(1) The potential stressor of interest (the IP2 and IP3 cooling system) occupies a fixed position on the Hudson River, while many of the RIS that the NRC staff have chosen for evaluation have the freedom to move up- and down-river during different stages in their growth and development, during different seasons of the year, and, in some cases, at different times of day.

(2) The Hudson River estuary is a dynamic, open-ended system containing a complex food web that extends from the freshwater portion of the river downstream of the Troy Dam to the Atlantic Ocean. Detectable changes in RIS populations may be influenced by natural stressors or may be the result of stressors associated with human activities, which include the operation of IP2 and IP3.

(3) Because the Hudson River estuary represents a complex system with hundreds of aquatic species, the NRC staff chose to focus its analysis of impact on a subset of RIS historically used to monitor the lower Hudson River (as indicated in Section 2.2.5.4 of this SEIS). By focusing on a subset of species that are representative of many of the species that exist in the lower Hudson River fish community, the NRC staff can more easily analyze impacts to the Hudson River community, and the NRC staff can make use of a large body of sampling data compiled over many years. The NRC staff acknowledges that the simplification inherent in relying on RIS may introduce some additional uncertainty, but the NRC staff finds that the utility of the RIS approach (due to the availability of large, long-term data sets; applicability to species with similar characteristics; and comparability to other Hudson River studies) in evaluating communitywide effects outweighs the uncertainties associated with using it.

Because impingement and entrainment are fundamentally linked, the NRC staff determined that the effects of each should be assessed using an integrated approach, described in Section 4.1.3 of this SEIS. The NRC staff assessed thermal impacts separately in Section 4.1.4. Because the analysis of the environmental impacts associated with the IP2 and IP3 cooling system is complex, the NRC staff provides summary results, analyses, and conclusions in this chapter, and provides a complete discussion of the environmental impact assessment in Appendix H, with supporting statistical analyses in Appendix I to this SEIS.

4.1.1 Impingement of Fish and Shellfish

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingent can kill organisms immediately or contribute to a slower death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwashing and fish return system that the plant operator uses. In this section, the NRC staff provides a summary assessment of impingement impacts based on the NRC staff analyses of available data. More details appear in Appendix H.

The NRC staff employed a weight-of-evidence (WOE) approach during the development of the draft SEIS to evaluate the effects of the IP2 and IP3 cooling system on the aquatic resources of the Hudson River estuary. The WOE consisted of two lines of evidence: (1) long-term population trends of RIS that live in the Hudson River and (2) strength of connection, defined by the staff as the potential for the operation of the IP2 and IP3 cooling system to directly affect aquatic resources of interest. In this SEIS, the NRC staff modified and refined some aspects of the WOE to provide a better assessment of the potential for adverse effects to aquatic resources in response to public comments received on the draft SEIS. The major changes from the draft SEIS to this SEIS included a more straightforward, simplified approach to assessing RIS population trends and the use of Monte Carlo population simulations to assess the strength of connection. The NRC staff also removed the coastal population trend information from the WOE but used it as ancillary information for RIS population trend discussions. Section 4.1.3 describes an overview of the modified WOE approach; Appendixes H and I contain specific details of the final analyses. Other changes in the final analysis were the use of updated environmental data from the operation of IP2 and IP3, which the applicant provided after the publication of the draft SEIS to replace previously submitted information that contained errors.

Thus, the data, analysis, and conclusions presented in this SEIS reflect modifications to the WOE analysis and the corrected information provided by the applicant.

Impingement monitoring at IP2 and IP3 was conducted by former plant owners and their contractors between 1975 and 1990 using a variety of techniques, as summarized in Appendix H of this SEIS. The NRC staff assessment for the effects of cooling water system operation concentrated on 18 RIS identified in Section 2.2.5.4, which include the 17 species identified in the Hudson River utilities' DEIS (CHGEC et al. 1999) for assessing power plant effects plus the Atlantic menhaden (*Brevoortia tyranus*), a member of the herring family whose young are common inhabitants of the lower Hudson River. All but one RIS are fish; the exception is the blue crab (*Callinectes sapidus*). The estimated number of impinged RIS made up greater than 90 percent of all impinged taxa for all but one year at IP2 (Figure 4-1); at IP3, the estimated number of RIS impinged was greater than 85 percent for all but one year (Figure 4-2). To assess impingement impacts, the NRC staff analyzed weekly estimated impingement numbers at IP2 and IP3 from January 1975 to November 1980 and seasonally estimated impingement numbers from January 1981 to December 1990. (The former plant owners and their contractors based estimated numbers on sampling data.) The combined numbers of young of the year (YOY), yearling, and older fish were used for analysis since these data were available for all years of sampling.

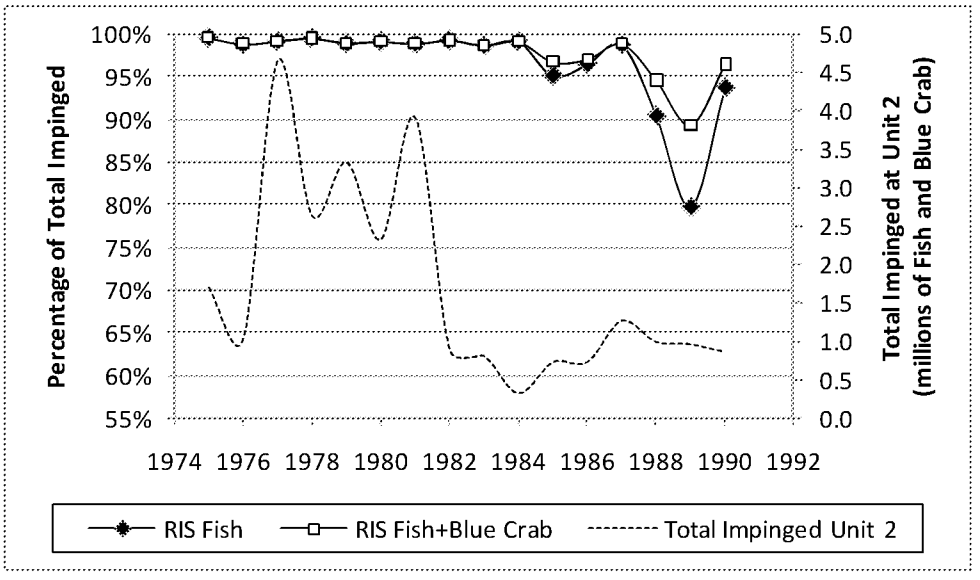


Figure 4-5. Percentage of impingement of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP2 (data from Entergy 2007b and 2009)

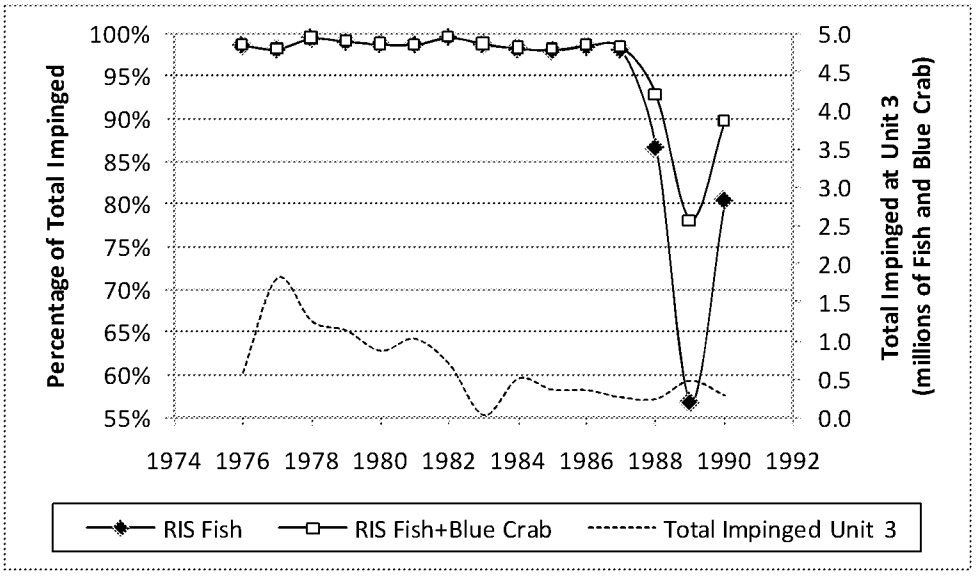


Figure 4-2. Percentage of impingement composed of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP3 (data from Entergy 2007b and 2009)

Total impingement trends at IP2 and IP3 suggest that the total number of fish and blue crab impinged tended to decrease between 1977 and 1982, then generally leveled off between 1982 and 1990 (as shown in Figures 4-1 and 4-2). If the IP2 and IP3 cooling systems are considered a relatively constant sampler of Hudson River aquatic biota (recognizing the slight increase in days of operation and volume of water circulated at IP2 and IP3 from 1975 to 1990), then the decrease in the percent of RIS impinged and total impingement would suggest that RIS and all other taxa within the vicinity of IP2 and IP3 have decreased from a high in 1977 to a relatively constant lower level between 1984 and 1990. This decline will be explored further in Section 4.1.3 of this SEIS.

In addition to evaluating trends in impingement losses, the NRC staff also reviewed the results of studies designed to evaluate impingement mortality. Before installation of modified Ristroph screen systems in 1991, impingement mortality was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species (see Appendix H for additional detail). The final design of the screens (Version 2), as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the existing (original) system in place at IP2 and IP3. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad (Table 4-3). As it was not required by NYSDEC, no further monitoring of impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991.

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

Species	Percent Dead and Injured
Alewife	62
American Shad	35
Atlantic Tomcod	17
Bay Anchovy	23
Blueback Herring	26
Hogchoker	13
Striped Bass	9
Weakfish	12
White Catfish	40
White Perch	14

Source: Fletcher 1990

Based on Fletcher's assessment, the NRC staff concludes that the IP2 and IP3 cooling system continues to impinge RIS of the lower Hudson River and that impingement mortality for 4 of the 10 species exceeds 25 percent. Monitoring data (Entergy 2007b and 2009), reviewed by NRC staff) also showed that impingement was greater at IP2 than at IP3 and that impingement has generally declined since 1976. Although IP2 and IP3 currently employ modified Ristroph

screens and fish return systems to increase the survival rates of impinged organisms, since impingement monitoring was required by NYSDEC after 1990, the actual improvements in fish survival after installation of these systems at IP2 and IP3 have not been established (impingement monitoring last occurred in 1990). In Section 4.1.3 of this SEIS, the NRC staff includes impingement results in a weight-of-evidence (WOE) analysis to evaluate the overall impacts of the IP2 and IP3 cooling system on lower Hudson River RIS.

4.1.2 Entrainment of Fish and Shellfish in Early Lifestages

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects organisms with limited swimming ability that can pass through the screen mesh, which is typically 0.25 to 0.5 inch (in.) (6.35 to 12.7 millimeters (mm)), used on the intake systems. Organisms typically entrained include phytoplankton, zooplankton, and the eggs, larvae, and juvenile forms of many of the fish and invertebrates.

Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system (see Appendix H for a more-detailed discussion). Despite increasingly refined study techniques, entrainment survival estimates were compromised by poor ichthyoplankton survival in control samples, and entrainment survival for many species is still unresolved. The variability of entrainment data informed the NRC staff's decision to employ a WOE approach.

To assess the effects of entrainment on the aquatic resources of the lower Hudson River, the NRC staff evaluated weekly average densities of entrained taxa for a given life stage for IP2 and IP3 from data provided by the applicant. The NRC staff then multiplied the mean weekly densities by the volume of circulated water to estimate the weekly number of organisms entrained for a given life stage, and then calculated the sum over weeks and life stage of the numbers entrained per taxa and season.

The entrainment monitoring data provided Entergy (2007b) contained 66 taxa. Blue crabs, shortnose and Atlantic sturgeon, and gizzard shad were not present in the 1981–1987 entrainment data. Some RIS data included taxa identified only to family or genus (e.g., anchovy family, *Alosa* spp., and *Morone* spp.) because the identification of early life stages for these groups is difficult. As shown in Figure 4-3, RIS fish represented greater than 70 percent of all

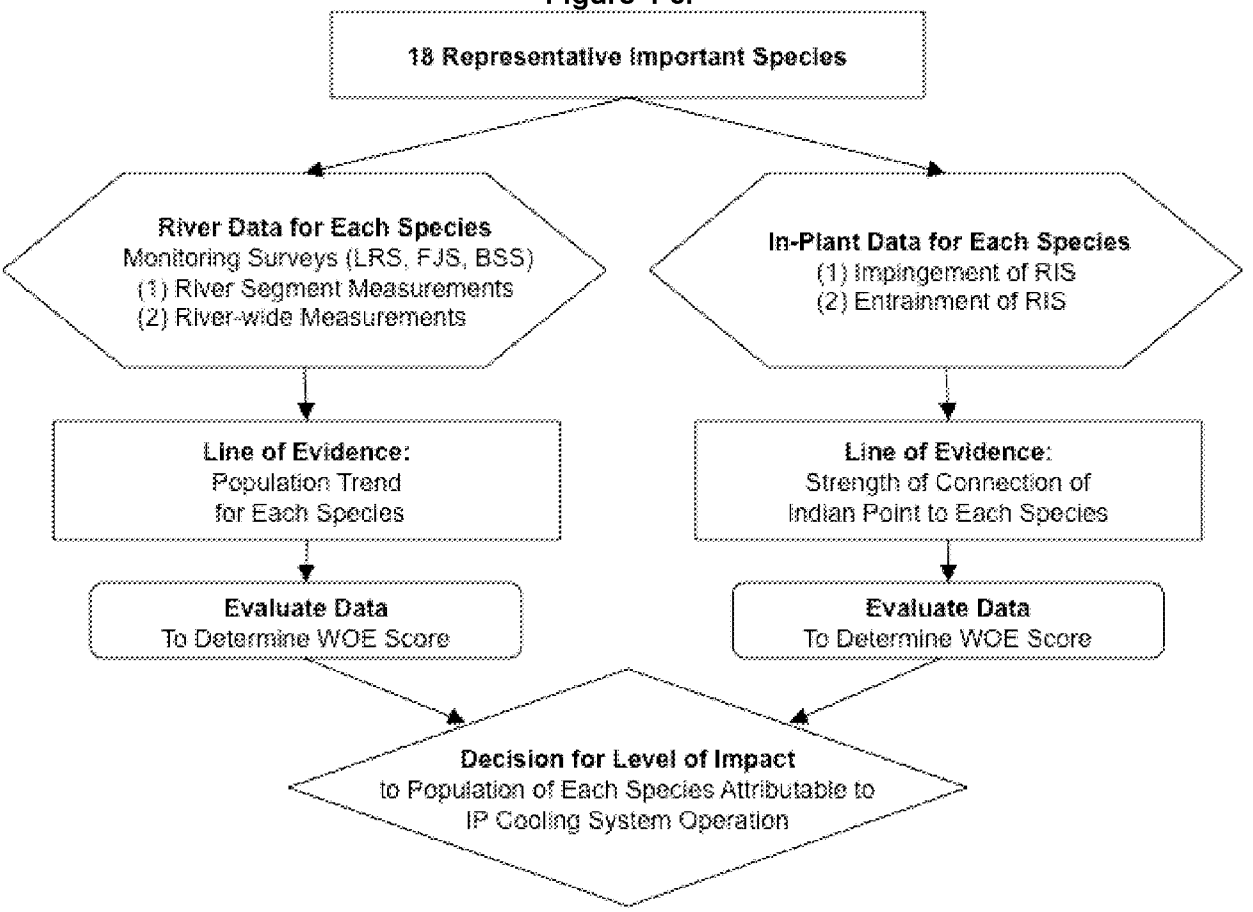
entrainment, except for 2 weeks in 1984 and 1985 (1 week in May and 1 in June) for which amphipods (*Gammarus* spp.) were present. The total number of identified fish entrained has decreased at a rate of 187 billion fish per year since 1984. This result is consistent with the decrease observed in the number of fish impinged (Figures 4-1 and 4-2).

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

4.1.3 Combined Effects of Impingement and Entrainment

The NRC staff used a modified WOE approach to evaluate whether the impingement and entrainment that occur during the operation of the IP2 and IP3 cooling system has the potential to adversely affect RIS in the lower Hudson River. The NRC staff followed a WOE approach (Figure 4-4) adapted from the process described in Menzie et al. (1996), which defines WOE as "...the process by which multiple measurement endpoints are related to an assessment endpoint to evaluate whether significant risk of harm is posed to the environment." The NRC staff describes the specific steps used in its WOE approach in the sections that follow, and provides a detailed discussion of its WOE process in Appendix H.

Figure 4-5.



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

Step 1: Identify the Environmental Component or Value to Be Protected

For this assessment, the environmental component to be protected is the Hudson River aquatic resources as represented by the 18 RIS identified in Table 2-4. These species represent a variety of feeding strategies and food web classifications and are ecologically, commercially, or recreationally important. The WOE approach focuses primarily on the potential impacts to young-of-the-year (YOY) and yearling fish and their food sources. The long-term sampling programs of the Hudson River, on which this analysis is based, focused on these early lifestages. Although eggs and larval forms are important components to the food web, the natural mortality to these lifestages is high. In contrast, fish surviving to the YOY stage and older are more likely to add to the adult breeding population and are at greater risk from the cooling system operation. Any factor that decreases (or increases) the survival of those fish during juvenile and yearling stages can affect the sustainability of the population.

Step 2: Identify Lines of Evidence and Quantifiable Measurements

The goal of this step is to identify data sets and information that can be used to assess the potential for adverse environmental effects and determine whether the IP2 and IP3 cooling

system is contributing to the effect. The NRC staff developed two lines of evidence (LOE) to evaluate impacts. The first LOE was the long-term population trends of RIS species in the lower Hudson River which staff used to determine whether any populations were declining. The second LOE was a measure of the potential for the operation of the IP2 and IP3 cooling system to directly affect aquatic resources of interest (strength of connection). The NRC staff required the occurrence of a detectable population decline and the presence of a high strength of connection to declare an adverse impact to an RIS. To support these analyses, the NRC staff used data provided by the applicant including impingement and entrainment monitoring data obtained from the IP2 and IP3 facility and data from the lower Hudson River collected during the Long River Survey (LRS), Fall Juvenile/Fall Shoals Survey (FJS/FSS), and Beach Seine Survey (BSS)(Table 2-3). Appendix H contains a summary of measurements for each LOE

Step 3: Quantify the Use and Utility of Each Measurement.

The following attributes of each measurement within each LOE were assigned an ordinal score corresponding to a ranking of its use and utility of low, medium, or high:

- Strength of Association: The extent to which the measurement is representative of, correlated with, or applicable to the RIS.
- Stressor-specificity: The extent to which the measurement is associated with a specific stressor or the extent to which the data used in the assessment relate to the stressor of interest.
- Site-specificity: The extent to which data used in the assessment relate to the site of interest.
- Sensitivity of the Measurement: The ability of the measurement to detect a response.
- Spatial Representativeness: The degree of compatibility between the study area and the location of measurements, known stressors, and biological receptors.
- Temporal Representativeness: The degree of compatibility between the measurement and the time period during which effects are expected to occur.
- Correlation of Stressor to Response: The degree of correlation between the levels of exposure to a stressor and levels of response observed in the measurement.

The NRC staff then calculated overall use and utility scores for each measurement for the population LOE as the average of the individual attribute rankings. The NRC staff did not apply use and utility to the strength of connection LOE because it is semi-quantitative. The scores for each LOE are available in Appendix H.

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

The NRC staff developed decision rules for the first LOE to determine the historical trends in lower Hudson River RIS populations. The NRC staff used a mathematical approach to integrate the regression results (e.g., detected population decline) from each field survey to produce a single conclusion for a given RIS population trend. Appendices H and I provide detailed

discussions of how the decision rules were developed and used in the environmental assessment. The possible outcomes of this analysis are as follows:

- RIS populations were not declining if their population trends had slopes that were not significantly less than zero (i.e., undetected population declines or detectable population increases). This indicated that the RIS populations had not changed appreciably over time, or were increasing.
- RIS populations were declining if their population trends had slopes that were significantly less than zero (i.e., detectable population decline).
- RIS populations were variable if historical trend data were ambiguous (i.e., some data showed detectable declines, whereas others did not).

The NRC staff applied these decision rules for each RIS species if sufficient data were available to support a determination, but defined the level of impact "unresolved" if sufficient data were not available.

The NRC staff developed decision rules for the second LOE to determine the strength of connection between the operation of the IP2 and IP3 cooling system and the RIS in the lower Hudson River. The NRC staff's measure of the strength of connection was based on the magnitude of influence that impingement and entrainment by the IP2 and IP3 cooling system had on the RIS population abundance with respect to its temporal viability. Specifically, the staff used numerical model simulations to determine whether the difference in population abundances with and without losses from impingement and entrainment was detectable relative to annual population variability. The decision rules for this LOE were:

- A low strength of connection occurred when model simulations showed that it was not possible to detect differences in population abundance with and without impingement and entrainment losses. In this case, the RIS population variability was too large to enable detection of impingement and entrainment losses.
- The NRC staff also defined the strength of connection as low if an RIS could not be modeled with the Monte Carlo simulation because it occurred rarely in entrainment and impingement samples. Appendixes H and I provide a complete description of this process.
- A high strength of connection occurred when model simulations showed that the difference in population abundance with and without losses from impingement and entrainment was detectable with respect to annual population variability. In this case, the effects of impingement and entrainment were greater than the variability in the RIS population trends.

Step 5: Integrate the Results and Assess Impact

The NRC staff used a mathematical approach to integrate the regression results (e.g., detected population decline) from each of the field surveys to produce a single conclusion for a given RIS population trend. The staff used a logic-based approach to integrate the conclusions from the population trend LOE and the strength of connection LOE. NRC staff defined the IP2 and IP3

cooling system impact as SMALL for a given RIS if the second LOE concluded that there was a low strength of connection (i.e., no evidence that system operation was adversely influencing long-term population trends). Staff also defined the cooling system impact as SMALL for a given RIS if the first LOE concluded that there was not a detectable population decline even if the second LOE concluded that there was a high strength of connection. In that case, the losses of eggs, larvae, and YOY to the IP2 and IP3 cooling system were not sufficient to noticeably reduce the RIS population over time. The staff defined the IP2 and IP3 cooling system impact as MODERATE for a given RIS if the first LOE concluded that the RIS population trend was variable and the second LOE concluded a high strength of connection. The staff defined the cooling system impact as LARGE for a given RIS if the first LOE concluded that there was a detectable population decline and the second LOE concluded that there was a high strength of connection. Appendices H and I provide detailed descriptions of the process and statistical analysis that the NRC staff used to reach these determinations. The final cooling system impact assessments are consistent with the NRC guidelines for SMALL, MODERATE, and LARGE potential for adverse impacts as defined below:

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

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

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

What follows is the NRC staff assessment of the two LOE (population trends and strength of connection) and a determination of impact associated with impingement and entrainment at IP2 and IP3 using the above definitions.

4.1.3.1 Assessment of Population Trends—The First Line of Evidence

The NRC staff used data from the LRS, FSS, and BSS studies of the lower Hudson River from 1974 to 2005, as described above, to assess population trends. Staff obtained data from the applicant in electronic format including weekly catch density, an abundance index, total catch, and sample volumes. The staff also calculated catch-per-unit-effort values as a ratio of the total catch and sample volume. The NRC staff also used commercial and recreational harvest statistics from the Atlantic States Marine Fisheries Commission (ASMFC) as ancillary information to evaluate coastal population trends for striped bass, American shad, Atlantic sturgeon, river herring, bluefish, Atlantic menhaden, and weakfish.

The NRC staff assessed YOY population trends in river segment 4 (the region of the lower Hudson River where IP2 and IP3 are located) and the lower Hudson River from the Troy Dam to the Battery (river-wide). The final WOE score reflects an integrated result for both measurements (Table 4-4). The analysis showed that YOY American shad, Atlantic tomcod, blueback herring, bluefish, hogchoker, spottail shiner, and white perch populations were declining, and that bay anchovy and striped bass populations were not declining. Alewife, rainbow smelt, weakfish, and white catfish exhibited variable population trends, meaning some data showed detectable declines, whereas other data did not. Atlantic menhaden, Atlantic sturgeon, gizzard shad, shortnose sturgeon, and blue crab showed unresolved population trends because Hudson River monitoring programs did not collect enough of these species to

support statistically significant trend analyses. The impact on these species resulting from IP2 and IP3 operation under a renewed license is discussed in section 4.1.3.3 of the SEIS.

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

The NRC staff conducted strength of connection analyses to determine whether the operation of the IP2 and IP3 cooling system had the potential to influence RIS populations near the facility or within the lower Hudson River. Appendix H contains a summary of this analysis, and Appendix I has detailed information on the analysis procedures.

The strength of connection analysis assumes that the IP2 and IP3 cooling system can affect aquatic resources directly through impingement or entrainment or indirectly by impinging and entraining potential food (prey). The NRC staff used model simulations to evaluate the detectability of the influence of impingement and entrainment by the IP2 and IP3 cooling system on the RIS population abundance relative to the population variability. YOY population densities near Indian Point are inherently variable, and thus the effects of the cooling system operation on a given population must be greater than the variability in the abundance of the population over time for them to be detectable. The NRC staff compared population models that included impingement and entrainment losses with modeled trends without such losses by running multiple simulations of a given population trend with its associated variability.

The applicant acknowledged after the publication of the draft SEIS that the applicant and its contractors had provided NRC staff electronic impingement data that contained errors. The staff received updated information (verified as correct by the applicant) and used this information to develop the Final SEIS. Thus, the impingement losses reported and conclusions in the draft SEIS are revised in the FSEIS.

The population simulation analysis showed that alewife, bay anchovy, blueback herring, hogchoker, rainbow smelt, spottail shiner, striped bass, weakfish, and white perch exhibited a High strength of connection with operation of the IP2 and IP3 cooling system (Table 4-4). The Monte Carlo model simulations predicted that the population abundances for those species were detectibly smaller when impingement and entrainment losses were included than when they were not. American shad, Atlantic menhaden, Atlantic sturgeon, Atlantic tomcod, bluefish, gizzard shad, shortnose sturgeon, white catfish, and blue crab populations exhibited a Low strength of connection. The Monte Carlo model simulations for those species could not detect a difference in population size for scenarios with and without impingement and entrainment losses, or those species rarely occurred in entrainment and impingement samples.

4.1.3.3 Impingement and Entrainment Impact Summary

The NRC staff used two lines of evidence (LOE to determine whether the operation of the IP2 and IP3 cooling system had the potential to cause adverse impacts to the RIS populations of the lower Hudson River. The first LOE considered RIS population trends from long-term data sets; the second considered the potential for the operation of the IP2 and IP3 cooling system to influence RIS population abundance. The NRC staff integrated the results from these LOE to determine the impacts of cooling system operation on RIS populations that are indicative of the aquatic resources of the lower Hudson River.

Based on the WOE assessment (Table 4-4), the NRC staff concludes that impacts to American shad, Atlantic menhaden, Atlantic sturgeon, Atlantic tomcod, bay anchovy, bluefish, gizzard shad, shortnose sturgeon, striped bass, white catfish, and blue crab are SMALL. The NRC staff

concludes impacts to alewife, rainbow smelt and weakfish are MODERATE. The staff concludes that impacts to blueback herring, hogchoker, spottail shiner, and white perch are LARGE. The NRC staff used the river-wide abundance and CPUE data, and river segment 4 (Indian Point) density and CPUE information from FSS, BSS, and LRC studies for each RIS to support population trend analysis. Section 4.1.3.4 provides a discussion of the uncertainty associated with the impact analysis, and Section 4.1.3.5 presents the final integrated assessment of the impact of the IP2 and IP3 cooling system for all RIS combined.

Large Impacts

Blueback Herring

The NRC staff concludes that a LARGE impact is present for YOY blueback herring because a detectable population decline occurred in most of the river-wide (3 of 3) and river segment (2 of 3) data sets used in the analysis, and the strength of connection with the IP2 and IP3 cooling system is high. Blueback herring, which along with alewife are known as river herring, share many life history and distribution characteristics with alewife. An anadromous species, blueback herring migrate upriver to spawn during the spring, and live about 7-8 years. This species feeds primarily on insect larvae and copepods, and is prey for bluefish, weakfish, and striped bass (Hass-Castro 2006). Hass-Castro (2006) also reports that river herring populations are well below historic levels of the mid 20th century, possibly because of overfishing, habitat destruction, and states that a population assessment has been listed as a high priority by the Atlantic States Marines Fisheries Council (ASMFC), given that the blueback herring is listed as a species of concern by the NMFS.

Hogchoker

The NRC staff concludes that a Large impact is present for YOY hogchoker because a detectable population decline occurred in most of the river-wide (2 of 3) and river segment (3 of 3) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. This species is a right-eyed flatfish that occurs in the Hudson River estuary and surrounding bays and coastal waters. Adults are generalists, and eat annelids, arthropods, and siphons of clams; adults and juveniles are prey of striped bass. Coastal population trend data were not available for this species.

Spottail Shiner

The NRC staff concludes that a Large impact is present for YOY spottail shiner because a detectable population decline occurred in the river-wide (1 of 3) and river segment (1 of 1) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. The habitat for the spottail shiner includes small streams, lakes, and large rivers, including the Hudson. This species feeds primarily on aquatic insect larvae, zooplankton, benthic invertebrates, and fish eggs and larvae, and is the prey of striped bass. Spottail shiners spawn from May to June or July (typically later for the northern populations) over sandy bottoms and stream mouths (Smith 1985; Marcy et al. 2005); water chestnut (*Trapa natans*) beds provide important spawning habitat (CHGEC 1999). Individuals older than 3 years are rare, although some individuals may live 4 or 5 years (Marcy et al. 2005). Spottail shiner is not a marine or anadromous species, so coastal population trend data are not available.

White Perch

The NRC staff concludes that a large impact is present for YOY white perch because a detectable population decline occurred in the majority of the river-wide (3 of 3) and river segment (2 of 3) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. White perch is an estuarine species that is a year-round resident in the Hudson River and is commonly entrained by IP2 and IP3. An opportunistic feeder, this species is prey to large piscivorous fish and terrestrial vertebrates. Reported recreational and commercial landings in the Hudson River have never been great, and commercial fishing was closed in 1976 because of PCB contamination. In contrast to the Hudson River, white perch populations appear to be relatively stable in the Maryland portion of Chesapeake Bay, and the commercial harvest has generally increased since 1980 in that area (Maryland DNR 2005).

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

Species	Population Trend Line of Evidence	Strength of Connection Line of Evidence	Impacts of IP2 and IP3 Cooling Systems on YOY RIS
Alewife	Variable	High	Moderate
American Shad	Detected Decline	Low	Small
Atlantic Menhaden	Unresolved[a]	Low[b]	Small
Atlantic Sturgeon	Unresolved[a]	Low[b]	Small
Atlantic Tomcod	Detected Decline	Low	Small
Bay Anchovy	Undetected Decline	High	Small
Blueback Herring	Detected Decline	High	Large
Bluefish	Detected Decline	Low	Small
Gizzard Shad	Unresolved[a]	Low[b]	Small
Hogchoker	Detected Decline	High	Large
Rainbow Smelt	Variable	High	Moderate-Large[c]
Shortnose Sturgeon	Unresolved[a]	Low[b]	Small
Spottail Shiner	Detected Decline	High	Large
Striped Bass	Undetected Decline	High	Small
Weakfish	Variable	High	Moderate
White Catfish	Variable	Low	Small
White Perch	Detected Decline	High	Large
Blue Crab	Unresolved[a]	Low[b]	Small

(a) Population trend could not be established because of a lack of river survey data.
(b) Monte Carlo simulation could not be conducted because of the low rate of entrainment and impingement; a Low Strength of connection was concluded.
(c) Section 4.1.3.3 provides supplemental information.

Moderate Impacts

Alewife

The NRC staff concludes that a Moderate impact is present for YOY alewife because a detectable population decline occurred in river segment 4 (3 out of 3 data sets) and the strength of connection with the IP2 and IP3 cooling system is high. The NRC staff found that the population trend results were variable because the declines observed in river segment 4 were not confirmed by river- wide population trends. YOY alewife (river herring) are present in the lower and upper reaches of the Hudson River and feed as juveniles primarily on amphipods, zooplankton, and fish eggs and larvae, and, as adults on small fish. This species is also prey for bluefish, weakfish, and striped bass. The ASMFC implemented a combined fisheries management plan for American shad and river herring in 1985. Although the herring fishery is one of the oldest fisheries in the United States, no commercial fishery for river herring currently exists in the Hudson River. River herring population declines have been reported in Connecticut, Rhode Island, and Massachusetts, and NMFS has listed river herring as a species of concern throughout its range (Hass-Castro 2006).

Rainbow Smelt

The NRC staff concludes that the level of impact for rainbow smelt is MODERATE to LARGE because detectable population declines occurred in river-wide (1 of 2) and river segment (1 of 2) data sets and strength of connection with the IP2 and IP3 cooling system is high. Although detectable population declines occurred in two of four river data sets, indicating population trend results were variable, the staff concluded that a MODERATE to LARGE, rather than just MODERATE, impact was present based on the dramatic population declines observed for this species over the past three decades. Rainbow smelt is an anadromous species once commonly found along the Atlantic Coast. Larval and juvenile smelt feed primarily on planktonic crustaceans; adults eat crustaceans, polychaetes, and small fish. Bluefish and striped bass are primary predators of rainbow smelt. Once a prevalent fish in the Hudson River, the rainbow smelt has undergone an abrupt population decline in the Hudson River since 1994, and the species may no longer have a viable population within the Hudson River. The last tributary run of rainbow smelt was recorded in 1988, and the Hudson River Utilities' Long River Ichthyoplankton Survey showed that PYSL essentially disappeared from the river after 1995 (Daniels et al. 2005). The NRC staff's regression analysis of rainbow smelt population trends was affected by the lack of rainbow smelt caught by the Hudson River field surveys after 1995. Detectable population declines were present for CPUE data set but not for density or abundance index data, given the disappearance of this species from the Hudson river. Thus, the WOE conclusion of moderate impact may, in fact, be an underestimate of the true impact. Therefore, the staff concluded that a MODERATE to LARGE impact assessment was more appropriate.

Weakfish

The NRC staff concludes that a MODERATE impact is present for weakfish because detectable population declines occurred in river-wide (1 of 2) and river segment (1 of 2) data sets, and the strength of connection with the IP2 and IP3 cooling system is high. Because detectable declines occurred in two of four river data sets, staff determined that the population trend results were variable. The weakfish is historically one of the most abundant fish species along the Atlantic coast and is fished recreationally and commercially. Small weakfish prey primarily on crustaceans, whereas larger individuals eat small fish. Bluefish, striped bass, and larger weakfish are the primary predators of smaller weakfish. Weakfish are thought to be in decline based on decreased commercial landings in recent years. The weakfish stock declined suddenly in 1999 and approached even lower levels by 2003, which the ASMFC determined to be because of higher natural mortality rates rather than fishing mortality (ASMFC 2007). A leading hypothesis suggests that reduced prey availability and increased predation by striped bass may contribute significantly to rising natural mortality rates in the weakfish population (ASMFC 2007a).

4.1.3.4 Discussion of Uncertainty

This analysis generally follows the EPA (1998) guidelines for ecological risk assessment. In reporting risks of adverse effects, EPA (1998) recommends that practitioners acknowledge and summarize the major areas of uncertainty in their analyses. Uncertainty, as described by EPA, has many sources. The two lines of evidence in NRC's WOE approach have different sources of uncertainty.

NRC's population trends line of evidence (LOE-1) applies statistical tests to determine if YOY RIS populations have remained stable over time or have declined. The Hudson River utilities had collected the data used to assess aquatic RIR population trends continuously over three decades from a variety of locations along the Hudson River using standard protocols. They had applied accepted principles of experimental design and accepted sampling protocols. Over the years, they conducted special studies to resolve uncertainties identified in review of the studies by NYSDEC and others. They reported methods and results including both means and variances or other measures of central tendency and uncertainty. The NRC staff considers the data to be of high quality with minimal or known uncertainties and both useful and relevant for NRC's WOE analysis. A gear change in the FSS introduced an unquantifiable source of uncertainty in the RIS population trend results. The NRC applied analytic methods to minimize possible bias, but gear changes in monitoring programs almost always introduce uncertainties.

The NRC's strength of connection line of evidence (LOE-2) incorporates estimates of conditional mortality rate in Monte Carlo analyses to simulate changes in population trends with and without entrainment and impingement. The NRC calculated the conditional entrainment mortality rate and used estimates of conditional impingement mortality rate calculated by Entergy consultants. Both have quantifiable estimates of uncertainty. NRC provides the statistical basis for determining if simulated changes in population trends with and without entrainment and impingement differ. An unquantifiable source of uncertainty arises from the lack of studies at IP2 and IP3 since 1990 and 1987, respectively, confirming reductions of impingement mortality rates from improvements made to the IP2 and IP3 Ristroph screens and fish return system that appeared to reduce impingement mortality for some species in a pilot study (Fletcher 1990). The conditional impingement mortality rates used in NRC's analysis include adjustment for partial survival associated with the installation of Ristroph screens at IP2 and IP3.

NRC followed recommendations of the Massachusetts Weight-of-Evidence Workgroup (Menzie et al. 1996) in describing the overall value, use and utility, and uncertainties associated with the overall WOE approach. Consistent with Menzie et al. (1996), NRC staff used professional judgment to select and refine WOE methods before analyzing data and documented all steps (see Appendices H and I) to allow interested readers to gain an understanding of the assumptions, limitations, and uncertainties associated with this assessment. The NRC staff has also employed a similar methodology to assess effects of power plant operation on fish populations in its GEIS Supplement 22, regarding Millstone Power Station, Units 2 and 3 (NRC 2005). The NRC's staff's findings for impact from impingement and entrainment at IP2 and IP3, as described in Table 4-4, represent the NRC staff's best estimates based on the WOE derived from the available data and they contain both quantifiable and unquantifiable uncertainties.

4.1.3.5 Overall Impingement and Entrainment Impact

Because the WOE assessment results can be expressed numerically with respect to IP2 and IP3 adverse impacts (e.g. small adverse impacts = 1, moderate impacts = 2, large impacts = 4), it is possible to determine the overall impacts of the IP2 and IP3 cooling system using the WOE impact summary conclusions presented in Table 4-4. This type of scoring is reflective of an equally spaced interval on a logarithmic scale for which the magnitude of harm is doubled at each step. The NRC staff used these scoring criteria to calculate an average for the 18 RIS impact assessment results. Based on the assumption that the chosen RIS are representative surrogates for the aquatic community important to the lower Hudson River, the NRC staff

concludes that the overall impact of the operation of IP2 and IP3 cooling systems to the aquatic resources of the lower Hudson River is MODERATE during the relicensing period.

4.1.4 Heat Shock

As discussed in Chapter 2, thermal discharges associated with the operation of the once-through cooling water system for IP2 and IP3 are regulated by NYSDEC. Temperature limitations are established and imposed on a case-by-case basis for each facility subject to 6 NYCRR Part 704.

Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR Part 704 as follows:

> (5) Estuaries or portions of estuaries.
>
> (i) The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point.
>
> (ii) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or a maximum of 83°F, whichever is less.
>
> (iii) From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than an 83°F increase in temperature not to exceed 1.5°F at any point of the estuarine passageway as delineated above, may be permitted.
>
> (iv) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than 4°F from the temperature that existed immediately prior to such lowering.

Thermal discharges associated with the operation of IP2 and IP3 are regulated under existing SPDES permit NY-0004472. This permit imposes effluent limitations, monitoring requirements, and other conditions to ensure that all discharges are in compliance with Title 8 of Article 17 of the Environmental Conservation Law (ECL) of New York State, 6 NYCRR Part 704, and the CWA. Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified by NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110°F (43°C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2°F (34°C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2°F (34°C) on more than 15 days during that period in any year.

4.1.4.1 Potential Effects of Heated Water Discharges on Aquatic Biota

The discharge of heated water into the Hudson River can cause lethal or sublethal effects on resident fish, influence food web characteristics and structure, and create barriers to migratory fish moving from marine to freshwater environments. The potential for harm associated with the discharge of heated water into streams, rivers, bays, and estuaries became known during the early 1960s as new power facilities were being considered or constructed, and resulted in the definition of waste heat as a pollutant in the Federal Water Pollution Control Act of 1965. Waste heat discharges can directly kill sensitive aquatic organisms if the duration and extent of the organism's exposure exceeds its upper thermal tolerance limit. Indirect effects associated with exposure to nonlethal temperatures can result in disruptions or changes to spawning behavior, accelerated or diminished growth rates of early lifestages (both positive and negative), or changes in growth or survival in response to changes to food web dynamics or predator/prey interactions (CHGEC et al. 1999). Indirect effects can also occur if the presence of a thermal plume restricts or blocks a species' migratory pattern during a critical lifestage, or results in avoidance behavior that affects species' viability or increases the likelihood of predation.

Adverse thermal effects can also occur when thermal discharges are interrupted, resulting in cold shock. To evaluate the nature and extent of thermal discharges, it is necessary to have an understanding of the characteristics of the thermal plume when it enters the receiving water, the lethal and sublethal tolerance limits for key aquatic species and lifestages of interest, and the possible exposure scenarios (nature and extent). Thus, regulatory agencies tasked with developing thermal discharge criteria that are protective of aquatic resources (in this case, NYSDEC) generally set limits on the extent, magnitude, and duration of the thermal plume to ensure it addresses potential lethal and sublethal effects associated with the temperature of heated water discharged into the environment, and its characteristics when it enters receiving waters.

4.1.4.2 Historical Context

Thermal impacts associated with the operation of IP2 and IP3, Roseton, and the Bowline Point electrical generating stations have been a concern of NYSDEC, the NRC's predecessor organization (the U.S. Atomic Energy Commission (USAEC)), and the NRC. In the 1972 final environmental statement (FES) for the IP2 operating license (USAEC 1972), the USAEC concluded that, although operation of IP2 would meet New York thermal standards for river surface water temperature, there was evidence to suggest that the IP2 discharge could exceed New York State standards for surface area and cross-sectional area enclosed within the 4°F isotherm. The USAEC, accordingly, issued an operating license for IP2 with the following conditions related to potential thermal impacts:

- operation of the once-through system would be permitted until January 1, 1978, and thereafter a closed-cycle system would be required;
- the applicant would perform an economic and environmental impact analysis of an alternative closed-cycle system, and provide the evaluation to the USAEC by July 1, 1973; and
- after approval by the USAEC, the required closed-cycle cooling system would be designed, built, and placed in operation no later than January 1, 1978.

The operating license also required the applicant to monitor dissolved oxygen in the discharge water and thermal plume, and monitor the size, shape, and locations of isotherms in the thermal plume (USAEC 1972). In the FES developed for the IP3 operating license, the NRC staff assessed the impact of thermal discharges from once-through cooling for all units (IP1, IP2, and IP3) and again concluded that, under certain conditions, the thermal discharges from the three units would exceed New York State thermal criteria (NRC 1975). The NRC issued an operating license to IP3 with conditions similar to those of IP2, but reflecting the decisions of the Atomic Safety and Licensing Board in 1974 that required closed-cycle cooling by May 1, 1979.

In 1976, the former owners of IP2 and IP3 submitted an environmental report to the NRC that evaluated various alternative closed-cycle cooling systems from an economic and environmental standpoint. In 1978, the former owners submitted a 316(a) determination to NYSDEC asserting that the facility complied with thermal standards established by New York State (6 NYCRR 704). In 1980, litigation between New York State and electric generating station owners, associated with the operation of electric generation stations along the Hudson River, resulted in the HRSA. In place of the cooling tower requirement, HRSA required a variety of mitigation measures including seasonal outages and the installation of dual-speed or variable-speed pumps at IP2 and IP3. The existence of HRSA also superseded the 1978 section 316(a) study. In support of the Fourth Amended Consent Order to HRSA (NYSDEC 1997), the owners of IP2 and IP3 developed flow efficiency curves for each unit that related flow to inlet temperature. For both units, flows of 500,000 gallons per minute (gpm) (1900 cubic meters per minute (m^3/min)) were generally attainable during the winter months (December–March when water inlet temperatures were less than 50°F (10°C), while flow rates of 700,000 gpm (2650 m^3/min) were required during the summer months when inlet temperatures exceeded 70°F (21°C) (NYSDEC 1997, Figures B-1 and B-2). The Fourth HRSA Consent Order also developed a system of "flow variation points" as a means of evaluating changes in plant operations at IP2 and IP3, Bowline Point, and Roseton that offset exceedences of recommended flows with reductions at other times.

4.1.4.3 Thermal Studies and Conclusions

A detailed discussion of the thermal studies conducted at IP2 and IP3 to supplement the initial 316(a) work performed in the late 1970s is presented in CHGEC et al. (1999). The studies included thermal modeling of near-field effects using the Cornell University Mixing Zone Model (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology (MIT) dynamic network model (also called the far-field thermal model). For the purpose of modeling, near field was defined as the region in the immediate vicinity of each station discharge where cooling water occupies a clearly distinguishable, three-dimensional temperature regime in the river that is not yet fully mixed; far field was defined as the region farthest from the discharges where the plumes are no longer distinguishable from the river, but the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed sufficient by the utilities and their contractor and was designed and configured to account for time-variable hydraulic and meteorological conditions and heat sources of artificial origins. Model output included a prediction of temperature distribution for the Hudson River from the Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the permit applicants applied CORMIX modeling to develop a three-dimensional plume configuration of near-field thermal conditions that could be compared to applicable water quality

criteria (CHGEC et al. 1999).

The former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September (CHGEC et al. 1999). These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available, and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

(1) Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.

(2) Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 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°F (2°C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999).

For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86°F (1.18 to 1.59°C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4°F (2°C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24°F (1.80°C) during June ebb tides to 4.63°F (2.57°C) during flood tides in August. Temperature increases exceeded 4°F (2°C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near

IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4°F (2°C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events. These results suggest that the 4°F (2°C) lateral extent and cross-sectional criteria may sometimes be exceeded at IP2 and IP3. Exceedences generally occurred under scenarios that the applicants indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding, CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

Entergy has been engaged in discussions with the NYSDEC concerning the thermal impacts of IP2 and IP3 cooling water system operation. As a result of those discussions, the NRC staff notes that Entergy recently performed a triaxial thermal study of the Hudson River from September 9 to November 1 of 2009 (Entergy 2010). Given the months involved in this study, the study period did not include days with the highest average annual water temperature. Entergy has indicated that it will perform modeling of the river based on its field data in order to determine whether the power plant is in compliance with conditions of its permit; it also indicated that it may conduct additional monitoring in 2010. The NYSDEC, in its recent Notice of Denial of Water Quality Certification, indicated that additional verification of any modeled results would be necessary (NYSDEC 2010). Entergy did conduct additional studies in 2010. This issue continues to be subject to NYSDEC authority and review.

4.1.4.4 Assessments of Thermal Impacts

In this section, the NRC staff provides a summary of the various assessments of impacts associated with thermal discharges from the IP2 and IP3 cooling system. The applicant's assessment is based primarily on statements made in the ER (Entergy 2007a). The conclusions of NYSDEC concerning the thermal impacts of the IP2 and IP3 cooling system are presented in the final impact statement associated with the SPDES permits for Roseton Units 2 and 3, Bowline Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a). The NRC staff also notes that NGOs and members of the public have expressed concern that the applicant's assessment of the effect of thermal discharges is incomplete, and that there is evidence to suggest that the existing thermal discharges do not consistently meet applicable criteria as defined in 6 NYCRR 704.2(b)(5).

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 indicate that the current owners of IP2 and IP3 hold a NYSDEC SPDES permit (NY-0004472) and that the station is complying with the terms of this permit. The conclusions of the ER also describe the current mitigation required under the terms of the Fourth HRSA Consent Order that include flow reductions to limit aquatic impacts and extensive studies in the Hudson River to evaluate

temporal and spatial trends. The applicant concludes that "continued operation in the manner required by the current SPDES permit and the associated agreement to continue implementation of the fourth Consent Degree ensures that thermal impacts will satisfy the requirements of CWA 316(a) and will thus remain SMALL during the license renewal term. Therefore, no further mitigation measures are warranted" (Entergy 2007a).

As noted in 4.1.4.3, Entergy conducted additional studies in 2009. While Entergy indicated it would likely undertake additional modeling and verification of modeled results (if necessary), Entergy (2010) concluded that IP2 and IP3 are in compliance with NYSDEC's thermal requirements.

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 4°F over the temperature that existed before the addition of heat, or a maximum of 83°F, whichever is less, in the estuary cross sections specified in 6 NYCRR § 704.2(b)(5)."

According to NYSDEC (2003b), the last SPDES permit for the Indian Point facility has been administratively continued under provisions of the NY State Administrative Procedure Act since 1992. The fact sheet published by NYSDEC (2003b) in November 2003 describes the environmental and facility operational issues and permit conditions of the draft SPDES permit that NYSDEC has proposed to issue for IP2 and IP3. In Section IV, "Overview of the Permit" (Section B, "Thermal Discharges"), NYSDEC indicates that the permittee must satisfy the provisions of Section 316(a) of the CWA and related requirements in 6 NYCRR Section 704.2 "which provide that the thermal discharges from IP2 and IP3 to the Hudson River should meet regulatory temperature criteria for estuaries, and must meet the NYS standard of ensuring the propagation and survival of a balanced, indigenous population of shellfish, fish, and other aquatic species."

To meet this goal, NYSDEC requires, within the first 2 years of the SPDES permit term, that Entergy conduct a triaxial (three-dimensional) thermal study to document whether the thermal discharges associated with the operation of IP2 and IP3 comply with New York State water quality criteria. In the event the discharges do not comply, the permittee is allowed to apply for a modification of one or more criteria as provided by 6 NYCRR Section 704.4, but must demonstrate to the satisfaction of NYSDEC "that one or more of the criteria are unnecessarily restrictive and that the modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish, and wildlife in the Hudson River" (NYSDEC 2003a). In the ongoing proceeding before NYSDEC, Entergy has indicated that it would propose an alternative study. This matter is still under review before NYSDEC, and may not be resolved before NRC issues a final SEIS (Entergy 2007c).

Entergy conducted a thermal study in 2009. In its 2010 Notice of Denial related to Entergy's application for Water Quality Consistency Review, the NYSDEC noted that Entergy's 2009 thermal study did not directly address the period of highest river temperatures, and as such, would require additional confirmatory monitoring to determine whether any modeled results accurately show compliance with thermal standards (NYSDEC 2010).

4.1.4.5 NRC Staff Assessment of Thermal Impacts

In the absence of a completed thermal study proposed by NYSDEC (or an alternative proposed by Entergy and accepted by NYSDEC), existing information must be used to determine the appropriate thermal impact level to sensitive life stages of important aquatic species. Since NYSDEC modeling in the FEIS (NYSDEC 2003a) indicates that discharges from IP2 and IP3 could raise water temperatures to a level greater than that permitted by water quality criteria that are a component of existing NYSDEC permits, the staff must conclude that adverse impacts are possible. Cold water fish species such as Atlantic tomcod and rainbow smelt may be particularly vulnerable to temperature changes caused by thermal discharges. The population of both species has declined, and rainbow smelt may have been extirpated from the Hudson River. The NYSDEC's issuance of a SPDES permit provides a basis to conclude that the thermal impacts of IP2 and IP3 discharges could meet applicable regulatory temperature criteria. The NYSDEC's recent pronouncements and its ongoing re-examination of this issue create uncertainty, and this issue is currently being addressed in NYSDEC administrative proceedings. Accordingly, in the absence of specific studies, and in the absence of results sufficient to make a determination of a specific level of impact, the NRC staff concludes that thermal impacts from IP2 and IP3 potentially could range from SMALL to LARGE depending on the extent and magnitude of the thermal plume, the sensitivity of various aquatic species and life stages likely to encounter the thermal plume, and the probability of an encounter occurring that could result in lethal or sublethal effects. This range of impact levels expresses the uncertainty accruing from the current lack of studies and data. Either additional thermal studies or modeling and verification of Entergy's 2009 thermal study might generate data to further refine or modify this impact level. For the purposes of this Final SEIS, the NRC staff concludes that the impact level could range from SMALL to LARGE. This conclusion is meant to satisfy NRC's NEPA obligations and is not intended to prejudice any determination the NYSDEC may reach in response to new studies and information submitted to it by Entergy.

4.1.5 Potential Mitigation Options

Potential mitigation options related to the operation of the IP2 and IP3 once-through cooling system are discussed in Chapter VII of the DEIS (CHGEC et al. 1999). Impacts associated with impingement were assumed by the Hudson River utilities to be adequately mitigated because previous IP2 and IP3 owners installed dual- and variable-speed pumps at IP2 and IP3, respectively, in 1994, and also installed modified Ristroph screens at both units in the early 1990s (CHGEC et al. 1999). The summary conclusion of the DEIS in 1999 was that the Hudson River utilities considered the system to be the best technology available to mitigate impingement losses (CHGEC et al. 1999). The NYSDEC, however, has determined that closed-cycle cooling is the best technology available to protect aquatic resources (NYSDEC 2003b).

CHGEC et al. (1999) also discusses the mitigation of entrainment losses at IP2 and IP3 by ensuring that minimum flows are used for reactor cooling through the use of dual- or variable-speed pumps. In the ER (Entergy 2007a), the applicant concludes that, because impingement and entrainment are not having any demonstrable negative effects on Hudson River RIS, further mitigation measures are not warranted. NYSDEC's FEIS (2003a) indicated that "a range of available technologies exist to minimize aquatic resource mortality from the cooling water intake structures" at the Hudson River power plants, including IP2 and IP3. While NYSDEC indicated that IP2 and IP3 pump systems and modified Ristroph screens help mitigate impingement

mortality, it also indicated that "significant unmitigated mortalities from entrainment and impingement" remain at all of the Hudson River power plants (NYSDEC 2003a).

The NRC staff, in the results of its analysis provided in Sections 4.1.3 and 4.1.4 of this SEIS, has found that impingement and entrainment from the operation of IP2 and IP3 are likely to have an adverse effect on aquatic ecosystems in the lower Hudson River during the period of extended operation. The available evidence suggests that the operation of the cooling systems directly affects RIS by impingement and entrainment, and indirectly affects these resources through the impingement and entrainment of their prey. The thermal discharges may also be influencing RIS, but the extent of this influence cannot be determined without further studies, such as those proposed in the draft SPDES permit for IP2 and IP3 and ongoing proceedings before the NYSDEC.

To assess potential mitigation options, the NRC staff reviewed the comments and responses provided in NYSDEC (2003a) and information provided by EPA in support of its Phase II 316(b) program (EPA 2008a). Based on this review, additional mitigation options that may be available for the existing cooling system include the following:

- additional flow reductions or planned outages
- use of wedgewire or fine-mesh screens
- use of barrier systems at the intake locations
- use of behavioral deterrent systems
- closed-cycle cooling using cooling towers (e.g., hybrid wet/dry mechanical draft towers)

What follows is an overview of the effects of employing the above mitigation options to the existing system currently in operation at IP2 and IP3. Because NYSDEC indicated closed-cycle cooling is the best technology available for IP2 and IP3 (NYSDEC 2003b), the NRC staff will review a cooling tower alternative in Chapter 8. Because the NRC staff will address a cooling tower alternative in greater depth in Chapter 8, closed-cycle cooling will not be addressed further in this chapter.

Costs and benefits of these measures have been addressed in the 1999 DEIS and evaluated by NYSDEC in the FEIS. Of these alternative options, NYSDEC received comments indicating that the cost figures for closed-cycle cooling in the DEIS were inflated by the Hudson River utilities. After reviewing cost data with consultants, however, NYSDEC indicated that costs were generally reasonable (noting that site-specific factors and changes in the cost of replacement power may affect cost estimates) (NYSDEC 2003a).

The measures the NRC staff addresses below and in Chapter 8, as well as any other measures to reduce entrainment and impingement at Indian Point, fall under the regulatory authority of NYSDEC and the powers delegated to it by the EPA under the CWA. While the NRC has no role in regulating or enforcing water quality standards, the NRC staff has included a discussion of these mitigation measures in the interest of fulfilling the NRC's obligations under the National Environmental Policy Act (NEPA) (42 USC 4321, et. seq) and 10 CFR Part 51.

Additional Flow Reductions or Shutdowns

As discussed in Section 4.1.1.1 of this SEIS, under the conditions of HRSA and the subsequent

consent orders, the operators of IP2 and IP3 developed programs to employ flow-reduction measures and scheduled outages to reduce impingement and entrainment impacts. Because flow rates were dependent on water temperature, greater flows were required during the months of May through October when river water temperatures were above 15°C. It may be possible to further reduce flows or increase the length or frequency of scheduled outages, though these options will cause the plant operator to lose revenue from operating IP2 and IP3. In the 1999 DEIS, CHGEC et al. estimated that outages could cost between $14 million and $73 million per year.

Wedgewire or Fine-Mesh Screens

In some cases, the use of wedgewire or fine-mesh screens has shown potential for decreasing entrainment at once-through powerplants. Wedgewire screens typically have a screen size of 0.5 to 10 mm and are designed to reduce entrainment by physical exclusion and exploiting hydrodynamic patterns (EPA 2008a). Fine-mesh screens generally employ a mesh size of 0.5 mm or less, and reduce entrainment by gently trapping organisms and reintroducing them back into the environment via plant-specific collection and transfer systems. Factors influencing the use of this technology include the screen size, the location, and configuration of the system relative to the intake, the intake flow rates, the presence and magnitude of a "sweeping" current that can limit impingement or move organisms past the screen into safe water, and the size of the organism present near the intake. In its evaluation of wedgewire and fine-mesh screens, EPA (2008a) indicated that these technologies showed promise for reducing entrainment, but expressed concerns about the maintenance required to prevent clogging and the potential for this technology to reduce entrainment but increase impingement. EPA (2008a) considered the use of wedgewire screen technology to be more suitable for use in closed-cycle makeup water systems where lower flow rates exist and fewer screens are required.

Because the portion of the Hudson River near IP2 and IP3 is subject to tidal influence, there are periods of time when a sweeping current is not present. During this time, impingement against wedgewire or fine-mesh screen systems would be exacerbated. Although the use of these technologies at IP2 and IP3 is possible, numerous technical challenges would exist, including how to configure and clean the screens, how to evaluate capture and removal success, and how to assess the environmental effects and tradeoffs that would occur when one type of impact (entrainment) is reduced while another impact (impingement) may increase. CHGEC estimated that wedgewire screens could cost $44 million to $55 million per year in lost electricity production, and indicated that fine-mesh screens would not be feasible.

The NRC staff notes that NYSDEC has indicated that Wedgewire screens would not be adequate for meeting NYSDEC's BTA requirements under 316(b)(NYSDEC 2010). The NRC staff includes wedgewire screens here as an option that could reduce impacts from operation of the once-through cooling system and reiterates that only NYSDEC has the authority to establish requirements for mitigation measures to address aquatic impacts of the cooling system.

Barrier Systems

Gunderboom® and Marine Life Exclusion System™ (MLES™) technologies provide additional exclusion of entrainable-sized organism from cooling systems. Nets or screens are deployed during peak periods of entrainment to reduce overall entrainment. Gunderboom technology has been evaluated at the Lovett fossil fuel generating station since 1994. The system deployed in 2000 consisted of a two-ply fabric 500 feet (ft) (150 meters (m)) long, with a surface area of

8000 square feet (ft^2) (743 square meters (m^2)), and equipped with 500-micrometer (0.020 in.) perforations. The system extended to a depth of 20–30 ft (6.1–9.1 m) and was held in place with anchors. An automated airburst system with strain gages and head differential monitors was used to release compressed air at depth to clean the screens. The preliminary results from the 2000 deployment documented by Raffenberg et al. (2008) suggested that the system resulted in an 80-percent reduction in ichthyoplankton entering the facility, and that periodic elevated densities of ichthyoplankton inside the barrier were linked to breaches of the system. Impingement investigations suggested that eggs did not adhere to fabric, and mortality was below 2 percent in laboratory studies. Based on observational data, larvae did not orient toward the flow, and did not impinge on the fabric with a through-fabric velocity of 5 gallons per minute per square foot or 0.20 meters per minute (Raffenberg et al. 2008).

The use of barrier systems may be feasible at IP2 and IP3 as a mitigation action, but further study may be needed to determine the long-term impacts of these systems. CHGEC et al. (1999) indicated that barrier nets or fine-mesh barrier nets would not be feasible at Indian Point, and did not assign a cost. EPA (2008), however, has indicated that barrier systems like Gunderboom show significant promise for minimizing entrainment, but considers the technology "experimental in nature." Some advantages of the systems are that they can be deployed, retrieved, and replaced seasonally as needed. They are suitable for use in all types of water bodies and appear to reduce entrainment and impingement losses. The disadvantages are related to the limited number of long-term studies available to assess the performance of the technology, the durability of the systems in high-energy areas, the level of maintenance and monitoring required, the effects of biofouling on system performance, and the large volume of water that IP2 and IP3 withdraw. Additionally, it may be necessary to determine whether potential safety issues associated with the deployment of the systems at a nuclear generating station can be addressed.

Behavioral Deterrent Systems

Behavioral deterrent systems such as noncontact sound barriers or the use of light sources to reduce impingement have been evaluated at a variety of power generating stations in marine, estuarine, and freshwater environments (EPA 2008a). At present, a sonic deterrent system is being used at the Danskammer Point fossil energy plant on the Hudson River, and a similar system has been evaluated at Roseton. The advantage to these systems is that they can be configured and deployed at a variety of locations at costs that are not prohibitively high for simple system configurations. The disadvantages of the systems are that pneumatic air guns, hammers, and fishpulser systems are not considered reliable, the cost of sophisticated acoustic sound-generating systems can be high, and the use of high-technology equipment requires maintenance at the site (EPA 2008a). EPA (2008a) further states that, although many studies have been conducted to evaluate the feasibility of sound and light to reduce impingement and entrainment, the results "have either been inconclusive or shown no tangible reduction in impingement or entrainment" (EPA 2008a). There is, however, evidence that the use of acoustic sound barriers at a site in Pickering, Ontario, did appear to reduce the impingement and entrainment of alewife, but no benefits were realized for rainbow smelt or gizzard shad. At the Roseton facility, the use of sound barriers provided little or no deterrence for any species (EPA 2008a). In its review, the EPA concluded that it may be possible to employ acoustic or light barrier systems in conjunction with other technologies to reduce impingement or entrainment, but further studies are likely necessary to evaluate the feasibility of various

technology combinations. The 1999 DEIS from CHGEC et al. indicated an unknown cost associated with implementing behavioral deterrence systems.

4.2 Transmission Lines

The two transmission lines and right-of-ways (ROWs) built to connect IP2 and IP3 with the transmission system that existed before their construction are described in Section 2.1.7 and mapped on Figure 2-3 of this SEIS. The lines are each about 2000 ft (610 m) in length, and have ROW widths of approximately 150 ft (46 m). The transmission lines are located within the site except for a terminal, 100-ft (30.5-m) segment of each that crosses the facility boundary and Broadway (a public road) to connect to the Buchanan substation (Entergy 2007a).

Of the total of 4000 ft (1220 m) of transmission line, about 3500 ft (1070 m) traverses buildings, roads, parking lots, and other developed areas. The remaining 500 ft (150 m) of ROW is vegetated. In these segments, the growth of trees is prevented and a cover of mainly grasses and forbs is maintained.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to the IP2 and IP3 transmission lines are listed in Table 4-5 of this SEIS. The applicant stated in its ER that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses (Entergy 2007a). The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, the NRC staff's site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The NRC staff identified no new and significant information associated with these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The NRC staff has identified one Category 2 issue and one uncategorized issue related to transmission lines. These issues are listed in Table 4-6 and are discussed in Sections 4.2.1 and 4.2.2 of this SEIS.

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

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

4.2.1 Electromagnetic Fields—Acute Effects

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

In the GEIS, the NRC staff found that, without a review of the conformance of each nuclear plant transmission line to National Electrical Safety Code (NESC) (IEEE 1997) criteria, it was not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

As described in Section 2.1.7 of this SEIS, two 345-kilovolt (kV) transmission lines were built to distribute power from IP2 and IP3 to the electric grid. Also, two 138-kV lines that use the same transmission towers supply offsite (standby) power to IP2 and IP3. These lines are contained within the IP2 and IP3 site, except for where they cross Broadway (a public road) to connect to the Buchanan substation. Electric lines having voltages exceeding 98 kV of alternating current to ground must comply with the NESC provision on minimum vertical clearance, adopted in 1977, that limits the steady-state current from electrostatic effects to 5 milliamperes (mA) if the largest anticipated truck, vehicle, or equipment under the line were short circuited to ground. The New York Public Service Commission (NYPSC) requires a more restrictive induced current limit of 4.5 mA (Entergy 2007a).

Entergy indicates that at the time it acquired IP2 from the Consolidated Edison Company of New York, the transmission lines connecting IP2 and IP3 to the Buchanan substation were in compliance with the applicable NESC provisions for preventing electric shock from induced current. The lines were also in compliance with the NYPSC 4.5-mA criterion, as calculated using the methods described in the Electric Power Research Institute (EPRI) document "Transmission Line Reference Book" (Con Edison 2007). There have been no configuration or operation changes made to these lines since transfer of their ownership to Entergy (Entergy 2007a). Entergy indicates that it has maintenance procedures to ensure that the transmission lines continue to conform to ground clearance standards (Entergy 2008a).

Entergy commissioned a study of the two 345-kV lines that connect IP2 and IP3 to the electric transmission system to demonstrate to the NRC staff that they meet the NESC and NYPSC requirements (Enercon 2008). The two 138-kV lines, which are at similar ground-crossing heights to the 345-kV lines, are also addressed by the study. The analysis was performed using the EPRI TL Workstation calculation software to determine the highest ground-level electric field strengths at the ROWs where they cross Broadway. Enercon employed procedures and calculations from the EPRI "Transmission Line Reference Book, 200kV and Above (Third Edition)", which Enercon indicates is the industry-accepted reference for transmission line design and field effects. Enercon notes that The EPRI parameters for a 55-ft- (17-m)-long tractor trailer were used, with the length increased to 65 ft (20 m) to represent the maximum allowed under New York size restrictions. The analysis revealed a maximum calculated induced current for the 345-kV lines of 1.3 mA, below the NYPSC 4.5-mA limit (Enercon 2008).

In the GEIS, the NRC staff found that electrical shock is of SMALL significance for transmission lines that are operated in adherence with the NESC criteria for limiting hazards. Based on a review of the available information, including that provided in the ER (Entergy 2007a), the NRC staff's environmental site audit, the scoping process, the NRC staff's evaluation of Entergy's

2008 study (Enercon 2008), and existing NESC requirements, the NRC staff concludes that the transmission lines associated with IP2 and IP3 meet NESC criteria for limiting hazards, and thus the potential impact from electric shock during the renewal term is SMALL.

The NRC staff identified measures that could further mitigate potential acute EMF impacts resulting from continued operation of the IP2 and IP3 transmission lines, including installing road signs at road crossings and increasing transmission line clearances. These mitigation measures could reduce human health impacts by minimizing public exposures to electric shock hazards. The staff did not identify any cost benefit studies applicable to the mitigation measures mentioned above.

4.2.2 Electromagnetic Fields—Chronic Effects

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

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

> The NIEHS concludes that ELF-EMF [extremely low frequency-electromagnetic field] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the NRC to reach a conclusion with respect to the chronic effects of EMFs as detailed below (from 10 CFR Part 51, Subpart A, Appendix B, Table B-1):

> If, in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

The NRC staff considers the GEIS finding of "uncertain" still appropriate and continues to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, applicable to IP2 and IP3 in regard to radiological impacts of normal operations are listed in Table 4-7. Entergy stated in its ER that it was aware of one new issue associated with the renewal of the IP2 and IP3 operating licenses—potential ground water contamination and a new radioactive liquid effluent release pathway as a result of leakage from the plant. The NRC staff has discussed this issue and the various studies relating to it in Section 2.2.7 of this SEIS, and addresses the significance of this issue in Section 4.5. The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER, during its independent review of Entergy's ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information.

As discussed in Sections 2.2.7 and 4.5 of this SEIS, the NRC staff concludes that the new issue is not significant, and thus does not challenge the finding in the GEIS. According to the GEIS, the impacts to human health during license renewal term are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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

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

The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER concerning potential ground water contamination and a new radioactive effluent release pathway for leakage from the plant, during its independent review of Entergy's ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information. The NRC evaluated the detailed information provided by the applicant, State agencies, and NRC inspections on the new issue and concluded that the new issue is not significant and that the impacts to human health during the license renewal term are SMALL. Therefore, the NRC staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

The NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20, "Standards for Protection against Radiation," and are not considered to have a significant impact on plant workers, the public, or the environment. Furthermore, the NRC staff acknowledges that the commitments made by Entergy—and identified in Section 2.2.7 of this SEIS—for long-term monitoring and remediation will help to minimize the potential impacts from contaminated ground water and help maintain radiological impacts within NRC radiation safety standards.

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

  Radiation doses to the public will continue at current levels associated with

normal operations.

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

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

The NRC staff identified no information that was both new and significant on these issues during the review of the IP2 and IP3 LRA. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

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

4.4 Socioeconomic Impacts of Plant Operations during the License Renewal Term

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B–1, applicable to socioeconomic impacts during the renewal term are listed in Table 4-8 of this SEIS. As stated in the GEIS, the impacts associated with these Category 1 issues were determined to be SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

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

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

The NRC staff reviewed and evaluated the IP2 and IP3 ER, scoping comments, and other available information. The NRC staff also visited IP2 and IP3 in search of new and significant information that would change the conclusions presented in the GEIS. No new and significant information was identified during this review and evaluation. Therefore, the NRC staff concludes that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS.

The results of the review and brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, for each of the socioeconomic Category 1 issues are provided below:

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

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

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

  Only impacts of small significance are expected.

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

  No significant impacts are expected during the license renewal term.

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

  No significant impacts are expected during the license renewal term.

The NRC staff identified no new and significant information regarding these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

Table 4-9 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and an environmental justice impact analysis, which was not addressed in the GEIS.

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

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

[(a)]Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in plant-specific reviews.

4.4.1 Housing Impacts

Appendix C to the GEIS presents a population characterization method based on two factors, sparseness and proximity (see Section C.1.4). Sparseness measures population density within 20 miles (mi) (32 kilometers (km)) of the site, and proximity measures population density and

city size within 50 mi (80 km). Each factor has categories of density and size (see Table C.1 of the GEIS). A matrix is used to rank the population category as low, medium, or high (see Figure C.1 of the GEIS).

In Chapter 2 of this SEIS, the NRC staff describes the local population around IP2 and IP3. As NRC staff indicated in Section 2.2.8.5, the 2000 U.S. Census noted that approximately 1,113,089 people lived within 20 mi (32 km) of IP2 and IP3, which equates to a population density of 886 persons per square mi (332 persons per square km). This density translates to the least sparse Category 4 (greater than or equal to 120 persons per square mi within 20 mi). Approximately 16,791,654 people live within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a). This equates to a population density of 2138 persons per square mi (825 persons per square km). Applying the GEIS proximity measures, the IP2 and IP3 site is classified as proximity Category 4 (greater than or equal to 190 persons per square mi within 50 mi). Therefore, according to the sparseness and proximity matrix presented in the GEIS, IP2 and IP3 ranks of sparseness Category 4 and proximity Category 4 result in the conclusion that Indian Point is located in a high population area.

Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, states that impacts on housing availability are expected to be of small significance in high-density population areas where growth-control measures are not in effect. Since Indian Point is located in a high population area and Dutchess, Orange, Putnam, and Westchester Counties are not subject to growth-control measures that would limit housing development, any changes in IP2 and IP3 employment would have little noticeable effect on housing availability in these counties. Because Entergy has indicated in its ER that there would be no hiring of additional workers to support license renewal, nonoutage employment levels at IP2 and IP3 would remain relatively constant with no additional demand for permanent housing during the license renewal term (Entergy 2007a). In addition, the number of available housing units has kept pace with or exceeded the low growth in the area population. Based on this information, the NRC staff concludes that there would be no impact on permanent housing during the license renewal term beyond what is currently being experienced.

However, as stated in section 3.1 of this SEIS, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms (CRDMs) during the license renewal term,. Entergy estimates that this replacement activity at IP2 and IP3 would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would increase the demand for temporary (rental) housing in the immediate vicinity of IP2 and IP3. The NRC staff has reviewed the potential environmental impacts of this replacement activity, as discussed in Chapter 3 of this SEIS.

4.4.2 Public Services—Public Utility Impacts

The GEIS indicates that impacts on public utilities are SMALL if the existing infrastructure could accommodate plant-related demand without a noticeable effect on the level of service. The GEIS indicates that MODERATE impacts arise when the demand for service or use of the infrastructure is sizeable and would noticeably decrease the level of service or require additional resources to maintain the level of service. The GEIS indicates that LARGE impacts would result when new programs, upgraded or new facilities, or substantial additional staff are required because of plant-related demand.

In the absence of new and significant information to the contrary, the only impacts on public utilities that the NRC staff found in the GEIS could be significant during license renewal are impacts on public water supplies. The NRC staff's analysis of impacts on the public water and sewer systems considered both plant demand and plant-related population growth. In the GEIS, the NRC staff found that impacts from license renewal on public water supplies could range from SMALL to MODERATE, with the site-specific impact depending on factors that exist at each plant site.

As previously discussed (in Section 2.2.8.2) of this SEIS, potable water and process water is supplied to IP2 and IP3 by the Village of Buchanan water supply system (VBNY 2006). IP2 and IP3 use approximately 2.3 million ft^3 (65,000 m^3]) or 17.4 million gallons of potable water per month, and there is no indicated restriction on the amount of potable water that IP2 and IP3 can use. Further, Entergy (Entergy 2007a) does not project an increase in plant demand.

Because Entergy has indicated that there would be no hiring of additional workers during the license renewal period (Entergy 2007a), overall employment levels at IP2 and IP3 would remain relatively unchanged with no additional demand for public water and sewer services. Public water systems in the region would remain adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no impact to public water and sewer services during the license renewal term beyond what is currently being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of refueling outage workers needed for this replacement activity would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this SEIS.

4.4.3 Offsite Land Use—License Renewal Period

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

Section 4.7.4 of the GEIS defines the magnitude of land use changes as a result of plant operation during the license renewal term as follows:

> SMALL—Little new development and minimal changes to an area's land use pattern.
>
> MODERATE—Considerable new development and some changes to the land use pattern.
>
> LARGE—Large-scale new development and major changes in the land use pattern.

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land use impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues, (2) the nature of the community's existing land use pattern, and (3) the extent to

which the community already has public services in place to support and guide development. If the plant's tax payments are projected to be small relative to the community's total revenue, tax-driven land use changes during the plant's license renewal term would be SMALL, especially where the community has preestablished patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be SMALL. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land use changes would be MODERATE. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land use changes would be LARGE. This would be especially true where the community has no preestablished pattern of development or has not provided adequate public services to support and guide development.

4.4.3.1 Population-Related Impacts

Since Entergy has indicated that it has no plans to add nonoutage employees during the license renewal period, there would be no noticeable population change to drive changes in land use conditions in the vicinity of IP2 and IP3 that is attributable to the plant. Therefore, there would be no population-related land use impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Because of the short amount of time needed for this replacement activity, the NRC staff finds that additional number of refueling outage workers would not cause any permanent population-related land use changes in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this SEIS.

4.4.3.2 Tax-Revenue-Related Impacts

As discussed in Chapter 2 of this SEIS, Entergy pays annual real estate taxes to the Town of Cortlandt, Hendrick Hudson Central School District, and the Village of Buchanan (see Table 2-18 in Chapter 2 for more detail). As reported in Chapter 2, tax payments to the Town of Cortlandt represented between 11 and 16 percent of the town's total annual tax revenues for the 3-year period from 2003 through 2005, and payments to the Hendrick Hudson Central School District represented approximately 30 to 38 percent of the school district's total revenues over the same time period. Entergy's tax payments to the Village of Buchanan make up a high percentage of the village's tax collection. For the period 2003 through 2005, tax payments to the Village of Buchanan represented 39 to 44 percent of the village's total revenues.

The NRC staff notes that since Entergy started making payments to local jurisdictions, population levels and land use conditions in the Town of Cortlandt, Village of Buchanan, and Westchester County have not changed significantly, which might indicate that these tax revenues have had little or no effect on land use activities within the county.

Entergy has indicated that it plans no license-renewal-related construction activities to support the continued operation of IP2 and IP3 during the license renewal period. Accordingly, the NRC staff expects that there would be no increase in the assessed value of IP2 and IP3 and that the annual payment-in-lieu-of-taxes and property taxes paid to the Town of Cortlandt, the Hendrick Hudson Central School District, and the Village of Buchanan would remain relatively unchanged throughout the license renewal period. Based on this information, there would be no tax-

revenue-related land use impacts during the license renewal term beyond those currently being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). This replacement activity would not likely increase the assessed value of IP2 and IP3, and property tax payments would remain unchanged. These impacts are discussed in Chapter 3 of this SEIS.

4.4.4 Public Services: Transportation Impacts during Operations

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states the following:

> Transportation impacts (level of service) of highway traffic generated...during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

All applicants are required by 10 CFR 51.53(c)(3)(ii)(J) to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license.

Since Entergy has no plans to add non-outage employees during the license renewal period, there would be no noticeable change in traffic volume and levels of service on roadways in the vicinity of IP2 and IP3. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of outage workers and truck material deliveries needed to support this replacement activity could cause short-term transportation impacts on access roads in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this SEIS.

4.4.5 Historic and Archeological Resources

The National Historic Preservation Act (NHPA), as amended, requires Federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places. The criteria for eligibility are listed in 36 CFR 60.4, "Criteria for Evaluation," and include (1) association with significant events in history, (2) association with the lives of persons significant in the past, (3) embodies distinctive characteristics of type, period, or construction, and (4) yielded or is likely to yield important information (ACHP 2008). The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, "Protection of Historic Properties." The issuance of a renewed operating license for a nuclear power plant is a Federal action that could possibly affect either known or currently undiscovered historic properties located on or near the plant site and its associated transmission lines. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effect. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office before proceeding. If it is determined that historic properties are

present, the NRC is required to assess and resolve possible adverse effects of the undertaking.

4.4.5.1 Site-Specific Cultural Resources Information

A review of the New York State Historic Preservation Office (NYSHPO) files shows that there are no previously recorded archeological or above-ground historic architectural resources identified on the IP2 and IP3 property. As noted in Section 2.2.9.1 of this SEIS, a Phase 1A survey (literature review and background research) of the plant property was conducted in 2006; however, no systematic pedestrian or subsurface archeological surveys have been conducted at the IP2 and IP3 site. In 2009, however, Entergy conducted a Phase 1b survey of possible locations for cooling towers, should proceedings before the NYSDEC require that they be installed at the site (Entergy 2009b). The survey addressed only those portions of the site likely to be affected by cooling tower installation. Subsurface investigation – shovel testing – revealed no artifacts or other resources in the areas considered for the northernmost of two cooling towers. Investigations for the southern tower, however, identified historical artifacts at multiple locations within the potential tower footprint, as well as prehistoric artifacts (primarily lithic shatter) in a portion of the potential tower footprint.

Background research revealed a total of 76 resources listed on the National Register of Historic Places within a 5-mile radius of IP2 and IP3 Also, as noted in Chapter 2, Stony Point Battlefield State Historic Site – a National Historic Landmark – is located across the Hudson River and south of IP2 and IP3. None of these historic resources, however, are located within the boundaries of the property.

The NRC staff noted in the draft SEIS that there is potential for archeological resources to be present on some portions of the IP2 and IP3 property. As noted in Section 2.2.9.2 of this SEIS, because of disturbances associated with site preparation and construction, the power block area at IP2 and IP3 has little or no potential for archeological resources. There is potential for archeological resources to be present in the wooded area northeast of the power block area outside the area surveyed for possible cooling tower installation. A portion of the property south and east of the power block area, which contains a variety of ancillary plant facilities, has been disturbed by construction activities over the course of the plant's history. It is possible, however, that portions of that area not disturbed by construction activities – including those investigated in the recent Phase 1b survey – may contain intact subsurface archeological deposits. In addition, the IP1 reactor was one of three "demonstration plants" that began operation in the early 1960s. It is representative of the earliest era of commercial reactors to operate in the United States. To date, no formal significance or eligibility evaluation has been conducted for IP1; however, the plant could become eligible for inclusion on the National Register of Historic Places. As mandated by Section 106 of the NHPA, an evaluation would be conducted if it was determined that a project could affect IP1.

4.4.5.2 Conclusions

Entergy has proposed no specific new facilities, service roads, or transmission lines for the IP2 and IP3 site associated with continued operation and refurbishment (which does not include the installation of cooling towers). However, Entergy indicated that it plans to replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal period. This activity could involve ground-disturbing activities associated with the construction of a storage building for the existing reactor vessel heads and CRDMs. Ground-disturbing activities would be reviewed in accordance with Entergy nuclear fleet procedures, which are designed to ensure that

investigations and consultations are conducted as needed, and that existing or potentially existing cultural resources are adequately protected by Entergy such that the applicant can meet State and Federal expectations (Enercon 2007). The NRC staff considers the potential impacts to historic and archaeological resources on the IP2 and IP3 site that may result from installation of cooling towers, should such towers be required by the NYSDEC, in the discussion of alternatives in Chapter 8 of this SEIS.

The potential for impacts from continued operation of IP2 and IP3 on historic or archeological resources eligible for the National Register is SMALL. However, as noted in the NRC staff walkover survey discussed in Chapter 2 of this SEIS, there is a potential for prehistoric and historic archeological resources to be present on the northeastern portion of the site, although this area was previously disturbed by surface mining in the 19th century, the potential for intact prehistoric/historic and archeological resources remains. Further, recent investigations have identified existing historic and prehistoric resources on less-disturbed portions of the site south of the power block (Entergy 2009b). . Section 106 of the NHPA requires that lands not previously surveyed in the vicinity of IP2 and IP3 would require investigation by a professional archeologist in consultation with the NYSHPO before any ground-disturbing activities. To mitigate any potential adverse impacts to historic and archeological resources from continued plant operations in these areas, field surveys (archeological investigations) and consultation under the NHPA should be conducted before any ground-disturbing activities take place. Entergy's procedures should be followed to mitigate any potential adverse impacts to historic and archeological resources.

4.4.6 Environmental Justice

Under Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations" (Volume 59, page 7629 of the *Federal Register* (59 FR 7629)), Federal agencies are responsible for identifying and addressing potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued its "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions" (69 FR 52040), which states, "The Commission is committed to the general goals set forth in E.O. 12898, and strives to meet those goals as part of its NEPA review process."

The Council of Environmental Quality (CEQ) provides the following information in its publication entitled, "Environmental Justice: Guidance under the National Environmental Policy Act" (1997):

- **Disproportionately High and Adverse Human Health Effects.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).

- **Disproportionately High and Adverse Environmental Effects.** A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of IP2 and IP3 during the renewal term. In assessing the impacts, the following CEQ (1997) definitions of minority individuals and populations and low-income population were used:

(1) **Minority individuals**. Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.

(2) **Minority populations**. Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

(3) **Low-income populations**. Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

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 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).

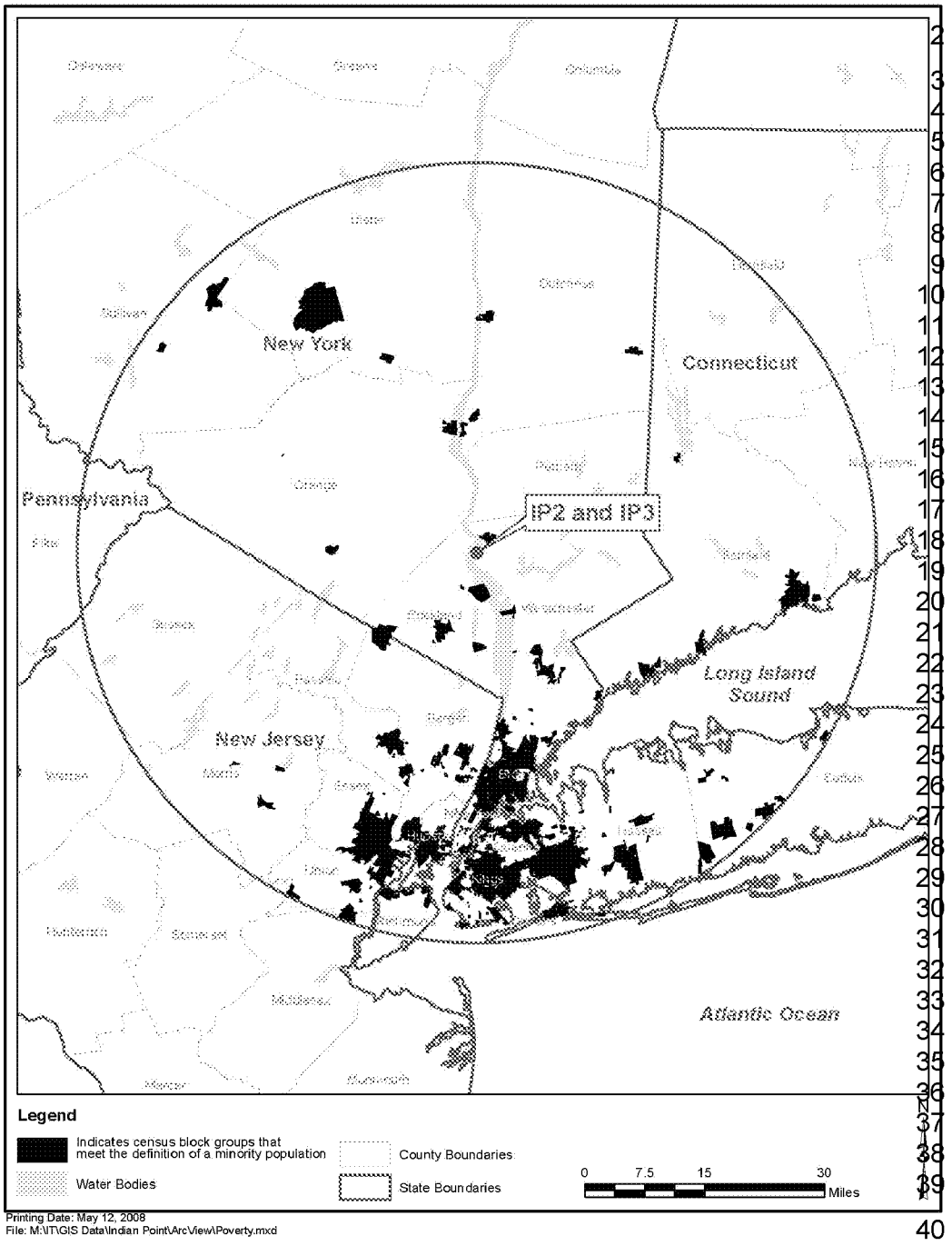


Figure 4-5. Minority block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

Census block groups were considered low-income block groups if the percentage of the population living below the Federal poverty threshold exceeded the State percentage of 14.5 percent. Based on 2000 census data, Figure 4-6 of this SEIS shows low-income block groups within a 50-mi (80-km) radius of IP2 and IP3.

Analysis of Impacts

The NRC addresses environmental justice matters for license renewal through (1) identification of minority and low-income populations that may be affected by the proposed license renewal, and (2) examining any potential human health or environmental effects on these populations to determine if these effects may be disproportionately high and adverse.

The discussion and figures above indentify the location of minority and low-income populations residing within a 50-mile (80-kilometer) radius of IP2 and IP3. This area of impact is consistent with the impact analysis for public and occupational health and safety, which also considers the radiological effects on populations located within a 50-mile (80-kilometer) radius of IP2 and IP3. As previously discussed for the other resource areas in Chapter 4, the analyses of impacts for all environmental resource areas indicated that the impact from license renewal would be SMALL.

Socioeconomic conditions in minority and low-income communities would not change as a result of renewing the IP2 and IP3 operating licenses. Employment levels and tax revenue would remain relatively unchanged, so direct and indirect employment opportunities caused by IP2 and IP3 would remain unchanged. Therefore, there would be no additional socioeconomic impact to minority and low-income populations during the license renewal term beyond what is currently being experienced.

Potential impacts to minority and low-income populations would mostly consist of radiological effects; however radiation doses from continued operations associated with license renewal are expected to continue at current levels, and would remain within regulatory limits. Chapter 5 discusses the environmental impacts from postulated accidents that might occur during the license renewal term, which include both design basis and severe accidents. In both cases, the Commission has generically determined that impacts associated with such accidents are SMALL because nuclear plants are designed and operated to successfully withstand design basis accidents, and the probability weighted impacts risks associated with severe accidents were also SMALL.

Therefore, based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5 of this SEIS, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of IP2 and IP3 during the license renewal period.

As discussed in Section 4.4.1, Entergy may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Entergy estimates that this would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). This replacement activity would have little noticeable affect on minority and/or low-income populations in the region. These impacts are discussed in Chapter 3 of this SEIS.

As part of addressing environmental justice associated with license renewal, the NRC also analyzed the risk of radiological exposure through the consumption patterns of special pathway receptors, including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Subsistence Consumption of Fish and Wildlife

Section 4-4 of Executive Order 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this SEIS, the NRC staff considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the IP2 and IP3 site were considered.

Entergy has a comprehensive Radiological Environmental Monitoring Program (REMP) at IP2 and IP3 to assess the impact of site operations on the environment. Samples are collected from the aquatic and terrestrial pathways in the vicinity of IP2 and IP3. The aquatic pathways include fish, Hudson River water, ground water, aquatic vegetation, sediment, and shoreline soil. The terrestrial pathways include airborne particulates, broad leaf vegetation, and direct radiation. During 2006, Entergy or its contractors performed 1342 analyses on collected samples of environmental media as part of the required REMP which showed no significant or measurable radiological impact from IP2 and IP3 operations (ENN 2007).

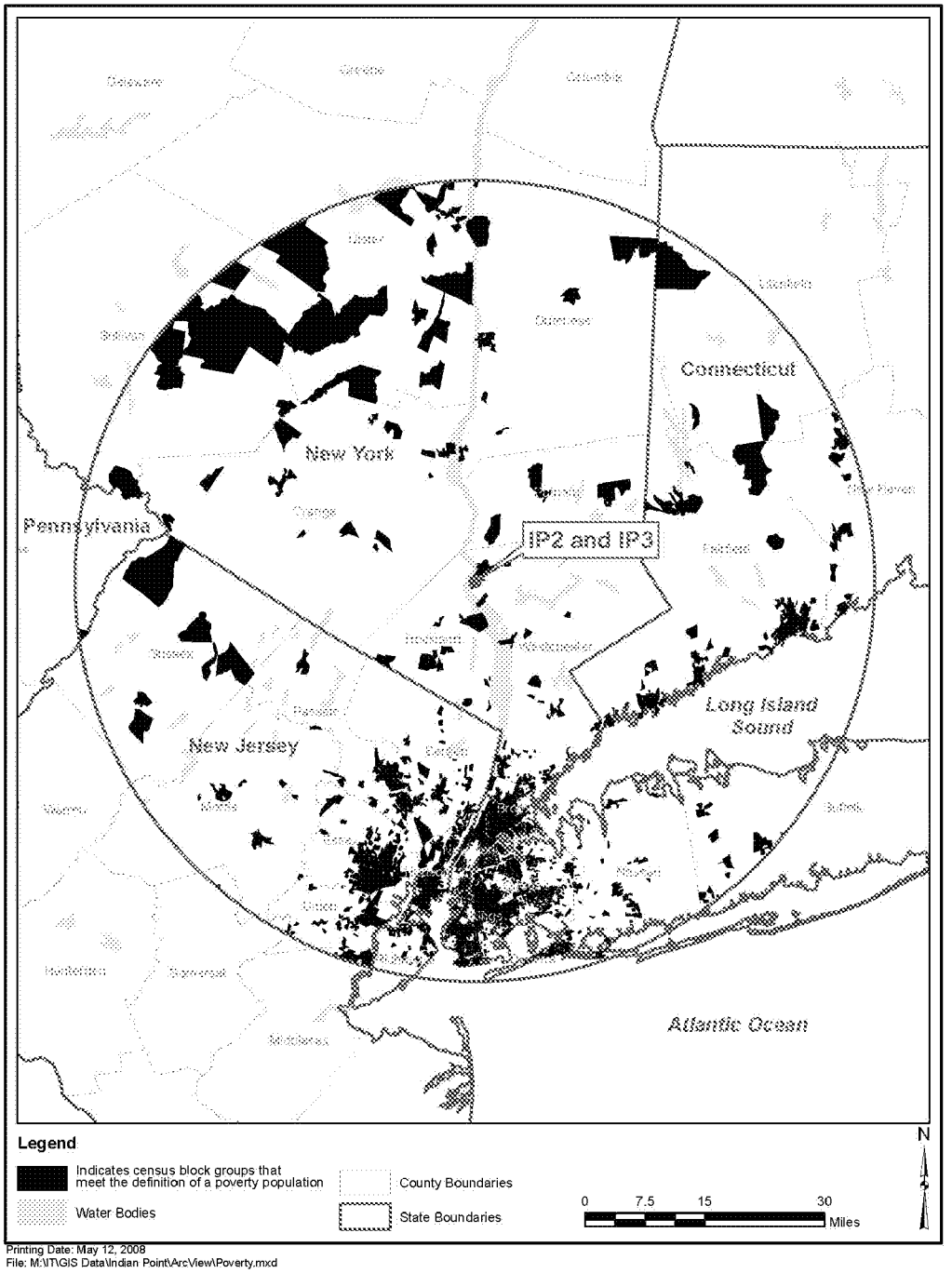


Figure 4-6. Low-income block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

The NRC staff presents a summary of results from the IP2 and IP3 REMP program in Section 2.2.7 of this SEIS. The results of the 2006 REMP (the most recent available) demonstrate that the routine operation at the IP2 and IP3 site has had no significant or measurable radiological impact on the environment. No elevated radiation levels were detected in the offsite environment as a result of plant operations and the storage of radioactive waste. The results of the REMP continue to demonstrate that the operation of IP2 and IP3 did not result in a significant measurable dose to a member of the general population or adversely impact the environment as a result of radiological effluents. The REMP continues to demonstrate that the dose to a member of the public from the operation of IP2 and IP3 remains significantly below the Federally required dose limits specified in 10 CFR Part 20 and 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

The NRC staff's review of recent REMP monitoring results shows that concentrations of contaminants in native leafy vegetation, soils and sediments, surface water, and fish in areas surrounding IP2 and IP3 have been quite low (at or near the threshold of detection) and seldom above background levels. Consequently, the NRC staff concludes that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

4.5 Ground Water Use and Quality

No Category 1 or Category 2 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, are potentially applicable to IP2 and IP3 ground water use and quality during the renewal term. The applicant stated in its ER that IP2 and IP3 do not use any ground water, though onsite monitoring wells exist for the purpose of monitoring ground water conditions.

In the IP2 and IP3 ER, Entergy identified leakage from onsite spent fuel pools as potentially new and significant information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this SEIS. Based on the NRC staff's review of Entergy's analysis, the NRC staff's adoption of the NRC inspection report findings in this SEIS, and Entergy's subsequent statements (all discussed in Section 2.2.7), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

4.6 Threatened or Endangered Species

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

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

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

This issue requires consultation under Section 7 of the Endangered Species Act of 1973 (ESA 1973) with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of the nuclear facility during the license renewal term. The presence of threatened or endangered species in the vicinity of the IP2 and IP3 site is discussed in Sections 2.2.5.5 and 2.2.6.2 of this SEIS. In 2007, the NRC staff contacted NMFS and the U.S. Fish and Wildlife Service (FWS) to request information on the occurrence of threatened or endangered species in the vicinity of the site and the potential for impacts on those species from license renewal. NMFS identified in its response two Federally protected sturgeon species under its jurisdiction as having the potential to be affected by the proposed action (NMFS 2007a). FWS provided a link to the Web site of its New York Field Office, where lists of species occurrences were available by county (FWS 2007). Three terrestrial species with a Federal listing status were identified as potentially occurring at or near the site—the Indiana bat (*Myotis sodalis*), bog turtle (*Clemmys muhlenbergii*), and New England cottontail (*Sylvilagus transitionalis*).

Because the NRC recognizes that there is the potential that the continued operation of IP2 and IP3 could adversely affect the Federally listed species shortnose sturgeon (*Acipenser brevirostrum*), the NRC staff has prepared a biological assessment (BA) for NMFS that documents its review. The BA is provided in Appendix E to this SEIS. During informal consultation regarding the potential for effects on terrestrial threatened or endangered species, FWS determined that a BA was not needed because there was no likelihood of adverse effects on potentially occurring species under its jurisdiction (NRC 2008).

4.6.1 Aquatic Special Status Species

Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA 1973), the NRC staff requested in a letter dated August 16, 2007 (NRC 2007a), that NMFS provide information on Federally listed endangered or threatened species, as well as proposed candidate species. In its response on October 4, 2007 (NMFS 2007b), NMFS expressed concern that the continued operation of IP2 and IP3 could have an adverse impact on the shortnose sturgeon, an endangered species that occurs in the Hudson River. NMFS also noted that the Atlantic sturgeon (*A. oxyrinchus*) also occurs in the river and is currently a candidate for listing as threatened or endangered. The NRC staff also reviewed the list of threatened and endangered fish species available at the NYSDEC Web site (NYSDEC 2008a) and determined that the only listed species occurring in the Hudson River near the IP2 and IP3 facility was the shortnose sturgeon. Based on this information, the NRC staff determined that an analysis of impacts was required only for the shortnose sturgeon. The NRC staff has also included an assessment of impact for the Atlantic sturgeon in this section on special status species given its status as a candidate for listing.

As described in Section 2.2.5.5 of this SEIS, the shortnose sturgeon is amphidromous, with a range extending from St. Johns River, Florida, to St. John River, Canada. Unlike anadromous species, shortnose sturgeons spend the majority of their lives in freshwater and move to salt water periodically, independent of spawning periods (Collette and Klein-MacPhee 2002). The shortnose sturgeon was listed on March 11, 1967, as endangered under the Endangered Species Act of 1973, as amended. In 1998, a recovery plan for the shortnose sturgeon was finalized by NMFS (NMFS 1998).

Shortnose sturgeon are found in the lower Hudson River and are dispersed throughout the river-estuary from late spring to early fall, congregating to winter near Sturgeon Point (RKM 139; RM 86). The population of shortnose sturgeon in the Hudson River has increased 400 percent since the 1970s, according to Cornell University researchers (Bain et al. 2007). Woodland and Secor (2007) estimate a fourfold increase in sturgeon abundance over the past 3 decades, but report that the population growth slowed in the late 1990s as evidenced by the nearly constant recruitment pattern at depressed levels relative to the classes in 1986–1992. Although the Hudson River appears to support the largest population of shortnose sturgeon in the region, Bain et al. (2007) report that other populations along the Atlantic coast are also increasing and some appear to be nearing safe levels, suggesting that the overall population could recover if full protection and management continue.

As described in Section 2.2.5.5 of this SEIS, the Atlantic sturgeon is an anadromous species with a range extending from St. Johns River, Florida, to Labrador, Canada. This species is long lived, matures slowly, and can reach 60 years of age (ASMFC 2007b; Gilbert 1989). In 1996, the State of New York placed a moratorium on harvesting Atlantic sturgeon when it became apparent that the Hudson River stock was overfished. Unfortunately, the American shad gill net fishery continues to take subadult sturgeon as bycatch (e.g., the unintentional collection of some species during the harvest or others). The Status Review Team for Atlantic Sturgeon concluded in 2007 that the Hudson River subpopulation has a moderate risk (less than 50 percent) of becoming endangered in the next 20 years because of the threat of commercial bycatch. However, the New York Bight distinct population segment, which includes the Hudson River subpopulation, was determined to have a greater than 50-percent chance of becoming endangered in the foreseeable future. Despite this, the Hudson River supports the largest subpopulation of spawning adults and juveniles, and the abundance appears to be stable or even increasing (ASSRT 2007). Recent work by Sweka et al. (2007) suggests that a substantial population of juvenile Atlantic sturgeon is present in Haverstraw Bay, and that this area should be the focus of future monitoring studies to obtain the greatest statistical power for assessing population trends.

To determine the potential adverse impacts of the IP2 and IP3 cooling system on these species, the NRC staff evaluated the potential effects of entrainment, impingement, and thermal discharges for all RIS, including both sturgeon species, in Sections 4.1.1, 4.1.2, and 4.1.3 of this SEIS. Based on an evaluation of entrainment data provided by the applicant, there is no evidence that the eggs or larvae of either species are commonly entrained at IP2 or IP3. The potential impacts of thermal discharges on shortnose and Atlantic sturgeon cannot be determined at this time because additional studies are required to quantify the extent and magnitude of the thermal plume, as discussed in Section 4.1.4 of this SEIS.

Corrected impingement data provided by the applicant after the publication of the draft SEIS (Entergy 2007b and 2009) shows that both species of sturgeon have been impinged at IP2 and

IP3, with impingement of Atlantic sturgeon accounting for the largest losses (Table 4-11). The corrected data, however, reflect an order of magnitude less impingement than had been suggested earlier. The corrected impingement data for the endangered shortnose sturgeon show that from 1975 to 1990, 20 fish were impinged at IP2 and 11 fish were impinged at IP3. Impingement of Atlantic sturgeon was much greater than that observed for shortnose sturgeon, with 250 fish impinged at IP2 and 265 fish impinged at IP3 between 1975 and 1988. Installation of modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement levels. Nonetheless, because more recent data are not available, the NRC staff cannot determine whether the current impingement losses are similar to the past observations.

Table 4-11. Impingement Data for Shortnose and Atlantic Sturgeon at IP2 and IP3, 1975–1990 (data from Entergy 2009 and Barnthouse et al. 2009)

Study Year	IP2		IP2 Total	IP3		IP3 Total	Grand Total
	Shortnose Sturgeon	Atlantic Sturgeon		Shortnose Sturgeon	Atlantic Sturgeon		
1975	1	118	119	NS[a]	NS	NS	119
1976	2	8	10	0	8	8	18
1977	6	44	50	1	153	154	204
1978	2	16	18	3	21	24	42
1979	2	32	34	2	38	40	74
1980	0	9	9	1	10	11	20
1981	0	3	3	0	5	5	8
1982	0	1	1	0	1	1	2
1983	0	3	3	0	0	0	3
1984	1	3	4	1	5	6	10
1985	0	8	8	0	17	17	25
1986	0	2	2	0	4	4	6
1987	2	2	4	1	1	2	6
1988	3	1	4	1	0	1	5
1989	0	0	0	1	0	1	1
1990	1	0	1	0	2	2	3
Grand Total	20	250	270	11	265	276	546

[a] – = not sampled, unit not in operation

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from NMFS. Based on the WOE information presented in Table 4-4, The NRC staff concludes that the impacts associated with the IP2 and IP3 cooling system are Small for both Atlantic and shortnose sturgeon. The population trend LOE evaluation was unresolved because the Hudson River monitoring programs were not designed to catch either species. The NRC staff was also unable to determine the strength of connection for either species using the Monte Carlo simulation modeling. Because historical impingements of sturgeon have been relatively low, especially for shortnose sturgeon, the NRC staff concluded

that the strength of connection was low. Based on the WOE analysis described above, a determination of Moderate or Large impact is not supported, and the NRC staff concludes that the impacts of an additional 20 years (beyond the current term) of operation and maintenance of the site on aquatic species that are Federally listed as threatened or endangered is SMALL.

The NRC staff is sending a revised biological assessment (BA) of the impacts of license renewal on the shortnose sturgeon to NMFS to review as this SEIS goes to press (the BA will be publicly available at ML102990042). Should NMFS determine that continued operation of IP2 and IP3 has the potential to adversely impact the shortnose sturgeon, NMFS will issue a biological opinion. Included in the biological opinion would be any reasonable and prudent measures that the applicant could undertake, as well as the terms and conditions for the applicant to comply with the formal Section 7 consultation. Possible mitigation measures could range from a resumption of monitoring to determine the number of shortnose sturgeon impinged at IP2 and IP3 to changes in the cooling water intake system, as described in Section 4.1.5 of this FEIS. Additionally, as described in Chapter 8, the installation of cooling towers could reduce impingement, entrainment, and thermal impacts for all aquatic resources, including those that are Federally listed.

4.6.2 Terrestrial Threatened or Endangered Species

There are two Federally listed terrestrial species that have the potential to occur at or near the IP2 and IP3 site and its associated transmission line ROWs, the endangered Indiana bat (M. *sodalis*) and the threatened bog turtle (C. *muhlenbergii*). A candidate species, the New England cottontail (S. *transitionalis*), also may occur in the vicinity. The characteristics, habitat requirements, and likelihood of occurrence of each of these species are discussed in Section 2.2.6.2 of this SEIS.

Although Westchester County is within the potential range of the Indiana bat in New York, winter hibernacula and summer maternity colonies and bachelor colonies are not known to be present in the county or the vicinity of the site (NYNHP 2008a). The NRC staff notes that it is possible that the 70-acre (ac) (28-hectare (ha)) forest at the north end of the site could provide summer habitat for the Indiana bat because of the presence of suitable foraging habitat and possible roosting trees in the forest and the presence of large hibernacula within migration distance of the site. The ER indicated that no expansion of existing facilities or disturbance of forest or other land on the site would occur during the renewal period. Thus, even if Indiana bats currently utilize habitat on the site, it is not likely that they would be adversely affected by ongoing operations and maintenance activities during the renewal period.

In Section 2.2.6.2, the NRC staff noted that the IP2 and IP3 site area does not have suitable habitat for the bog turtle, and that bog turtles have not been observed in the region of Westchester County near the IP2 and IP3 site (NYSDEC 2008b). The NRC staff acknowledged that wetlands nearest the site had not, however, been evaluated for the presence of the bog turtle. Given the available information, the NRC staff concludes that the bog turtle is not likely to occur on or in the immediate vicinity of the site.

The known locations of the New England cottontail in Westchester County are in the central and northeastern areas of the county (NYNHP 2008b), not in the northwestern area where the site is located. The forests on the site consist mainly of mature hardwoods and do not contain early successional habitats, such as thickets, that are required by the New England cottontail, so the

NRC staff does not expect the species to occur on or in the immediate vicinity of the site.

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from FWS. Operation of IP2 and IP3 is not expected to adversely affect any threatened or endangered terrestrial species during the license renewal term. Therefore, the NRC staff concludes that the impacts of an additional 20 years of operation and maintenance of the site, on terrestrial species that are Federally listed as threatened or endangered would be SMALL. Because no listed species are known to be present in the area of the IP2 and IP3 site, there are no recommended mitigation measures, unless the applicant becomes aware of the presence of a listed species, in which case appropriate protective action should be taken, and the NRC and FWS should be notified. Informal consultation with FWS indicated that formal consultation and a BA are not required for terrestrial threatened or endangered species.

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

The NRC staff has conducted its own independent review of environmental issues through staff research, consultation with State and Federal agencies, and comments delivered to the NRC by the public during the environmental scoping period and comments on the draft SEIS to identify potentially new and significant information about environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, related to operation of IP2 and IP3 during the renewal term. Processes for identification and evaluation of new information are described in Section 1.2.2 of this SEIS.

As discussed in Section 2.2.7 of this SEIS and synopsized in Section 4.5 of this chapter, Entergy identified leakage from onsite spent fuel pools as potentially new information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this SEIS. Based on the NRC staff's review of Entergy's ground water analyses, the NRC ground water inspection report, and Entergy's subsequent statements (all discussed in Section 2.2.7 of this SEIS), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while constituting new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff did not identify any other information that was both new and significant. As such, the NRC staff adopts the GEIS findings for Category 1 issues applicable to Indian Point, as described in the previous sections of this chapter.

4.8 Cumulative Impacts

The NRC staff considered potential cumulative impacts on the environment resulting from past, present, and reasonably foreseeable future actions. The geographical area over which past, present, and future actions are assessed is dependent on the affected resource.

The impacts of the proposed action, license renewal, as described in previous sections of

Chapter 4 of this SEIS, are combined with other past, present, and reasonably foreseeable future actions in the potentially affected area regardless of which agency (Federal or non-Federal) or entity is undertaking the actions. The combined impacts are defined as "cumulative" in 40 CFR 1508.7, "Cumulative Impact," and include individually minor but collectively significant actions taking place over a period of time (CEQ 1997). It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL direct or indirect impact could be important if it contributes to or accelerates the overall resource decline.

The NRC staff has identified the principal past, present, and reasonably foreseeable future actions potentially impacting the environment affected by IP2 and IP3. The potential cumulative impacts of these actions are discussed below.

4.8.1 Cumulative Impacts on Aquatic Resources

The purpose of this section is to address past, present, and future actions that have created or could result in cumulative adverse impacts to the aquatic resources of the lower Hudson River. In Section 2.2.5.2 of this SEIS, the NRC staff discussed a wide variety of historical events that have affected the Hudson River and its resources. The NRC staff notes that these historical events are contributors to the cumulative effects on the Hudson River. In addition to the past events in Section 2.2.5.2, the NRC staff has identified a variety of current and likely future stressors that may also contribute to cumulative impacts. These stressors, included in the following list, are consistent with those identified by the Pew Oceans Commission (2003).

- the continued operation of the IP2 and IP3 once-through cooling system (addressed in Section 4.1 of this Chapter)
- continued withdrawal of water to support fossil fuel electrical generation or water for human use
- the presence of invasive or nuisance species
- fishing pressure
- habitat loss
- changes to water and sediment quality
- climate change

Each of these potential stressors may influence the structure and function of freshwater, estuarine, and marine food webs and result in observable changes to the aquatic resources in the lower Hudson River estuary. Examples of measurable changes to aquatic resources could include the following:

- reductions or increases in RIS populations or changes in their distribution
- changes in predator-prey relationships or noticeable alterations to food webs, including the permanent loss of species

- changes in contaminant body-burdens in fish and shellfish that result in the imposition or lifting of consumption advisories
- introduction of exotic or nuisance species and increases or decreases in populations of existing invasive species

What follows is a brief discussion of how the stressors listed above might have cumulative impacts on aquatic resources of the lower Hudson River estuary. An expanded discussion of cumulative impacts is presented in Appendix H to this SEIS. Because in most cases it is not possible to quantitatively determine the impact of each stressor, or a collection of stressors, on the aquatic resources of the lower Hudson River, the following is a general discussion of cumulative impacts.

Continued Operation of the IP2 and IP3 Once-Through Cooling System

Based on the assessment presented in Sections 4.1.3 and 4.1.4 of this SEIS, the NRC staff concludes that the operation of IP2 and IP3 has the potential to adversely affect a variety of RIS species that currently exist in the Hudson River between Troy Dam and the Battery. Based on the staff's analysis of entrainment and impingement impacts, effects to RIS range from SMALL to LARGE, depending on the species affected. As discussed in Section 4.6.1 of this SEIS, it is also possible that the operation of IP2 and IP3 could be affecting the endangered shortnose sturgeon and the listed Atlantic sturgeon. If the IP2 and IP3 once-through cooling system continues to operate as it has for the past 3 decades, the NRC staff finds that it will continue to contribute to cumulative effects.

Continued Water Withdrawals

As described in Section 2.2.5 of this SEIS, water is withdrawn from the Hudson River to support fossil fuel electrical generation and to provide a source of drinking water. Although some fossil fuel electrical generating stations that use natural gas or oil operate only intermittently, coal-fired electrical generation stations that employ once-through cooling systems are expected to continue to operate in the future. Likewise, water withdrawals in the freshwater portions of the Hudson River will continue to occur and increase in the future. Because the NRC staff concludes that water withdrawals from the Hudson River to support human needs will continue and will likely increase during the relicensing term, this stressor will continue to contribute to the cumulative effects in the river.

Invasive and Nuisance Species

As discussed in Section 2.2.5 of this SEIS, the presence of invasive or nuisance species in the Hudson River estuary has been documented for over 200 years. While the presence of new or exotic species can benefit some existing species, introductions of new species often have a negative impact on their new environment. A classic example of the latter is the appearance of the zebra mussel in the freshwater portion of the Hudson River in 1991. Since 1992, zebra mussels have been a dominant species in the freshwater tidal portion of the Hudson River and constitute more than half of heterotrophic biomass. Strayer (2007) estimated that the current population is capable of filtering a volume of water equal to all of the water in the estuary every 1 to 4 days during the summer.

Some evidence suggests that the presence of zebra mussels can affect the species composition in the Hudson River and the abundance of some Hudson River RIS. Strayer et al.

(2004) hypothesized that the abundance or growth rates of American shad, blueback herring, alewife, gizzard shad, white perch, and striped bass would decline following the zebra mussel invasion or that their distributions within the river would shift downriver away from the zone of greatest zebra mussel impacts. The authors found that significant decreases in the estimated river-wide abundance of early life stages of several species of fish, including American shad and white perch, coincided with the zebra mussel invasion. Barnthouse et al. (2008) also concluded that zebra mussels may have contributed to declines in white perch populations but rejected the hypothesis that zebra mussels were affecting American shad. The NRC staff's independent analysis concluded that the presence of zebra mussels in the river would have a Small potential for adverse impacts to the alewife, American shad, blueback herring, spottail shiner, striped bass, white catfish, and white perch (Appendices H and I). The presence of invasive or nuisance species in the lower Hudson River will continue to be a concern, as it is in other locations throughout the world, and the presence of these species will continue to represent an important source of cumulative impacts to the river.

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 SEIS, alterations to terrestrial, wetland, nearshore, and aquatic habitats have occurred in the Hudson River estuary since colonial times. During the colonization of the region, upland habitat alterations profoundly influenced watershed dynamics. The creation of dams and the filling or isolation of wetlands to support industrial activities have dramatically changed patterns of nutrients and sediment loading to the estuary. In addition, historic dredging activities altered aquatic environments and affected river flow patterns, and future activities, as described in Section 2.2.10 of this SEIS, may continue to influence the river. Finally, development along the shores of the Hudson has resulted in the loss or isolation of nearshore habitat, and the armoring of the shoreline in the lower portions of the river from Yonkers to the Battery has effectively eliminated nearshore habitat. The NRC staff recognizes that Federal, State, and local agencies, as well as many NGOs, are interested in restoring habitat lost during past development and notes that the identification of four locations along the lower Hudson River estuary for inclusion in the National Estuarine Research Reserve System in 1982 represents an important step in protecting and restoring important habitats.

Because habitat loss remains a concern, the NRC staff concludes that this stressor will continue to be an important contributor to cumulative impacts to the lower Hudson River.

Water and Sediment Quality

In general, there is evidence to conclude that the overall quality of water and sediment in the lower Hudson River is improving. Cleanup of polychlorinated biphenyls in stretches of the river above the Troy Dam continues, and upgrades to wastewater treatment facilities during the past 20 years have reduced the amount of untreated sewage discharged into the river and contributed to reductions in nutrients and an apparent increase in dissolved oxygen. Chemical contaminants continue to persist in the tissues of fish and invertebrates inhabiting the lower Hudson River, and the presence of nonpoint discharges of chemicals and constituents continues to be a concern of local, State, and Federal regulatory agencies and NGOs. The NRC staff concludes that the quality of water and sediment in the lower Hudson River will continue to be a concern and a potential contributor to cumulative impacts.

Climate Change

The potential cumulative effects of climate change on the Hudson River watershed, whether from natural cycles or related to anthropogenic activities, could result in a variety of changes that would affect aquatic resources. The environmental factors of significance identified by Kennedy (1990) that could affect estuarine systems included sea level rise, temperature increase, salinity changes, and wind and water circulation changes. Changes in sea level could result in dramatic effects to nearshore communities, including the reduction or redistribution of submerged aquatic vegetation, changes to marsh communities, and influences to wetland areas adjacent to nearshore systems. Water temperature increases could affect spawning patterns or success, or influence the distribution of key RIS when cold-water species move northward while warm-water species become established in new habitats. Changes to river salinity and the presence of the salt front could influence the spawning and distribution of RIS and the range of exotic or nuisance species. Fundamental changes in precipitation could profoundly influence water circulation and change the nature of sediment and nutrient inputs to the system. This could result in changes to primary production and influence the estuarine food web on many levels. Kennedy (1990) also concluded that some fisheries and aquaculture enterprises might benefit from climate change, while others would suffer extensive economic losses.

The extent and magnitude of climate change impacts to the aquatic resources of the lower Hudson River are an important component of the cumulative assessment analyses and could be substantial.

Final Assessment of Cumulative Impacts on Aquatic Resources

Based on the NRC staff's review, it is clear that Hudson River RIS are affected (some to a lesser degree than others) by multiple stressors. The NRC staff's analysis (Appendix H) demonstrated that the food web and abundance of RIS were noticeably altered, and many RIS appeared to be directly influenced by the operation of the IP2 and IP3 cooling system (e.g., high strength of connection). The impacts of some of the stressors may be addressed by management actions (e.g., IP2 and IP3 cooling system operation, fishing pressure, and water quality) and some cannot (e.g., long-term impacts associated with climate change). Although the impacts associated with increased human populations and associated development of the Hudson River basin, climate change, redistribution of resources, and the presence of invasive species and disease cannot be quantitatively calculated, the cumulative impacts on aquatic resources have had destabilizing effects on Hudson River living resources, including threatened and endangered species (i.e., the net effect of all stressors destabilized some populations) and

are considered by the NRC staff to be LARGE.

4.8.2 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in cumulative adverse impacts on terrestrial resources, including wildlife populations, vegetation communities of uplands and riparian zones, wetlands, and land use. For purposes of this analysis, the geographic area considered consists of the IP2 and IP3 site, which encompasses its associated transmission line ROWs, and the surrounding region of the lower Hudson Valley.

The changes in land use associated with historical settlement and development of this region are described in Section 2.2.5.2 of this SEIS. During precolonial and colonial settlement by European immigrants, large areas of the forest that had almost completely covered the region were cleared for agriculture, and by 1880, 68 percent of the Hudson River watershed had become farmland. Also in the 19th century, major changes in land use occurred in the region in conjunction with the industrial revolution as human populations grew and houses, roads, railroads, bridges, and industrial facilities were constructed. These historical trends of increasing development and decreasing terrestrial habitat in the region continued through the 20th century to the present, resulting in large reductions in native forests and other habitats for terrestrial wildlife, increases in precipitation runoff due to impervious surfaces, and pollution (Swaney et al. 2006).

Before the historical clearing of land at the IP2 and IP3 site, the terrestrial communities of the area consisted mainly of upland and riparian forests (NRC 1975). The site was originally purchased in 1683 by a Dutch settler, who established a homestead there. By the latter 19th century, the north end of Indian Point was being surface mined for iron, and a lime kiln and blast furnace were located at the shoreline. By 1900 a brickyard existed on the site, and farming still occurred there. In 1920 an amusement park was built on the site. The park closed in 1956, and construction of the first commercial nuclear reactor in the United States then began at the site (Enercon 2007). Thus, the site had been largely cleared of forest and developed for various uses for well over a century before its development for power generation began in the second half of the 20th century. Power plant development resulted in over half of the site (134 ac (54.2 ha)) being covered by facilities and pavement, with forest having regenerated at the north end of the site where mining occurred historically. Remaining native forest habitat in central and southern portions of the site has been fragmented by roads, ROWs, parking areas, and other development, a phenomenon that has commonly occurred in the region.

Developed areas with impervious surfaces have increased precipitation runoff and reduced infiltration into the soil, thus reducing ground water recharge, altering streamflow, and increasing soil erosion. Maintenance of vegetation in ROWs and other developed areas, such as by mowing and spraying of herbicides, has altered the ecological communities in these areas by preventing natural succession. It also likely has resulted in increases in invasive species, such as Japanese knotweed (*Fallopia japonica*), which typically are more aggressive than native species in colonizing disturbed areas; increases in species that prefer edge habitat; and decreases in species that prefer interior forest habitat. Such effects from development within the IP2 and IP3 site contribute to cumulative impacts from similar effects on native ecological communities from other development in the region.

Land use data provide an indication of the impacts on terrestrial resources that have resulted

from historical and ongoing development. Current land uses in the region are discussed by county in Section 2.2.8.3 of this SEIS. In Westchester County, based on 1992 data, forest was the predominant type of land cover (53 percent), followed by residential (30 percent), agricultural and recreational (7 percent), and commercial/industrial/transportation uses (3 percent) (Entergy 2007a). In four nearby counties in the lower Hudson Valley (Rockland, Orange, Putnam, and Dutchess), forest also was the predominant type of land cover, followed by residential or agricultural, and commercial/industrial/transportation land uses ranged from about 1 to 4 percent (Entergy 2007a). Thus, commercial, industrial, and transportation facilities, including the IP2 and IP3 site, have had a relatively small impact on the loss of native terrestrial forest habitats in the region compared to residential and agricultural development. The commercial, industrial, and transportation facilities that have impacted terrestrial resources in the region in addition to the IP2 and IP3 site include six power generation facilities on the Hudson River between RM 37 and 67 (RKM 60 to 97), highways, railways along both sides of the river, and manufacturing plants.

Although development of the site has contributed to cumulative impacts on terrestrial resources from historical and ongoing development in the region, portions of the site have been protected from development. The 70-ac (28-ha) forest community at the north end of the site has been and, under the proposed action, would continue to be preserved, providing a beneficial effect by reducing the potential for cumulative impacts from further loss of forests in the region. In conjunction with this onsite forest tract, public lands in the region also preserve forest habitat and have a beneficial cumulative impact on terrestrial resources. These lands include three State parks in Westchester County and a total of 22 others in Rockland, Orange, Putnam, and Dutchess Counties (Entergy 2007a), as well as forested lands of the New York State National Guard's Camp Smith and the U.S. Military Academy at West Point.

Ultimately, development of the IP2 and IP3 site for power generation contributed incrementally to a substantial, cumulative reduction in terrestrial resources resulting from other development activities in the region that have occurred since precolonial times. However, as discussed in Section 4.4.3 of this SEIS, there would be no population-related land use impacts attributable to IP2 and IP3 during the license renewal term beyond those already being experienced, and there would be no noticeable change in land use conditions in the vicinity of IP2 and IP3.

The NRC staff concludes that the impact of past, present, and reasonably foreseeable future actions in the region on terrestrial resources is considered LARGE relative to predevelopment conditions, and that much of this impact had occurred before the construction and operation of IP2 and IP3.

4.8.3 Cumulative Radiological Impacts

The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of the IP2 and IP3 site was included. The radiological environmental monitoring program conducted by Entergy in the vicinity of the IP2 and IP3 site measures radiation and radioactive materials from all sources; therefore, the monitoring program measures cumulative radiological impacts. Within the 50-mi (80-km) radius of the IP2 and IP3 site there are no other nuclear power reactors or uranium fuel cycle facilities. The NRC staff reviewed the 1993 and 1994

radiological environmental monitoring data from the area around IP2 and IP3 reported by New York State; the data showed no adverse environmental impact. For the new issue identified by Entergy concerning the tritium leak into the Hudson River, the NRC staff also reviewed the information reported by Entergy, the NYSDEC and NYSDOH, and by the NRC. No adverse impacts were identified (Entergy 2007b, NYSDEC and NYSDOH 2008, NRC 2006b, NRC 2007b).

Radiation monitoring results for the 5-year period from 2002 to 2006 were reviewed as part of the cumulative impacts assessment. In Sections 2.2.7 and 4.3 of this SEIS, the NRC staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of IP2 and IP3 during the renewal term are SMALL. The NRC and the State of New York would regulate any future actions in the vicinity of the IP2 and IP3 site that could contribute to cumulative radiological impacts (Entergy 2003, 2004, 2005, 2006, 2007b).

Entergy constructed an independent spent fuel storage installation (ISFSI) on the IP2 and IP3 site in 2008 for the storage of its spent fuel. The installation and monitoring of this facility is governed by NRC requirements in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste." Radiation from this facility as well as from the operation of IP2 and IP3 must not exceed the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 72 (Entergy 2007a).

In addition, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and CRDMs during the period of extended operation. Such an action is not expected to change the applicant's ability to maintain radiological doses to members of the public well within regulatory limits because the amount of radioactive liquid, gaseous, and solid waste is not expected to increase significantly (see Sections 2.1.4 and 2.2.7 of this SEIS for the detailed discussion).

For these reasons, the NRC staff concludes that cumulative radiological impacts are SMALL, as are the contribution to radiological impacts from continued operation of IP2 and IP3 and their associated ISFSI. The NRC and the State of New York will continue to regulate operation of IP2 and IP3 for radiological impacts.

4.8.4 Cumulative Socioeconomic Impacts

As discussed in Section 4.4 of this SEIS, continued operation of IP2 and IP3 during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already being experienced. Since Entergy has indicated that it plans to hire no additional non-outage workers during the license renewal term, overall expenditures and employment levels at IP2 and IP3 would be expected to remain relatively constant with no additional demand for permanent housing, public utilities, and public services. In addition, since employment levels and the value of IP2 and IP3 would not change, there would be no population and tax-revenue-related land use impacts. Also, there would be no disproportionately high and adverse health and environmental impacts on minority and low-income populations in the region.

Entergy has indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs, Entergy estimates that this replacement activity would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would create short-term increases in the demand for temporary (rental) housing, increased use of public water and

sewer services, and transportation impacts on access roads in the immediate vicinity of IP2 and IP3. Given the short amount of time needed for this replacement activity, the cumulative effects of these replacement activities on socioeconomic conditions in the vicinity of IP2 and IP3 would not likely be noticeable. Also, there would be no long-term cumulative socioeconomic impacts after the reactor vessel heads and CRDMs are replaced.

In general, the region surrounding IP2 and IP3 has experienced growing population, increasing economic activity and tax revenue, and changes in demographics over time. These effects in the region have been LARGE, though the contribution of IP2 and IP3 to these effects have been SMALL, except, in some cases, locally. Additionally, development in the region has had a significant effect on historical and archaeological resources, which could be LARGE, as the region is home to significant historic and prehistoric resources (as noted in 4.4.5, however, continued operation of the plant would only have SMALL effects on historic and archaeological resources).

4.8.5 Cumulative Impacts on Ground Water Use and Quality

In 2005 tritium was located in ground water beneath the IP2 and IP3 site. During a subsequent subsurface monitoring program at the site, radioactive forms of cesium, cobalt, nickel, and strontium also were found. The radiological impact of these elements to the ground water is discussed in Section 2.2.7 of this SEIS, and referenced in Sections 4.5 and 4.7.

The topography of the site and the foundation drains around the structures result in a flow regime that transports ground water towards the Hudson River. As a result, the contaminated ground water will be transported to the Hudson River and not offsite in a direction that might lead it to be captured by an offsite ground water user. The results of monitoring programs support this conclusion.

Because the water travels offsite and into the Hudson River, there are no users for onsite ground water. Any effects from the plant, previous development, or future development on site will likely remain confined to effects on ground water transiting the site to the Hudson River, and thus, are likely to be limited.

On the basis of the topography of the site, the characteristics of the subsurface media, location of the plant relative to the Hudson River, recent ground water monitoring observations, and the fact that there are no users for the site's ground water, the NRC staff concludes that the cumulative impact on the site's ground water use and quality are SMALL.

4.8.6 Conclusions Regarding Cumulative Impacts

The NRC staff considered the potential impacts resulting from the operation of IP2 and IP3 and resulting from other past, present, and reasonably foreseeable future actions in the vicinity. The NRC staff's determination is that the cumulative impacts to the environment surrounding IP2 and IP3 from past and present human activities (beyond impacts from IP2 and IP3) have generally been LARGE and could continue to be LARGE in some issue areas. Future development is likely to continue to affect these resources.

4.9 Summary of Impacts of Operations during the Renewal Term

The NRC staff did not identify any information that is both new and significant related to any of the applicable Category 1 issues associated with the operation of IP2 and IP3 during the renewal term, including information related to ground water contamination at Indian Point. Consequently, the NRC staff concludes that the environmental impacts associated with these issues are bounded by the impacts described in the GEIS. For each of these issues, the GEIS concluded that the impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Thirteen of the site-specific environmental issues identified in the GEIS related to operational impacts and postulated accidents during the renewal term are discussed in detail in this SEIS. These include 11 Category 2 issues and two uncategorized issues (environmental justice and the chronic effects of EMFs). The NRC staff did not evaluate the chronic effects of EMFs because research is continuing in the area and no scientific consensus on human health impacts exists. The NRC staff's will evaluation of severe accident mitigation alternatives is in Chapter 5.

For 6 of the remaining 10 Category 2 issues and environmental justice, the NRC staff concluded that the potential impacts of continued plant operation during the license renewal period on these issues are of SMALL significance in the context of the standards set forth in the GEIS. For four of these issues, the NRC staff concluded that the impacts of continued operation would have a significant effect. On the issue of heat shock on the aquatic ecology, the NRC staff concludes that effects are of SMALL to LARGE significance, given uncertainty about actual thermal effects of the plant. The NRC staff evaluated the combined effects of entrainment and impingement on aquatic life and found the impacts to be MODERATE. However, these impact level conclusions are based on historical data as previously discussed in this SEIS. Finally, unlike in the draft SEIS, the NRC staff found that impacts to threatened and endangered aquatic species are likely to be SMALL, based on corrected data submitted by Entergy.

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

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the

[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

plant can withstand normal and abnormal transients, as well as a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) and 10 CFR Part 100, "Reactor Site Criteria."

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

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, DBAs are designated as a Category 1 issue in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The early resolution of the DBAs makes them a part of the current licensing basis (CLB) of the plant; the CLB of the plant, which is maintained by the licensee under its current license, will continue to be maintained under a renewed license in accordance with 10 CFR 54.33, "Continuation of CLB and Conditions of Renewed License." Therefore, under the provisions of 10 CFR 54.30, "Matters Not Subject to a Renewal Review," the CLB is not subject to review under license renewal. This issue, applicable to Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3), is listed in Table 5-1.

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

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

Based on information in the GEIS, the Commission found the following:

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

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER)

(Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses. The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to DBAs beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, regardless of offsite consequences. In the GEIS, the NRC staff assessed the impacts of severe accidents using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Severe accidents initiated by external phenomena, such as tornadoes, floods, earthquakes, fires, and sabotage, traditionally have not been discussed in quantitative terms in FESs and were not specifically considered for IP2 and IP3 in the GEIS. However, in the GEIS, the NRC staff did evaluate existing impact assessments performed by the NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal documents a discretionary analysis of acts of sabotage in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the Commission concluded that the risk from sabotage and beyond-design-basis earthquakes at existing nuclear power plants is small and, additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (see Volume 1 of the GEIS, page 5-18).

Based on information in the GEIS, the Commission found the following:

> The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to IP2 and IP3, is listed in Table 5-2.

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

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

The NRC staff has not identified any new and significant information with regard to the consequences from severe accidents during its independent review of the IP2 and IP3 ER

(Entergy 2007a), the site visit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the NRC staff has reviewed severe accident mitigation alternatives (SAMAs) for IP2 and IP3. The results of its review are discussed in Section 5.2 of this draft SEIS.

5.2 Severe Accident Mitigation Alternatives

As required by 10 CFR 51.53(c)(3)(ii)(L), license renewal applicants must consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS), or related supplement, or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for IP2 and IP3; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

This section presents a summary of the SAMA evaluation for IP2 and IP3, conducted by Entergy, and the NRC staff's review of that evaluation. The NRC staff performed its review with contract assistance from Information Systems Laboratories, Inc. and Sandia National Laboratory. The NRC staff's review is available in greater detail in Appendix G to this draft SEIS; the SAMA evaluation is available in Entergy's ER and subsequent submittals identified herein.

The SAMA evaluation for IP2 and IP3 was conducted using a four-step approach. In the first step, Entergy quantified the level of risk associated with potential reactor accidents using the plant-specific probabilistic safety assessment (PSA) and other risk models.

In the second step, Entergy examined the major risk contributors and identified possible ways (i.e., SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. Entergy initially identified 231 and 237 potential SAMAs for IP2 and IP3, respectively. For each unit, Entergy performed an initial screening in which it eliminated SAMAs that are not applicable to IP2 and IP3 because of design differences, have already been implemented at IP2 and IP3, or are similar in nature and could be combined with another SAMA candidate. This screening reduced the list of potential SAMAs to 68 for IP2 and 62 for IP3.

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

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost benefit). Entergy concluded in its ER that several of the SAMAs evaluated for each unit are potentially cost beneficial (Entergy 2007b). However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs, the meteorological data used in the analysis, and lower cost alternatives, several additional potentially cost-beneficial SAMAs were identified (Entergy 2008a, Entergy 2009). The NRC staff identifies potentially cost-beneficial SAMAs in Section 5.2.5.

The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they are not required to be implemented as part of license renewal pursuant to 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Entergy's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.2 Estimate of Risk

Entergy submitted an assessment of SAMAs for IP2 and IP3 as part of the ER (Entergy 2007b). This assessment was based on the most recent IP2 and IP3 PSA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the IP2 and IP3 individual plant examination (Con Ed 1992; NYPA 1994) and individual plant examination of external events (Con Ed 1995 and NYPA 1997).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 1.79×10^{-5} per year for IP2 and 1.15×10^{-5} per year for IP3. The CDF values are based on the risk assessment for internally initiated events. Entergy did not include the contributions from external events within the IP2 and IP3 risk estimates; however, it did perform separate assessments of the CDF from external events and did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of approximately 3.8 for IP2 and 5.5 for IP3 (as discussed in Appendix G, Sections G.2.2, G.3.1, and G.6.2). The breakdown of CDF by initiating event for IP2 and IP3 is provided in Table 5-3.

IP2 and IP3 Core Damage Frequency (Entergy, 2007a)

Initiating Event	IP2		IP3	
	CDF (Per Year)	% Contribution to CDF	CDF (Per Year)	% Contribution to CDF
Loss of offsite power[1]	6.7×10^{-6}	38	1.2×10^{-7}	1
Internal flooding	4.7×10^{-6}	26	2.2×10^{-6}	20
Loss-of-coolant accident (LOCA)	1.5×10^{-6}	8	2.2×10^{-6}	19
Transients[1]	1.2×10^{-6}	7	8.5×10^{-7}	7
Anticipated transient without scram	9.9×10^{-7}	6	1.5×10^{-6}	13
Station blackout	8.5×10^{-7}	5	7.2×10^{-7}	6
Steam generator tube rupture	7.2×10^{-7}	4	1.6×10^{-6}	14
Loss of component cooling water	5.8×10^{-7}	3	1.1×10^{-7}	<1
Loss of nonessential service water	3.0×10^{-7}	2	2.8×10^{-7}	2
Interfacing systems LOCA	1.5×10^{-7}	<1	1.5×10^{-7}	1
Reactor vessel rupture	1.0×10^{-7}	<1	1.0×10^{-7}	<1
Loss of 125 volts direct current power	5.8×10^{-8}	<1	1.0×10^{-6}	9
Total loss of service water system	4.4×10^{-8}	<1	5.4×10^{-7}	5
Loss of essential service water	1.9×10^{-10}	<1	1.8×10^{-8}	<1
Total CDF (internal events)	**1.79×10^{-5}**	**100**	**1.15×10^{-5}**	**100**

[1]Contributions from SBO and ATWS events are noted separately and not included in the reported values for loss of offsite power or transients.

As shown in Table 5-3, for IP2, loss of offsite power sequences, including station blackout (SBO) events, and internal flooding initiators are the dominant contributors to CDF. For IP3, internal flooding initiators, loss-of-coolant accidents (LOCAs), steam generator tube rupture (SGTR) events, and anticipated transient without scram (ATWS) events are the dominant contributors to CDF. The differences in the CDF contributions are attributed, in large part, to several significant differences between the IP2 and IP3 units.

As shown in Table 5-4 below, Entergy's SAMA analysis, as revised, estimated the dose to the population within 80 kilometers (50 miles) of the IP2 and IP3 site to be approximately 0.87 person-sievert (Sv) (87 person-rem) per year for IP2, and 0.95 Sv (95 person-rem) per year for IP3 (Entergy 2009). The breakdown of the total population dose by containment failure mode is summarized in Table 5-4. SGTR events and late containment failures, caused by gradual overpressurization by steam and noncondensable gases, dominate the population dose risk for both units.

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

Table 5-4. Breakdown of Population Dose by Containment Failure Mode (Entergy 2009)

Containment Failure Mode	IP2		IP3	
	Population Dose (Person-Rem[1] Per Year)	% Contribution	Population Dose (Person-Rem[1] Per Year)	% Contribution
Intact Containment	<0.1	<1	<0.1	<1
Basemat Melt-through	4.1	5	2.4	3
Gradual Overpressure	28.3	32	16.8	18
Late Hydrogen Burns	3.6	4	2.1	2
Early Hydrogen Burns	8.6	10	3.2	3
In-Vessel Steam Explosion	0.6	<1	0.2	<1
Reactor Vessel Rupture	4.1	5	1.5	2
Interfacing System LOCA	6.6	8	4.2	4
SGTR	31.5	36	64.4	68
Total	**87.4**	**100**	**94.8**	**100**

[1]One person-rem = 0.01 person-sievert

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, Entergy searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, Entergy considered insights from the plant-specific PSA and SAMA analyses performed for other operating plants that have submitted license renewal applications. In its 2007 ER, Entergy identified 231 and 237 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training for IP2 and IP3, respectively.

As discussed in Entergy's ER, for IP2, Entergy removed all but 68 of the SAMAs from further consideration because they are not applicable to IP2 as a result of design differences, have already been implemented at IP2, or are similar in nature and could be combined with another SAMA candidate. For IP3, all but 62 of the SAMAs were removed from further consideration based on similar criteria. A detailed cost-benefit analysis was performed for each of the remaining SAMAs.

The staff has concluded that Entergy's ER SAMA analysis used a systematic and comprehensive process for identifying potential plant improvements for IP2 and IP3, and that the set of potential plant improvements identified by Entergy is reasonably comprehensive and, therefore, acceptable.

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

In its ER, Entergy evaluated the risk-reduction potential of the remaining candidate SAMAs that were applicable to each unit (68 for IP2 and 62 for IP3). The SAMA evaluations were performed using realistic assumptions with some conservatism.

Entergy estimated the costs of implementing the candidate SAMAs through the application of engineering judgment and the use of other licensees' estimates for similar improvements. The cost estimates reported in the ER conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they account for inflation.

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

The staff reviewed the basis for the applicant's cost estimates. For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The staff found the cost estimates to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The staff concluded that the risk reduction and the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

5.2.5 Cost-Benefit Comparison

The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook" (NRC 1997) and was executed consistent with this guidance. NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NRC 2004), has recently been revised to reflect the agency's revised policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed—one at 3 percent and one at 7 percent (NRC 2004). Entergy provided both sets of estimates (Entergy 2007b).

As described in Section G.6.1, Entergy identified 10 potentially cost-beneficial SAMAs (5 for IP2 and 5 for IP3) in the baseline analysis (using a 7-percent discount rate) and sensitivity analysis (using a 3-percent discount rate) contained in the ER. Based on consideration of analysis uncertainties, Entergy identified two additional potentially cost-beneficial SAMAs for IP2 in the ER (IP2 SAMAs 44 and 56).

In response to an NRC staff request, Entergy provided the results of a revised uncertainty analysis in which the impact of lost tourism and business was accounted for in the baseline analysis (rather than as a separate sensitivity case) (Entergy 2008a). The revised uncertainty analysis resulted in the identification of two additional potentially cost-beneficial SAMAs for IP2 (IP2 SAMAs 9 and 53) and one additional potentially cost-beneficial SAMA for IP3 (IP3 SAMA 53), as reported in the draft Supplemental Environmental Impact Statement (DSEIS). Subsequent to issuance of the DSEIS, in response to NRC staff questions, Entergy identified an error in the Indian Point site meteorological file used to calculate offsite consequences of severe accidents, and submitted a SAMA re-analysis based on corrected meteorological data (Entergy 2009). The SAMA re-analysis resulted in identification of three additional potentially cost – beneficial SAMAs for IP2 (IP2 SAMAs 21, 22, and 62) and three additional potentially cost-beneficial SAMAS for IP3 (IP3 SAMAs 7, 18, and 19).

The potentially cost-beneficial SAMAs for IP2 include the following:

- SAMA 9 – Create a reactor cavity flooding system to reduce the impact of core-concrete interaction from molten core debris following core damage and vessel failure.
- SAMA 21 – Install additional pressure or leak monitoring instrumentation to reduce the frequency of interfacing system loss of coolant accidents.
- SAMA 22 – Add redundant and diverse limit switches to each containment isolation valve. This modification would reduce the frequency of an interfacing system loss of coolant activity.
- SAMA 28 – Provide a portable diesel-driven battery charger to improve direct current (dc) power reliability. Safety-related disconnect would be used to change a selected battery. This modification would enhance the long-term operation of the turbine-driven auxiliary feed water (AFW) pump on battery depletion.
- SAMA 44 – Use fire water as backup for steam generator inventory to increase the availability of steam generator water supply to ensure adequate inventory for the operation of the turbine-driven AFW pump during SBO events.
- SAMA 53 – Keep both pressurizer power-operated relief valve block valves open. This modification would reduce the CDF contribution from loss of secondary heat sink by improving the availability of feed and bleed.
- SAMA 54 – Install a flood alarm in the 480-volt (V) alternating current (ac) switchgear room to mitigate the occurrence of internal floods inside the 480-V ac switchgear room.
- SAMA 56 – Keep residual heat removal (RHR) heat exchanger discharge valves, motor-operated valves 746 and 747, normally open. This procedure change would reduce the CDF contribution from transients and LOCAs.
- SAMA 60 – Provide added protection against flood propagation from stairwell 4 into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within stairwell 4 adjacent to the 480-V ac switchgear room.
- SAMA 61 – Provide added protection against flood propagation from the deluge room into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within the deluge room adjacent to the 480-V ac switchgear room.