

Plant and the Environment

1 **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 **2.2.8.2 Public Services**

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

5 Water Supply

6 IP2 and IP3 do not utilize a public water system for plant circulating and service water purposes,
 7 but instead rely on surface water from the Hudson River. Potable water and process water are
 8 supplied to the site by the Village of Buchanan water supply system. Based on water bills, IP2
 9 and IP3 utilize approximately 2.3 million cubic feet (ft³) or 17.4 million gal per month (65,000 m³
 10 or 8.7 million L per month) of potable water (VBNY 2006). There are no restrictions on the
 11 supply of potable water from the Village of Buchanan. The Village of Buchanan obtains its
 12 water from two sources, the City of Peekskill Public Water System and the Montrose
 13 Improvement District. While the demand on the City of Peekskill Public Water System currently
 14 appears to be near the system design capacity, the contract with the Montrose Improvement
 15 District (now consolidated with the Northern Westchester Joint Water Works) appears to NRC
 16 staff to be capable of providing an adequate supply of potable water based on treatment
 17 capacity upgrades.

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

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

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

10 The Town of Cortlandt purchases 80 percent of its water supply from the Montrose
11 Improvement District, which treats raw water purchased from the New York City Catskill
12 Aqueduct. The town purchases 10 percent from the City of Peekskill, which filters and treats
13 raw water pumped from the Peekskill Hollow Brook to the city's Camp Field Reservoir, and
14 10 percent from the Town of Yorktown, which purchases water filtered and treated by the
15 Westchester County-owned Amawalk treatment plant (CCWD no date).

16 The Cortlandt Consolidated Water District (CCWD) has joined with the Yorktown and Montrose
17 Improvement District in a new corporation known as the Northern Westchester Joint Water
18 Works (NWJWW). The NWJWW has assumed ownership of the Amawalk treatment plant,
19 which has been upgraded to 7 mgd (26,000 m³/day) capacity. A new NWJWW 7 mgd (26,000
20 m³/day) plant (Catskill water treatment plant) has been in operation since 2000 (CCWD no
21 date).

22 Westchester Joint Water Works (WJWW) serves the municipalities of the Village/Town of
23 Mamaroneck, Town/Village of Harrison, portions of the City of New Rochelle, and the City of
24 Rye. WJWW, which has a capacity of 14.2 mgd (53,800 m³/day) and an average daily demand
25 of 13.1 mgd (49,600 m³/d), obtains its water from the Catskill and Delaware watersheds of the
26 New York City water system, which includes the Delaware Aqueduct, Rye Lake (Delaware
27 watershed), and the Kensico reservoir (WJWW 2006).

28 A majority of Rockland County uses groundwater to supply numerous small public water
29 systems, most of which are supplied by a single well (RWS 2006). The large public water
30 systems of Rockland County include United Water New York (UWNY), Nyack Village Public
31 Water System, and Suffern Village Public Water System (RWS 2006). UWNY provides water to
32 approximately 267,000 residents from 53 groundwater wells drilled throughout the county, Lake
33 DeForest, and the Letchworth reservoirs (UWNY 2006). The UWNY peak demand in 2006 was
34 estimated at 47.5 mgd (180,000 m³/day) and its peak supply at approximately 48.5 mgd
35 (184,000 m³/day) (RCDH 2006).

36 The Poughkeepsie Water Treatment Facility, which is owned and operated by the City and
37 Town of Poughkeepsie, provides drinking water in Dutchess County to the City of
38 Poughkeepsie, Town of Poughkeepsie, and Village of Wappingers Falls. The plant is located
39 along and draws water from the Hudson River. The plant was built in 1962 and is currently
40 rated at a maximum capacity of 16 mgd (61,000 m³/day). Average demand is reported to be
41 approximately 8 mgd (31,000 m³/day) (PTWD 2005).

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

Plant and the Environment

1 of water is approximately 63 percent from the Croton Reservoir and 37 percent from the Indian
2 Brook Reservoir. The system obtains its water from the Croton watershed in Putnam and
3 | Westchester counties and serves approximately 30,000 people. The Village of Ossining Water
4 System services an average daily demand of approximately 3.7 mgd (14,000 m³/day) (VOWS
5 2005).

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

15 | The Village of Croton-on-Hudson public water system is supplied by a groundwater well system
16 | located downstream from the New Croton Dam and spillway. Groundwater is pumped from the
17 well system directly into the distribution system. The system has a total storage capacity of
18 2.3 mgd (8700 m³/day) and supplies approximately 7600 people an average of 1.1 mgd
19 (4200 m³/day) (VCOH 2005).

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

21

1

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).

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

8 Education

9 IP2 and IP3 are located in the Hendrick Hudson Central School District, Westchester County,
 10 which had an enrollment of approximately 2800 students in 2003. Including the Hendrick
 11 Hudson Central School District, Westchester County has 40 school districts with a total
 12 enrollment of approximately 147,000 students. In contrast, Dutchess, Orange, and Putnam
 13 Counties have 16, 17, and 6 school districts with a total enrollment of approximately 46,000,
 14 66,000, and 17,000 students, respectively (WCDP 2005).

15 Transportation

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

Plant and the Environment

1 through both counties. The Taconic State Parkway and the Saw Mill River Parkway connect
2 near Hawthorne, New York, southeast of the site. Interstate 684 runs north and south along the
3 eastern side of Westchester County and connects to Interstate 84 in Putnam County. US 6 runs
4 east and west through the southern end of Putnam County and the northern portion of
5 Westchester County. US 202 runs east and west across northern Westchester County. The
6 Saw Mill River Parkway extends northeast and southwest between US 9 at Riverdale, New
7 York, and Interstate 684. Additional highways within the two counties include State Routes 117,
8 120, 129, 100, 139, and 301.

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

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

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

32

1

2

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.**3 2.2.8.3 Offsite Land Use**

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

9 Dutchess County

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

15 Dutchess County occupies roughly 802 sq mi (2080 sq km) or approximately 513,000 acres
16 (208,000 ha) (USCB 2008b). The largest category of land use in Dutchess County is
17 agriculture. Evenly distributed throughout the county, land used for agriculture makes up
18 21.3 percent (112,339 acres (45,462 ha)) of the county's area (USDA 2002a). Major agricultural
19 land uses consist of cropland (52.75 percent), woodland (23.32 percent), pasture
20 (11.12 percent), and other uses (12.81 percent) (USDA 2002a). Residential land areas cover
21 approximately 7.1 percent of Dutchess County, with approximately 1.4 percent being devoted to
22 commercial, industrial, and transportation uses (Entergy 2007a).

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

Plant and the Environment

1 Orange County

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

8 Orange County occupies roughly 816 sq mi (2110 sq km) or approximately 522,000 acres
9 (211,000 ha) (USCB 2008b). Approximately 107,977 acres (43,697 ha) are used for agricultural
10 purposes, with major agricultural land uses consisting of cropland (65.53 percent), woodland
11 (16.50 percent), pasture (8.99 percent), and other uses (8.98 percent) (USDA 2002b).
12 Residential land areas cover approximately 7.5 percent of Orange County, with approximately
13 1.7 percent devoted to commercial, industrial, and transportation uses (Entergy 2007a).

14 Orange County's Comprehensive Development Plan continues to reflect the importance of
15 transportation interchanges, crossroads, and corridors (Orange County Department of Planning
16 2003). The dynamic real estate market and the loss of open spaces has been a challenge for
17 Orange County. The county, along with civic organizations, has been inventorying current open
18 spaces as part of defining and recommending future open space needs. Orange County also
19 plans to initiate a redevelopment program to assist with historical improvements to the cities and
20 villages within Orange County. With the increasing growth of Orange County, nontraditional
21 zoning strategies are expected to help maintain historical and open spaces throughout the
22 county (Orange County Department of Planning 2003).

23 Putnam County

24 Putnam County occupies roughly 231 sq mi (598 sq km) or approximately 148,000 acres
25 (59,900 ha) (USCB 2008b) and is one of the fastest growing counties in New York (Putnam
26 County Division of Planning and Development 2003). Approximately 6720 acres (2720 ha)
27 (4.3 percent) are in agricultural use, with major agricultural land uses consisting of woodland
28 (59.87 percent), cropland (26.49 percent), and other uses (13.65 percent) (USDA 2002c). Hilly
29 topography has prevented or slowed development in the more rugged parts of the county.
30 Additionally, there are many wetlands throughout the county. The most significant wetland in
31 the county is the Great Swamp, which is a 4200-acre (1700-ha) wetland. Agricultural land use,
32 undeveloped land, and forest land within the county have been decreasing. Residential land
33 use occurs on large lot subdivisions or in rural areas. Industrial and commercial development
34 can be found around the villages and along the major transportation corridors (Putnam County
35 Division of Planning and Development 2003). Residential land use accounts for approximately
36 6.9 percent of the county's land, while only 1.1 percent is used for commercial, industrial, or
37 transportation purposes (Entergy 2007a).

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

1 Westchester County

2 Westchester County occupies roughly 433 sq mi (1121 sq km) or approximately 277,000 acres
3 (112,000 ha) (USCB 2008b). According to the 2002 U.S. Department of Agriculture (USDA)
4 Census of Agriculture, 129 farms were located in Westchester County, which is a 10 percent
5 increase since 1997 (USDA 2002e). Land acreage associated with farms increased 14 percent
6 during this period with total acreage increasing from 8681 acres (3513 ha) to over 9917 acres
7 (4013 ha). The average size of farms also increased 4 percent, from 74 to 77 acres (30 to
8 31 ha) from 1997 to 2002. Of the approximately 9917 acres (4013 ha) in agricultural land use in
9 2002, the major agricultural land uses consisted of woodland (48.84 percent), cropland
10 (24.83 percent), pasture (12.81 percent), and other uses (13.53 percent) (USDA 2002d).

11 Residential land areas cover approximately 30.1 percent of Westchester County, with
12 approximately 3.1 percent devoted to commercial, industrial, and transportation uses (Entergy
13 2007a). The long-range plan for the physical development of Westchester County concentrates
14 on three distinct physical characteristics—centers, corridors, and open space (Westchester
15 County Department of Planning 2000).

16 IP2 and IP3 are located in Westchester County in the Village of Buchanan, within the Town of
17 Cortlandt. IP2 and IP3 provide tax revenues and other payments to both the Town of Cortlandt
18 and the Village of Buchanan. The Town of Cortlandt encompasses 34.5 sq mi (89.4 sq km) or
19 22,080 acres (8935 ha) (TOCNY 2006). Land use is predominately residential zoning with
20 ½-acre to 2-acre plots further protecting environmentally sensitive areas and open spaces
21 (TOCNY 2004). The town's growth was intentionally slowed over the past several decades,
22 allowing the town's leaders to plan its development. Significant commercial development has
23 taken place along major transportation corridors, as well as at new community facilities within
24 the area. From 1992 to 2004, the Town of Cortlandt has increased open space by 65 percent
25 from 2729 acres (1104 ha) to 4502 acres (1822 ha) (TOCNY 2004). The town also has made
26 an effort to increase public access to the Hudson River waterfront and encourage historic
27 preservation (TOCNY 2004).

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

33 **2.2.8.4 Visual Aesthetics and Noise**

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

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

Plant and the Environment

1 showed that IP2 and IP3 meet the Village of Buchanan’s sound ordinance (Enercon Services
2 2003).

3 **2.2.8.5 Demography**

4 According to the 2000 census, approximately 1,113,089 people lived within 20 mi (32 km) of IP2
5 and IP3, which equates to a population density of 886 persons per sq mi (332 persons per
6 sq km) (Entergy 2007a). This density translates to the least sparse Category 4 (greater than or
7 equal to 120 persons per square mile within 20 mi). Approximately 16,791,654 people live
8 within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a). This equates to a population density of
9 2138 persons per sq mi (825 persons per sq km). Applying the proximity measures from
10 NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear
11 Power Plants” (GEIS), IP2 and IP3 are classified as proximity Category 4 (greater than or equal
12 to 190 persons per square mile within 50 mi (80 km)). Therefore, according to the sparseness
13 and proximity matrix presented in the GEIS, the IP2 and IP3 ranks of sparseness Category 4
14 and proximity Category 4 indicate that IP2 and IP3 are located in a high-population area.

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

22 The 2000 and 2006 (estimate) demographic profiles of the four-county ROI population are
23 presented in Table 2-12 and Table 2-13. Minority individuals (both race and ethnicity) constitute
24 28.8 percent of the total four-county population. The minority population was composed largely
25 of Hispanic or Latino and Black or African-American residents.

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

32

1
2

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

Year	Dutchess		Orange		Putnam		Westchester	
	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)

3

1 **Table 2-12. Demographic Profile of the Population in the IP2 and IP3**
 2 **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

3 Source: USCB 2008c
 4

**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

3 Transient Population

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

8 In 2000 in Westchester County, 0.8 percent of all housing units were considered temporary
9 housing for seasonal, recreational, or occasional use. By comparison, seasonal housing
10 accounted for 2.3 percent, 1.8 percent, 4.0 percent, and 3.1 percent of total housing units in
11 Dutchess, Orange, and Putnam Counties, and New York as a whole, respectively (USCB
12 2008c). Table 2-14 provides information on seasonal housing located within 50 mi (80 km) of
13 IP2 and IP3.

14

1

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

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

Source: USCB 2008c

^a Counties within 50 mi of IP2 and IP3 with at least one block group located within the 50-mi radius
 avg = percent average for counties within the IP2 and IP3 50-mi radius and excludes state percentage

1 Migrant Farm Workers

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

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

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

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

26 According to 2002 Census of Agriculture estimates, 275 temporary farm laborers (those working
27 fewer than 150 days per year) were employed on 34 farms in Westchester County, and 435,
28 1583, and 127 temporary farm workers were employed on 132, 244, and 22 farms, respectively,
29 in Dutchess, Orange, and Putnam Counties (USDA 2002e).

30

1 **Table 2-15. Migrant Farm Worker and Temporary Farm Labor within 50 mi (80 km)**
 2 **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

3

1

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 2.2.8.6 Economy

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

5 Employment and Income

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

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

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

25

Plant and the Environment

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

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

Source: The Journal News 2006

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

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

Source: USCB 2008c

1 Unemployment

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

5 Taxes

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

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

16 The Village of Buchanan is the principal local jurisdiction that receives direct revenue from the
17 site. In fiscal year 2006, PILOT payments, property taxes, and other taxes from the site
18 contributed about 39 percent of the Village of Buchanan's total revenue of \$5.07 million, which
19 is used for police, fire, health, transportation, recreation, and other community services for over
20 2100 residents (NYSOSC 2007). Additionally in fiscal year 2006, PILOT payments, property
21 taxes, and other taxes from the site contributed over 27 percent of the total revenue collected
22 for the Hendrick Hudson Central School District.

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

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

29 From 2003 through 2006, the Hendrick Hudson Central School District had between \$51 and
30 \$57 million annually in total revenues (NYSOSC 2008). Between 2003 and 2006, IP2 and IP3
31 PILOT payments represented 27 to 38 percent of the school district's total revenues (see
32 Table 2-18).

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

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

Entity	Year	PILOT and Property Tax		
		Total Revenue (millions of dollars)	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

4 **2.2.9 Historic and Archeological Resources**

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

9 **2.2.9.1 Cultural Background**

10 Prehistory

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

17

1

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

2 Paleo-Indian Period

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

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

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

21 Archaic Period

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

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

Plant and the Environment

1 Woodland Period

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

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

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

20 European Contact, 1524–1608

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

28 Historic Period

29 The Colonial Period, 1608–1776

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

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

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

3 The Revolutionary War, 1776–1783

4 New York and, more specifically, Westchester County were the site of many significant events
5 during the American Revolution. The social and economic structure of the State was still
6 dominated by large landowners, and discontent had already emerged among tenant farmers
7 during the 1750s and 1760s. British troops landed on Staten Island in July 1776 and advanced
8 northward, pressing colonial forces under the command of George Washington to make a
9 strategic retreat north into Westchester County (Griffin 1946). With a large British force
10 advancing, the bulk of American forces in Westchester retreated across the Hudson to New
11 Jersey (Griffin 1946; Countryman 2001). Westchester remained on the front lines until the end
12 of the war. The American defense line stretched from Mamaroneck to Peekskill, with British
13 forces arrayed across southern Westchester County, creating a “neutral ground” in between,
14 across which violence raged. The British gradually captured the bulk of Westchester County by
15 1779 but were unable to press their advantage further (Griffin 1946; Countryman 2001).

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

21 19th Century Development

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

29 The landscape of New York State and Westchester County was profoundly transformed by land
30 speculation, which opened virtually the entirety of the State for farming, and more gradually by
31 the spread of industry. Copper was mined near Sing-Sing and iron near Port Chester and
32 Irvington, and iron working was established in Peekskill. During the latter part of the
33 19th century, the area just north of the IP2 and IP3 site was surface-mined, and a small lime kiln
34 and blast furnace were operated within or adjacent to the footprint of the current facility
35 (Enercon, 2006). By the end of the 19th century, industrialization was widespread in
36 Westchester County.

37 20th Century Development

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

Plant and the Environment

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

3 **2.2.9.2 Historic and Archeological Resources at the IP2 & IP3 Site**

4 Previously Recorded Resources

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

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

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

19 There are no previously recorded archeological sites within the IP2 and IP3 property. A search
20 for sites within a 1 mi (1.6 km) radius of the plant also revealed no previously recorded sites.
21 The nearest recorded site (A-119-02-0003) is located southwest of the plant, at Verplanck's
22 Point. Site A-119-02-003 is the site of the Revolutionary War era Fort Lafayette. The New York
23 State Historic Trust site inventory form indicates that there is no longer any visible, above
24 ground evidence of the fort; however, the inventory form documents artifacts from the fort site
25 (including cannonballs and uniform buttons) found in the collections of local residents in the mid-
26 1970s. The nearest previously recorded prehistoric archaeological site is the "Peekskill Shell
27 Heap" (NYSM 6910). This site is a shell and artifact midden deposit located northeast of the
28 IP2 and IP3 site in the City of Peekskill.

29 A review of the NYSHPO files was conducted to identify aboveground historic resources within
30 5 mi (8 km) of the plant. In Westchester County, 29 resources are listed on the National
31 Register of Historic Places (NRHP) within the 5 mi (8 km) radius. Additionally, there are
32 16 NRHP-listed resources in Rockland County, 19 in Orange County, and 22 in Putnam County
33 within 5 mi (8 km) of the site. The nearest NRHP-listed historic resource to the IP2 and IP3
34 facilities is the Standard House in the City of Peekskill, approximately 2 mi (3.2 km) to the
35 northeast. The Standard House is a three-story Italianate structure built in 1855 and originally
36 used as a boarding house and tavern. As mentioned in Section 2.2.9.1, the Stony Point
37 Battlefield, a National Historic Landmark, is located across the Hudson River and south of IP2
38 and IP3.

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

1 Results of Walkover Survey

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

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

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

17 The NRC staff observed a concrete stairway and retaining wall (remnants of an early
18 20th century park) south of the main power block area. These appear to be the only remaining
19 features of the former Indian Point Park, a popular recreation area from 1923 to 1956 (Enercon
20 2006).

21 Potential Archeological Resources

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

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

38 **2.2.10 Related Federal Project Activities and Consultations**

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

Plant and the Environment

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

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

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

13 | New York/New Jersey/Philadelphia Airspace Redesign

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

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

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

1 Hudson River PCBs Site

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

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

20 Phase 1 of the project was completed in October 2009, and resulted in the removal of 293,000
21 cubic yards of PCB-contaminated sediment from the river. While this volume exceeded
22 established goals for Phase 1, removal was completed for only 10 of 18 targeted areas due to
23 the presence of contamination in some areas that was deeper than expected, and the presence
24 of woody debris and PCB oil in the sediment that complicated the removal effort. Phase 2 of the
25 project will begin with removal actions at areas that were not completed under Phase 1 (EPA
26 2009).

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

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

36 Coastal Zone Management Act

37 In the United States, coastal areas are managed through the Coastal Zone Management Act of
38 1972 (CZMA). The Act, administered by the NOAA Office of Ocean and Coastal Resource
39 Management, provides for management of the nation's coastal resources, including the Great
40 Lakes, and balances economic development with environmental conservation. The Federal
41 Consistency Regulations implemented by NOAA are contained in 15 CFR Part 930.

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

Plant and the Environment

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

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

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

18 **2.3 References**

19 10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, “Standards for
20 Protection Against Radiation.”

21 10 CFR Part 50. Code of Federal Regulations, Title 10, Energy, Part 50, “Domestic Licensing of
22 Production and Utilization Facilities.”

23 10 CFR Part 51. Code of Federal Regulations, Title 10, Energy, Part 51, “Environmental
24 Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

25 10 CFR Part 100. Code of Federal Regulations, Title 10, Energy, Part 100, “Reactor Site
26 Criteria.”

27 40 CFR Part 190. Code of Federal Regulations, Title 40, Protection of Environment, Part 190,
28 “Environmental Radiation Protection Requirements for Normal Operations of Activities in the
29 Uranium Fuel Cycle.”

30 40 CFR Part 261. Code of Federal Regulations, Title 40, Protection of Environment, Part 261,
31 “Identification and Listing of Hazardous Waste.”

32 40 CFR Part 264. Code of Federal Regulations, Title 40, Protection of Environment, Part 264,
33 “Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal
34 Facilities.”

35 40 CFR Part 273. Code of Federal Regulations, Title 40, Protection of Environment, Part 273,
36 “Standards for Universal Waste Management.”

37 32 FR 4001. U.S. Department of the Interior. “Native Fish and Wildlife: Endangered Species.”
38 March 11, 1967.

- 1 41 FR 41914. U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants:
2 Determination of Critical Habitat for American Crocodile, California Condor, Indiana Bat, and
3 Florida Manatee." September 24, 1976.
- 4 69 FR 39395. U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants;
5 90-Day Finding on a Petition to List the New England Cottontail as Threatened or Endangered."
6 June 30, 2004.
- 7 71 FR 61022. National Marine Fisheries Services. "Endangered and Threatened Species;
8 Revision of Species of Concern List, Candidate Species Definition, and Candidate Species List."
9 October 17, 2006.
- 10 72 FR 37346. U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants:
11 Removing the Bald Eagle in the Lower 48 States from the List of Endangered and Threatened
12 Wildlife." Final rule. July 9, 2007.
- 13 72 FR 69033. U.S. Fish and Wildlife Service. "Review of Native Species That Are Candidates
14 or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on
15 Resubmitted Petitions; Annual Description of Progress on Listing Actions." Proposed Rule.
16 December 12, 2007.
- 17 6 New York Codes, Rules, and Regulations (NYCRR) Subpart B. Title 6 of the Official
18 Compilation of New York Codes, Rules and Regulations, Subpart B, "Solid Waste."
- 19 16 U.S.C. Section 668aa(c). "Endangered Species Preservation Act." October 15.
- 20 16 U.S.C. Section 1531 to 1544. "Endangered Species Act of 1973" (16 U.S.C. 1531–1544, 87
21 Stat. 884), as amended. Public Law 93-205, approved December 28, 1973.
- 22 16 U.S.C. Section 5151 to 5158. "Atlantic Striped Bass Conservation Act" (16 U.S.C. 5151–
23 1544, 98 Stat. 3187). Public Law 98-613, approved 1984.
- 24 Abood, K.A., T.L. Englert, S.G. Metzger, C.V. Beckers, Jr., T.J. Groninger, and S. Mallavaram.
25 2006. "Current and Evolving Physical and Chemical Conditions in the Hudson River Estuary."
26 American Fisheries Society Symposium 51, pp. 39–61.
- 27 Achman, D.R., B.J. Brownawell, and L. Zhang. 1996. "Exchange of Polychlorinated Biphenyls
28 Between Sediment and Water in the Hudson River Estuary." *Estuaries* 19:4, pp. 950–965.
- 29 ASA (ASA Analysis and Communication). 2007. 2005 Year Class Report for the Hudson River
30 Estuary Monitoring Program. Prepared on behalf of Dynergy Roseton LLC, Entergy Nuclear
31 Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, and Mirant Bowline LLC. January
32 2007. ADAMS No. ML073331067.
- 33 Ashizawa, D., and J.J. Cole. 1994. "Long-Term Temperature Trends of the Hudson River: A
34 Study of the Historical Data." *Estuaries* 17:18, pp. 166–171.
- 35 ASSRT (Atlantic Sturgeon Status Review Team). 2007. "Status Review of Atlantic Sturgeon
36 (*Acipenser oxyrinchus oxyrinchus*)." Report to National Marine Fisheries Service, Northeast
37 Regional Office. February 23, 2007. 174 pp. Accessed at
38 <http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/atlanticsturgeon2007.pdf> on December 7,
39 2007.

Plant and the Environment

- 1 Atlantic States Marine Fisheries Commission (ASMFC). 1998. "American Shad Stock
2 Assessment: Peer Review Report." March 1998. Washington, DC. Accessed at
3 <http://www.asmfc.org/speciesDocuments/shad/stockassmtreports/shadstockassmtreport.PDF>
4 on January 21, 2008.
- 5 Atlantic States Marine Fisheries Commission (ASMFC). 2004. "Status of the Blue Crab
6 (*Callinectes sapidus*) on the Atlantic Coast." Special Report No. 80.
- 7 Atlantic States Marine Fisheries Commission (ASMFC). 2006a. "2006 Stock Assessment
8 Report for Atlantic Menhaden." Atlantic Menhaden Technical Committee. September 26, 2006.
9 Accessed at
10 http://www.asmfc.org/speciesDocuments/menhaden/reports/stockAssessments/2006StockAssessmentReport.pdf?bcsi_scan_513F405096A035F7=0&bcsi_scan_filename=2006StockAssessmentReport.pdf on February 5, 2008.
- 13 Atlantic States Marine Fisheries Commission (ASMFC). 2006b. "Species profile: Atlantic
14 striped bass, the challenges of managing a restored stock." Accessed at
15 <http://www.asmfc.org/speciesDocuments/stripedBass/speciesprofile.pdf> on December 10, 2007.
16 ADAMS No. ML083360698.
- 17 Atlantic States Marine Fisheries Commission (ASMFC). "2006c Weakfish Stock Assessment
18 Report." December 2006. Accessed at
19 http://www.asmfc.org/speciesDocuments/weakfish/stockassessmentreports/2006WeakfishStockAssessment.pdf?bcsi_scan_B666A1DE717DB577=0&bcsi_scan_filename=2006WeakfishStockAssessment.pdf on February 13, 2008.
- 22 Atlantic States Marine Fisheries Commission (ASMFC). 2007a. "American Shad Stock
23 Assessment Report for Peer Review." Stock Assessment Report No. 07-01 (Supplement) of the
24 Atlantic States Marine Fisheries Commission. August 16, 2007. Accessed at
25 <http://www.asmfc.org/speciesDocuments/shad/stockassmtreports/2007ShadStockAssmtReportVolumel.pdf> on January 21, 2008.
- 27 Atlantic States Marine Fisheries Commission (ASMFC). 2007b. "Species Profile: Weakfish—
28 The Challenge of Managing a Stock Decline When Fishing is Not the Cause." ASMFC
29 Fisheries Focus, Vol. 16, Issue 4: May/June 2007. Accessed at
30 <http://www.asmfc.org/speciesDocuments/weakfish/weakfishProfile.pdf> on February 17, 2008.
- 31 Atlantic States Marine Fisheries Commission (ASMFC). 2007c. "Species Profile: Atlantic
32 Sturgeon, Ancient Species' Slow Road to Recovery." Accessed at
33 <http://www.asmfc.org/speciesDocuments/sturgeon/sturgeonProfile.pdf> on December 6, 2007.
- 34 Bain, M.B., N. Haley, D.L. Peterson, K.K. Arend, K.E. Mills, and P.J. Sullivan. 2007. "Recovery
35 of a U.S. Endangered Fish." PLoS ONE 2(1): e168. Department of Natural Resources, Cornell
36 University, Ithaca, New York. Accessed at
37 <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0000168#s3> on
38 December 11, 2007.
- 39 Barnthouse, L.W., and W. Van Winkle. 1988. "Analysis of Impingement Impacts on Hudson
40 River Fish Populations." American Fisheries Society Monograph 4, pp. 182–190.

- 1 Berggren, T.J., and J.T. Lieberman. 1978. "Relative Contribution of Hudson, Chesapeake, and
2 Roanoke Striped Bass, *Morone saxatilis*, Stocks to the Atlantic Coast Fishery." U.S. National
3 Marine Fisheries Service Fishery Bulletin 76, pp. 335–345.
- 4 Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin 74,
5 Fishery Bulletin of the Fish and Wildlife Service, Volume 53, Contribution No. 592, Woods Hole
6 Oceanographic Institution. U.S. Government Printing Office. Accessed at
7 <http://www.gma.org/fogm> on January 21, 2008.
- 8 Blumberg, A.F., and F.L. Hellweger. 2006. "Hydrodynamics of the Hudson River Estuary."
9 American Fisheries Society Symposium 51, pp. 9–28.
- 10 Boreman, J., and C.P. Goodyear. 1988. "Estimates of Entrainment Mortality for Striped Bass
11 and Other Fish Species Inhabiting the Hudson River Estuary." American Fisheries Society
12 Monograph 4, pp. 152–160.
- 13 Brennan, L.A. 1977. "The Lower Hudson: The Archaic." In *Amerinds and their
14 Paleoenvironments in Northeastern North America*. pp. 411–430. Edited by Walter S. Newman
15 and Bert Salwen. New York Academy of Sciences, NY.
- 16 Britton, N.L., and A. Brown. 1913. *An Illustrated Flora of the Northern United States, Canada
17 and the British Possessions*. Volume II. Second edition, revised and enlarged. Charles
18 Scribner's Sons, New York.
- 19 Brosnan, T.M., and M.L. O'Shea. 1996. "Long-term Improvements in Water Quality Due to
20 Sewage Abatement in the Lower Hudson River." *Estuaries* 19:4, pp. 890–900.
- 21 Buckley, J.L. 1989. "Species Profiles: Life Histories and Environment; Requirements of Coastal
22 Fishes and Invertebrates (North Atlantic)—Rainbow Smelt." U.S. Fish and Wildlife Service
23 Biological Report 82(11.106), U.S. Army Corps of Engineers, TR EL-82-4. 11 pp. Accessed at
24 http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-106.pdf on March 13, 2008.
- 25 Caraco, N.F., J.J. Cole, P.A. Raymond, D.L. Strayer, M.L. Pace, S.E.G. Findlay, and D.T.
26 Fisher. 1997. "Zebra Mussel Invasion in a Large, Turbid River: Phytoplankton Response to
27 Increased Grazing." *Ecology* 78, pp. 588–602.
- 28 Caraco, N.F., J.J. Cole, S.E.G. Findlay, D.T. Fischer, G.G. Lampman, M.L. Pace, and D.L.
29 Strayer. 2000. "Dissolved Oxygen Declines in the Hudson River Associated with the Invasion
30 of the Zebra Mussel (*Dreissena polymorpha*)." *Environmental Science and Technology* 34, pp.
31 1204–1210.
- 32 Caraco, N.F., and J.J. Cole. 2006. "Hydrologic Control of External Carbon Loads and Primary
33 Production in the Tidal Freshwater Hudson." American Fisheries Society Symposium 51, pp.
34 63–74.
- 35 Center for Plant Conservation (CPC). 2008. "National Collection of Endangered Plants—Plant
36 Profiles." Accessed at http://www.centerforplantconservation.org/ASP/CPC_NCList_Alpha.asp
37 on March 12, 2008. ADAMS No. ML083390228.
- 38 Chesapeake Bay Program. 2006. "White Perch." Accessed at
39 http://www.chesapeakebay.net/white_perch.htm on January 11, 2008. ADAMS No.
40 ML083390252.

Plant and the Environment

- 1 CHGEC (Central Hudson Gas and Electric Corporation). 1999. "Draft Environmental Impact
2 Statement for State Pollutant Discharge Elimination System Permits for Bowline Point, Indian
3 Point 2 and 3, and Roseton Steam Electric Generating Stations." Consolidated Edison
4 Company New York, Inc. New York Power Authority and Southern Energy New York.
5 December 1999. ADAMS Accession No. ML083400128.
- 6 Christensen, S.W., and T.L. Englert. 1988. "Historical Development of Entrainment Models for
7 Hudson River Striped Bass." *American Fisheries Society Monograph* 4, 133–142.
- 8 Collette, B.B., and G. Klein-MacPhee (eds.). 2002. *Bigelow and Schroeder's Fishes of the Gulf
9 of Maine (3rd Ed.)*. 748 pp. Smithsonian Institution Press, Herndon, VA.
- 10 Conant, R., and J.T. Collins. 1998. *A Field Guide to Reptiles and Amphibians, Eastern and
11 Central North America*. Third edition, expanded. Houghton Mifflin Co., Boston.
- 12 Cortlandt Consolidated Water District (CCWD). 2006. "Annual Water Supply Statement," p. 1.
13 Accessed at www.townofcortlandt.com on July 15, 2006. ADAMS No. ML083390256.
- 14 Countryman, E. 2001. "From Revolution to Statehood (1776–1825)." In *The Empire State: A
15 History of New York*, p. 237. Edited by Milton M. Klein. Cornell University Press, Ithaca, NY.
- 16 Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. "Synopsis of
17 Biological Data on Shortnose Sturgeon, *Acipenser brevirostrum* LeSueur 1818". NOAA
18 Technical Report NMFS-14, FAO Fisheries Synopsis No. 140, 45 pp. Accessed at
19 http://www.nmfs.noaa.gov/pr/pdfs/species/shortnosesturgeon_biological_data.pdf on December
20 11, 2007.
- 21 Daniels, R.A., K.E. Limburg, R.E. Schmidt, D.L. Strayer, and R.C. Chambers. 2005. "Changes
22 in Fish Assemblages in the Tidal Hudson River, New York." *American Fisheries Society
23 Symposium* 45: pp. 471–503. Accessed at
24 http://www.ecostudies.org/reprints/daniels_et_al_2005.pdf on March 13, 2008.
- 25 Deason, E.E. 1982. "Mnemiopsis leidyi (Ctenophora) in Narragansett Bay, 1975–1979:
26 Abundance, Size, Composition, and Estimation of Grazing." *Estuarine, Coastal and Shelf
27 Science* 15(2), pp. 121–134.
- 28 Department of Transportation (DOT)/Federal Aviation Administration (FAA). 2007. Final
29 Environmental Impact Statement, New York/New Jersey/Philadelphia Metropolitan Area
30 Airspace Redesign. July 2007.
- 31 Derrick, P.A., and V.S. Kennedy. 1997. "Prey Selection by the Hogchoker, *Trinectes maculatus*
32 (Pisces: Soleidae), Along Summer Salinity Gradients in Chesapeake Bay, USA." *Marine
33 Biology* 129(4), pp. 699–711.
- 34 Dew, C.B., and J.H. Hecht. 1994. "Hatching, Estuarine Transport, and Distribution of Larval
35 and Early Juvenile Atlantic Tomcod, *Microgadus tomcod*, in the Hudson River." *Estuaries*, Vol.
36 17, No. 2, pp. 472–488. Accessed at
37 http://estuariesandcoasts.org/cdrom/ESTU1994_17_2_472_488.pdf on December 11, 2007.
38 (Agencywide Documents Access and Management System (ADAMS) Accession No.
39 ML073460164)
- 40 Dovel, W.L., J.A. Mihursky, and A.J. McErlean. 1969. "Life History Aspects of the Hogchoker,
41 *Trinectes maculatus*, in the Patuxent River Estuary, Maryland." *Chesapeake Science* 10(2), pp.

- 1 104–119. Accessed at http://estuariesandcoasts.org/cdrom/CPSC1969_10_2_104_119.pdf on
2 February 18, 2008.
- 3 Dunn, J.L., and J. Alderfer (eds.). 2006. National Geographic Field Guide to the Birds of North
4 America. Fifth Edition. National Geographic, Washington, DC.
- 5 Dunning, D.J., Q.E. Ross, M.T. Mattson, and D.G. Heimbuch. 2006a. “Distribution and
6 Abundance of Bay Anchovy Eggs and Larvae in the Hudson River and Nearby Waterways.”
7 American Fisheries Society Symposium 51, pp. 215–226.
- 8 Dunning, D.J., J.R. Waldman, Q.E. Ross, and M.T. Mattson. 2006b. “Dispersal of Age-2+
9 Striped Bass Out of the Hudson River.” American Fisheries Society Symposium 51, pp. 287–
10 294.
- 11 Dutchess County Department of Planning and Development—Greenway Connections Report.
12 2006. Dutchess County New York. Accessed at
13 <http://www.co.dutchess.ny.us/EnvironmentLandPres/ELPgreenwayguide.htm> on June 30, 2006.
- 14 Enercon Services, Inc. (Enercon). 2003. “Economic and Environmental Impacts Associated
15 with Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water
16 Configuration.”
- 17 Enercon Services, Inc. (Enercon). 2006. “Phase 1A Literature Review and Archaeological
18 Sensitivity Assessment of the Indian Point Site, Westchester County, New York.” Tulsa, OK.
- 19 Entergy Nuclear Northeast (ENN). 2007a. “Indian Point 2, Offsite Dose Calculation Manual
20 (ODCM), Part II—Calculation Methodology.” Revision 11, Table 2-9.
- 21 Entergy Nuclear Northeast (ENN). 2007b. “Indian Point Site Audit Information Needs” (Letter
22 from Fred R. Dacimo, Indian Point Energy Center to the U.S. Nuclear Regulatory Commission).
23 Buchanan, NY. November 14, 2007. (ADAMS Accession No. ML073330590)
- 24 Entergy Nuclear Northeast (ENN). 2007c. “Supplement to License Renewal Application (LRA)
25 Environmental Report References.” November 14, 2007. (ADAMS Accession No.
26 ML073330590)
- 27 Entergy Nuclear Operations Inc. (Entergy). 2003a. “Indian Point Units 1 and 2—Annual
28 Effluent and Waste Disposal Report.” Docket Numbers 50-3 and 50-247, Buchanan, NY.
29 (ADAMS Accession No. ML031220099)
- 30 Entergy Nuclear Operations Inc. (Entergy). 2003b. “Indian Point Unit 3—Annual Radioactive
31 Effluent Release Report.” Docket Number 50-286, Buchanan, NY. (ADAMS Accession No.
32 ML031220024)
- 33 Entergy Nuclear Operations Inc. (Entergy). 2004. “Indian Point Units 1, 2, and 3—2003 Annual
34 Effluent and Waste Disposal Report.” Docket Numbers 50-3, 50-247, and 50-286, Buchanan,
35 NY. (ADAMS Accession No. ML041250522)
- 36 Entergy Nuclear Operations Inc. (Entergy). 2005a. “Indian Point Units 1, 2, and 3—2004
37 Radioactive Effluent Release Report.” Docket Numbers 50-3, 50-247, and 50-286, Buchanan,
38 NY. (ADAMS Accession No. ML051180211)
- 39 Entergy Nuclear Operations, Inc. (Entergy). 2005b. “Indian Point Energy Center, Indian Point
40 3, Updated Final Safety Analysis Report,” Revision 01.

Plant and the Environment

- 1 Entergy Nuclear Operations, Inc. (Entergy). 2006a. "Indian Point 2 UFSAR," Revision 20.
- 2 Entergy Nuclear Operations Inc. (Entergy). 2006b. "Indian Point Units 1, 2, and 3—2005
3 Annual Radioactive Effluent Release Report." Docket Numbers 50-3, 50-247, and 50-286,
4 Buchanan, NY. (ADAMS Accession No. ML061240373)
- 5 Entergy Nuclear Operations, Inc. (Entergy). 2006c. "Abundance and Stock Characteristics of
6 the Atlantic Tomcod Spawning Population in the Hudson River, Winter 2003–2004." Prepared
7 by Normandeau Associates, Inc., Document R-19900.000. December 2006. ADAMS No.
8 ML073511572.
- 9 Entergy Nuclear Operations Inc. (Entergy). 2006d. "Indian Point, Units 1, 2 and 3—Annual
10 Radiological Environmental Operating Report for 2005." Docket Numbers 50-3, 50-247, and 50
11 286, Buchanan, NY. (ADAMS Accession No. ML061290085)
- 12 Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Applicant's Environmental Report,
13 Operating License Renewal Stage." (Appendix E of "Indian Point, Units 2 & 3, License Renewal
14 Application.") April 23, 2007. (ADAMS Accession No. ML071210530)
- 15 Entergy Nuclear Operations, Inc. (Entergy). 2007b. "Indian Point, Units 2 & 3, License
16 Renewal Application." April 23, 2007. (ADAMS Accession No. ML071210512)
- 17 Entergy Nuclear Operations Inc. (Entergy). 2007c. "Indian Point Units 1, 2, and 3—2006
18 Annual Radioactive Effluent Release Report." Docket Numbers 50-3, 50-247, and 50-286,
19 Buchanan, NY. (ADAMS Accession No. ML071230305)
- 20 Entergy Nuclear Operations Inc. (Entergy). 2007d. "Indian Point, Units 1, 2, and 3—Annual
21 Radiological Environmental Operating Report for 2006." Docket Numbers 50-3, 50-247, and 50
22 286, Buchanan, NY. (ADAMS Accession No. ML071420088)
- 23 Entergy Nuclear Operations Inc. (Entergy). 2008. "Dry Cask Storage Information Sheet"
24 ([http://www.entergy-nuclear.com/content/Resource_Library/dry_cask/Dry_Cask_Storage_info_](http://www.entergy-nuclear.com/content/Resource_Library/dry_cask/Dry_Cask_Storage_info_sheet.pdf)
25 [sheet.pdf](http://www.entergy-nuclear.com/content/Resource_Library/dry_cask/Dry_Cask_Storage_info_sheet.pdf)). Accessed at http://www.entergy-nuclear.com/resource_library/IPEC.aspx on June
26 26, 2008. ADAMS No. ML083390262.
- 27 Entergy Nuclear Operations Inc. (Entergy). 2010a. "2009 Annual Radioactive Effluent Release
28 Report." Indian Point Units 1, 2 & 3; Docket Nos. 50-003, 50-247, and 50-286; License Nos.
29 DPR-5, DPR-26, DPR-64. Buchanan, NY. (ADAMS Accession No. ML101240989)
- 30 Entergy Nuclear Operations Inc. (Entergy). 2010b. "Indian Point Nuclear Power Plants Units 1,
31 2, and 3—Annual Radiological Environmental Operating Report for 2009." Indian Point Units 1,
32 2 and 3; Docket Nos. 50-003, 50-247, and 50-286; License Nos. DPR-5, DPR-26, DPR-64;
33 Buchanan, NY. (ADAMS Accession No. ML101390564)
- 34 Environmental Protection Agency (EPA). 2004. "Total Maximum Daily Loads, Listed Water
35 Information, Cycle: 2004. Hudson River, Lower Hudson River." Accessed at
36 http://oaspub.epa.gov/tmdl/enviro.control?p_list_id=NY-1301-0002&p_cycle=2004 on February
37 23, 2008.
- 38 Environmental Protection Agency (EPA). 2006a. "Green Book." Accessed at
39 <http://www.epa.gov/air/oaqps/greenbk/ancl.html> on August 10, 2007. ADAMS No. ML083390099

- 1 Environmental Protection Agency (EPA). 2006b. "Safe Drinking Water Information System
2 (SDWIS) Database." Accessed at <http://oaspub.epa.gov> on January 24, 2006. ADAMS No.
3 ML083390264.
- 4 Environmental Protection Agency (EPA). 2007a. "Level III Ecoregions of the Conterminous
5 United States." Western Ecology Division. Accessed at
6 http://www.epa.gov/wed/pages/ecoregions/level_iii.htm on March 11, 2008. ADAMS No.
7 ML083390482
- 8 Environmental Protection Agency (EPA). 2007b. "Nanotechnology White Paper." EPA 100/B-
9 07/001, February 2007. Science Policy Council, Washington, D.C. Accessed at
10 [http://www.epa.gov/osa/pdfs/nanotech/epa-nanotechnology-whitepaper-
11 0207.pdf?bcsi_scan_A3171404B2C9D30E=0&bcsi_scan_filename=epa-nanotechnology-
12 whitepaper-0207.pdf](http://www.epa.gov/osa/pdfs/nanotech/epa-nanotechnology-whitepaper-0207.pdf?bcsi_scan_A3171404B2C9D30E=0&bcsi_scan_filename=epa-nanotechnology-whitepaper-0207.pdf) on December 2, 2008.
- 13 Environmental Protection Agency (EPA). 2008a. "Hudson River PCB Superfund Site, Dredge
14 Area 2 Delineation Fact Sheet, 2008." Accessed at
15 http://www.epa.gov/hudson/factsheet_2nd_phaselow.pdf on February 4, 2008. ADAMS No.
16 ML083360712.
- 17 Environmental Protection Agency (EPA). 2008b. "Local Drinking Water Information,
18 Pennsylvania Drinking Water, Envirofacts Data on Pennsylvania, County Search—Allegheny
19 and Beaver Counties—January 18, 2008." Accessed at
20 http://oaspub.epa.gov/enviro/sdw_form_v2.create_page?state_abbr=PA in April 2008. ADAMS
21 No. ML083390266.
- 22 Environmental Protection Agency (EPA). 2008c. "Hudson River PCBs" Web page. Accessed
23 at <http://www.epa.gov/hudson> on March 5, 2008. ADAMS No. ML083390040.
- 24 Environmental Protection Agency (EPA). 2009. "First Phase of Hudson River Dredging Project
25 Complete." Accessed at <http://www.epa.gov/Hudson/> on December 14, 2009.
- 26 Euston, E.T., S.A. Haney, K.A. Hattala, and A.W. Kahnle. 2006. "Overview of the Hudson
27 River Recreational Fisheries, with an Emphasis on Striped Bass." American Fisheries Society
28 Symposium 51, pp. 295–315.
- 29 Everly, A.W., and J. Boreman. 1999. "Habitat Use and Requirements of Important Fish
30 Species Inhabiting the Hudson River Estuary." National Oceanic and Atmospheric
31 Administration, Technical Memorandum NMFS-NE-121. Accessed at
32 <http://www.nefsc.noaa.gov/nefsc/publications/tm/tm121/> on November 29, 2007. (ADAMS
33 Accession No. ML073460167)
- 34 Fabrizio, M.C. 1987. "Contribution of Chesapeake Bay and Hudson River Stocks of Striped
35 Bass to Rhode Island Coastal Waters as Estimated by Isoelectric Focusing of Eye Lens
36 Proteins." Transactions of the American Fisheries Society 116, pp. 588–593.
- 37 Facey, D.E., and M.J. Van Den Avyle. 1986. "Species Profile: Life Histories and
38 Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)—American
39 Shad." U.S. Fish and Wildlife Service Biol. Rep. 82 (11.76). U.S. Army Corps of Engineers, TR
40 EL-82-4. Accessed at
41 [http://conserveonline.org/workspaces/atlantic.diadromous.migratory.fish/alosa.sapidissima/Shad
42 %20profile.pdf](http://conserveonline.org/workspaces/atlantic.diadromous.migratory.fish/alosa.sapidissima/Shad%20profile.pdf) on December 18, 2007.

Plant and the Environment

- 1 Fay, C.W., R.J. Neves, and G.B. Pardue. 1983. "Species Profile: Life Histories and
2 Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—
3 Alewife/Blueback Herring." U.S. Fish and Wildlife Service Biol. Rep. 82 (11.45). U.S. Army
4 Corps of Engineers, TR EL-82-4. Accessed at
5 http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-009.pdf on November 29, 2007.
6 (ADAMS Accession No. ML073460154)
- 7 Federal Aviation Administration (FAA). 2007. Press Release: "FAA Issues Final Decision on
8 Airspace Redesign." September 5, 2007. Accessed at
9 <http://news.thomasnet.com/companystory/535311> on March 5, 2008. ADAMS No.
10 ML083390269.
- 11 Findlay, S., D. Strayer, M. Bain, and W.C. Nieder. 2006. "Ecology of Hudson River Submerged
12 Aquatic Vegetation." Final Report to the New York State Department of Environmental
13 Conservation. Accessed at <http://www.nysl.nysed.gov/scandoclinks/ocm82162378.htm> on
14 February 21, 2008.
- 15 Fish and Wildlife Service (FWS). 2001. "Bog Turtle (*Clemmys muhlenbergii*), Northern
16 Population, Recovery Plan." Hadley, Massachusetts. 103 pp. Accessed at
17 http://ecos.fws.gov/docs/recovery_plan/010515.pdf on March 4, 2008.
- 18 Fish and Wildlife Service (FWS). 2002. "Threatened and Endangered Species: Indiana Bat
19 (*Myotis sodalis*)." Accessed at <http://www.fws.gov/midwest/Endangered/> on March 4, 2008.
20 ADAMS No. ML083390273.
- 21 Fish and Wildlife Service (FWS). 2004. "Plant Invaders of Mid-Atlantic Natural Areas: Aquatic
22 Plants." U.S. Fish and Wildlife Service Bayscapes Conservation Landscaping Program.
23 October 7, 2004. Accessed at <http://www.nps.gov/plants/alien/pubs/midatlantic/trna.htm> on
24 February 23, 2008. ADAMS No. ML083390277.
- 25 Fish and Wildlife Service (FWS). 2007a. "Indiana Bat (*Myotis sodalis*) Draft Recovery Plan:
26 First Revision." Fort Snelling, Minnesota. 258 pp. Accessed at
27 http://www.fws.gov/midwest/Endangered/mammals/documents/inba_fnldrftrecpln_apr07.pdf on
28 March 4, 2008.
- 29 Fish and Wildlife Service (FWS). 2007b. "Species Assessment and Listing Priority Assignment
30 Form, Scientific Name: *Sylvilagus transitionalis*, Common Name: New England Cottontail."
31 April 16, 2007. Accessed at http://ecos.fws.gov/docs/candforms_pdf/r5/A09B_V01.pdf on
32 March 10, 2008.
- 33 Fish and Wildlife Service (FWS). 2008a. Significant Habitats and Habitat Complexes of the
34 New York Bight Watershed. Lower Hudson River Complex #21. Accessed at
35 http://training.fws.gov/library/pubs5/web_link/text/low_hud.htm on February 23, 2008. ADAMS
36 No. ML083390034.
- 37 Fish and Wildlife Service (FWS). 2008b. "Westchester County Federally Listed Endangered
38 and Threatened Species and Candidate Species." Accessed at
39 <http://www.fws.gov/northeast/nyfo/es/CountyLists/WestchesterDec2006.htm> on February 26,
40 2008. ADAMS No. ML083390032.

- 1 Flora of North America (FNA) Editorial Committee (eds.). 1993+. Flora of North America North
2 of Mexico. 12+ vols. New York and Oxford. Accessed at
3 http://www.efloras.org/flora_page.aspx?flora_id=1 on March 11, 2008.
- 4 Francis, P., Jr. 1997. "The Beads that Did Not Buy Manhattan Island." *New York History* 78:
5 411–428.
- 6 Froese, R., and D. Pauly (eds.). 2007a. "Microgadus Tomcod Atlantic Tomcod" on FishBase:
7 World Wide Web Electronic Database. Version (10/2007). Accessed at
8 <http://www.fishbase.org/summary/Speciessummary.php?id=316> on November 30, 2007.
9 (ADAMS Accession No. ML073460169)
- 10 Froese, R., and D. Pauly (eds.) 2007b. "Dorosoma cepedianum American Gizzard Shad" on
11 FishBase: World Wide Web Electronic Database. Version (10/2007). Accessed at
12 <http://www.fishbase.org/Summary/SpeciesSummary.php?id=1604> on February 6, 2008.
13 ADAMS No. ML083390031.
- 14 Froese, R., and D. Pauly (eds.) 2007c. "Cynoscion regalis Gray Weakfish" on FishBase:
15 World Wide Web Electronic Database. Version (10/2007). Accessed at
16 <http://www.fishbase.org/Summary/SpeciesSummary.php?id=406> on February 14, 2008.
17 ADAMS No. ML083390030.
- 18 Funk, R.E. 1976. *Recent Contributions to Hudson Valley Prehistory*. ed. Vol. pp. 272–275.
19 State University of New York, State Education Department, Albany, NY.
- 20 Gilbert, C.R. 1989. "Species Profiles: Life Histories and Environmental Requirements of
21 Coastal Fishes and Invertebrates (Mid-Atlantic Bight)—Atlantic and Shortnose Sturgeons." U.S.
22 Fish and Wildlife Service Biological Report 82 (11.122). U.S. Army Corps of Engineers TR 82 4.
23 28 pp.
- 24 Griffin, E.F. 1946. *Westchester County and Its People, A Record*. pp. 281–294. Lewis
25 Historical Publishing Company, New York.
- 26 Haas-Castro, R. 2006a. "Status of Fishery Resources off the Northeastern U.S.: River
27 Herring." Northeast Fisheries Science Center Resource Evaluation and Assessment Division,
28 National Oceanic and Atmospheric Administration. Accessed at
29 http://www.nefsc.noaa.gov/sos/spsyn/af/herring/archives/38_RiverHerring_2006.pdf on
30 December 17, 2007. ADAMS No. ML083390029.
- 31 Haas-Castro, R. 2006b. "Status of Fishery Resources off the Northeastern U.S.: American
32 Shad." Northeast Fisheries Science Center Resource Evaluation and Assessment Division,
33 National Oceanic and Atmospheric Administration. Accessed at
34 http://www.nefsc.noaa.gov/sos/spsyn/af/shad/archives/39_AmericanShad_2006.pdf on
35 December 18, 2007. ADAMS Accession No. ML083390028.
- 36 Haddock, S.H.D. 2007. "Comparative Feeding Behavior of Planktonic Ctenophores."
37 *Integrative and Comparative Biology* 47(6), pp. 847–853.
- 38 Hall, C.A.S. 1977. "Model and the Decision Making Process: The Hudson River Power Plant
39 Case." *Ecosystem Modeling in Theory and Practice*, pp. 345–364. C.A.S. Hall and J.W. Day,
40 Editors. Wiley, New York.

Plant and the Environment

- 1 Hartman, K.J., J. Howell, and J.A. Sweka. 2004. "Diet and Daily Ration of Bay Anchovy in the
2 Hudson River, New York." *Transactions of the American Fisheries Society* 133, pp. 762–771.
- 3 Hirschberg, D.J., P. Chen, H. Feng, and J.K. Cochran. 1996. "Dynamics of Sediment and
4 Contaminant Transport in the Hudson River Estuary: Evidence from Sediment Distributions of
5 Naturally Occurring Radionuclides." *Estuaries* 19:4, pp. 931–949.
- 6 Howard, R.W. 2001. "The English Province (1664–1776)." In *The Empire State: A History of*
7 *New York*, pp. 112–228. Edited by Milton M. Klein. Cornell University Press, Ithaca.
- 8 Idaho Department of Fish and Game, Bureau of Fisheries (IDFG). 1985. "Proposal for the
9 Introduction of Spottail Shiner (*Notropis hudsonius*) into Ondeida Narrows Reservoir."
10 November 1985. Accessed at
11 [https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Volume%20087_Article%20](https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Volume%20087_Article%2007.pdf)
12 [07.pdf](https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Volume%20087_Article%2007.pdf) on March 12, 2008.
- 13 Indian Point Energy Center. 2004. Meteorological Tower Data, 2000–2004. ADAMS No.
14 ML083390408
- 15 Indian Point Energy Center. 2005. "Indian Point 3, Updated Final Safety Analysis Report,"
16 Revision 1, Section 2.6.5.
- 17 Institute of Educational Science (IES). 2008. U.S. Department of Education. National Center
18 for Educational Statistics. "College Opportunities Online Locator." Accessed at
19 <http://nces.ed.gov/ipeds/cool/RefineSearch.aspx> in April 2008.
- 20 Invasive Plant Council of New York State (IPCNY). 2008. "Water Chestnut—Overview."
21 Accessed at http://www.ipcnys.org/sections/target/water_chestnut_overview.htm on February
22 23, 2008.
- 23 Iverson, L.R., D. Ketzner, and J. Karnes. 1999. Illinois Plant Information Network. Illinois
24 Natural History Survey and USDA Forest Service. Accessed at
25 <http://www.fs.fed.us/ne/delaware/ilpin/ilpin.html> on March 11, 2008. ADAMS Accession No.
26 ML083390027.
- 27 Juanes, F., R.E. Marks, K.A. McKown, and D.O. Conover. 1993. "Predation by Age-0 Bluefish
28 on Age-0 Anadromous Fishes in the Hudson River Estuary." *Transactions of the American*
29 *Fisheries Society* 122, pp. 348–356.
- 30 Kenney, G. 2002. "Annual Report on the Commercial Monitoring of the Hudson River Blue
31 Crab Fishery." New England Interstate Water Pollution Control Commission and New York
32 State Department of Environmental Conservation. New Paltz, NY.
- 33 Kentucky State Nature Preserves Commission (KSNPC). 2008. Kentucky Rare Plant
34 Database. Accessed at <http://eppcapps.ky.gov/nprareplants/> on March 14, 2008. ADAMS
35 Accession No. ML083390026.
- 36 Klauda, R.J., J.B. McLaren, R.E. Schmidt, and W.P. Dey. 1988. "Life History of White Perch in
37 the Hudson River Estuary." *American Fisheries Society Monograph* 4, 69–88.
- 38 Koski, R.T. 1978. "Age, Growth, and Maturity of the Hogchoker, *Trinectes maculatus*, in the
39 Hudson River, New York." *Transactions of the American Fisheries Society* 107(3), pp. 449–
40 453.

- 1 Kraft, H.C. 1991. "The Indians of the Lower Hudson Valley at the Time of European Contact."
2 In *The Archaeology and Ethnohistory of the Lower Hudson Valley and Neighboring Regions:*
3 *Essays in Honor of Louis A. Brennan.* Edited by Herbert C. Kraft. Archaeological Services,
4 Bethlehem, CT.
- 5 Kynard, B. 1997. "Life History, Latitudinal Patterns, and Status of the Shortnose Sturgeon
6 *Acipenser brevirostrum.*" *Environmental Biology of Fishes* 48, pp. 319–334.
- 7 Lady Bird Johnson Wildflower Center Native Plant Information Network (NPIN). 2008. Native
8 Plant Database. Accessed at <http://www.wildflower.org/plants/> on March 14, 2008. ADAMS
9 Accession No. ML083390025.
- 10 Larson, R.J. 1988. "Feeding and Functional Morphology of the Lobate Ctenophore *Mnemiopsis*
11 *mccradyi.*" *Estuarine, Coastal and Shelf Science* 27(5), pp. 495–502.
- 12 Levine, M.A. 1989. "New Evidence for Postglacial Occupations in the Upper Hudson Valley."
13 *Bulletin, Journal of the New York State Archaeological Association* 98: 5–12.
- 14 Levinton, J.S., and J.R. Waldman (eds.). 2006. *The Hudson River Estuary.* Cambridge
15 University Press, New York.
- 16 Limburg, K.E. 1996. "Modeling the Ecological Constraints on Growth and Movement of
17 Juvenile American Shad (*Alosa sapidissima*) in the Hudson River Estuary." *Estuaries* 19:4, pp.
18 794–813.
- 19 Lonsdale, D.J., E.M. Cospser, and M. Doall. 1996. "Effects of Zooplankton Grazing on
20 Phytoplankton Size-Structure and Biomass in the Lower Hudson River Estuary." *Estuaries*
21 19:4, pp. 874–889.
- 22 Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005a. "Spottail
23 Shiner." In: *Fishes of the Middle Savannah River Basin.* Athens, GA: University of Georgia
24 Press, pp. 153–156.
- 25 Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005b. "White
26 Catfish." In: *Fishes of the Middle Savannah River Basin,* pp. 212–214. University of Georgia
27 Press, Athens, GA.
- 28 Maryland Department of Natural Resources (MDNR). 2007a. "Maryland Fish Facts: American
29 Gizzard Shad." Accessed at
30 <http://www.dnr.state.md.us/fisheries/fishfacts/americangizzardshad.asp> on February 6, 2008.
31 ADAMS Accession No. ML083390023.
- 32 Maryland Department of Natural Resources (MDNR). 2007b. "White Catfish—*Ameiurus catus.*"
33 Accessed at <http://www.dnr.state.md.us/fisheries/fishfacts/whitecatfish.asp> on March 13, 2008.
34 ADAMS Accession No. ML080730512.
- 35 McGovern, J.C., and J.E. Olney. 1988. "Potential Predation by Fish and Invertebrates on Early
36 Life History Stages of Striped Bass in the Pamunkey River, Virginia." *Transactions of the*
37 *American Fisheries Society* 117, pp. 152–161.
- 38 McLaren, J.B., T.H. Peck, W.P. Dey, and M. Gardinier. 1988. "Biology of Atlantic Tomcod in
39 the Hudson River Estuary." *American Fisheries Society Monograph* 4, pp. 102–112.

Plant and the Environment

- 1 Menhaden Resource Council (MRC). 2006. "Atlantic Menhaden Biology." Accessed at
2 <http://www.menhaden.org/biology.htm> on February 4, 2008.
- 3 Mercer, L.P. 1989. "Species Profile: Life Histories and Environmental Requirements of
4 Coastal Fishes and Invertebrates (Mid-Atlantic)—Weakfish." U.S. Fish and Wildlife Service
5 Biological Report 82 (11.109). U.S. Army Corps of Engineers, TR EL-82-4. Accessed at
6 http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-109.pdf on February 8, 2008.
- 7 Miller, B. (Building Inspector). Village of Buchanan. 2006. Phone conversation concerning
8 land development in the Village of Buchanan on January 24, 2006.
- 9 Miller, D., J. Ladd, and W. Nieder. 2006. "Channel Morphology in the Hudson River Estuary:
10 Historical Changes and Opportunities for Restoration." American Fisheries Society Symposium
11 51, pp. 29–37.
- 12 Mills, E.L., D.L. Strayer, M.D. Scheuerell, and J.T. Carlton. 1996. "Exotic Species in the
13 Hudson River Basin: A History of Invasions and Introductions." *Estuaries* 19:4, pp. 814–823.
- 14 Morris, C. 2001. "Dorosoma cepedianum." Animal Diversity Web. Accessed at
15 http://animaldiversity.ummz.umich.edu/site/accounts/information/Dorosoma_cepedianum.html
16 on February 6, 2008.
- 17 Morton, T. 1989. "Species Profiles: Life Histories and Environmental Requirements of Coastal
18 Fishes and Invertebrates (Mid-Atlantic)—Bay Anchovy." U.S. Fish and Wildlife Service
19 Biological Report 82 (11.97). U.S. Army Corps of Engineers TR EL-82-4 13 pp. Accessed at
20 http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-097.pdf on March 13, 2008.
- 21 National Marine Fisheries Service (NMFS). 2009. Letter from Mary A. Colligan to David J.
22 Wrona on February 24, 2009.
- 23 National Marine Fisheries Service (NMFS). 1998. Recovery Plan for the Shortnose Sturgeon
24 (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National
25 Marine Fisheries Service, Silver Spring, Maryland. 104 pages. Accessed at
26 http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_shortnose.pdf on November 17, 2010.
- 27 National Oceanic and Atmospheric Administration (NOAA). 2004. Local Climatological Data—
28 Annual Summary with Comparative Data—Binghamton, Albany, and New York City, New York.
29 ISSN 0198-2419, Asheville, NC.
- 30 National Oceanic and Atmospheric Administration (NOAA). 2007. "Species of Concern:
31 Rainbow Smelt, *Osmerus mordax*." Updated May 17, 2007. Accessed at
32 http://nmfs.noaa.gov/pr/pdfs/species/rainbowsmelt_detailed.pdf on March 12, 2008.
- 33 National Oceanic and Atmospheric Administration (NOAA). 2008a. "Hudson River Reserve,
34 New York." National Estuarine Research Reserve System. Accessed at
35 <http://www.nerrs.noaa.gov/HudsonRiver/> on February 23, 2008.
- 36 National Oceanic and Atmospheric Administration (NOAA). 2008b. "Pharmaceuticals in the
37 Environment, Information for Assessing Risk." National Centers for Coastal Ocean Science
38 (NCCOS), National Ocean Service. Accessed at <http://www.chbr.noaa.gov/peiar> on December
39 2, 2008.

- 1 National Park Service (NPS). 2006a. "Class I Mandatory Areas." Accessed at
2 <http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm> on December 4, 2008. ADAMS No.
3 ML083390507
- 4 National Park Service (NPS). 2006b. "Explore Air. Class I Receptors." Accessed at
5 <http://www2.nature.nps.gov/air/Maps/images/ClassIAreas.jpg> on December 3, 2008. ADAMS
6 No. ML083390114
- 7 National Severe Storm Laboratory (NSSL). 2006. "Tornadoes... Nature's Most Violent Storms."
8 Natural Resources Conservation Service (NRCS). 2008. Plants Database. U.S. Department of
9 Agriculture. Accessed at <http://plants.usda.gov/java/factSheet> on March 10, 2008.
- 10 NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life (Web application).
11 Version 6.2. NatureServe, Arlington, VA. Accessed at <http://www.natureserve.org/explorer/> in
12 March 2008.
- 13 Nearctica.com, Inc. (Nearctica). 2008. "Wildflowers of the Eastern United States." Accessed at
14 <http://www.nearctica.com/flowers/index.htm> on March 12, 2008.
- 15 New Jersey Department of Environmental Protection (NJDEP). 2005. "White Catfish."
16 Accessed at http://www.nj.gov/dep/fgw/fish_wht_cat.htm on March 13, 2008. (ADAMS
17 Accession No. ML080730514)
- 18 New Jersey Department of Environmental Protection (NJDEP) and New Jersey Department of
19 Health and Senior Services (NJDHSS). 2006. "Fish Smart, Eat Smart: A Guide to Health
20 Advisories for Eating Fish and Crabs Caught in New Jersey Waters." Accessed at
21 <http://www.state.nj.us/dep/dsr/2006fishadvisorybrochure.pdf> on March 13, 2008. (ADAMS
22 Accession No. ML080730515)
- 23 New York Natural Heritage Program (NYNHP). 2007. "New York Rare Plant Status Lists."
24 Albany, New York. 115 pp. June 2007. Accessed at
25 http://www.dec.ny.gov/docs/wildlife_pdf/Rare_Plant_Status_Lists_2007.pdf on March 11, 2008.
- 26 New York Natural Heritage Program (NYNHP). 2008a. "Online Conservation Guide for *Myotis*
27 *sodalis*." Accessed at <http://www.acris.nynhp.org/guide.php?id=7405> on March 21, 2008.
28 ADAMS Accession No. ML083390018.
- 29 New York Natural Heritage Program (NYNHP). 2008b. "Online Conservation Guide for
30 *Glyptemys muhlenbergii*." Accessed at <http://www.acris.nynhp.org/guide.php?id=7507> on
31 March 21, 2008. ADAMS Accession No. ML083390017.
- 32 New York Natural Heritage Program (NYNHP). 2008c. "Online Conservation Guide for
33 *Sylvilagus transitionalis*." Accessed at <http://www.acris.nynhp.org/guide.php?id=7415> on March
34 21, 2008. ADAMS Accession No. ML083390015.
- 35 New York Natural Heritage Program (NYNHP). 2008d. "Animal and Plant Guides." Accessed
36 at <http://www.acris.nynhp.org/> in March 2008. ADAMS Accession No. ML083390012.
- 37 New York Metropolitan Transportation Council. 2004. Accessed at
38 <http://www.nymtc.org/Project/conformity/Appendix/Appendix%20B%20Population.pdf> on April
39 2008.

Plant and the Environment

- 1 New York State Department of Environmental Conservation (NYSDEC). 2003a. "Final
2 Environmental Impact Statement Concerning the Applications to Renew New York State
3 Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1&2 Bowline 1&2 and
4 Indian Point 2&3 Steam Electric Generating Stations, Orange, Rockland and Westchester
5 Counties." Hudson River Power Plants FEIS. June 25, 2003. ADAMS Accession No.
6 ML083360752.
- 7 New York State Department of Environmental Conservation (NYSDEC). 2003b. "Fact Sheet.
8 New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal with
9 Modification, Indian Point Electric Generating Station, Buchanan, NY." November 2003.
10 Accessed at http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf on July
11 12, 2007. ADAMS Accession No. ML083360743.
- 12 New York State Department of Environmental Conservation (NYSDEC). 2004a. "Descriptive
13 Data of Municipal Wastewater Treatment Plants in New York State." New York Department of
14 Environmental Conservation, Division of Water, Bureau of Water Compliance. January 2004.
15 Accessed at http://www.dec.ny.gov/docs/water_pdf/descdata2004.pdf on January 15, 2008.
- 16 New York State Department of Environmental Conservation (NYSDEC). 2004b. "Abundance
17 and Distribution of Blue Crab (*Callinectes sapidus*) Overwintering in the Hudson River Estuary."
18 Prepared by Normandeau Associates Inc. for New York State Department of Environmental
19 Conservation, Hudson River Fisheries Unit. R-19934.000, March 2004. Accessed at
20 <http://www.nysl.nysed.gov/scandoclinks/ocm60127660.htm> on March 15, 2008.
- 21 New York State Department of Environmental Conservation (NYSDEC). 2004c. New York
22 State Freshwater Wetlands Map, Westchester County, Map 1 of 14. Promulgated October 7,
23 1987. Revised July 28, 2004.
- 24 New York State Department of Environmental Conservation (NYSDEC). 2005. "New York
25 State Breeding Bird Atlas, 2000–2005." Release 1.0. Albany, NY. Updated June 2007.
26 Accessed at <http://www.dec.ny.gov/animals/7312.html> on March 5, 2008. ADAMS Accession
27 No. ML083380509.
- 28 New York State Department of Environmental Conservation (NYSDEC). 2007a. "Hudson River
29 Estuary Program Annual Report for the Period April 1, 2006–March 30, 2007." The Hudson
30 River Estuary Program, New York State Department of Environmental Conservation.
31 Accessed at http://www.dec.ny.gov/docs/remediation_hudson_pdf/annrep07.pdf on February
32 21, 2008. ADAMS Accession No. ML083380517.
- 33 New York State Department of Environmental Conservation (NYSDEC). 2007b. "Checklist of
34 Amphibians, Reptiles, Birds and Mammals of New York State—Including Their Legal Status."
35 Division of Fish, Wildlife and Marine Resources, Wildlife Diversity Group. Eighth revision.
36 Accessed at www.dec.ny.gov/docs/wildlife_pdf/vertchecklist0907.pdf on March 3, 2008.
37 ADAMS Accession No. ML083380524.
- 38 New York State Department of Environmental Conservation (NYSDEC). 2007c. Letter from
39 Tara Seoane, Information Services, New York Natural Heritage Program, to Rani Franovitch,
40 NRC. Response to November 27, 2007, request from the NRC for information on State-listed,
41 proposed, and candidate species and critical habitat that may be in the vicinity of Indian Point.
42 December 28, 2007. ADAMS Accession No. ML080070085.

- 1 New York State Department of Environmental Conservation (NYSDEC). 2008a. "Some
2 Catfishes of New York." Accessed at <http://www.dec.ny.gov/animals/7046.html> on March 13,
3 2008. (ADAMS Accession No. ML080730517)
- 4 New York State Department of Environmental Conservation (NYSDEC). 2008b. "Bald Eagle
5 Fact Sheet." Accessed at <http://www.dec.ny.gov/animals/9383.html?showprintstyles> on March
6 13, 2008. ADAMS Accession No. ML083380531.
- 7 New York State Department of Environmental Conservation (NYSDEC). 2008c. "Bald Eagles
8 of the Hudson River." Accessed at <http://www.dec.ny.gov/animals/9382.html?showprintstyles>
9 on March 13, 2008. ADAMS Accession No. ML083380535.
- 10 New York State Department of Environmental Conservation (NYSDEC). 2008d. "Peregrine
11 Falcon Fact Sheet." Accessed at <http://www.dec.ny.gov/animals/7294.html?showprintstyles> on
12 March 5, 2008. ADAMS Accession No. ML083380540.
- 13 New York State Department of Environmental Conservation (NYSDEC). 2008e. "Peregrine
14 Falcon." Accessed at <http://www.dec.ny.gov/animals/7059.html?showprintstyles> on March 13,
15 2008. ADAMS Accession No. ML083380542.
- 16 New York State Department of Environmental Conservation (NYSDEC). 2008f. "Bog Turtle
17 Fact Sheet." Accessed at <http://www.dec.ny.gov/animals/7164.html?showprintstyles> on March
18 13, 2008. ADAMS Accession No. ML083380545.
- 19 New York State Department of Environmental Conservation (NYSDEC). 2008g. "New York
20 State Amphibian and Reptile Atlas Project." Accessed at
21 <http://www.dec.ny.gov/animals/7479.html?showprintstyles> on March 13, 2008. ADAMS
22 Accession No. ML083380553.
- 23 New York State Department of Environmental Conservation (NYSDEC). 2008h. "List of
24 Endangered, Threatened and Special Concern Fish & Wildlife Species of New York State."
25 Accessed at <http://www.dec.ny.gov/animals/7082.html> on March 17, 2008.
- 26 New York State Department of Environmental Conservation (NYSDEC). 2008i. "Red-
27 shouldered Hawk Fact Sheet." Accessed at <http://www.dec.ny.gov/animals/7082.html> on March
28 17, 2008. ADAMS Accession No. ML083380558.
- 29 New York State Department of Health (NYSDOH). 1994. "Environmental Radiation in New
30 York State." 1993 Annual Report. Albany, NY. ADAMS Accession No. ML070380534.
- 31 New York State Department of Health (NYSDOH). 1995. "Environmental Radiation in New
32 York State." 1994 Annual Report. Albany, NY. ADAMS Accession No. ML070380532.
- 33 New York State Department of Health (NYSDOH). 2007. "Chemicals in Sportfish and Game:
34 2007–2008 Health Advisories." Division of Environmental Health Assessment. Accessed at
35 <http://www.health.state.ny.us/environmental/outdoors/fish/docs/fish.pdf> on March 13, 2008.
36 ADAMS Accession No. ML083380561.
- 37 New York State Department of State (NYSDOS). 2004. "Coastal Resources Online:
38 Significant Coastal Fish and Wildlife Habitats—Hudson River Mile 44–56 link." Division of
39 Coastal Resources. Accessed at
40 http://www.nyswaterfronts.com/waterfront_natural_narratives.asp on March 17, 2008. ADAMS
41 Accession No. ML083380563.

Plant and the Environment

- 1 New York State Department of Transportation (NYSDOT). 2005. "2004 Traffic Data Report for
2 New York State."
- 3 New York State Office of the State Comptroller (NYSOSC). 2008. "Local Government Services
4 and Economic Development." Accessed at <http://www.osc.state.ny.us> on May 30, 2008.
5 ADAMS Accession No. ML083380565.
- 6 New York State Ornithological Association (NYSOA). 2007. "Historical Waterfowl Count Data,
7 1973–2007." Accessed at <http://www.nybirds.org/ProjWaterfowl.htm> on March 5, 2008.
8 ADAMS Accession No. ML083380567.
- 9 Nieder, W.C., E. Barnaba, S.E.G. Findlay, S. Hoskins, N. Holochuck, and E.A. Blair. (2004).
10 "Distribution and Abundance of Submerged Aquatic Vegetation and *Trapa natans* in the Hudson
11 River Estuary." *Journal of Coastal Research* 45: 150–161.
- 12 Niering, W.A. and N.C. Olmstead. 1979. *The Audubon Society Field Guide to North American
13 Wildflowers, Eastern Region.* 863 pp. Alfred A. Knopf, Inc., NY.
- 14 North Carolina State University (NCSU). 2008. "Plant Fact Sheets." Accessed at
15 <http://www.ces.ncsu.edu/depts/hort/consumer/factsheets/index.html> on March 12, 2008.
16 ADAMS Accession No. ML083380570.
- 17 Northeast Regional Climate Center (NRCC). 2006. New York Climate Office. "The Climate of
18 New York." Accessed at http://nysc.eas.cornell.edu/climate_of_ny.html on December 3, 2008.
19 ADAMS No. ML083380625
- 20 Northern Westchester Water Works (NWWW). 2006. Telephone correspondence from R.
21 Schoenewe (Enercon) to B. Leibowitz (Northern Westchester Water Works) regarding the
22 Westchester County, NY, Public Water Supply. January 27, 2006.
- 23 Nuclear Regulatory Commission (NRC). 1975. "Final Environmental Statement Related to the
24 Operation of Indian Point Nuclear Generating Plant Unit No. 3," Volume 1. Office of Nuclear
25 Reactor Regulation. NUREG-75/002. February 1975.
- 26 Nuclear Regulatory Commission (NRC). 2006. "Indian Point Nuclear Generating Unit 2—NRC
27 Special Inspection Report No. 05000247/2005011." Docket Number 50-247. Washington, DC.
28 (ADAMS Accession No. ML060750842)
- 29 Nuclear Regulatory Commission (NRC). 2007. "Indian Point Nuclear Generating Unit 2—
30 Routine Integrated Inspection Report No. 05000247/07003." Docket Number 50-247.
31 Washington, DC. (ADAMS Accession No. ML072150161)
- 32 Nuclear Regulatory Commission (NRC). 2008. "Indian Point Nuclear Generating Unit Nos. 1 &
33 2 – NRC Inspection Report Nos. 05000003/2007010 and 05000247/2007010." Washington,
34 DC. (ADAMS Accession No. ML081340425).
- 35 Nuclear Regulatory Commission (NRC). 2009. "NRC Inspection Report No.
36 05000003/2009006, Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit 1,
37 Buchanan, NY." Docket Number 50-003. Washington, DC. (ADAMS Accession No.
38 ML091470168).
- 39 Office of Protected Resources (OPR). Undated. "Shortnose Sturgeon (*Acipenser
40 brevirostrum*)." National Marine Fisheries Service. Accessed at

- 1 <http://www.nmfs.noaa.gov/pr/species/fish/shortnosesturgeon.htm> on December 11, 2007.
2 ADAMS Accession No. ML083380572.
- 3 Opler, P.A., H. Pavulaan, R.E. Stanford, and M. Pogue, coordinators. 2006. "Butterflies and
4 Moths of North America." Bozeman, MT: NBII Mountain Prairie Information Node. Accessed at
5 <http://www.butterfliesandmoths.org/> on March 18, 2008. ADAMS Accession No. ML083380575.
- 6 Orange County Department of Planning. 2003. Orange County Comprehensive Plan:
7 Strategies for Quality Communities. Accessed at
8 <http://www.orangecountygov.com/documentView.asp?docID=138> on May 30, 2006. ADAMS
9 Accession No. ML083380576.
- 10 Orange County Water Authority (OCWA). 2006. Telephone correspondence from R.
11 Schoenewe (Enercon) to J. Beaumont (Orange County Water Works) regarding the Orange
12 County, NY, Public Water Supply. January 27, 2006.
- 13 Pace, M.L., S.E.G. Findlay, and D. Fischer. 1998. "Effects of an Invasive Bivalve on the
14 Zooplankton Community of the Hudson River." *Freshwater Biology* 39, pp. 103–116.
- 15 Peekskill Water Department, City of (PWD). 2005. "Annual Drinking Water Quality Report for
16 2005, City of Peekskill—Water Department." Accessed at <http://www.ci.peekskill.ny.us> on June
17 30, 2006. ADAMS Accession No. ML083380578.
- 18 Perry, H.M., and T.D. McIlwain. 1986. "Species Profiles: Life Histories and Environmental
19 Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico)—Blue Crab." U.S. Fish and
20 Wildlife Service Biological Report 82 (11.55). U.S. Army Corps of Engineers, TR EL-82-4.
- 21 Peteet, D.M., D.C. Pederson, D. Kurdyla, and T. Guilderson. 2006. "Hudson River
22 Paleoecology from Marshes: Environmental Change and its Implications for Fisheries."
23 *American Fisheries Society Monograph* 51, pp. 113–128.
- 24 Phillips, P.J., and D.W. Hanchar. 1996. "Water-Quality Assessment of the Hudson River Basin
25 in New York and Adjacent States—Analysis of Available Nutrient, Pesticide, Volatile Organic
26 Compound, and Suspended-Sediment Data, 1970–1990." U.S. Geological Survey, Water-
27 Resources Investigations Report 96-4065.
- 28 Pottorn, G.B., M.T. Huish, and J.H. Kerby. 1989. "Species Profile: Life Histories and
29 Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Bluefish."
30 U.S. Fish and Wildlife Service Biological Report 82 (11.94). U.S. Army Corps of Engineers, TR
31 EL-82-4. Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-094.pdf on
32 February 7, 2008. ADAMS Accession No. ML083380583.
- 33 Poughkeepsie Townwide Water District (PTWD). 2005. "Annual Water Quality Report for
34 Calendar Year 2005." Accessed at
35 <http://www.townofpoughkeepsie.com/PoughkeepsieTWWD2005.pdf> on July 10, 2006.
- 36 Poughkeepsie-Dutchess County Transportation Council (PDCTC) Planning and Development.
37 2006. Divisions: Poughkeepsie-Dutchess County Transportation Council. Accessed at
38 <http://www.co.dutchess.ny.us/CountyGov/Departments/Planning/PLpdctcIndex.htm> on June 30,
39 2006. ADAMS Accession No. ML083380587.

Plant and the Environment

- 1 Pullen Herbarium. 2008. Pullen Herbarium Specimen Database (MISS), University of
2 Mississippi Department of Biology. Accessed at <http://herbarium.olemiss.edu> on March 14,
3 2008. ADAMS Accession No. ML083380589.
- 4 Purcell, J.E., D.A. Namazie, S.E. Dorsey, E.D. Houde, and J.C. Gamble. 1994. "Predation
5 Mortality of Bay Anchovy *Anchoa mitchelli* Eggs and Larvae Due to Scyphomedusae and
6 Ctenophores in Chesapeake Bay." *Marine Ecology Progress Series* 114, pp. 47–58.
- 7 Putnam County Division of Planning and Development. 2003. "Report on the Task Force on
8 Vision 2010: Guiding Putnam into the Next Decade." Accessed at
9 <http://www.putnamcountyny.com/vision2010.html> on May 30, 2006.
- 10 Putnam County Water Department (PCWD). 2006. Telephone correspondence from R.
11 Schoenewe (Enercon) to E. Bartus (Putnam County Water Works) regarding the Putnam
12 County, NY, Public Water Supply System. January 27, 2006.
- 13 Ritchie, W.A. 1980. *The Archaeology of New York State*. pp. 196–200. Harbor Hill Books,
14 Harrison, NY.
- 15 Ritchie, W.A. 1994 (orig. 1980). *The Archaeology of New York State*. pp. xvii–xviii. Purple
16 Mountain Press, Fleischmanns, NY.
- 17 Rockland County Department of Health (RCDH). 2006. "Assessment of United Water New
18 York Supply." Accessed for New Projects, 2006. Accessed at
19 http://www.co.rockland.ny.us/health/pdf/SupplyDemandTracking_1.pdf on August 28, 2006.
20 ADAMS Accession No. ML083380591.
- 21 Rockland's Water Supply (RWS). 2006. *Clearwater*. Poughkeepsie, NY. Accessed at
22 www.clearwater.org/sustainablewatershed/pdfs/miller.pdf on February 20, 2007.
- 23 Roditi, H.A., N.F. Caraco, J.J. Cole, and D.L. Strayer. 1996. "Filtration of Hudson Water by the
24 Zebra Mussel (*Dreissena polymorpha*)." *Estuaries* 19:4, pp. 824–832.
- 25 Rogers, S.G., and M.J. Van Den Avyle. 1989. "Species Profile: Life Histories and
26 Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Atlantic
27 Menhaden." U.S. Fish and Wildlife Service Biological Report 82 (11.108). U.S. Army Corps of
28 Engineers, TR EL-82-4. Accessed at
29 http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-108.pdf on February 5, 2008.
30 ADAMS Accession No. ML083380608.
- 31 Rohmann, S.O., N. Lilienthal, R.L. Miller, R.M. Szwed, and W.R. Muir. 1987. "Tracing a River's
32 Toxic Pollution: A Case Study of the Hudson. Phase 2. 209 pp. Inform, Inc., NY.
- 33 Roundtree, R.A. 1999. "Nov. Diets of NW Atlantic Fishes and Squid." Accessed at
34 <http://www.fishecology.org/diets/diets.htm> on February 20, 2008. ADAMS Accession No.
35 ML083380610.
- 36 Salwen, Bert. 1975. "Post-glacial Environments and Cultural Change in the Hudson River
37 Basin." *Man in the Northeast* 10: 43–70.
- 38 Sanders, C., and J. Cheng. 2001. "Williams Lake Telemetry Study: New York Indiana Bat
39 Spring Migration Tracking." *Bat Conservation and Management*, Mechanicsburg, PA.
40 Accessed at <http://www.batmanagement.com/Projects/kings/WilliamsScreen.pdf> on March 19,
41 2008. ADAMS Accession No. ML083380612.

- 1 Schmidt, R.E., and T.R. Lake. 2006. "Tributaries and Hudson River Fishes." In: The Hudson
2 River Estuary. J.S. Levinton and J.R. Waldman, eds. 209 pp Cambridge University Press,
3 Cambridge.
- 4 Schultz, E.T., K.M.M. Lwiza, J.R. Young, K.J. Hartman, and R.C. Tipton. 2006. "The Dynamics
5 of Bay Anchovy in the Hudson River Estuary: Process-oriented Studies and Long-term
6 Changes." American Fisheries Society Symposium 51, pp. 197–213.
- 7 Shepherd, G. 2006a. "Status of Fishery Resources off the Northeastern U.S.: Bluefish."
8 Northeast Fisheries Science Center Resource Evaluation and Assessment Division, National
9 Oceanic and Atmospheric Administration. Accessed at
10 http://www.nefsc.noaa.gov/sos/spsyn/op/bluefish/archives/25_Bluefish_2006.pdf on February 7,
11 2008. ADAMS Accession No. ML083360690.
- 12 Shepherd G. 2006b. "Atlantic Striped Bass." Accessed at
13 http://www.nefsc.noaa.gov/sos/spsyn/af/sbass/archives/40_StripedBass_2006.pdf on December
14 10, 2007. ADAMS Accession No. ML083360766.
- 15 Shepard, G. 2006c. "Status of Fishery Resources off the Northeastern US, NEFSC—Resource
16 Evaluation and Assessment Division, Atlantic and Shortnose Sturgeons." Accessed at
17 <http://www.nefsc.noaa.gov/sos/spsyn/af/sturgeon/> on December 10, 2007. ADAMS Accession
18 No. ML083380619.
- 19 Smith, C.L. 1985a. "Spottail Shiner." In: The Inland Fishes of New York State, pp. 194–195.
20 New York State Department of Environmental Conservation, Albany, NY.
- 21 Smith, C.L. 1985b. "White Catfish." In: The Inland Fishes of New York State," pp. 78–79.
22 New York State Department of Environmental Conservation, Albany, NY.
- 23 Snow, D.R. 1995. Mohawk Valley Archaeology: the Sites. Matson Museum of Anthropology,
24 Pennsylvania State University, University Park, PA.
- 25 Stanley, J.G., and D.S. Danie. 1983. "Species Profiles: Life Histories and Environmental
26 Requirements of Coastal Fishes and Invertebrates (North Atlantic)—White Perch." U.S. Fish
27 and Wildlife Service, Division of Biological Services, FWS/OBS-82/11.7. U.S. Army Corps of
28 Engineers, TR EL-82-4. 12pp. Accessed at
29 http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-007.pdf on March 14, 2008.
30 ADAMS Accession No. ML083380621.
- 31 Steinberg, N., D.J. Suszkowski, L. Clark, and J. Way. 2004. Health of the Harbor: The First
32 Comprehensive Look at the State of the NY, NY Harbor Estuary. A Report to the New
33 York/New Jersey Harbor Estuary Program. Hudson River Foundation, New York. ADAMS
34 Accession No. ML083380622.
- 35 Stewart, L.L., and P.J. Auster. 1987. "Species Profile: Life Histories and Environmental
36 Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Atlantic Tomcod." U.S. Fish
37 and Wildlife Service Biological Report 82 (11.76). U.S. Army Corps of Engineers, TR EL-82-4.
38 Accessed at http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-076.pdf on November
39 29, 2007. ADAMS Accession No. ML073460171.
- 40 Strayer, D.L., and L.C. Smith. 1996. "Relationships Between Zebra Mussels (*Dreissena*
41 *polymorpha*) and Unionid Clams During the Early Stages of the Zebra Mussel Invasion of the
42 Hudson River." *Freshwater Biology* 36, pp. 771–779.

Plant and the Environment

- 1 Strayer, D.L., K.A. Hattala, and A.W. Kahnle. 2004. "Effects of an Invasive Bivalve (*Dreissena*
2 *polymorpha*) on Fish in the Hudson River Estuary." *Canadian Journal of Fisheries and Aquatic*
3 *Sciences* 61, pp. 924–941.
- 4 Strayer, D.L., and H.M. Malcom. 2006. "Long-term Demography of a Zebra Mussel (*Dreissena*
5 *polymorpha*) Population. *Freshwater Biology* 51, pp. 117–130.
- 6 Strayer, D.L. 2007. "Zebra Mussels and the Hudson River." Cary Institute of Ecosystem
7 Studies. Accessed at http://www.ecostudies.org/people_sci_strayer_zebra_mussels.html on
8 January 8, 2008. ADAMS Accession No. ML083380623.
- 9 Steinberg, N., D.J. Suszkowski, L. Clark, and J. Way. 2004. *Health of the Harbor: The First*
10 *Comprehensive Look at the State of NY.NY Harbor Estuary. A Report to the New York/New*
11 *Jersey Harbor Estuary Program.* Hudson River Foundation. New York, New York. ADAMS
12 Accession No. ML083360721.
- 13 Swaney, D.P., K.E. Limburg, and K. Staingrook. 2006. "Some Historical Changes in the
14 Pattern of Population and Land Use in the Hudson River Watershed." *American Fisheries*
15 *Society Symposium* 51, pp. 75–112.
- 16 Sweka, J.A., J. Mohler, M.J. Millard, T. Kehler, A. Kahnle, K. Hattala, G. Kenney, and A. Higgs.
17 2007. "Juvenile Atlantic Sturgeon Habitat Use in Newburgh and Haverstraw Bays of the
18 Hudson River: Implications for Population Monitoring." *North American Journal of Fisheries*
19 *Management* 27, pp. 1058–1067.
- 20 The Journal News, New York's Lower Hudson Valley. 2006 "Westchester County's major
21 employers." From Staff Reports dated March 19, 2006. Accessed at
22 <http://www.lohud.com/apps/pbcs.dll/article?AID=/20060319/BUSINESS/603190302/1066/BUSI>
23 *NESS01* in April 2008. ADAMS Accession No. ML083380624.
- 24 Tipton, R.C. 2003. "Distributional Ecology of Bay Anchovy (*Anchoa mitchilli*) in the Hudson
25 River Estuary, USA." A dissertation submitted to West Virginia University. Forest Resources
26 Sciences Wildlife and Fisheries Program. Accessed at
27 http://kitkat.wvu.edu:8080/files/2930/Tipton_Ronald_Dissertation.pdf on March 13, 2008.
28 ADAMS Accession No. ML083380626.
- 29 Town of Cortlandt, New York (TOCNY). 2004. *Comprehensive Master Plan, Town of Cortlandt,*
30 *July 2004.* Accessed at <http://www.townofcortlandt.com/> on May 30, 2006. ADAMS Accession
31 No. ML083380627.
- 32 Town of Cortlandt, New York (TOCNY). 2006. *Town Profile.* Accessed at
33 <http://www.townofcortlandt.com/Cit-e-Access/webpage.cfm?TID=20&TPID=2564> on July 15,
34 2006. ADAMS Accession No. ML083380629.
- 35 U.S. Army Corps of Engineers (USACE). 2006. Public Notice No. HR-AFO-06. "Hudson River,
36 New York (Coeymans and Kingstong Reaches) Federal Navigation Projects Maintenance
37 Dredging." April 7. Accessed at
38 <http://www.nan.usace.army.mil/.../buslinks/navig/cntldpth/kingston.pdf> on March 5, 2008.
- 39 U.S. Atomic Energy Commission (USAEC). 1972. "Final Environmental Statement Related to
40 the Operation of Indian Point Nuclear Generating Plant Unit No. 2." Directorate of Licensing.
41 Docket No. 50-247. September 1972.

- 1 U.S. Census Bureau (USCB). 2000. State and County Quick Facts. Accessed at
2 <http://www.census.gov> on March 4, 2008. ADAMS Accession No. ML083380631.
- 3 U.S. Census Bureau (USCB). 2006. American Fact Finder, New York City, NY. Accessed at
4 http://factfinder.census.gov/home/saff/main.html?_lang=en on March 4, 2008.
- 5 U.S. Census Bureau (USCB). 2008a. American FactFinder, American Community Survey of
6 Dutchess, Orange, Putnam, and Westchester Counties, Data Profile Highlights. Housing
7 Characteristics for 2000 and 2006. Accessed at <http://factfinder.census.gov> in April 2008.
- 8 U.S. Census Bureau (USCB). 2008b. "New York Quickfacts: Dutchess, Orange, Putnam, and
9 Westchester Counties." Accessed at <http://quickfacts.census.gov/> on March 11, 2008. ADAMS
10 Accession No. ML083380632.
- 11 U.S. Census Bureau (USCB). 2008c. Decennial Census 2000 Data and American FactFinder,
12 American Community Survey of Dutchess, Orange, Putnam, and Westchester Counties, Data
13 Profile Highlights. ACS Demographic Estimates for 2006. Accessed at
14 <http://factfinder.census.gov> in April 2008.
- 15 U.S. Department of Agriculture (USDA). 2002a. "Dutchess County: 2002 Census of
16 Agriculture County Profile." Accessed at
17 <http://www.nass.usda.gov/census/census02/profiles/ny/> on May 15, 2005.
- 18 U.S. Department of Agriculture (USDA). 2002b. "Orange County: 2002 Census of Agriculture
19 County Profile." Accessed at <http://www.nass.usda.gov/census/census02/profiles/ny/> on May
20 15, 2005.
- 21 U.S. Department of Agriculture (USDA). 2002c. "Putnam County: 2002 Census of Agriculture
22 County Profile." Accessed at
23 <http://www.nass.usda.gov/census/census02/profiles/ny/cp36079.PDF> on May 15, 2005.
- 24 U.S. Department of Agriculture (USDA). 2002d. "Westchester County: Farm Statistics."
25 Accessed at <http://www.nass.usda.gov/census/census02/profiles/ny/cp36119.PDF> on May 15,
26 2006.
- 27 U.S. Department of Agriculture (USDA). 2002e. "Census of Agriculture." Accessed at
28 <http://www.nass.usda.gov/census/census02/volume1/pa/index2.htm> in April 2008. ADAMS
29 Accession No. ML083380633.
- 30 U.S. Department of Commerce (USDOC). 2006a. National Climatic Data Center, NOAA
31 Satellite and Information Service, Tornado Climatology. Accessed at
32 <http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html> on August 28, 2006.
33 ADAMS Accession No. ML083380644.
- 34 U.S. Department of Commerce (USDOC). 2006b. National Climatic Data Center (NCDC), 2006
35 Westchester County Tornado Query Results. Accessed at [http://www4.ncdc.noaa.gov/cgi-
36 win/wwcgi.dll/wwevent~storms](http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll/wwevent~storms) on July 6, 2006.
- 37 U.S. Geological Survey (USGS). 2008. "Hudson River Salt Front Data." Accessed at
38 http://ny.water.usgs.gov/projects/dialer_plots/saltfront.html on January 31, 2008.
- 39 United Water New York (UWNY). 2006. "Annual Water Quality Report 2005." Accessed at
40 <http://www.unitedwater.com/uwny/pdfs/dNY.pdf> on August 28, 2006. ADAMS Accession No.
41 ML083380655.

Plant and the Environment

- 1 Village of Buchanan, New York (VBNY). 1998. "About Our Village." Accessed at
2 <http://www.villageofbuchanan.com/> on July 7, 2006.
- 3 Village of Buchanan, New York (VBNY). 2006. Buchanan Water Department, Entergy Nuclear
4 Operations, March, April, and May 2006 Account Statements.
- 5 Village of Croton-on-Hudson (VCOH). 2005. "Annual Water Quality Report 2005." Accessed at
6 <http://Village.croton>
7 onhudson.ny.us/Public_Documents/CrotonHudsonNY_WebDocs/Water/CCReport2005.pdf on
8 July 14, 2006.
- 9 Village of Ossining Water System (VOWS). 2005. "Annual Drinking Water Report for 2005."
10 Accessed at http://www.Village.ossining.ny.us/documents/wqr_2005.pdf on July 14, 2006.
- 11 Waldman, J.R., K.E. Limburg, and D.L. Strayer. 2006. "The Hudson River Environment and Its
12 Dynamic Fish Community." American Fisheries Society Symposium 51, pp. 1–7.
- 13 Walter, J.F., A.S. Overton, K.H. Ferry, and M.E. Mather. 2003. "Atlantic Coast Feeding Habits
14 of Striped Bass: A Synthesis Supporting a Coast-wide Understanding of Trophic Biology."
15 Fisheries Management and Ecology 10 (5), pp. 349–360.
- 16 Westchester County Department of Planning (WCDDP). 2003. "Northern Westchester County,
17 Groundwater Conditions Summary, Data Gaps, and Program Recommendations Contract C PL-
18 02-71." Prepared by The Chazen Companies, April 2003.
- 19 Westchester County Department of Planning (WCDDP). 2005. "Databook Westchester County,
20 Education, School Districts 2003." November 30, 2005.
- 21 Westchester County Department of Planning. 2000. Westchester County Databook: History,
22 Geography and Land Use. Accessed at
23 <http://www.westchestergov.com/planning/research/main.htm> on May 31, 2006. ADAMS
24 Accession No. ML083380659.
- 25 Westchester Joint Water Works (WJWW). 2006. "Annual Drinking Water Quality Report for
26 2005." Accessed at <http://www.wjww.com> on June 30, 2006. ADAMS Accession No.
27 ML083380661.
- 28 Whitaker, J.O., Jr. 1980. The Audubon Society Field Guide to North American Mammals. 745
29 pp. Alfred A. Knopf, Inc., New York.
- 30 Whiteside, B.G., and T.H. Bonner. 2007. "Trinectes maculatus fasciatus: Hogchoker."
31 Department of Biology, Texas State University, San Marcos. Accessed at
32 <http://www.bio.txstate.edu/~tbonner/txfishes/trinectes%20maculatus%20fasciatus.htm> on
33 February 19, 2008. ADAMS Accession No. ML083380667.
- 34 Wingate, R.L. and D.H. Secor. 2007. "Intercept Telemetry of the Hudson River Striped Bass
35 Resident Contingent: Migration and Homing Patterns." Transactions of the American Fisheries
36 Society 136, pp. 95–104.
- 37 Wirgin, I., L. Maceda, J.R. Waldman, and R.N Crittenden. 1993. "Use of Mitochondrial DNA
38 Polymorphisms to Estimate the Relative Contributions of the Hudson River and Chesapeake
39 Bay Striped Bass Stocks to the Mixed Fishery on the Atlantic Coast." Transactions of the
40 American Fisheries Society 122, pp. 669–684.

- 1 Wirgin, I., and R.C. Chambers. 2006. "Atlantic Tomcod *Microgadus tomcod*: A Model Species
- 2 for the Responses of Hudson River Fish to Toxicants." *American Fisheries Society Symposium*
- 3 51, pp. 331–365.
- 4 Wolfe, D.A., E.R. Long, and G.B. Thursby. 1996. "Sediment Toxicity in the Hudson-Raritan
- 5 Estuary: Distribution and Correlations with Chemical Contamination." *Estuaries* 19:4, pp. 901–
- 6 912.
- 7 Woodland, R.J., and D.H. Secor. 2007. "Year-Class Strength and Recovery of Endangered
- 8 Shortnose Sturgeon in the Hudson River, New York." *Transactions of the American Fisheries*
- 9 *Society* 136, pp. 72–81.
- 10 World Book Encyclopedia. 2006. "New York Climate." Chicago York Climate." Chicago, IL.

3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

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

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

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

3.1 Potential Refurbishment Activities

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

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

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

Environmental Impacts of Refurbishment

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

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

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

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

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

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

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

Environmental Impacts of Refurbishment

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

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

36 Since the NRC staff published the draft SEIS, Entergy indicated (at the 2009 Annual
37 Assessment meeting in Tarrytown, NY), that it planned to replace the Unit 2 vessel head in
38 2014, and the Unit 3 vessel head in 2016. Entergy did not directly address timing for CRDM
39 replacement at this meeting, but NRC staff finds it likely that Entergy would replace vessel
40 heads and CRDMs at the same time. NRC staff addresses the potential environmental impacts

Environmental Impacts of Refurbishment

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

1 for Domestic Licensing and Related Regulatory Functions,” Subpart A, “National Environmental
 2 Policy Act—Regulations Implementing Section 102(2),” Appendix B, “Environmental Effect of
 3 Renewing the Operating License of a Nuclear Power Plant,” for each of the Category 1
 4 refurbishment issues listed in Table 3-1. For each Category 1 issue, the NRC staff has not
 5 identified any new and significant information during its review of the Entergy ER (Entergy
 6 2007), its site audit, the SEIS scoping process, public comments on the draft SEIS, and its
 7 evaluation of other available information, including Entergy’s May 14, 2008, RAI response
 8 (Entergy 2008b).

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

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

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

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

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

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

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

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

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

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

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

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

Environmental Impacts of Refurbishment

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

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

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

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

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

13 No significant impacts are expected during refurbishment.

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

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

22

1
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.		

3

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

6 **3.2.1 Terrestrial Ecology—Refurbishment Impacts**

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

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

Environmental Impacts of Refurbishment

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

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

15 | **3.2.2 Threatened or Endangered Species—Refurbishment Impacts**

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

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

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

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

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

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

7 **3.2.3 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)**

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

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

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

21 Entergy indicates that the bulk of air quality impacts during the postulated refurbishment activity
 22 would result from exhaust emissions released by onsite motorized equipment and workers'
 23 vehicles (Entergy 2008b). These effects include temporary increases in atmospheric
 24 concentrations of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO₂), volatile
 25 organic compounds (VOCs), ammonia, and particulate matter (PM).

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

32 Based on a conservative assumption that 400 additional vehicles would travel to and from the
 33 site each day during a 65-day outage period (conservative because Entergy projects that only
 34 300 additional workers over 60 days could accomplish the replacement activities), Entergy
 35 estimated that air emissions of VOCs, CO, and NO_x would increase by 0.95 tons (0.86 metric
 36 tons (MT)), 16.1 tons (14.6 MT), and 1.02 tons (0.926 MT), respectively (Entergy 2008b). The
 37 regulatory conformity thresholds for VOCs, CO, and NO_x are 50 tons (45 MT), 100 tons
 38 (90.7 MT), and 50 tons (45 MT), respectively, as indicated in 40 CFR 51.853(b). A comparison
 39 of Entergy's conservative estimates for vehicle emissions versus the associated regulatory
 40 conformity levels indicates that none of the thresholds would be exceeded. Based on this
 41 analysis, the NRC staff finds that air quality impacts during the postulated reactor vessel head
 42 and CRDM replacement would be SMALL.

Environmental Impacts of Refurbishment

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

6 **3.2.4 Housing Impacts—Refurbishment**

7 Housing impacts during refurbishment are a Category 2 issue. Table B-1 of Appendix B to
8 10 CFR Part 51, Subpart A, notes the following:

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

15 Entergy estimates that reactor vessel head and CRDM replacement would increase the number
16 of refueling outage workers at the Indian Point site for up to 60 days during two separate
17 refueling outages, one for each unit, 12 months apart. Approximately 250 workers would be
18 needed for each replacement in addition to the normal number of refueling outage workers. An
19 additional 50 workers would construct a storage structure for the old reactor vessel heads and
20 CRDMs. This work would be completed before the beginning of the refueling outage (Entergy
21 2008b).

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

31 **3.2.5 Public Services: Public Utilities—Refurbishment**

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

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

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

9 **3.2.6 Public Services: Education—Refurbishment**

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

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

19 **3.2.7 Offsite Land Use—Refurbishment**

20 Offsite land use is a Category 2 refurbishment issue. Table B-1 of Appendix B to
21 10 CFR Part 51, Subpart A, notes that “Impacts may be of moderate significance at plants in
22 low population areas.”

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

28 **3.2.8 Public Services: Transportation—Refurbishment**

29 Transportation is a Category 2 refurbishment issue. Table B-1 of Appendix B to
30 10 CFR Part 51, Subpart A, notes the following:

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

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

Environmental Impacts of Refurbishment

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

11 **3.2.9 Historic and Archeological Resources—Refurbishment**

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

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

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

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

37 The impacts associated with this activity are not expected to adversely impact historic or
38 archeological sites in the area of IP2 and IP3. Therefore, the potential impacts from this activity
39 on National Register-eligible historic or archeological resources would be SMALL. However,
40 should historic archeological resources be encountered during construction, work would cease
41 until Entergy environmental personnel would perform an evaluation and consider possible
42 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.”

Environmental Impacts of Refurbishment

- 1 | Enercon Services, Inc. (Enercon). 2006. "Phase 1A Literature Review and Archaeological
2 | Sensitivity Assessment of the Indian Point Site, Westchester County, New York." Tulsa, OK.
- 3 | Entergy Nuclear Operations, Inc. (Entergy). 2007. "Applicant's Environment Report, Operating
4 | License Renewal Stage." (Appendix E of "IP2 and IP3, Units 2 and 3, License Renewal
5 | Application"). April 23, 2007. Agency wide Documents Access and Management System
6 | (ADAMS) Accession No. ML071210530.
- 7 | Entergy Nuclear Operations, Inc. (Entergy). 2008a. "Indian Point, Units 2 and 3—Reply to
8 | Request for Additional Information Regarding Environmental Review for License Renewal
9 | Application." January 4, 2008. ADAMS Accession No. ML080110372.
- 10 | Entergy Nuclear Operations, Inc. (Entergy). 2008b. "Indian Point Units 2 & 3, Reply to Request
11 | for Additional Information Regarding License Renewal Application—Refurbishment." May 14,
12 | 2008. ADAMS Accession No. ML081440052.
- 13 | Kaplowitz, Michael. 2007. Letter to Pao-Tsin Kuo, "Incompleteness and Inaccurate License
14 | Renewal Application for Indian Point Energy Center, Units 2 and 3." June 27, 2007. ADAMS
15 | Accession No. ML071990093.
- 16 | Shapiro, Milton B. and Susan H. Shapiro. 2007. Letter to Pao-Tsin Kuo, "Comments on Scope
17 | of Environmental Impact Statement and Scoping Process Indian Point Energy Center Unit 2 and
18 | Unit 3." October 24, 2007. ADAMS Accession No. ML073100985.
- 19 | U.S. Nuclear Regulatory Commission. (NRC) 1996. "Generic Environmental Impact Statement
20 | for License Renewal of Nuclear Plants." NUREG-1437, Volumes 1 and 2. Office of Nuclear
21 | Regulatory Research, Washington, DC.
- 22 | U.S. Nuclear Regulatory Commission. (NRC) 1999. "Generic Environmental Impact Statement
23 | for License Renewal of Nuclear Plant." NUREG-1437, Volume 1, Addendum 1. Office of
24 | Nuclear Reactor Regulation, Washington, DC.
- 25 | U.S. Nuclear Regulatory Commission. (NRC) 2007. "Request for Additional Information
26 | Regarding Environmental Review for Indian Point Nuclear Generating Unit Nos. 2 and 3 License
27 | Renewal (TAC Nos. MD5411 and MD5412)." December 5, 2007. ADAMS Accession
28 | No. ML073330931.
- 29 | U.S. Nuclear Regulatory Commission. (NRC) 2008a. Summary of Telephone Conference Call
30 | between NRC and Entergy Nuclear Operations, Inc., Pertaining to the Indian Point Units 2 & 3,
31 | License Renewal Application—Environmental Request for Additional Information. March 18,
32 | 2008. ADAMS Accession No. ML080920983.
- 33 | U.S. Nuclear Regulatory Commission. (NRC) 2008b. "Request for Additional Information
34 | Regarding the Review of the License Renewal Application for Indian Point Nuclear Generating
35 | Unit Nos. 2 & 3 (TAC Nos. MD5411 and MD5412)." April 14, 2008. ADAMS Accession
36 | 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
-------	-------

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

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

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

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

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

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

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

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

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

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

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

31

Environmental Impacts of Operation

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

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

5 Effects are readily controlled through the NPDES permit² and periodic
6 modifications, if needed, and are not expected to be a problem during the license
7 renewal term.

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

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

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

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

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

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

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

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

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

30 Cold shock has been satisfactorily mitigated at operating nuclear plants with
31 once-through cooling systems, has not endangered fish populations or been
32 found to be a problem at operating nuclear power plants with cooling towers or
33 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.

1 term.

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

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

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

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

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

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

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

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

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

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

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

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

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

36 Stimulation of nuisance organisms has been satisfactorily mitigated at the single

Environmental Impacts of Operation

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

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

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

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

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

19 **Table 4-2. Site-Specific (Category 2) Issues Applicable to the Operation of the IP2 and IP3**
 20 **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

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

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

1 NYSDEC administrative proceedings continue.

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

15 Applicant Assessment

16 In the draft environmental impact statement (DEIS) for the SPDES permits for IP2 and IP3,
17 Roseton, and the Bowline Point generating stations (CHGEC et al. 1999), as well as in the IP2
18 and IP3 ER (Entergy 2007a), the plant owner or owners (IP2 and IP3 had separate owners in
19 1999) acknowledged that some impinged fish survive and others die. Mortality can occur
20 immediately or at a later time. The DEIS examined impingement effects by evaluating
21 conditional mortality rates (CMR) and trends (through 1997) associated with population
22 abundance for eight selected taxa representing 90 percent of those fish species collected from
23 screens at IP2 and IP3. These included striped bass, white perch, Atlantic tomcod, American
24 shad, bay anchovy, alewife, blueback herring, and spottail shiner. Estimates of CMR, defined
25 as the fractional reduction in the river population abundance of the vulnerable age group caused
26 by a single source of mortality (in this case impingement) were assumed to be the same as or
27 lower than that which occurred in the years before installation of modified Ristroph screens and
28 fish return systems at IP2 and IP3 in 1991. For species exhibiting low impingement mortality
29 (e.g., striped bass, white perch, and Atlantic tomcod), future impingement effects were expected
30 to be substantially lower than they were before installation and use of modified Ristroph screens
31 and fish return systems.

32 The Hudson River electric-generating utilities (CHGEC et al. 1999) estimated the maximum
33 expected total impingement CMR for white perch and other taxa to quantify impact to the
34 species. In the ER, Entergy (2007a) stated that the results of in-river population studies
35 performed from 1974 to 1997 did not show any negative trend in overall aquatic river species
36 populations attributable to plant operations. The ER also stated that ongoing population studies
37 continued to support these conclusions. Thus, the applicant asserted that impingement impacts
38 were SMALL and did not warrant further mitigation measures. In support of this assessment,
39 the applicant provided two reviews (Barthouse et al. 2002, 2008) in addition to the DEIS
40 (CHGEC et al. 1999).

41 Regarding entrainment, the applicant concluded that population studies performed from 1974
42 through 1997 have not shown any negative trend in overall aquatic populations attributable to
43 plant operations and that current mitigation measures will ensure that entrainment impacts
44 remain SMALL during the license renewal term. Therefore, the applicant asserted (Entergy

Environmental Impacts of Operation

1 2007a) that continued operation of once-through cooling at the site “does not have any
2 demonstrable negative effect on representative Hudson River fish populations nor does it
3 warrant further mitigation measures.” Barnthouse et al. (2008) used an ecological risk
4 assessment approach to evaluate the potential for adverse impacts to the representative
5 important species (RIS) of the Hudson River from a variety of natural and anthropogenic
6 stressors, including the operation of the IP2 and IP3 cooling water intake system, fishing
7 pressure, the presence of zebra mussels, predation by striped bass, and water temperature.
8 The authors concluded that operation of the IP2 and IP3 cooling met the NRC criteria for a
9 SMALL impact level.

10 NYSDEC Assessment

11 Under the CWA, the U.S. Environmental Protection Agency (EPA) has delegated authority for
12 the NPDES permit and Water Quality Certification programs in the State of New York to
13 NYSDEC. The regulatory role of NYSDEC in the operation of the IP2 and IP3 cooling system
14 includes protecting aquatic resources from impacts associated with impingement, entrainment,
15 and thermal and chemical discharges through issuance of State (SPDES) permits and other
16 means. As indicated above, the SPDES permit for IP2 and IP3 has been administratively
17 continued under provisions of the New York State Administrative Procedure Act. Regarding
18 Section 316(b) of the CWA and New York Code, Rules and Regulations, Section 704.5
19 (6 NYCRR Section 704.5), NYSDEC (2003b) has determined that the site-specific best
20 technology available to minimize the adverse environmental impact of the IP1, IP2, and IP3
21 cooling water intake structures is closed-cycle cooling.

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

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

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

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

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

23 On April 2, 2010, NYSDEC issued a Notice of Denial regarding the Clean Water Act Section
24 401 Water Quality Certification for IP2 and IP3. Entergy has since requested a hearing on the
25 issue, and the matter will be decided through NYSDEC’s hearing process.

26 NRC Assessment

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

- 35 (1) The potential stressor of interest (the IP2 and IP3 cooling system) occupies a fixed
36 position on the Hudson River, while many of the RIS that the NRC staff have chosen for
37 evaluation have the freedom to move up- and down-river during different stages in their
38 growth and development, during different seasons of the year, and, in some cases, at
39 different times of day.
- 40 (2) The Hudson River estuary is a dynamic, open-ended system containing a complex food
41 web that extends from the freshwater portion of the river downstream of the Troy Dam to
42 the Atlantic Ocean. Detectable changes in RIS populations may be influenced by
43 natural stressors or may be the result of stressors associated with human activities,
44 which include the operation of IP2 and IP3.

Environmental Impacts of Operation

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

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

20 **4.1.1 Impingement of Fish and Shellfish**

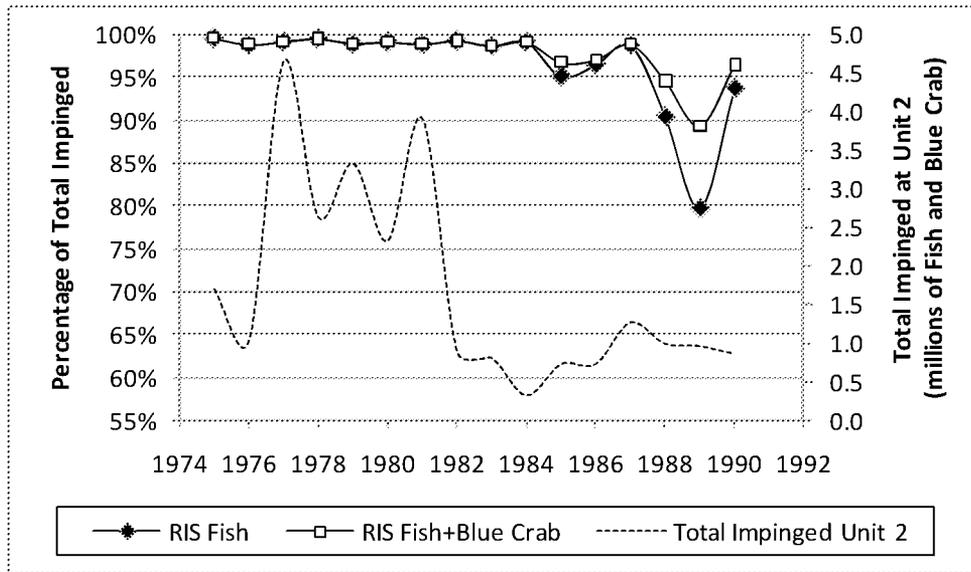
21 Impingement occurs when organisms are trapped against cooling water intake screens or racks
22 by the force of moving water. Impingement can kill organisms immediately or contribute to a
23 slower death resulting from exhaustion, suffocation, injury, or exposure to air when screens are
24 rotated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

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

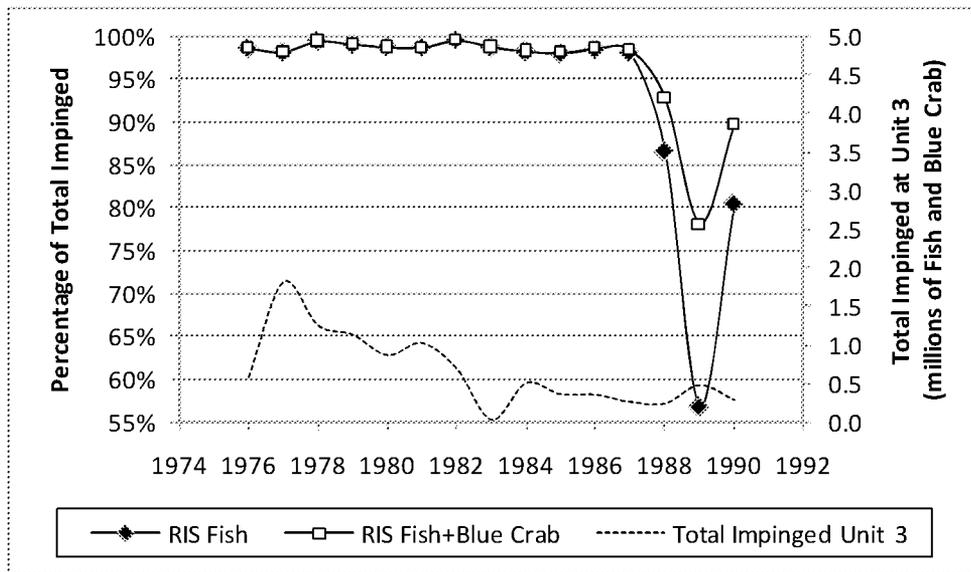
1 Thus, the data, analysis, and conclusions presented in this SEIS reflect modifications to the
2 WOE analysis and the corrected information provided by the applicant.

3 Impingement monitoring at IP2 and IP3 was conducted by former plant owners and their
4 contractors between 1975 and 1990 using a variety of techniques, as summarized in Appendix
5 H of this SEIS. The NRC staff assessment for the effects of cooling water system operation
6 concentrated on 18 RIS identified in Section 2.2.5.4, which include the 17 species identified in
7 the Hudson River utilities' DEIS (CHGEC et al. 1999) for assessing power plant effects plus the
8 Atlantic menhaden (*Brevoortia tyranus*), a member of the herring family whose young are
9 common inhabitants of the lower Hudson River. All but one RIS are fish; the exception is the
10 blue crab (*Callinectes sapidus*). The estimated number of impinged RIS made up greater than
11 90 percent of all impinged taxa for all but one year at IP2 (Figure 4-1); at IP3, the estimated
12 number of RIS impinged was greater than 85 percent for all but one year (Figure 4-2). To
13 assess impingement impacts, the NRC staff analyzed weekly estimated impingement numbers
14 at IP2 and IP3 from January 1975 to November 1980 and seasonally estimated impingement
15 numbers from January 1981 to December 1990. (The former plant owners and their contractors
16 based estimated numbers on sampling data.) The combined numbers of young of the year
17 (YOY), yearling, and older fish were used for analysis since these data were available for all
18 years of sampling.

Environmental Impacts of Operation



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



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

1 Total impingement trends at IP2 and IP3 suggest that the total number of fish and blue crab
 2 impinged tended to decrease between 1977 and 1982, then generally leveled off between 1982
 3 and 1990 (as shown in Figures 4-1 and 4-2). If the IP2 and IP3 cooling systems are considered
 4 a relatively constant sampler of Hudson River aquatic biota (recognizing the slight increase in
 5 days of operation and volume of water circulated at IP2 and IP3 from 1975 to 1990), then the
 6 decrease in the percent of RIS impinged and total impingement would suggest that RIS and all
 7 other taxa within the vicinity of IP2 and IP3 have decreased from a high in 1977 to a relatively
 8 constant lower level between 1984 and 1990. This decline will be explored further in Section
 9 4.1.3 of this SEIS.

10 In addition to evaluating trends in impingement losses, the NRC staff also reviewed the results
 11 of studies designed to evaluate impingement mortality. Before installation of modified Ristroph
 12 screen systems in 1991, impingement mortality was assumed to be 100 percent. Beginning in
 13 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would
 14 decrease impingement mortality for representative species (see Appendix H for additional
 15 detail). The final design of the screens (Version 2), as reported in Fletcher (1990), appeared to
 16 reduce impingement mortality for some species based on a pilot study compared to the existing
 17 (original) system in place at IP2 and IP3. Based on the information reported by Fletcher (1990),
 18 impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and
 19 highest for alewife, white catfish, and American shad (Table 4-3). As it was not required by
 20 NYSDEC, no further monitoring of impingement rates or impingement mortality estimates was
 21 conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991.

22 **Table 4-3. Cumulative Mortality and Injury of Selected Fish Species after Impingement on**
 23 **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

24 Based on Fletcher’s assessment, the NRC staff concludes that the IP2 and IP3 cooling system
 25 continues to impinge RIS of the lower Hudson River and that impingement mortality for 4 of the
 26 10 species exceeds 25 percent. Monitoring data (Entergy 2007b and 2009), reviewed by NRC
 27 staff) also showed that impingement was greater at IP2 than at IP3 and that impingement has
 28 generally declined since 1976. Although IP2 and IP3 currently employ modified Ristroph

Environmental Impacts of Operation

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

7 **4.1.2 Entrainment of Fish and Shellfish in Early Lifestages**

8 Entrainment occurs when small aquatic life forms are carried into and through the cooling
9 system during water withdrawals. Entrainment primarily affects organisms with limited
10 swimming ability that can pass through the screen mesh, which is typically 0.25 to 0.5 inch (in.)
11 (6.35 to 12.7 millimeters (mm)), used on the intake systems. Organisms typically entrained
12 include phytoplankton, zooplankton, and the eggs, larvae, and juvenile forms of many of the fish
13 and invertebrates.

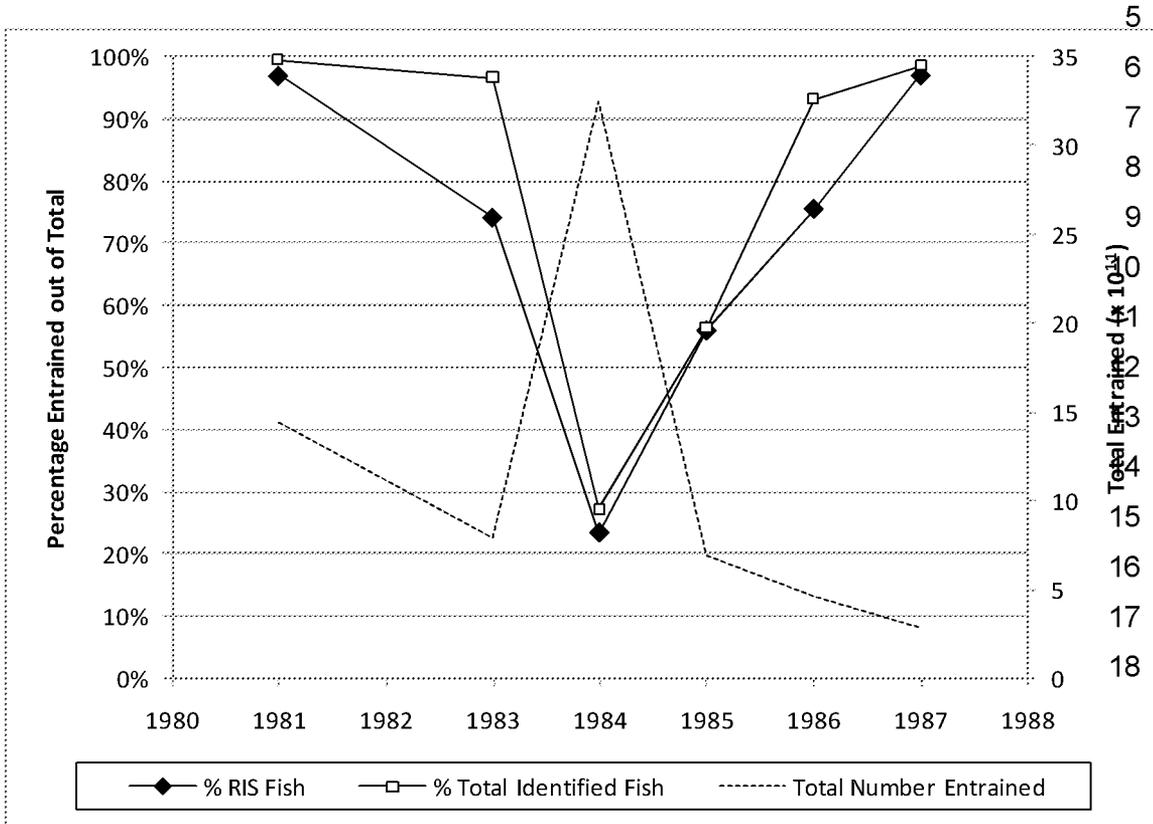
14 Once entrained, organisms pass through the circulating pumps and are carried with the water
15 flow through the intake conduits toward the condenser units. They are then drawn through one
16 of the many condenser tubes used to cool the turbine exhaust steam (where cooling water
17 absorbs heat) and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

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

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

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

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



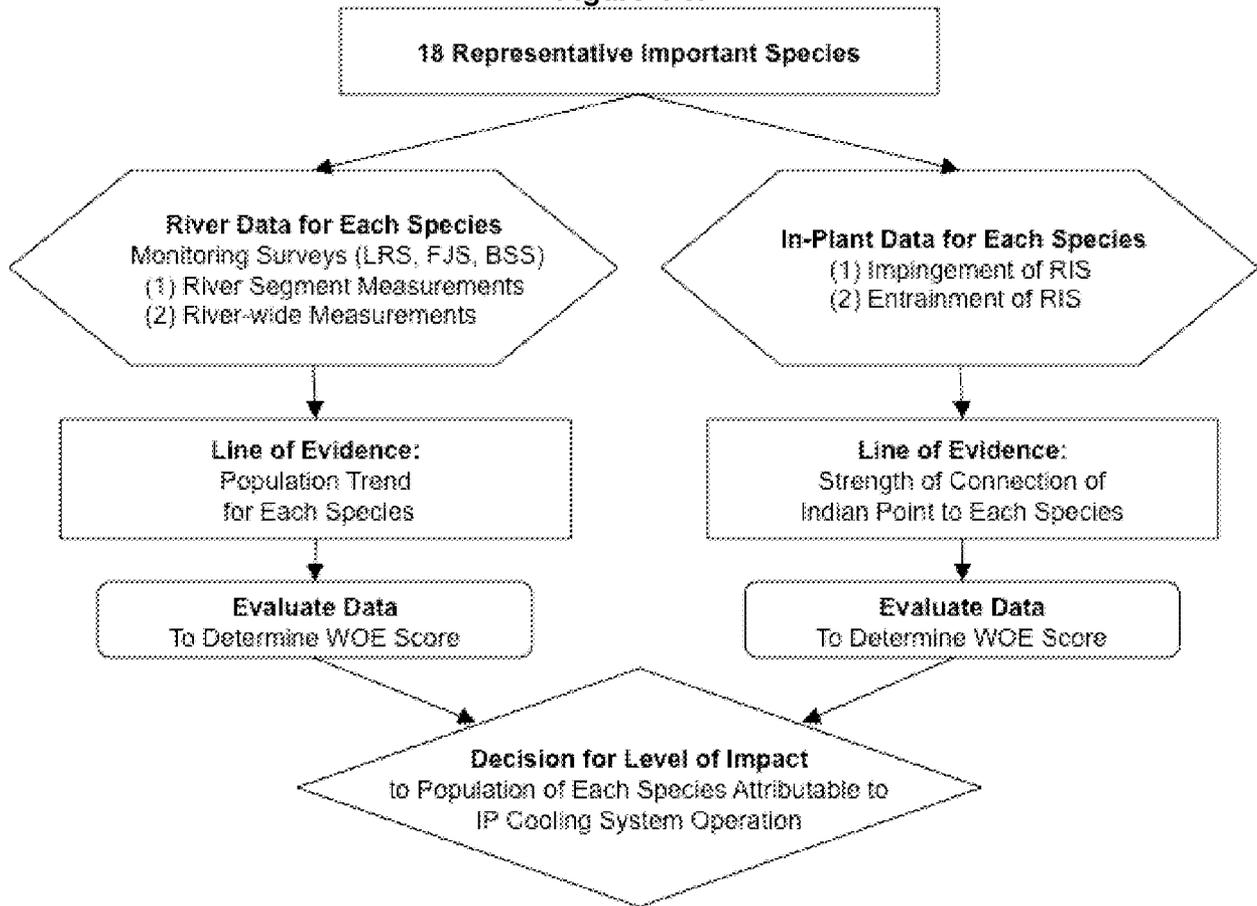
19 **Figure 4-3. Percentage of entrainment of RIS fish and total identified fish relative to the**
 20 **estimated total entrainment at IP2 and IP3 combined (data from Entergy 2007b)**

21 **4.1.3 Combined Effects of Impingement and Entrainment**

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

1

Figure 4-5.



2

3

4

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

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

For this assessment, the environmental component to be protected is the Hudson River aquatic resources as represented by the 18 RIS identified in Table 2-4. These species represent a variety of feeding strategies and food web classifications and are ecologically, commercially, or recreationally important. The WOE approach focuses primarily on the potential impacts to young-of-the-year (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

19

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

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

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

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

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

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

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

Environmental Impacts of Operation

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

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

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

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

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

35 Step 5: Integrate the Results and Assess Impact

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

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

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

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

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

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

25 **4.1.3.1 Assessment of Population Trends—The First Line of Evidence**

26 The NRC staff used data from the LRS, FSS, and BSS studies of the lower Hudson River from
 27 1974 to 2005, as described above, to assess population trends. Staff obtained data from the
 28 applicant in electronic format including weekly catch density, an abundance index, total catch,
 29 and sample volumes. The staff also calculated catch-per-unit-effort values as a ratio of the total
 30 catch and sample volume. The NRC staff also used commercial and recreational harvest
 31 statistics from the Atlantic States Marine Fisheries Commission (ASMFC) as ancillary
 32 information to evaluate coastal population trends for striped bass, American shad, Atlantic
 33 sturgeon, river herring, bluefish, Atlantic menhaden, and weakfish.

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

Environmental Impacts of Operation

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

3 **4.1.3.2 Assessment of Strength of Connection—The Second Line of Evidence**

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

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

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

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

33 **4.1.3.3 Impingement and Entrainment Impact Summary**

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

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

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

8 **Large Impacts**

9 *Blueback Herring*

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

22 *Hogchoker*

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

30 *Spottail Shiner*

31 The NRC staff concludes that a Large impact is present for YOY spottail shiner because a
32 detectable population decline occurred in the river-wide (1 of 3) and river segment (1 of 1) data
33 sets, and the strength of connection with the IP2 and IP3 cooling system is high. The habitat for
34 the spottail shiner includes small streams, lakes, and large rivers, including the Hudson. This
35 species feeds primarily on aquatic insect larvae, zooplankton, benthic invertebrates, and fish
36 eggs and larvae, and is the prey of striped bass. Spottail shiners spawn from May to June or
37 July (typically later for the northern populations) over sandy bottoms and stream mouths (Smith
38 1985; Marcy et al. 2005); water chestnut (*Trapa natans*) beds provide important spawning
39 habitat (CHGEC 1999). Individuals older than 3 years are rare, although some individuals may
40 live 4 or 5 years (Marcy et al. 2005). Spottail shiner is not a marine or anadromous species, so
41 coastal population trend data are not available.

42 *White Perch*

Environmental Impacts of Operation

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

11

1 **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.

2 **Moderate Impacts**

3 *Alewife*

4
 5 The NRC staff concludes that a Moderate impact is present for YOY alewife because a
 6 detectable population decline occurred in river segment 4 (3 out of 3 data sets) and the strength
 7 of connection with the IP2 and IP3 cooling system is high. The NRC staff found that the
 8 population trend results were variable because the declines observed in river segment 4 were
 9 not confirmed by river- wide population trends. YOY alewife (river herring) are present in the
 10 lower and upper reaches of the Hudson River and feed as juveniles primarily on amphipods,
 11 zooplankton, and fish eggs and larvae, and, as adults on small fish. This species is also prey
 12 for bluefish, weakfish, and striped bass. The ASMFC implemented a combined fisheries
 13 management plan for American shad and river herring in 1985. Although the herring fishery is
 14 one of the oldest fisheries in the United States, no commercial fishery for river herring currently
 15 exists in the Hudson River. River herring population declines have been reported in
 16 Connecticut, Rhode Island, and Massachusetts, and NMFS has listed river herring as a species
 17 of concern throughout its range (Hass-Castro 2006).
 18

Environmental Impacts of Operation

1 | *Rainbow Smelt*

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

24 | *Weakfish*

25
26
27 | The NRC staff concludes that a MODERATE impact is present for weakfish because detectable
28 population declines occurred in river-wide (1 of 2) and river segment (1 of 2) data sets, and the
29 strength of connection with the IP2 and IP3 cooling system is high. Because detectable
30 declines occurred in two of four river data sets, staff determined that the population trend results
31 were variable. The weakfish is historically one of the most abundant fish species along the
32 Atlantic coast and is fished recreationally and commercially. Small weakfish prey primarily on
33 crustaceans, whereas larger individuals eat small fish. Bluefish, striped bass, and larger
34 weakfish are the primary predators of smaller weakfish. Weakfish are thought to be in decline
35 based on decreased commercial landings in recent years. The weakfish stock declined
36 suddenly in 1999 and approached even lower levels by 2003, which the ASMFC determined to
37 be because of higher natural mortality rates rather than fishing mortality (ASMFC 2007). A
38 leading hypothesis suggests that reduced prey availability and increased predation by striped
39 bass may contribute significantly to rising natural mortality rates in the weakfish population
40 (ASMFC 2007a).

41 | **4.1.3.4 Discussion of Uncertainty**

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

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

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

26 NRC followed recommendations of the Massachusetts Weight-of-Evidence Workgroup (Menzie
27 et al. 1996) in describing the overall value, use and utility, and uncertainties associated with the
28 overall WOE approach. Consistent with Menzie et al. (1996), NRC staff used professional
29 judgment to select and refine WOE methods before analyzing data and documented all steps
30 (see Appendices H and I) to allow interested readers to gain an understanding of the
31 assumptions, limitations, and uncertainties associated with this assessment. The NRC staff
32 has also employed a similar methodology to assess effects of power plant operation on fish
33 populations in its GEIS Supplement 22, regarding Millstone Power Station, Units 2 and 3 (NRC
34 2005). The NRC's staff's findings for impact from impingement and entrainment at IP2 and IP3,
35 as described in Table 4-4, represent the NRC staff's best estimates based on the WOE derived
36 from the available data and they contain both quantifiable and unquantifiable uncertainties.

37 **4.1.3.5 Overall Impingement and Entrainment Impact**

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

Environmental Impacts of Operation

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

3 | **4.1.4 Heat Shock**

4 | As discussed in Chapter 2, thermal discharges associated with the operation of the once-
5 | through cooling water system for IP2 and IP3 are regulated by NYSDEC. Temperature
6 | limitations are established and imposed on a case-by-case basis for each facility subject to
7 | 6 NYCRR Part 704.

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

10 | (5) Estuaries or portions of estuaries.

11 | (i) The water temperature at the surface of an estuary shall not be raised to more
12 | than 90°F at any point.

13 | (ii) At least 50 percent of the cross sectional area and/or volume of the flow of the
14 | estuary including a minimum of one-third of the surface as measured from water
15 | edge to water edge at any stage of tide, shall not be raised to more than 4°F over
16 | the temperature that existed before the addition of heat of artificial origin or a
17 | maximum of 83°F, whichever is less.

18 | (iii) From July through September, if the water temperature at the surface of an
19 | estuary before the addition of heat of artificial origin is more than an 83°F
20 | increase in temperature not to exceed 1.5°F at any point of the estuarine
21 | passageway as delineated above, may be permitted.

22 | (iv) At least 50 percent of the cross sectional area and/or volume of the flow of
23 | the estuary including a minimum of one-third of the surface as measured from
24 | water edge to water edge at any stage of tide, shall not be lowered more than
25 | 4°F from the temperature that existed immediately prior to such lowering.

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

- 32 | • The maximum discharge temperature is not to exceed 110°F (43°C).
- 33 | • The daily average discharge temperature between April 15 and June 30 is not to exceed
34 | 93.2°F (34°C) for an average of more than 10 days per year during the term of the
35 | permit, beginning in 1981, provided that it not exceed 93.2°F (34°C) on more than 15
36 | 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.

Environmental Impacts of Operation

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

9 In 1976, the former owners of IP2 and IP3 submitted an environmental report to the NRC that
10 evaluated various alternative closed-cycle cooling systems from an economic and
11 environmental standpoint. In 1978, the former owners submitted a 316(a) determination to
12 NYSDEC asserting that the facility complied with thermal standards established by New York
13 State (6 NYCRR 704). In 1980, litigation between New York State and electric generating
14 station owners, associated with the operation of electric generation stations along the Hudson
15 River, resulted in the HRSA. In place of the cooling tower requirement, HRSA required a variety
16 of mitigation measures including seasonal outages and the installation of dual-speed or
17 variable-speed pumps at IP2 and IP3. The existence of HRSA also superseded the 1978
18 section 316(a) study. In support of the Fourth Amended Consent Order to HRSA (NYSDEC
19 1997), the owners of IP2 and IP3 developed flow efficiency curves for each unit that related flow
20 to inlet temperature. For both units, flows of 500,000 gallons per minute (gpm) (1900 cubic
21 meters per minute (m³/min)) were generally attainable during the winter months (December–
22 March when water inlet temperatures were less than 50°F (10°C), while flow rates of 700,000
23 gpm (2650 m³/min) were required during the summer months when inlet temperatures
24 exceeded 70°F (21°C) (NYSDEC 1997, Figures B-1 and B-2). The Fourth HRSA Consent
25 Order also developed a system of “flow variation points” as a means of evaluating changes in
26 plant operations at IP2 and IP3, Bowline Point, and Roseton that offset exceedences of
27 recommended flows with reductions at other times.

4.1.4.3 Thermal Studies and Conclusions

28 A detailed discussion of the thermal studies conducted at IP2 and IP3 to supplement the initial
29 316(a) work performed in the late 1970s is presented in CHGEC et al. (1999). The studies
30 included thermal modeling of near-field effects using the Cornell University Mixing Zone Model
31 (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology
32 (MIT) dynamic network model (also called the far-field thermal model). For the purpose of
33 modeling, near field was defined as the region in the immediate vicinity of each station
34 discharge where cooling water occupies a clearly distinguishable, three-dimensional
35 temperature regime in the river that is not yet fully mixed; far field was defined as the region
36 farthest from the discharges where the plumes are no longer distinguishable from the river, but
37 the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to
38 simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed
39 sufficient by the utilities and their contractor and was designed and configured to account for
40 time-variable hydraulic and meteorological conditions and heat sources of artificial origins.
41 Model output included a prediction of temperature distribution for the Hudson River from the
42 Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the
43 permit applicants applied CORMIX modeling to develop a three-dimensional plume
44 configuration of near-field thermal conditions that could be compared to applicable water quality
45

1 criteria (CHGEC et al. 1999).

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

- 14 (1) Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3,
15 or Bowline Point Units 1 and 2, with no other sources of artificial heat.
- 16 (2) Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point
17 Units 1 and 2, and all other sources of artificial heat operating at full capacity.

18 Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of
19 maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by
20 later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions
21 represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each
22 station, and concurrent operation of all three generating stations at maximum permitted capacity
23 (CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents
24 the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that
25 flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX
26 model runs were integrated with the riverwide temperature profiles developed by the MIT
27 dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises
28 above ambient) for various operating scenarios, the surface width of the plume, the depth of the
29 plume, the percentage of surface width relative to the river width at a given location, and the
30 percentage of cross-sectional area bounded by the 4°F (2°C) isotherm. In addition, the decay
31 in excess temperature was estimated from model runs under near slack water conditions
32 (CHGEC et al. 1999).

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

Environmental Impacts of Operation

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

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

27 **4.1.4.4 Assessments of Thermal Impacts**

28 In this section, the NRC staff provides a summary of the various assessments of impacts
29 associated with thermal discharges from the IP2 and IP3 cooling system. The applicant's
30 assessment is based primarily on statements made in the ER (Entergy 2007a). The
31 conclusions of NYSDEC concerning the thermal impacts of the IP2 and IP3 cooling system are
32 presented in the final impact statement associated with the SPDES permits for Roseton Units 2
33 and 3, Bowline Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a). The NRC staff also notes
34 that NGOs and members of the public have expressed concern that the applicant's assessment
35 of the effect of thermal discharges is incomplete, and that there is evidence to suggest that the
36 existing thermal discharges do not consistently meet applicable criteria as defined in 6 NYCRR
37 704.2(b)(5).

38 Applicant's Assessment

39 The IP2 and IP3 ER (Entergy 2007a) discusses the potential environmental impacts of thermal
40 discharges from IP2 and IP3. The conclusions provided in the ER indicate that the current
41 owners of IP2 and IP3 hold a NYSDEC SPDES permit (NY-0004472) and that the station is
42 complying with the terms of this permit. The conclusions of the ER also describe the current
43 mitigation required under the terms of the Fourth HRSA Consent Order that include flow
44 reductions to limit aquatic impacts and extensive studies in the Hudson River to evaluate

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

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

10 NYSDEC Assessment

11 In the FEIS associated with the SPDES permits for Roseton Units 1 and 2, Bowline Point Units
12 1 and 2, and IP2 and IP3 (NYSDEC 2003a), NYSDEC concludes that “Thermal modeling
13 indicates that the thermal discharge from IP2 and IP3 causes water temperatures to rise more
14 than allowed, which is 4°F over the temperature that existed before the addition of heat, or a
15 maximum of 83°F, whichever is less, in the estuary cross sections specified in 6 NYCRR §
16 704.2(b)(5).”

17 According to NYSDEC (2003b), the last SPDES permit for the Indian Point facility has been
18 administratively continued under provisions of the NY State Administrative Procedure Act since
19 1992. The fact sheet published by NYSDEC (2003b) in November 2003 describes the
20 environmental and facility operational issues and permit conditions of the draft SPDES permit
21 that NYSDEC has proposed to issue for IP2 and IP3. In Section IV, “Overview of the Permit”
22 (Section B, “Thermal Discharges”), NYSDEC indicates that the permittee must satisfy the
23 provisions of Section 316(a) of the CWA and related requirements in 6 NYCRR Section 704.2
24 “which provide that the thermal discharges from IP2 and IP3 to the Hudson River should meet
25 regulatory temperature criteria for estuaries, and must meet the NYS standard of ensuring the
26 propagation and survival of a balanced, indigenous population of shellfish, fish, and other
27 aquatic species.”

28 To meet this goal, NYSDEC requires, within the first 2 years of the SPDES permit term, that
29 Entergy conduct a triaxial (three-dimensional) thermal study to document whether the thermal
30 discharges associated with the operation of IP2 and IP3 comply with New York State water
31 quality criteria. In the event the discharges do not comply, the permittee is allowed to apply for
32 a modification of one or more criteria as provided by 6 NYCRR Section 704.4, but must
33 demonstrate to the satisfaction of NYSDEC “that one or more of the criteria are unnecessarily
34 restrictive and that the modification would not inhibit the existence and propagation of a
35 balanced indigenous population of shellfish, fish, and wildlife in the Hudson River” (NYSDEC
36 2003a). In the ongoing proceeding before NYSDEC, Entergy has indicated that it would
37 propose an alternative study. This matter is still under review before NYSDEC, and may not be
38 resolved before NRC issues a final SEIS (Entergy 2007c).

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

1 **4.1.4.5 NRC Staff Assessment of Thermal Impacts**

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

27 **4.1.5 Potential Mitigation Options**

28 | Potential mitigation options related to the operation of the IP2 and IP3 once-through cooling
29 | system are discussed in Chapter VII of the DEIS (CHGEC et al. 1999). Impacts associated with
30 | impingement were assumed by the Hudson River utilities to be adequately mitigated because
31 | previous IP2 and IP3 owners installed dual- and variable-speed pumps at IP2 and IP3,
32 | respectively, in 1994, and also installed modified Ristroph screens at both units in the early
33 | 1990s (CHGEC et al. 1999). The summary conclusion of the DEIS in 1999 was that the Hudson
34 | River utilities considered the system to be the best technology available to mitigate impingement
35 | losses (CHGEC et al. 1999). The NYSDEC, however, has determined that closed-cycle cooling
36 | is the best technology available to protect aquatic resources (NYSDEC 2003b).

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

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

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

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

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

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

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

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

39 Additional Flow Reductions or Shutdowns

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

Environmental Impacts of Operation

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

9 Wedgewire or Fine-Mesh Screens

10 | In some cases, the use of wedgewire or fine-mesh screens has shown potential for decreasing
11 | entrainment at once-through powerplants. Wedgewire screens typically have a screen size of
12 | 0.5 to 10 mm and are designed to reduce entrainment by physical exclusion and exploiting
13 | hydrodynamic patterns (EPA 2008a). Fine-mesh screens generally employ a mesh size of
14 | 0.5 mm or less, and reduce entrainment by gently trapping organisms and reintroducing them
15 | back into the environment via plant-specific collection and transfer systems. Factors influencing
16 | the use of this technology include the screen size, the location, and configuration of the system
17 | relative to the intake, the intake flow rates, the presence and magnitude of a “sweeping” current
18 | that can limit impingement or move organisms past the screen into safe water, and the size of
19 | the organism present near the intake. In its evaluation of wedgewire and fine-mesh screens,
20 | EPA (2008a) indicated that these technologies showed promise for reducing entrainment, but
21 | expressed concerns about the maintenance required to prevent clogging and the potential for
22 | this technology to reduce entrainment but increase impingement. EPA (2008a) considered the
23 | use of wedgewire screen technology to be more suitable for use in closed-cycle makeup water
24 | systems where lower flow rates exist and fewer screens are required.

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

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

39 Barrier Systems

40 | Gunderboom® and Marine Life Exclusion System™ (MLES™) technologies provide additional
41 | exclusion of entrainable-sized organism from cooling systems. Nets or screens are deployed
42 | during peak periods of entrainment to reduce overall entrainment. Gunderboom technology has
43 | been evaluated at the Lovett fossil fuel generating station since 1994. The system deployed in
44 | 2000 consisted of a two-ply fabric 500 feet (ft) (150 meters (m)) long, with a surface area of

1 8000 square feet (ft²) (743 square meters (m²)), and equipped with 500-micrometer (0.020 in.)
2 perforations. The system extended to a depth of 20–30 ft (6.1–9.1 m) and was held in place
3 with anchors. An automated airburst system with strain gages and head differential monitors
4 was used to release compressed air at depth to clean the screens. The preliminary results from
5 the 2000 deployment documented by Raffenberg et al. (2008) suggested that the system
6 resulted in an 80-percent reduction in ichthyoplankton entering the facility, and that periodic
7 elevated densities of ichthyoplankton inside the barrier were linked to breaches of the system.
8 Impingement investigations suggested that eggs did not adhere to fabric, and mortality was
9 below 2 percent in laboratory studies. Based on observational data, larvae did not orient toward
10 the flow, and did not impinge on the fabric with a through-fabric velocity of 5 gallons per minute
11 per square foot or 0.20 meters per minute (Raffenberg et al. 2008).

12 The use of barrier systems may be feasible at IP2 and IP3 as a mitigation action, but further
13 study may be needed to determine the long-term impacts of these systems. CHGEC et al.
14 (1999) indicated that barrier nets or fine-mesh barrier nets would not be feasible at Indian Point,
15 and did not assign a cost. EPA (2008), however, has indicated that barrier systems like
16 Gunderboom show significant promise for minimizing entrainment, but considers the technology
17 “experimental in nature.” Some advantages of the systems are that they can be deployed,
18 retrieved, and replaced seasonally as needed. They are suitable for use in all types of water
19 bodies and appear to reduce entrainment and impingement losses. The disadvantages are
20 related to the limited number of long-term studies available to assess the performance of the
21 technology, the durability of the systems in high-energy areas, the level of maintenance and
22 monitoring required, the effects of biofouling on system performance, and the large volume of
23 water that IP2 and IP3 withdraw. Additionally, it may be necessary to determine whether
24 potential safety issues associated with the deployment of the systems at a nuclear generating
25 station can be addressed.

26 Behavioral Deterrent Systems

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

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

3 **4.2 Transmission Lines**

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

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

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

24

1
2

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

3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

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.

Environmental Impacts of Operation

- 1 • Air quality effects of transmission lines. Based on the information in the GEIS, the
2 Commission found the following:
3 Production of ozone and oxides of nitrogen is insignificant and does not
4 contribute measurably to ambient levels of these gases.
 - 5 • Onsite land use. Based on the information in the GEIS, the Commission found the
6 following:
7 Projected on-site land use changes required during... the renewal period would
8 be a small fraction of any nuclear power plant site and would involve land that is
9 controlled by the applicant.
 - 10 • Power line right-of-way. Based on information in the GEIS, the Commission found the
11 following:
12 Ongoing use of power line rights-of-way would continue with no change in
13 restrictions. The effects of these restrictions are of small significance.
- 14 The NRC staff identified no new and significant information associated with these issues during
15 the review. Therefore, the NRC staff expects that there would be no impacts during the renewal
16 term beyond those discussed in the GEIS.
- 17 The NRC staff has identified one Category 2 issue and one uncategorized issue related to
18 transmission lines. These issues are listed in Table 4-6 and are discussed in Sections 4.2.1
19 and 4.2.2 of this SEIS.

20 **Table 4-6. Category 2 and Uncategorized Issues Applicable to the IP2 and IP3**
21 **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

22 **4.2.1 Electromagnetic Fields—Acute Effects**

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

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

11 As described in Section 2.1.7 of this SEIS, two 345-kilovolt (kV) transmission lines were built to
12 distribute power from IP2 and IP3 to the electric grid. Also, two 138-kV lines that use the same
13 transmission towers supply offsite (standby) power to IP2 and IP3. These lines are contained
14 within the IP2 and IP3 site, except for where they cross Broadway (a public road) to connect to
15 the Buchanan substation. Electric lines having voltages exceeding 98 kV of alternating current
16 to ground must comply with the NESC provision on minimum vertical clearance, adopted in
17 1977, that limits the steady-state current from electrostatic effects to 5 milliamperes (mA) if the
18 largest anticipated truck, vehicle, or equipment under the line were short circuited to ground.
19 The New York Public Service Commission (NYPSC) requires a more restrictive induced current
20 limit of 4.5 mA (Entergy 2007a).

21 Entergy indicates that at the time it acquired IP2 from the Consolidated Edison Company of
22 New York, the transmission lines connecting IP2 and IP3 to the Buchanan substation were in
23 compliance with the applicable NESC provisions for preventing electric shock from induced
24 current. The lines were also in compliance with the NYPSC 4.5-mA criterion, as calculated
25 using the methods described in the Electric Power Research Institute (EPRI) document
26 "Transmission Line Reference Book" (Con Edison 2007). There have been no configuration or
27 operation changes made to these lines since transfer of their ownership to Entergy (Entergy
28 2007a). Entergy indicates that it has maintenance procedures to ensure that the transmission
29 lines continue to conform to ground clearance standards (Entergy 2008a).

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

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

Environmental Impacts of Operation

1 2008 study (Enercon 2008), and existing NESC requirements, the NRC staff concludes that the
2 transmission lines associated with IP2 and IP3 meet NESC criteria for limiting hazards, and thus
3 the potential impact from electric shock during the renewal term is SMALL.

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

10 **4.2.2 Electromagnetic Fields—Chronic Effects**

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

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

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

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

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

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

39 **4.3 Radiological Impacts of Normal Operations**

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

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

15 **Table 4-7. Category 1 Issues Applicable to Radiological Impacts of Normal Operations**
 16 **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

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

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

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

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

Environmental Impacts of Operation

1 normal operations.

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

4 Projected maximum occupational doses during the license renewal term are

5 within the range of doses experienced during normal operations and normal

6 maintenance outages, and would be well below regulatory limits.

7 The NRC staff identified no information that was both new and significant on these issues during

8 the review of the IP2 and IP3 LRA. Therefore, the NRC staff expects that there would be no

9 impacts during the renewal term beyond those discussed in the GEIS.

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

11 | **4.4 Socioeconomic Impacts of Plant Operations during the**

12 **License Renewal Term**

13 Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B–1, applicable to

14 socioeconomic impacts during the renewal term are listed in Table 4-8 of this SEIS. As stated

15 in the GEIS, the impacts associated with these Category 1 issues were determined to be

16 SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be

17 warranted.

18 **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

19 The NRC staff reviewed and evaluated the IP2 and IP3 ER, scoping comments, and other

20 available information. The NRC staff also visited IP2 and IP3 in search of new and significant

21 information that would change the conclusions presented in the GEIS. No new and significant

22 information was identified during this review and evaluation. Therefore, the NRC staff

23 concludes that there would be no impacts related to these Category 1 issues during the renewal

24 term beyond those discussed in the GEIS.

25 The results of the review and brief statement of GEIS conclusions, as codified in Table B-1 of

26 10 CFR Part 51, Subpart A, Appendix B, for each of the socioeconomic Category 1 issues are

27 provided below:

- 1 • Public services: public safety, social services, and tourism and recreation. Based on
2 information in the GEIS, the Commission found the following:
3 Impacts to public safety, social services, and tourism and recreation are
4 expected to be of small significance at all sites.
 - 5 • Public services, education (license renewal term). Based on information in the GEIS,
6 the Commission found the following:
7 Only impacts of small significance are expected.
 - 8 • Aesthetic impacts (license renewal term). Based on information in the GEIS, the
9 Commission found the following:
10 No significant impacts are expected during the license renewal term.
 - 11 • Aesthetic impacts of transmission lines (license renewal term). Based on information in
12 the GEIS, the Commission found the following:
13 No significant impacts are expected during the license renewal term.
- 14 The NRC staff identified no new and significant information regarding these issues during the
15 review. Therefore, the NRC staff expects that there would be no impacts during the renewal
16 term beyond those discussed in the GEIS.

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

19 **Table 4-9. Category 2 Issues Applicable to Socioeconomics**
20 **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.

21 **4.4.1 Housing Impacts**

22 Appendix C to the GEIS presents a population characterization method based on two factors,
23 sparseness and proximity (see Section C.1.4). Sparseness measures population density within
24 20 miles (mi) (32 kilometers (km)) of the site, and proximity measures population density and

Environmental Impacts of Operation

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

4 | In Chapter 2 of this SEIS, the NRC staff describes the local population around IP2 and IP3. As
5 NRC staff indicated in Section 2.2.8.5, the 2000 U.S. Census noted that approximately
6 1,113,089 people lived within 20 mi (32 km) of IP2 and IP3, which equates to a population
7 density of 886 persons per square mi (332 persons per square km). This density translates to
8 the least sparse Category 4 (greater than or equal to 120 persons per square mi within 20 mi).
9 Approximately 16,791,654 people live within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a).
10 This equates to a population density of 2138 persons per square mi (825 persons per square
11 km). Applying the GEIS proximity measures, the IP2 and IP3 site is classified as proximity
12 Category 4 (greater than or equal to 190 persons per square mi within 50 mi). Therefore,
13 according to the sparseness and proximity matrix presented in the GEIS, IP2 and IP3 ranks of
14 sparseness Category 4 and proximity Category 4 result in the conclusion that Indian Point is
15 located in a high population area.

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

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

37 **4.4.2 Public Services—Public Utility Impacts**

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

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

8 As previously discussed (in Section 2.2.8.2) of this SEIS, potable water and process water is
 9 supplied to IP2 and IP3 by the Village of Buchanan water supply system (VBNY 2006). IP2 and
 10 IP3 use approximately 2.3 million ft³ (65,000 m³) or 17.4 million gallons of potable water per
 11 month, and there is no indicated restriction on the amount of potable water that IP2 and IP3 can
 12 use. Further, Entergy (Entergy 2007a) does not project an increase in plant demand.

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

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

24 **4.4.3 Offsite Land Use—License Renewal Period**

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

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

31 SMALL—Little new development and minimal changes to an area's land use
 32 pattern.

33 MODERATE—Considerable new development and some changes to the land
 34 use pattern.

35 LARGE—Large-scale new development and major changes in the land use
 36 pattern.

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

Environmental Impacts of Operation

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

13 | **4.4.3.1 Population-Related Impacts**

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

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

25 | **4.4.3.2 Tax-Revenue-Related Impacts**

26 As discussed in Chapter 2 of this SEIS, Entergy pays annual real estate taxes to the Town of
27 Cortlandt, Hendrick Hudson Central School District, and the Village of Buchanan (see Table 2-
28 18 in Chapter 2 for more detail). As reported in Chapter 2, tax payments to the Town of
29 Cortlandt represented between 11 and 16 percent of the town's total annual tax revenues for the
30 3-year period from 2003 through 2005, and payments to the Hendrick Hudson Central School
31 District represented approximately 30 to 38 percent of the school district's total revenues over
32 the same time period. Entergy's tax payments to the Village of Buchanan make up a high
33 percentage of the village's tax collection. For the period 2003 through 2005, tax payments to
34 the Village of Buchanan represented 39 to 44 percent of the village's total revenues.

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

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

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

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

7 **4.4.4 Public Services: Transportation Impacts during Operations**

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

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

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

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

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

26 **4.4.5 Historic and Archeological Resources**

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

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

2 | **4.4.5.1 Site-Specific Cultural Resources Information**

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

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

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

37 | **4.4.5.2 Conclusions**

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

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

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

22 **4.4.6 Environmental Justice**

23 Under Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority
24 Populations and Low-Income Populations" (Volume 59, page 7629 of the *Federal Register*
25 (59 FR 7629)), Federal agencies are responsible for identifying and addressing potential
26 disproportionately high and adverse human health and environmental impacts on minority and
27 low-income populations. In 2004, the Commission issued its "Policy Statement on the
28 Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions"
29 (69 FR 52040), which states, "The Commission is committed to the general goals set forth in
30 E.O. 12898, and strives to meet those goals as part of its NEPA review process."

31 The Council of Environmental Quality (CEQ) provides the following information in its publication
32 entitled, "Environmental Justice: Guidance under the National Environmental Policy Act"
33 (1997):

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

Environmental Impacts of Operation

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

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

- 16 | (1) **Minority individuals.** Individuals who identify themselves as members of the following
17 population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black
18 or African American, Native Hawaiian or Other Pacific Islander, or two or more races
19 meaning individuals who identified themselves on a Census form as being a member of
20 two or more races, for example, Hispanic and Asian.
- 21 (2) **Minority populations.** Minority populations are identified when (1) the minority
22 population of an affected area exceeds 50 percent or (2) the minority population
23 percentage of the affected area is meaningfully greater than the minority population
24 percentage in the general population or other appropriate unit of geographic analysis.
- 25 (3) **Low-income populations.** Low-income populations in an affected area are identified
26 with the annual statistical poverty thresholds from the Census Bureau's Current
27 Population Reports, Series PB60, on Income and Poverty.

28 Minority Population in 2000

29 According to 2000 census data, 48.7 percent of the population (approximately 16,805,000
30 individuals) residing within a 50-mi (80-km) radius of IP2 and IP3 identified themselves as minority
31 individuals. The largest minority group was Black or African American (3,480,000 persons or
32 20.7 percent), followed by Hispanic or Latino of any race (3,439,000 or about 20.5 percent)
33 (USCB 2003—LandView 6). About 36 percent of the Westchester County population were
34 minorities, with Hispanic or Latino the largest minority group (15.6 percent) followed by Black or
35 African American (13.6 percent) (USCB 2008).

36 Census block groups with minority populations exceeding 50 percent were considered minority
37 | block groups. Based on 2000 census data, Figure 4-5 of this SEIS shows minority block groups
38 within a 50-mi (80-km) radius of IP2 and IP3 in which more than 50 percent of the block group
39 population is minority.

40 Low-Income Population in 2000

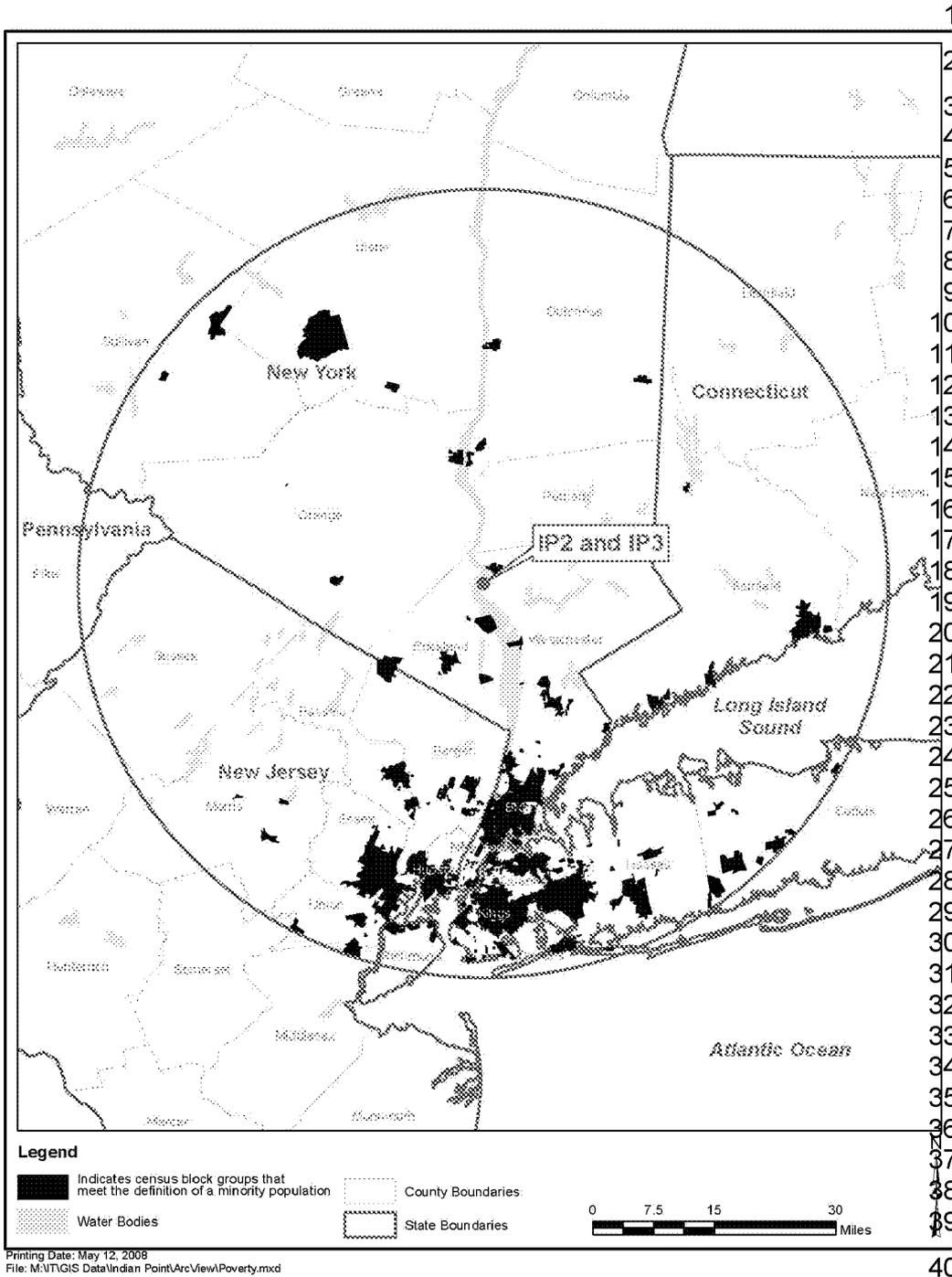
41 According to 2000 census data, approximately 484,000 families (approximately 11.7 percent)
42 residing within a 50-mi (80-km) radius of the IP2 and IP3 were identified as living below the

Environmental Impacts of Operation

1 Federal poverty threshold in 1999 (USCB 2003—LandView 6). The 1999 Federal poverty
2 threshold was \$17,029 for a family of four.

3 According to census data, the median household income for New York in 2004 was \$45,343,
4 while 14.5 percent of the State's population was determined to be living below the Federal
5 poverty threshold. Westchester County had a much higher median household income
6 (\$63,924) and a lower percentage (8.9 percent) of individuals living below the poverty level
7 when compared to the State. Dutchess, Orange, and Putnam Counties also had much higher
8 median household incomes in 2004 (\$56,971, \$54,771, and \$75,514, respectively) and lower
9 percentages (7.7 percent, 10.2 percent, and 4.5 percent, respectively) of individuals living below
10 the poverty level when compared to the State (USCB 2008).

11



41
 42
 43
 44

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

1 Census block groups were considered low-income block groups if the percentage of the
2 population living below the Federal poverty threshold exceeded the State percentage of
3 14.5 percent. Based on 2000 census data, Figure 4-6 of this SEIS shows low-income block
4 groups within a 50-mi (80-km) radius of IP2 and IP3.

5 Analysis of Impacts

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

10
11 The discussion and figures above identify the location of minority and low-income populations
12 residing within a 50-mile (80-kilometer) radius of IP2 and IP3. This area of impact is consistent
13 with the impact analysis for public and occupational health and safety, which also considers the
14 radiological effects on populations located within a 50-mile (80-kilometer) radius of IP2 and IP3.
15 As previously discussed for the other resource areas in Chapter 4, the analyses of impacts for
16 all environmental resource areas indicated that the impact from license renewal would be
17 SMALL.

18
19 Socioeconomic conditions in minority and low-income communities would not change as a
20 result of renewing the IP2 and IP3 operating licenses. Employment levels and tax revenue
21 would remain relatively unchanged, so direct and indirect employment opportunities caused by
22 IP2 and IP3 would remain unchanged. Therefore, there would be no additional socioeconomic
23 impact to minority and low-income populations during the license renewal term beyond what is
24 currently being experienced.

25
26 Potential impacts to minority and low-income populations would mostly consist of radiological
27 effects; however radiation doses from continued operations associated with license renewal are
28 expected to continue at current levels, and would remain within regulatory limits. Chapter 5
29 discusses the environmental impacts from postulated accidents that might occur during the
30 license renewal term, which include both design basis and severe accidents. In both cases, the
31 Commission has generically determined that impacts associated with such accidents are
32 SMALL because nuclear plants are designed and operated to successfully withstand design
33 basis accidents, and the probability weighted impacts risks associated with severe accidents
34 were also SMALL.

35
36 Therefore, based on this information and the analysis of human health and environmental
37 impacts presented in Chapters 4 and 5 of this SEIS, there would be no disproportionately high
38 and adverse impacts to minority and low-income populations from the continued operation of
39 IP2 and IP3 during the license renewal period.

40
41 As discussed in Section 4.4.1, Entergy may replace the IP2 and IP3 reactor vessel heads and
42 CRDMs during the license renewal term (Entergy 2008b). Entergy estimates that this would
43 require an increase in the number of refueling outage workers for up to 60 days during two
44 separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). This
45 replacement activity would have little noticeable affect on minority and/or low-income
46 populations in the region. These impacts are discussed in Chapter 3 of this SEIS.

Environmental Impacts of Operation

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

8 Subsistence Consumption of Fish and Wildlife

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

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

26

Environmental Impacts of Operation

1 The NRC staff presents a summary of results from the IP2 and IP3 REMP program in
2 Section 2.2.7 of this SEIS. The results of the 2006 REMP (the most recent available)
3 demonstrate that the routine operation at the IP2 and IP3 site has had no significant or
4 measurable radiological impact on the environment. No elevated radiation levels were detected
5 in the offsite environment as a result of plant operations and the storage of radioactive waste.
6 The results of the REMP continue to demonstrate that the operation of IP2 and IP3 did not
7 result in a significant measurable dose to a member of the general population or adversely
8 impact the environment as a result of radiological effluents. The REMP continues to
9 demonstrate that the dose to a member of the public from the operation of IP2 and IP3 remains
10 significantly below the Federally required dose limits specified in 10 CFR Part 20 and 40 CFR
11 Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."
12 The NRC staff's review of recent REMP monitoring results shows that concentrations of
13 contaminants in native leafy vegetation, soils and sediments, surface water, and fish in areas
14 surrounding IP2 and IP3 have been quite low (at or near the threshold of detection) and seldom
15 above background levels. Consequently, the NRC staff concludes that no disproportionately
16 high and adverse human health impacts would be expected in special pathway receptor
17 populations in the region as a result of subsistence consumption of fish and wildlife.

18 **4.5 Ground Water Use and Quality**

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

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

33 **4.6 Threatened or Endangered Species**

34 Potential impacts to threatened or endangered species are listed as a Category 2 issue in
35 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-10.
36

1 **Table 4-10. Category 2 Issues Applicable to Threatened or Endangered Species during**
 2 **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

3 This issue requires consultation under Section 7 of the Endangered Species Act of 1973 (ESA
 4 1973) with appropriate agencies to determine whether threatened or endangered species are
 5 present and whether they would be adversely affected by continued operation of the nuclear
 6 facility during the license renewal term. The presence of threatened or endangered species in
 7 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
 8 2007, the NRC staff contacted NMFS and the U.S. Fish and Wildlife Service (FWS) to request
 9 information on the occurrence of threatened or endangered species in the vicinity of the site and
 10 the potential for impacts on those species from license renewal. NMFS identified in its response
 11 two Federally protected sturgeon species under its jurisdiction as having the potential to be
 12 affected by the proposed action (NMFS 2007a). FWS provided a link to the Web site of its New
 13 York Field Office, where lists of species occurrences were available by county (FWS 2007).
 14 Three terrestrial species with a Federal listing status were identified as potentially occurring at
 15 or near the site—the Indiana bat (*Myotis sodalis*), bog turtle (*Clemmys muhlenbergii*), and New
 16 England cottontail (*Sylvilagus transitionalis*).

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

24 **4.6.1 Aquatic Special Status Species**

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

Environmental Impacts of Operation

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

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

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

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

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

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

11 **Table 4-11. Impingement Data for Shortnose and Atlantic Sturgeon at IP2 and IP3,**
 12 **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

13 The NRC staff reviewed information from the site audit, Entergy’s ER for the IP2 and IP3 site,
 14 other reports, and information from NMFS. Based on the WOE information presented in Table
 15 4-4, The NRC staff concludes that the impacts associated with the IP2 and IP3 cooling system
 16 are Small for both Atlantic and shortnose sturgeon. The population trend LOE evaluation was
 17 unresolved because the Hudson River monitoring programs were not designed to catch either
 18 species. The NRC staff was also unable to determine the strength of connection for either
 19 species using the Monte Carlo simulation modeling. Because historical impingements of
 20 sturgeon have been relatively low, especially for shortnose sturgeon, the NRC staff concluded

Environmental Impacts of Operation

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

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

17 4.6.2 Terrestrial Threatened or Endangered Species

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

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

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

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

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

13 **4.7 Evaluation of New and Potentially Significant Information on** 14 **Impacts of Operations during the Renewal Term**

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

22 As discussed in Section 2.2.7 of this SEIS and synopsised in Section 4.5 of this chapter,
23 Entergy identified leakage from onsite spent fuel pools as potentially new information (Entergy
24 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an
25 extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this
26 SEIS. Based on the NRC staff's review of Entergy's ground water analyses, the NRC ground
27 water inspection report, and Entergy's subsequent statements (all discussed in Section 2.2.7 of
28 this SEIS), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in
29 its ER, while constituting new information, are within the NRC's radiation safety standards
30 contained in 10 CFR Part 20 and are not considered to have a significant impact on plant
31 workers, the public, or the environment (i.e., while the information related to spent fuel pool
32 leakage is new, it is not significant).

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

36 **4.8 Cumulative Impacts**

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

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

Environmental Impacts of Operation

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

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

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

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

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

21 Continued Water Withdrawals

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

31 Invasive and Nuisance Species

32 As discussed in Section 2.2.5 of this SEIS, the presence of invasive or nuisance species in the
33 Hudson River estuary has been documented for over 200 years. While the presence of new or
34 exotic species can benefit some existing species, introductions of new species often have a
35 negative impact on their new environment. A classic example of the latter is the appearance of
36 the zebra mussel in the freshwater portion of the Hudson River in 1991. Since 1992, zebra
37 mussels have been a dominant species in the freshwater tidal portion of the Hudson River and
38 constitute more than half of heterotrophic biomass. Strayer (2007) estimated that the current
39 population is capable of filtering a volume of water equal to all of the water in the estuary every
40 1 to 4 days during the summer.

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

Environmental Impacts of Operation

1 (2004) hypothesized that the abundance or growth rates of American shad, blueback herring,
2 alewife, gizzard shad, white perch, and striped bass would decline following the zebra mussel
3 invasion or that their distributions within the river would shift downriver away from the zone of
4 greatest zebra mussel impacts. The authors found that significant decreases in the estimated
5 river-wide abundance of early life stages of several species of fish, including American shad and
6 white perch, coincided with the zebra mussel invasion. Barnthouse et al. (2008) also concluded
7 that zebra mussels may have contributed to declines in white perch populations but rejected the
8 hypothesis that zebra mussels were affecting American shad. The NRC staff's independent
9 analysis concluded that the presence of zebra mussels in the river would have a Small potential
10 for adverse impacts to the alewife, American shad, blueback herring, spottail shiner, striped
11 bass, white catfish, and white perch (Appendices H and I). The presence of invasive or
12 nuisance species in the lower Hudson River will continue to be a concern, as it is in other
13 locations throughout the world, and the presence of these species will continue to represent an
14 important source of cumulative impacts to the river.

15 Fishing Pressure

16 Many RIS are commercially or recreationally important, and are thus subject to effects from
17 fishing pressure. In many cases, the commercial or recreational catches of RIS are regulated
18 by Federal or State agencies or entities, but losses of some RIS continue to occur as the result
19 of bycatch. The extent and magnitude of fishing pressure and its relationship to overall
20 cumulative impacts to the aquatic resources of the lower Hudson River is difficult to determine
21 because of the large geographic scale and the natural variation that exists in the system.
22 Recent work by Barnthouse et al. (2008) has suggested that fishing pressure is contributing to
23 the decline of some RIS in the lower Hudson River, but this could not be confirmed by the staff.
24 The staff does acknowledge that fishing pressure (or the lack of it due to catch restrictions) has
25 the potential to influence the freshwater, estuarine, and marine food webs present in the lower
26 Hudson River and may contribute to cumulative impacts in the future.

27 Habitat Loss

28 As described in Section 2.2.5 of this SEIS, alterations to terrestrial, wetland, nearshore, and
29 aquatic habitats have occurred in the Hudson River estuary since colonial times. During the
30 colonization of the region, upland habitat alterations profoundly influenced watershed dynamics.
31 The creation of dams and the filling or isolation of wetlands to support industrial activities have
32 dramatically changed patterns of nutrients and sediment loading to the estuary. In addition,
33 historic dredging activities altered aquatic environments and affected river flow patterns, and
34 future activities, as described in Section 2.2.10 of this SEIS, may continue to influence the river.
35 Finally, development along the shores of the Hudson has resulted in the loss or isolation of
36 nearshore habitat, and the armoring of the shoreline in the lower portions of the river from
37 Yonkers to the Battery has effectively eliminated nearshore habitat. The NRC staff recognizes
38 that Federal, State, and local agencies, as well as many NGOs, are interested in restoring
39 habitat lost during past development and notes that the identification of four locations along the
40 lower Hudson River estuary for inclusion in the National Estuarine Research Reserve System in
41 1982 represents an important step in protecting and restoring important habitats.
42 Because habitat loss remains a concern, the NRC staff concludes that this stressor will continue
43 to be an important contributor to cumulative impacts to the lower Hudson River.

1 Water and Sediment Quality

2 In general, there is evidence to conclude that the overall quality of water and sediment in the
3 lower Hudson River is improving. Cleanup of polychlorinated biphenyls in stretches of the river
4 above the Troy Dam continues, and upgrades to wastewater treatment facilities during the past
5 20 years have reduced the amount of untreated sewage discharged into the river and
6 contributed to reductions in nutrients and an apparent increase in dissolved oxygen. Chemical
7 contaminants continue to persist in the tissues of fish and invertebrates inhabiting the lower
8 Hudson River, and the presence of nonpoint discharges of chemicals and constituents
9 continues to be a concern of local, State, and Federal regulatory agencies and NGOs. The
10 NRC staff concludes that the quality of water and sediment in the lower Hudson River will
11 continue to be a concern and a potential contributor to cumulative impacts.

12 Climate Change

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

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

32 Final Assessment of Cumulative Impacts on Aquatic Resources

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

Environmental Impacts of Operation

1 are considered by the NRC staff to be LARGE.

2 **4.8.2 Cumulative Impacts on Terrestrial Resources**

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

8 The changes in land use associated with historical settlement and development of this region
9 are described in Section 2.2.5.2 of this SEIS. During precolonial and colonial settlement by
10 European immigrants, large areas of the forest that had almost completely covered the region
11 were cleared for agriculture, and by 1880, 68 percent of the Hudson River watershed had
12 become farmland. Also in the 19th century, major changes in land use occurred in the region in
13 conjunction with the industrial revolution as human populations grew and houses, roads,
14 railroads, bridges, and industrial facilities were constructed. These historical trends of
15 increasing development and decreasing terrestrial habitat in the region continued through the
16 20th century to the present, resulting in large reductions in native forests and other habitats for
17 terrestrial wildlife, increases in precipitation runoff due to impervious surfaces, and pollution
18 (Swaney et al. 2006).

19 Before the historical clearing of land at the IP2 and IP3 site, the terrestrial communities of the
20 area consisted mainly of upland and riparian forests (NRC 1975). The site was originally
21 purchased in 1683 by a Dutch settler, who established a homestead there. By the latter 19th
22 century, the north end of Indian Point was being surface mined for iron, and a lime kiln and blast
23 furnace were located at the shoreline. By 1900 a brickyard existed on the site, and farming still
24 occurred there. In 1920 an amusement park was built on the site. The park closed in 1956, and
25 construction of the first commercial nuclear reactor in the United States then began at the site
26 (Enercon 2007). Thus, the site had been largely cleared of forest and developed for various
27 uses for well over a century before its development for power generation began in the second
28 half of the 20th century. Power plant development resulted in over half of the site (134 ac
29 (54.2 ha)) being covered by facilities and pavement, with forest having regenerated at the north
30 end of the site where mining occurred historically. Remaining native forest habitat in central and
31 southern portions of the site has been fragmented by roads, ROWs, parking areas, and other
32 development, a phenomenon that has commonly occurred in the region.

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

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

1 from historical and ongoing development. Current land uses in the region are discussed by
2 county in Section 2.2.8.3 of this SEIS. In Westchester County, based on 1992 data, forest was
3 the predominant type of land cover (53 percent), followed by residential (30 percent),
4 agricultural and recreational (7 percent), and commercial/industrial/transportation uses
5 (3 percent) (Entergy 2007a). In four nearby counties in the lower Hudson Valley (Rockland,
6 Orange, Putnam, and Dutchess), forest also was the predominant type of land cover, followed
7 by residential or agricultural, and commercial/industrial/transportation land uses ranged from
8 about 1 to 4 percent (Entergy 2007a). Thus, commercial, industrial, and transportation facilities,
9 including the IP2 and IP3 site, have had a relatively small impact on the loss of native terrestrial
10 forest habitats in the region compared to residential and agricultural development. The
11 commercial, industrial, and transportation facilities that have impacted terrestrial resources in
12 the region in addition to the IP2 and IP3 site include six power generation facilities on the
13 Hudson River between RM 37 and 67 (RKM 60 to 97), highways, railways along both sides of
14 the river, and manufacturing plants.

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

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

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

35 **4.8.3 Cumulative Radiological Impacts**

36 The radiological dose limits for protection of the public and workers have been developed by the
37 NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation
38 and radioactive material. These dose limits are codified in 10 CFR Part 20 and
39 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of
40 the IP2 and IP3 site was included. The radiological environmental monitoring program
41 conducted by Entergy in the vicinity of the IP2 and IP3 site measures radiation and radioactive
42 materials from all sources; therefore, the monitoring program measures cumulative radiological
43 impacts. Within the 50-mi (80-km) radius of the IP2 and IP3 site there are no other nuclear
44 power reactors or uranium fuel cycle facilities. The NRC staff reviewed the 1993 and 1994

Environmental Impacts of Operation

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

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

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

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

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

29 **4.8.4 Cumulative Socioeconomic Impacts**

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

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

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

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

14 **4.8.5 Cumulative Impacts on Ground Water Use and Quality**

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

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

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

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

32 **4.8.6 Conclusions Regarding Cumulative Impacts**

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

39 **4.9 Summary of Impacts of Operations during the Renewal** 40 **Term**

Environmental Impacts of Operation

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

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

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

26 4.10 References

27 Abood, K.A., T.L. Englert, S.G. Metzger, C.V. Beckers, Jr., T.J. Groninger, and S. Mallavaram.
28 2006. Current and evolving physical and chemical conditions in the Hudson River Estuary.
29 American Fisheries Society Symposium 51:39-61.

30 Achman, D.R., B.J. Brownawell, and L. Zhang. 1996. Exchange of polychlorinated biphenyls
31 between sediment and water in the Hudson River Estuary. *Estuaries* 19(4):950-965.

32 Atlantic States Marine Fisheries Commission (ASMFC). 2006. "Species Profile: Atlantic
33 Striped Bass, The Challenges of Managing a Restored Stock." Available at URL:
34 <http://www.asmfc.org/speciesDocuments/stripedBass/speciesprofile.pdf>. Accessed December
35 10, 2007.

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

40 Atlantic States Marine Fisheries Commission (ASMFC). 2007b. "Species Profile: Atlantic
41 Sturgeon, Ancient Species' Slow Road to Recovery." Available at URL: [http://www.asmfc.org/](http://www.asmfc.org/speciesDocuments/sturgeon/sturgeonProfile.pdf)
42 [speciesDocuments/sturgeon/sturgeonProfile.pdf](http://www.asmfc.org/speciesDocuments/sturgeon/sturgeonProfile.pdf). Accessed December 6, 2007. ADAMS

- 1 Accession No. ML083360698.
- 2 Atlantic Sturgeon Status Review Team (ASSRT). 2007. "Status Review of Atlantic Sturgeon
3 (*Acipenser oxyrinchus oxyrinchus*)." Report to National Marine Fisheries Service, Northeast
4 Regional Office. February 23, 2007. 174 pp. Available at URL:
5 <http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/atlanticsturgeon2007.pdf>. Accessed December
6 7, 2007.
- 7 Baird, D., and R.E. Ulanowicz. 1989. The seasonal dynamics of the Chesapeake Bay
8 ecosystem. *Ecological Monographs* 59(4):329–364.
- 9 Bain, M.B., N. Haley, D.L. Peterson, K.K. Arend, K.E. Mills, and P.J. Sullivan. 2007. "Recovery
10 of a US Endangered Fish." *PLoS ONE* 2(1): e168. Department of Natural Resources, Cornell
11 University, Ithaca, New York. Available at URL: <http://www.plosone.org/article/info>
12 [percent3Adoi percent2F10.1371 percent2Fjournal.pone.0000168#s3](http://www.plosone.org/article/info). Accessed December 11,
13 2007.
- 14 Barnthouse, L.W., C.C. Coutant, and W. Van Winkle. 2002. "Status and Trends of Hudson
15 River Fish Populations and Communities Since the 1970's: Evaluation of Evidence Concerning
16 Impacts of Cooling Water Withdrawals." January 2002. ADAMS Accession No. ML083360704.
- 17 Barnthouse, L.W., D.G. Heimbuch, W. Van Winkle, and J. Young. 2008. "Entrainment and
18 Impingement at IP2 and IP3: A Biological Impact Assessment." January 2008. ADAMS
19 Accession No. ML080390059.
- 20 Barnthouse, L.W., D.G. Heimbuch, M. Mattson, and J.R. Young. 2009. Review of NRC's
21 Impingement and Entrainment Assessment for IP2 and IP3. (Data from Table A-1). March 16,
22 2009. Enclosure 6 *in* Entergy Nuclear Northeast (Entergy). 2009. Letter from F. Dacimo, Vice
23 President, Entergy Nuclear Northeast, to U.S. Nuclear Regulatory Commission, Chief,
24 Rulemaking, Directives and Editing Branch. Reference NL-09-036. Subject: Comments on
25 NUREG-1437, Draft Supplement 38. March 18, 2009. ADAMS Accession No. ML091040133.
- 26 Brosnan, T.M. and M.L. O'Shea. 1996. Long-term improvements in water quality due to
27 sewage abatement in the lower Hudson River. *Estuaries* 19(4):890–900.
- 28 Central Hudson Gas and Electric Corporation; Consolidated Edison Company New York, Inc.;
29 New York Power Authority; and Southern Energy New York (CHGEC et al.). 1999. "Draft
30 Environmental Impact Statement for State Pollutant Discharge Elimination System Permits for
31 Bowline Point, Indian Point 2 and 3, and Roseton Steam Electric Generating Stations."
32 December 1999. ADAMS Accession No. ML083400128.
- 33 Clean Water Act of 1977 (CWA). 33 U.S.C. 1326 et seq. (common name of the Federal Water
34 Pollution Control Act of 1977).
- 35 Cochran, W.G. 1997. *Sampling Techniques*. John Wiley and Sons, New York, New York. 428
36 pp.
- 37 Collette, B.B., and G. Klein-MacPhee (eds.). 2002. *Bigelow and Schroeder's Fishes of the Gulf
38 Of Maine*. (3rd Ed.) 748 pp. Smithsonian Institution Press, Herndon, Virginia.
- 39 Consolidated Edison Company of New York (Con Edison). 1976a. "IP2 and IP3 Impingement
40 Study Report for the Period 1 January 1975–31 December 1975." Prepared by Texas
41 Instruments, Inc. ADAMS Accession No. ML083360750.

Environmental Impacts of Operation

- 1 Consolidated Edison Company of New York (Con Edison). 1976b. "Predation by Bluefish in the
2 Lower Hudson River." Prepared by Texas Instruments, Inc. ADAMS Accession No. ML
- 3 Consolidated Edison Company of New York (Con Edison). 1977. "Hudson River Ecological
4 Study in the Area of IP2 and IP3 1976 Annual Report." Prepared by Texas Instruments, Inc.
5 ADAMS Accession No. ML08309161.
- 6 Consolidated Edison Company of New York (Con Edison). 1979. "Hudson River Ecological
7 Study in the Area of IP2 and IP3 1977 Annual Report." Prepared by Texas Instruments, Inc.
8 ADAMS Accession No. ML083091068.
- 9 Consolidated Edison Company of New York (Con Edison). 1980. "Hudson River Ecological
10 Study in the Area of IP2 and IP3 1979 Annual Report." Prepared by Texas Instruments, Inc.
11 ADAMS Accession No. ML083360740.
- 12 Consolidated Edison Company of New York (Con Edison). 1984a. "Hudson River Ecological
13 Study in the Area of IP2 and IP3 1981 Annual Report." ADAMS Accession No. ML083091069.
- 14 Consolidated Edison Company of New York (Con Edison). 1984b. "Precision and Accuracy of
15 Stratified Sampling to Estimate Fish Impingement at Indian Point Unit No. 2 and Unit No. 3."
16 Prepared by Normandeau Associates, Inc. ADAMS Accession No. ML083360792.
- 17 Consolidated Edison Company of New York, Inc. (Con Edison). 2007. Letter from J. McAvoy,
18 Vice President, ConEdison, to F. Dacimo, Vice President, Entergy Nuclear Operations. January
19 19, 2007.
- 20 Consolidated Edison Company of New York (Con Edison) and New York Power Authority
21 (NYPA). 1984. "Indian Point Generating Station Entrainment Abundance and Outage
22 Evaluation 1993 Annual Report." Prepared by EA Science and Technology, Inc.
- 23 Consolidated Edison Company of New York (Con Edison) and New York Power Authority
24 (NYPA). 1986. "Hudson River Ecological Study in the Area of IP2 and IP3 1985 Annual
25 Report." Prepared by Normandeau Associates, Inc. ADAMS Accession No. ML083091074.
- 26 Consolidated Edison Company of New York (Con Edison) and New York Power Authority
27 (NYPA). 1987. "Hudson River Ecological Study in the Area of IP2 and IP3 1986 Annual
28 Report." Prepared by Normandeau Associates, Inc. ADAMS Accession No. ML083091087.
- 29 Consolidated Edison Company of New York (Con Edison) and New York Power Authority
30 (NYPA). 1988. "Hudson River Ecological Study in the Area of IP2 and IP3 1987 Annual
31 Report." Prepared by EA Science and Technology. ADAMS Accession No. ML083091084.
- 32 Consolidated Edison Company of New York (Con Edison) and New York Power Authority
33 (NYPA). 1991. "Hudson River Ecological Study in the Area of IP2 and IP3 1990 Annual
34 Report." Prepared by EA Science and Technology. ADAMS Accession No. ML083091086.
- 35 Council on Environmental Quality (CEQ). 1997. "Environmental Justice: Guidance under the
36 National Environmental Policy Act." Executive Office of the President, Washington, DC.
- 37 Daniels, R.A., K.E. Limburg, R.E. Schmidt, D.L. Strayer, and R.C. Chambers. 2005. "Changes
38 in Fish Assemblages in the Tidal Hudson River, New York." American Fisheries Society
39 Symposium 45:471–503. Available at URL: [http://www.ecostudies.org/reprints/
40 daniels_et_al_2005.pdf](http://www.ecostudies.org/reprints/daniels_et_al_2005.pdf). Accessed March 13, 2008.

- 1 Ecological Analyses, Inc. (EA). 1981a. "Indian Point Generating Station Entrainment Survival
2 and Related Studies. 1979 Annual Report." Prepared for Consolidated Edison Company of
3 New York, Inc., and Power Authority of the State of New York. Ecological Analysts, Inc.
4 January 1982. ADAMS Accession No. ML073330733.
- 5 Ecological Analyses, Inc. (EA). 1981b. "1981 Con Edison Automated Abundance Sampling
6 (AUTOSAM) and Laboratory Processing Standard Operating Procedures." Prepared for
7 Consolidated Edison Company of New York, Inc. Ecological Analysts, Inc. May 1981.
8 ADAMS Accession No. ML083100602.
- 9 Ecological Analyses, Inc. (EA). 1982. "Indian Point Generating Station Entrainment Survival
10 and Related Studies. 1980 Annual Report." Prepared for Consolidated Edison Company of
11 New York, Inc., and Power Authority of the State of New York. Ecological Analysts, Inc. April
12 1981. ADAMS Accession No. ML073330737.
- 13 Ecological Analyses, Inc. (EA). 1984. "Indian Point Generating Station Entrainment Abundance
14 and Outage Evaluation, 1983 Annual Report." Prepared for Consolidated Edison Company of
15 New York, Inc., and Power Authority of the State of New York. EA Engineering, Science, and
16 Technology, Inc. September 1984. ADAMS Accession No. ML083101084.
- 17 Ecological Analyses, Inc. (EA). 1985. "Indian Point Generating Station Entrainment Abundance
18 and Outage Evaluation, 1983 Annual Report." Prepared for Consolidated Edison Company of
19 New York, Inc., and Power Authority of the State of New York. EA Science and Technology.
20 July 1985. ADAMS Accession No. ML083101091.
- 21 Ecological Analyses, Inc. (EA). 1989. "Indian Point Generating Station 1988 Entrainment
22 Survival Study." Prepared for Consolidated Edison Company of New York, Inc., and Power
23 Authority of the State of New York. EA Engineering, Science, and Technology, Northeast
24 Regional Operations, Report No. 10648.03. August 1989. ADAMS Accession No.
25 ML083101103.
- 26 Enercon Services Inc. (Enercon). 2007. "Phase 1A Literature Review and Archaeological
27 Sensitivity Assessment of the Indian Point Site, Westchester County, New York." Enercon
28 Services Inc., Tulsa, Oklahoma. March 2007.
- 29 Enercon. 2008. "Enercon Study ELEC-IP-08001 for IP2 and IP3 License Renewal Project 345
30 kV Transmission Line-Induced Shock Study." April 11, 2008. Prepared for Entergy Nuclear
31 Operations, Inc.
- 32 Entergy Nuclear Northeast (ENN). 2007. "Indian Point Nuclear Power Plants Units 1, 2, and 3,
33 Annual Radiological Environmental Operating Report for 2006." Buchanan, New York. May
34 2007.
- 35 Entergy Nuclear Operations Inc. (Entergy). 2003. "Indian Point Nuclear Plant Units No. 1, 2,
36 and 3—Annual Radiological Environmental Operating Report for 2002." Docket Numbers 50-3,
37 50-247, and 50-286. Buchanan, New York. Agencywide Documents Access and Management
38 System (ADAMS) Accession No. ML031220085.
- 39 Entergy Nuclear Operations Inc. (Entergy). 2004. "Indian Point Nuclear Power Plants Units 1,
40 2, and 3—Annual Radiological Environmental Operating Report for 2003." Docket Numbers 50-
41 3, 50-247, and 50-286. Buchanan, New York. ADAMS Accession No. ML041340492.

42

Environmental Impacts of Operation

- 1 Entergy Nuclear Operations Inc. (Entergy). 2005. "Indian Point Units 1, 2, and 3—2004
2 Annual Radiological Environmental Operating Report." Docket Numbers 50-3, 50-247, and 50
3 286. Buchanan, New York. ADAMS Accession No. ML051220210.
- 4 Entergy Nuclear Operations Inc. (Entergy). 2006. "Indian Point, Units 1, 2 and 3—Annual
5 Radiological Environmental Operating Report for 2005." Docket Numbers 50-3, 50-247, and 50
6 286. Buchanan, New York. ADAMS Accession No. ML061290085.
- 7 Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Applicant's Environment Report,
8 Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License
9 Renewal Application). April 23, 2007. ADAMS Accession No. ML 071210530.
- 10 Entergy Nuclear Operations Inc. (Entergy). 2007b. "IP2 and IP3, Units 1, 2, and 3—Annual
11 Radiological Environmental Operating Report for 2006." Docket Numbers 50-3, 50-247, and 50
12 286. Buchanan, New York. ADAMS Accession No. ML071420088.
- 13 | Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from F.R. Dacimo, Vice President,
14 Entergy Nuclear Operations, Inc. to Document Control Desk, U.S. Nuclear Regulatory
15 Commission. Subject: Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit
16 Nos. 2 & 3; Docket Nos. 50-247 and 50-286; Supplement to License Renewal Application (LRA)
17 – Environmental Report References. ADAMS Nos. ML080080205, ML0800080209,
18 ML080080214, ML0800802161, ML0800080291, ML080080298, ML080080306, and
19 ML080080313.
- 20 | Entergy Nuclear Operations, Inc. (Entergy). 2008a. Letter from F. Dacimo, Vice President,
21 Entergy Nuclear Operations, to U.S. Nuclear Regulatory Commission Document Control Desk.
22 Subject: Reply to Document Request for Additional Information Regarding Site Audit Review of
23 License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2 and 3. April 23,
24 2008. ADAMS Accession No. ML081230243.
- 25 | Entergy Nuclear Operations, Inc. (Entergy). 2008b. Letter from F. Dacimo, Vice President,
26 License Renewal, to U.S. Nuclear Regulatory Commission Document Control Desk. Subject:
27 Reply to Document Request for Additional Information Regarding License Renewal
28 Application—Refurbishment. May 14, 2008. ADAMS Accession No. ML081440052.
- 29 | Entergy Nuclear Northeast (Entergy). 2009a. Letter from F. Dacimo, Vice President, Entergy
30 Nuclear Northeast, to U.S. Nuclear Regulatory Commission Document Control Desk.
31 Reference NL-09-160. Subject: Request for Additional Information Related to License Renewal
32 Indian Point Nuclear Application Environmental Report - Impingement Data Indian Point Nuclear
33 Generating Unit Nos. 2 & 3 Docket Nos. 50-247 and 50-286 License Nos. DPR-26 and DPR-64.
34 November 24, 2009. ADAMS Accession No. ML093420528.
- 35 Entergy Nuclear Northeast (Entergy). 2009b. "Documents Related to License Renewal
36 Application – Environmental Report. Indian Point Nuclear Generating Unit Nos. 2 & 3. Docket
37 Nos. 50-247 and 50-286. License Nos. DPR-26 and DPR-64." December 17, 2009. Buchanan,
38 NY. ADAMS No. ML100290495 (cover letter only; report withheld to protect sensitive
39 archaeological data).
- 40 Entergy Nuclear Northeast (Entergy). 2010. "Detailed Responses to the New York State
41 Department of Environmental Conservation's (the Department) Request for Information, dated
42 May 13, 2009 (the "RFI"), Exhibit K: Thermal Compliance Report." February 10, 2010.
43 Available URL: http://www.dec.ny.gov/docs/permits_ei_operations_pdf/elecbsdrexhi-k.pdf.

- 1 Environmental Protection Agency (EPA). 1998. Guidelines for Ecological Risk Assessment.
2 EPA/630/R-95/002F. Risk Assessment Forum, Washington, D.C. Available at URL:
3 <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12460>. Accessed December 12, 2008.
- 4 Environmental Protection Agency (EPA). 2004. "Total Maximum Daily Loads, Listed Water
5 Information, Cycle: 2004. Hudson River, Lower Hudson River." U.S. Environmental Protection
6 Agency. Available at URL: [http://oaspub.epa.gov/tmdl/enviro.control?p_list_id=NY-1301-
7 0002andp_cycle=2004](http://oaspub.epa.gov/tmdl/enviro.control?p_list_id=NY-1301-0002andp_cycle=2004). Accessed February 23, 2008.
- 8 Environmental Protection Agency (EPA). 2008a. "Phase II—Large Existing Electric Generating
9 Plant. Proposed Rule, Technical Development Document." Available at URL:
10 <http://www.epa.gov/waterscience/316b/phase2/devdoc/>. Accessed April 10, 2008.
- 11 Environmental Protection Agency (EPA). 2008b. "Hudson River PCB Superfund Site, Dredge
12 Area 2 Delineation Fact Sheet, 2008." Available at URL: [http://www.epa.gov/
13 hudson/factsheet_2nd_phaselow.pdf](http://www.epa.gov/hudson/factsheet_2nd_phaselow.pdf). Accessed February 4, 2008. ADAMS Accession No.
14 ML083360712.
- 15 Endangered Species Act of 1973 (ESA). 16 U.S.C 1531, et seq.
- 16 Fish and Wildlife Service (FWS). 2007. Letter from R.A. Niver, Endangered Species Biologist,
17 to Rani Franovich, Branch Chief, Projects Branch 2, Division of License Renewal, Office of
18 Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC.
19 Response to letter from the U.S. Nuclear Regulatory Commission requesting information on
20 Federally listed, proposed, and candidate species and critical habitat in the vicinity of Indian
21 Point Nuclear Generating Unit Nos. 2 and 3. August 29, 2007. ADAMS Accession No.
22 ML0732307840.
- 23 Fletcher, R.I. 1990. Flow dynamics and fish recovery experiments: Water intake systems. |
24 Transactions of the American Fisheries Society. 119:393–415.
- 25 Frank, K.T., B. Petrie, and N.L. Shackell. 2007. The ups and downs of trophic control in
26 continental shelf ecosystems. Trends in Ecology and Evolution 22(5):236–242.
- 27 Greenwood, M.F.D. 2008. Trawls and cooling-water intakes as estuarine fish sampling tools:
28 Comparisons of catch composition, trends in relative abundance, and length selectivity.
29 Estuarine, Coastal and Shelf Science 76:121–130.
- 30 Gilbert, C.R. 1989. "Species Profiles: Life Histories and Environmental Requirements of
31 Coastal Fishes and Invertebrates (Mid-Atlantic Bight)—Atlantic and Shortnose Sturgeons." U.S.
32 Fish and Wildlife Service Biological Report 82 (11.122). U.S. Army Corps of Engineers TR EL-
33 82-4. 28 pp.
- 34 Haas-Castro, R. 2006. "Status of Fishery Resources off the Northeastern U.S.: River Herring." |
35 Northeast Fisheries Science Center Resource Evaluation and Assessment Division, National
36 Oceanic and Atmospheric Administration. Accessed at
37 http://www.nefsc.noaa.gov/sos/spsyn/af/herring/archives/38_RiverHerring_2006.pdf on
38 December 17, 2007. ADAMS Accession No. ML083390029.
- 39 Institute of Electrical and Electric Engineers (IEEE). 1997. "National Electric Safety Code."
40 New York.

Environmental Impacts of Operation

- 1 | Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005. "Spottail
2 | Shiner." In: *Fishes of the Middle Savannah River Basin*. Athens, GA: University of Georgia
3 | Press, pp. 153–156.
- 4 | Maryland Department of Natural Resources, Fisheries Service, Chesapeake Finfish Program
5 | (MDNR). February 2005. 2004 Stock Assessment of Selected Resident and Migratory
6 | Recreational Finfish Species within Maryland's Chesapeake Bay. Accessed at
7 | <http://dnr.maryland.gov/fisheries/management/tidalmng.html> (under the link for White Perch) on
8 | February 4, 2010.
- 9 | Mayhew, D.A., L.D. Jensen, D.F. Hanson, and P.H. Muessig. 2000. A comparative review of
10 | entrainment survival studies at power plants in estuarine environments. *Environmental Science*
11 | *and Policy* 3:295–301.
- 12 | Menzie, C., M.H. Henning, J. Cura, K. Finkelstein, J. Gentile, J. Maughan, D. Mitchell, S.
13 | Petron, B. Potocki, S. Svirsky, and P. Tyler. 1996. Report of the Massachusetts Weight-of-
14 | Evidence Workgroup: A weight-of-evidence approach for evaluating ecological risks. *Human*
15 | *and Ecological Risk Assessment* 2:277–304.
- 16 | Munch, S.B., and D.O. Conover. 2000. Recruitment dynamics of bluefish (*Pomatomus*
17 | *saltatrix*) from Cape Hatteras to Cape Cod, 1973–1995. *ICES Journal of Marine Sciences*
18 | 57(2):393–402.
- 19 | National Environmental Policy Act of 1969 (NEPA). 42 U.S.C. 4321 et seq.
- 20 | National Institute of Environmental Health Sciences (NIEHS). 1999. "NIEHS Report on Health
21 | Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields." NIH Publication
22 | No. 99-4493, Research Triangle Park, North Carolina.
- 23 | National Marine Fisheries Service (NMFS). 1998. "Recovery Plan for the Shortnose Sturgeon
24 | (*Acipenser brevirostrum*)." Prepared by the Shortnose Sturgeon Recovery Team for the
25 | National Marine Fisheries Service, Silver Spring, Maryland. 104 pp. Available at URL:
26 | http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_shortnose.pdf. Accessed December 11,
27 | 2007.
- 28 | National Marine Fisheries Service (NMFS). 2007a. Letter from M. Colligan, Assistant Regional
29 | Administrator for Protected Resources, to Chief, Rules and Directives Branch, Division of
30 | Administrative Services, U.S. Nuclear Regulatory Commission, Washington, DC. Response to
31 | letter of August 10, 2007, from the U.S. Nuclear Regulatory Commission requesting information
32 | on Federally listed, proposed, and candidate species, critical habitat, and designated essential
33 | fish habitat in the vicinity of Indian Point Nuclear Generating Unit Nos. 2 and 3. October 4,
34 | 2007. ADAMS Accession No. ML073230796.
- 35 | National Marine Fisheries Service (NMFS). 2007b. "Species of Concern: Atlantic Sturgeon,
36 | *Acipenser oxyrinchus*." Available at URL: http://www.nmfs.noaa.gov/pr/pdfs/species/atlanticsturgeon_detailed.pdf. Accessed December 6, 2007.
- 38 | New York Natural Heritage Program (NYNHP). 2008a. "Online Conservation Guide for *Myotis*
39 | *sodalis*." Available at URL: <http://www.acris.nynhp.org/guide.php?id=7405>. Accessed March
40 | 21, 2008. ADAMS Accession No. ML083390018.

41 |

- 1 New York Natural Heritage Program (NYNHP). 2008b. "Online Conservation Guide for
 2 *Sylvilagus transitionalis*." Available at URL: <http://www.acris.nynhp.org/guide.php?id=7415>.
 3 Accessed March 21, 2008. ADAMS Accession No. ML083390017.
- 4 New York Power Authority. 1986. "Size Selectivity and Relative Catch Efficiency of a 3-m
 5 Beam Trawl and a 1-m² Epibenthic Sled for Sampling Young of the Year Striped Bass and
 6 Other Fishes in The Hudson River Estuary." Prepared by Normandeau Associates, Inc.
 7 January 1986. (HR Library #7180). ADAMS Accession No. ML083360641.
- 8 New York State Department of Environmental Conservation (NYSDEC). 1997. NRDC vs.
 9 NYSDEC, et al. Fourth Amended Consent Order. Letter from Keith Silliman on April 23, 1997.
 10 New York State Department of Environmental Conservation, Office of General Counsel.
- 11 New York State Department of Environmental Conservation (NYSDEC). 2003a. "Final
 12 Environmental Impact Statement Concerning the Applications to Renew New York State
 13 Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2, Bowline 1
 14 and 2, and Indian Point 2 and 3 Steam Electric Generating Stations, Orange, Rockland and
 15 Westchester Counties. Hudson River Power Plants FEIS." June 25, 2003. ADAMS Accession
 16 No. ML083360752.
- 17 New York State Department of Environmental Conservation (NYSDEC). 2003b. Fact Sheet.
 18 "New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal with
 19 Modification, IP2 and IP3 Electric Generating Station, Buchanan, NY." November 2003.
 20 Available at URL: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf.
 21 Accessed July 12, 2007. ADAMS Accession No. ML083360743.
- 22 New York State Department of Environmental Conservation (NYSDEC). 2007. State of New
 23 York Petition submitted to the U.S. Nuclear Regulatory Commission, November 30, 2007, on
 24 the Application of Entergy Nuclear Operations, Inc., for the 20-year Relicensing of Indian Point
 25 Nuclear Power Plants 1 and 2, Buchanan, New York. Summary of Some of the Key
 26 Contentions. Available at URL: <http://www.dec.ny.gov/permits/40237.html>. Accessed March
 27 18, 2008. ADAMS Accession No. ML083360757.
- 28 New York State Department of Environmental Conservation (NYSDEC). 2008a. "List of
 29 Endangered, Threatened and Special Concern Fish and Wildlife Species of New York."
 30 Available at URL: <http://www.dec.ny.gov/animals/7494.html>. Accessed May 3, 2008. ADAMS
 31 Accession No. ML083380558.
- 32 New York State Department of Environmental Conservation (NYSDEC). 2008b. "New York
 33 State Amphibian and Reptile Atlas Project." Available at URL: [http://www.dec.ny.gov/
 34 animals/7479.html?showprintstyles](http://www.dec.ny.gov/animals/7479.html?showprintstyles). Accessed March 13, 2008.
- 35 New York State Department of Environmental Conservation (NYSDEC). 2010. Letter from
 36 William R. Adriance, Chief Permit Administrator, to Dara F. Gray, Entergy Nuclear Operations,
 37 Inc. "Joint Application for CWA § 401 Water Quality Certification, NRC License Renewal –
 38 Entergy Nuclear Indian Point Units 2 and 3, DEC Nos.: 3-5522-00011/00030 (IP2) and 3-5522-
 39 00105/00031 (IP3), *Notice of Denial*." April 2, 2010. Albany, NY. Available URL:
 40 http://www.dec.ny.gov/docs/permits_ej_operations_pdf/ipdenial4210.pdf.
- 41 New York State Department of Environmental Conservation (NYSDEC) and New York State
 42 Department of Health (NYSDOH). 2008. "Groundwater Investigation." Albany, New York.
 43 Available at URL: <http://www.dec.ny.gov/permits/44014.html>.

Environmental Impacts of Operation

- 1 Normandeu Associates (Normandeu). 1987a. Prepared for Consolidated Edison Company of
2 New York, Inc., and New York Power Authority. Prepared by Normandeu Associates, Inc.
3 Report R-332-1062. April 1987. ADAMS Accession No. ML0803091074.
- 4 Normandeu Associates (Normandeu). 1987b. "Indian Point Generating Station Entrainment
5 Abundance Program, 1986 Annual Report." Prepared for Consolidated Edison Company of
6 New York, Inc., and New York Power Authority. Prepared by Normandeu Associates, Inc.
7 Report R 220. June 1987. ADAMS Accession No. ML083091087.
- 8 Normandeu Associates (Normandeu). 1988. "IP2 and IP3 Generating Station Entrainment
9 Abundance Program, 1987 Annual Report." Prepared for Consolidated Edison Company of
10 New York, Inc., and New York Power Authority. Prepared by Normandeu Associates, Inc.
11 Report R 1110. May 1988. ADAMS Accession No. ML083360798.
- 12 Northeast Fisheries Science Center (NEFSC). 2005. 41st Northeast Regional Stock
13 Assessment Workshop (41st SAW): 41st SAW Assessment Report. Northeast Fisheries
14 Science Center Reference Document 05-14.
- 15 Nuclear Regulatory Commission (NRC). 1975. "Final Environmental Statement Related to the
16 Operation of IP2 and IP3 Nuclear Generating Plant Unit No. 3, Consolidated Edison Company
17 of New York, Inc." NUREG-75/002.
- 18 Nuclear Regulatory Commission (NRC). 1996. "Generic Environmental Impact Statement for
19 License Renewal of Nuclear Power Plants." NUREG-1437, Volumes 1 and 2, Washington, DC.
- 20 Nuclear Regulatory Commission (NRC). 1999. "Generic Environmental Impact Statement for
21 License Renewal of Nuclear Plants Main Report," Section 6.3, "Transportation," Table 9.1,
22 "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants."
23 NUREG-1437, Volume 1, Addendum 1, Washington, DC
- 24 Nuclear Regulatory Commission (NRC). 2005. "Generic Environmental Impact Statement for
25 License Renewal of Nuclear Plants, Supplement 22 Regarding Millstone Power Station, Units 2
26 and 3, Final Report." NUREG-1437. Office of Nuclear Reactor Regulation. Washington, D.C.
- 27 Nuclear Regulatory Commission (NRC). 2006a. NUREG-1437, Supplement 20, "Generic
28 Environmental Impact Statement for License Renewal of Nuclear Plants Regarding Donald C.
29 Cook Nuclear Plant, Units No. 1 and 2," Washington, DC.
- 30 Nuclear Regulatory Commission (NRC). 2006b. "Indian Point Nuclear Generating Unit 2—NRC
31 Special Inspection Report No. 05000247/2005011." Docket Number 50-247. Washington, DC.
32 ADAMS Accession No. ML060750842.
- 33 Nuclear Regulatory Commission (NRC). 2007a. Letter from R. Franovich to Mr. Peter Colosi,
34 National Marine Fisheries Service, Gloucester, Massachusetts. Re: Request for List of
35 Protected Species and Essential Fish Habitat within the Area under Evaluation for the IP2 and
36 IP3 Nuclear Generating Unit Nos. 2 and 3 License Renewal Application Review. August 16,
37 2007. ADAMS Accession No. ML072130388.
- 38 Nuclear Regulatory Commission (NRC). 2007b. "Indian Point Nuclear Generating Unit 2—
39 Routine Integrated Inspection Report No. 05000247/07003." Docket Number 50-247.
40 Washington, DC. ADAMS Accession No. ML072150161.

41 |

1 Pew Oceans Commission. 2003. America’s Living Oceans: Charting a Course for Sea
 2 Change. Pew Oceans Commission, Arlington, VA. Available at <http://www.pewoceans.org>.

3 Raffenberg, M.J., J.A. Matousek, W.D. Saksen, A.J. McCusker, and E.W. Radle. 2008.
 4 “Development of Filter Fabric Barrier to Reduce Aquatic Impacts at Water Intake Structures.”
 5 Available at URL: <http://www.epa.gov/waterscience/presentations/raffenberg.pdf>. Accessed
 6 April 9, 2008.

7 Riverkeeper. 2007. Re: Acceptance Review for Entergy Nuclear IP2 and IP3 License Renewal
 8 Application. Letter to Mr. Bo Pham, Environmental Project Manager, Division of License
 9 Renewal, on June 4, 2007, from Phillip Musegaas, Riverkeeper Staff Attorney.

10 Secor, D.H. and E.D. Houde. 1995. Temperature effects on the timing of striped bass egg
 11 production, larval viability, and recruitment potential in the Patuxent River (Chesapeake Bay).
 12 *Estuaries* 18:527–533.

13 Shepherd G. 2006. ‘Atlantic Striped Bass.’ December 2006. Accessed at:
 14 http://www.nefsc.noaa.gov/sos/spsyn/af/sbass/archives/40_StripedBass_2006.pdf on December
 15 10, 2007. ADAMS Accession No. ML083360766.

16 Shepherd, G. 2006. “Bluefish.” Available at URL: http://www.nefsc.noaa.gov/sos/spsyn/op/bluefish/archives/25_Bluefish_2006.pdf. Accessed October 2, 2008. ADAMS
 17 Accession No. ML083360690.

19 Smith, C.L. 1985. “Spottail Shiner.” In: *The Inland Fishes of New York State*, pp. 194–195.
 20 New York State Department of Environmental Conservation, Albany, NY.

21 Snedecor, G.W. and W.G. Cochran. 1980. *Statistical Methods*. The Iowa State University
 22 Press, Ames, Iowa, 507 pp.

23 Steinberg, N., D.J. Suszkowski, L. Clark, and J. Way. 2004. “Health of the Harbor: The First
 24 Comprehensive Look at the State of the NY.NY Harbor Estuary. A Report to the New York/New
 25 Jersey Harbor Estuary Program.” Hudson River Foundation. New York, New York. ADAMS
 26 Accession No. ML083360712.

27 Strayer, D.L., K.A. Hattala, and A.W. Kahnle. 2004. Effects of an invasive bivalve (*Dreissena*
 28 *polymorpha*) on fish in the Hudson River Estuary. *Canadian Journal of Fisheries and Aquatic*
 29 *Sciences* 61:924–941.

30 Sweka, J.A., J. Mohler, M.J. Millard, T. Kehler, A. Kahnle, K. Hattala, G. Kenney, and A. Higgs.
 31 2007. Juvenile Atlantic sturgeon habitat use in Newburgh and Haverstraw Bays of the Hudson
 32 River: Implications for population monitoring. *North American Journal of Fisheries*
 33 *Management* 27:1058–1067.

34 Ulanowicz, R.E. 1995. “Trophic Flow Networks as Indicators of Ecosystem Stress.” In G.A.
 35 Polis and K.O. Winemiller (eds). *Food Webs: Integration of Patterns and Dynamics*, Chapman
 36 and Hall, New York. pp. 358–368.

37 U.S. Atomic Energy Commission (USAEC). 1972. “Final Environmental Statement Related to
 38 the Operation of Indian Point Nuclear Generating Plant No. 2.” Docket No. 50-247. United
 39 States Atomic Energy Commission, Directorate of Licensing. September 1972.

40

Environmental Impacts of Operation

- 1 U.S. Census Bureau (USCB). 2003. "LandView 6—Census 2000 Profile of General
- 2 Demographic Characteristics DP-1 (100 percent) and Census Profile of Selected Economic
- 3 Characteristics DP-3, Summary of Census Block Groups in a 50-Mile Radius around the IP2
- 4 and IP3 Energy Center (41.269722 Lat., -73.952083 Long.)." December 2003.
- 5 U.S. Census Bureau (USCB). 2008. "American FactFinder, Census 2000 Information and
- 6 State and County QuickFacts on Dutchess, Orange, Putnam, and Westchester Counties."
- 7 Available at URL: <http://factfinder.census.gov> and <http://quickfacts.census.gov>. Accessed April
- 8 2008.
- 9 Wolfe, D.A., E.R. Long, and G.B. Thursby. 1996. Sediment toxicity in the Hudson-Raritan
- 10 Estuary: Distribution and correlations with chemical contamination. *Estuaries* 19(4):901–912.
- 11 | Woodland, R.J. and D.H. Secor. 2007. Year-class strength and recovery of endangered
- 12 | shortnose sturgeon in the Hudson River, New York. *Transactions of the American Fisheries*
- 13 | *Society* 136:72–81.

5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

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

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

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

5.1 Postulated Plant Accidents

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

5.1.1 Design-Basis Accidents

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

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

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

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

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

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

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

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

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

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

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

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

5.1.2 Severe Accidents

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

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

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

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

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

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

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

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

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

5.2 Severe Accident Mitigation Alternatives

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

5.2.1 Introduction

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

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

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

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

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

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

5.2.2 Estimate of Risk

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

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

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

Initiating Event	IP2		IP3	
	CDF (Per Year)	% Contribution to CDF	CDF (Per Year)	% Contribution to CDF
Loss of offsite power ¹	6.7x10 ⁻⁶	38	1.2x10 ⁻⁷	1
Internal flooding	4.7x10 ⁻⁶	26	2.2x10 ⁻⁶	20
Loss-of-coolant accident (LOCA)	1.5x10 ⁻⁶	8	2.2x10 ⁻⁶	19
Transients ¹	1.2x10 ⁻⁶	7	8.5x10 ⁻⁷	7
Anticipated transient without scram	9.9x10 ⁻⁷	6	1.5x10 ⁻⁶	13
Station blackout	8.5x10 ⁻⁷	5	7.2x10 ⁻⁷	6
Steam generator tube rupture	7.2x10 ⁻⁷	4	1.6x10 ⁻⁶	14
Loss of component cooling water	5.8x10 ⁻⁷	3	1.1x10 ⁻⁷	<1
Loss of nonessential service water	3.0x10 ⁻⁷	2	2.8x10 ⁻⁷	2
Interfacing systems LOCA	1.5x10 ⁻⁷	<1	1.5x10 ⁻⁷	1
Reactor vessel rupture	1.0x10 ⁻⁷	<1	1.0x10 ⁻⁷	<1
Loss of 125 volts direct current power	5.8x10 ⁻⁸	<1	1.0x10 ⁻⁶	9
Total loss of service water system	4.4x10 ⁻⁸	<1	5.4x10 ⁻⁷	5
Loss of essential service water	1.9x10 ⁻¹⁰	<1	1.8x10 ⁻⁸	<1
Total CDF (internal events)	1.79x10⁻⁵	100	1.15x10⁻⁵	100

¹Contributions 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

¹One 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.